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Active Ageing and Healthy Living

A Human Centered Approach in Research and Innovation as Source of Quality of Life

Editors: Giuseppe Riva
Paolo Ajmone Marsan
Claudio Grassi

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ACTIVE AGEING AND HEALTHY LIVING

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as Source of Quality of Life

Edited by

Giuseppe Riva

Università Cattolica del Sacro Cuore, Milano, Italy

Paolo Ajmone Marsan

Università Cattolica del Sacro Cuore, Piacenza, Italy

and

Claudio Grassi

Università Cattolica del Sacro Cuore, Roma, Italy

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G. Riva et al. (Eds.)

PREFACE

The book *Active Ageing and Healthy Living: A human centered approach in research and innovation as a source of quality of life* fulfils, above all, a twofold purpose.

First, setting out in systematic manner the results of some among the numerous research projects that the Università Cattolica del Sacro Cuore of Milan has launched and supported in recent years, also with autonomous financing – fact that is not common within the national scenario. All these projects deal with topics which are considered strategic for the Università Cattolica del Sacro Cuore and are carried out in an interdisciplinary perspective.

Second, proposing visions matured on the basis of research developed thus far and that constitute fruitful experiences on which the Università Cattolica del Sacro Cuore will centre its research in the near future.

In this sense, aside from its specific contents, the book intends to be a significant demonstration of the Università Cattolica del Sacro Cuore's commitment to interpret in original and proactive way its nature as a 'research university'; a commitment which, besides relying on a solid basis of non-material and material resources for research activity, consists in pursuit of essential values and methodologies which find a first and fundamental starting point in the high scientific profile of research projects and their participants.

On these basis, a close attention to the social and human relevance of the topics on the research agenda, the conduct of multidisciplinary research (in response to the multidimensional complexity of the problems brought to the attention of scientific research) and, finally, a propensity to network with 'social worlds' (politics, industry, third sector, public opinion) engaged in the co-management of the research results, are integrated.

The topic of active ageing and quality of life (*Active Ageing and Healthy Living – AA&HL*) concerns people development, as both individuals and group members, and, for this reason interlaces and crosses a plurality of disciplinary fields; thus, this topic lends itself well to verification of the Università Cattolica del Sacro Cuore's scientific positioning in recent years as concerning its various and rich expressions and commitment in the social and human science, life science and mathematical and physical sciences: disciplines that are featured by heterogeneous knowledge and methods which are called to join a shared research field.

Moreover, this is a topic central to the mainstream of European research, that is leading the construction of its scientific agenda. Consider, for instance, the close attention paid to the AA&HL topic within the Horizon 2020 research programme, as well as the emergence of the *Knowledge Innovation Communities* (KIC) now organizing themselves around this topic whose implications on anthropological and cultural levels are now crucial and more and more relevant for the next future.

The Università Cattolica del Sacro Cuore, deeply involved and active in the main academic European scenarios, thus equipped itself in the aim to contribute to the collection and analysis of scientifically validated data which may be useful for the management of the future scenarios.

Moreover, the Università Cattolica del Sacro Cuore aims at further improving its capacity to generate proposals that may concurrently contribute to the scientific knowledge advancement and be useful to orient policy and institutional decision makers. To conclude, the aim of increasing the quantity and quality of life by fostering people's active engagement in healthcare practices constitutes a 'value choice' at both the scientific and social levels; a choice long taken by the Università Cattolica del Sacro Cuore and which today is confirmed for the future.

Franco Anelli

Rector of the
"Università Cattolica del Sacro Cuore"
(http://www.ucscinternational.it/)

INTRODUCTION

Active Ageing and Healthy Living (henceforth AA&HL) deals with a growing and ever more challenging issue at the social and scientific levels for all the Western countries, and especially for Europe.

At the social level, increased life expectancy and the ageing of the population have for some time enjoined the rethinking and updating of the healthcare agenda. New issues arise and must be addressed, together with ones already explored but which require further investigation: the increase in the quantity of life prompts closer attention to the quality of life; health expands its horizons to encompass the prevention of risk and the enhancement of well-being; medical action (centred on disease) seeks new synergies with social action (centred on changes to unhealthy lifestyles and dietary habits, the expansion of networks and social communication to promote health, the transfer of knowledge/skills/empowerment to the population); policy-makers must consider – besides their traditional interlocutors – an array of stakeholders of increasing complexity (in politics, industry, the third sector, and public opinion); health interventions are required to be not only effective but also sustainable (in economic, human and social terms).

Against this background – which grows increasingly clear and requires urgent responses – commitment to AA&HL is a significant and promising choice. The project is (apparently!) simple in its essential aims: to improve the quantity and quality of life through the direct engagement of people as co-authors of their own health and through a virtuous interweaving among the resources made available by medicine and society. The working hypothesis appears feasible and potentially able to 'square the circle' between ends and means, as well as between personal aspirations and systemic constraints in regard to health.

Obviously, the hypotheses must be primarily verified at scientific level by means of basic and applied research. To be observed at this level is a non-coincidental flourishing of interest in Europe – of which the Horizon 2020 research programme is perhaps the most evident sign, even if not the only one (see, for instance, the *European Innovation Partnership on Active and Healthy Ageing* initiative, the *Joint Programming Initiatives*, and so forth).

Moreover, science's concern with AA&HL is certainly not a novelty, and numerous research strands (well documented also in this book) have an appreciable history behind them. However, what today emerges as the new challenge for science is reconfiguration of the context in which research should be conducted; a reconfiguration that – without detracting from the traditional and physiological specialist orientation of individual disciplines – prompts their repositioning within a more composite framework with multi-disciplinary and meta-disciplinary features.

The broadness of the AA&HL topic is such that only a multi-disciplinary approach can investigate its manifold aspects without lapsing into useless and harmful reductionism. Incidentally, there is insufficient acknowledgement of the fact that the results of scientific research depend on how the field of observation is defined – and therefore more on what is excluded than what is considered! Combining the relevant points of

view and establishing a virtuous 'conversation' among them is therefore a precondition for addressing the AA&HL issue in an 'ecological' manner.

On the other hand, the high social expectations placed in applied science (see above) require that research should be able to establish both internal linkages (in the multi-disciplinary sense) and also ones with the outside (in the meta-disciplinary sense); that is, a linkage between the production of scientific knowledge and its application in the social domain.

Guiding the encounter between science and its applications is an increasingly crucial task: a major challenge for the *Knowledge Innovation Communities* (KIC) is arising around the theme of AA&HL. Here research is required to converse with other domains: the socio-political system, the technological-industrial system, the welfare system, private-social networks, the so-called citizen-consumer, the world of communications and education. Overall, it is evident that the efficacy of scientific research will depend to a large extent on its capacity to converse with the other components of the system and to accomplish the fertile transfer of its knowledge.

The book that we introduce here remains faithful to this line of inquiry and also represents a tangible result of it. Indeed, AA&HL can be seen as a balance – retrospective and prospective – drawn up on a research area that the Università Cattolica del Sacro Cuore has for some time decided to support proactively.

The first part of the book ("Vision") proposes research directions deemed particularly promising and on which the Università Cattolica focuses its interests. These projects concern these lines of inquiry: scenario-building in regard to demographic changes in Europe and the redesign of public health policies; exploration of new synergies between AA&HL and nutritional science, positive technology, social and intergenerational networks, financial-insurance services, and new ways to thematize elderly patients and their involvement in care practices (see in this regard the themes of frailty and patient engagement).

The second part of the book ("Work in progress") describes recent developments in the investigation of AA&HL. These are multi-disciplinary contributions intended to favour the development of knowledge and applications in the most significant areas of inquiry: lifestyles and nutrition; the psychogeriatric approach and enhancing the abilities of the elderly; reconfiguration of the work career; and the role of ICT in redesign of the everyday lives of the elderly.

We leave to the reader the task (and – we hope – the pleasure) of exploring in the following chapters the topics only outlined here. We also leave to the reader the task of evaluating the book's contents. This, however, does not prevent us from thanking all the researchers involved in producing its contents, and particularly the editors of the book for their work.

The Università Cattolica will continue its research commitment to these topics in the years to come, adopting an approach centred on participative cooperation with all agencies interested in developing research and action in the AA&HL area.

A. Claudio Bosio

Delegate from the "Università Cattolica del Sacro Cuore" for the LIFEKIC project (http://www.lifekic.eu)

Lorenzo Morelli

Coordinator of the "Strategies of Research" Committee of the "Università Cattolica del Sacro Cuore"

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Health of the Elderlies and Healthy Ageing: A Challenge for Europe

Walter RICCIARDI [a1], Maria Lucia SPECCHIA [a], Marta MARINO [a]
[a] *Department of Public Health – Section of Hygiene, Università Cattolica del Sacro Cuore, Rome, Italy*

Abstract. Population ageing is a major challenge for European Union (EU) society and economy, particularly for Italy, which is the oldest country in Europe. According to the World Health Organization, two-thirds of European citizens who have reached the retirement age suffer from at least two chronic conditions, with a strong pressure on healthcare systems. Moreover, EU countries already spend, on average, more than a quarter of their gross domestic product on social protection, above all pensions, health and long term care. The current financial crisis is putting a strain on this system. In this context, it becomes increasingly necessary to promote a healthy and independent ageing, by improving outcomes for patients and society while ensuring health systems sustainability. To this purpose a proactive approach to chronic diseases prevention (primary, secondary and tertiary) as well as an integrated healthcare approach and also patients' empowerment are required so as to make daily life more age-friendly. It is also necessary to share health and social best practices, adopt policies really effective against elderly social exclusion and strengthen older people participation in society. A joint effort of all key stakeholders is needed to create a society in which older people can play an active role.

Keywords. Active Ageing, Healthy Living, Health 2020, Chronic Diseases, Prevention, Università Cattolica del Sacro Cuore

1. Worldwide strategies and organization's point of view

1.1. The World Health Organization

According to the World Health Organization (WHO) [1], beside a privilege and a goal, getting old is also a challenge of the modern age, having an impact on all aspects of the 21st century society. The health of the elderly and healthy ageing are then, or rather should be, a priority for our health care system, characterized by the presence of several instruments in the field of preventive, diagnostic, therapeutic and rehabilitative care, to avoid or "relieve" the onset and/or worsening the course of many of the major chronic degenerative diseases.

In 2012 the WHO Regional Office for Europe approved an evidence-based health policy framework by releasing different papers. Among these, the document *Strategy and action plan for healthy ageing in Europe, 2012–2020* [2], published in 2012, is focused on healthy ageing. The most recent document *Health 2020. A European policy framework and strategy for the 21st century* [3], published in 2013, concerns healthy ageing in some parts.

[1] Corresponding Author: Department of Public Health – Section of Hygiene, Università Cattolica del Sacro Cuore, Largo F. Vito 1, 00168 Rome, Italy; E-mail: wricciardi@rm.unicatt.it

Strategy and Action Plan for Healthy Ageing in Europe, 2012–2020

The document *Strategy and action plan for healthy ageing in Europe 2012–2020* identifies 4 strategic areas, declining actions by WHO and Member States, and 5 priority interventions [2].

The objective of the strategic area n. 1, named "Healthy ageing over the life-course", is the delivering of health promotion and disease prevention services for healthy ageing by some actions, among which paying particular attention to the needs and special risks of persons aged ≥ 50 years, ensuring that gender aspects are well addressed, developing instruments for evaluation and monitoring of the implementation of policies for healthy ageing, supporting reporting systems and research to monitor the successful implementation of the actions.

The strategic area n. 2, "Supportive environments" aims to engage communities in developing strategies for becoming more age-friendly, by supporting environments for older people and allowing them to play an active role in building their social environment and defining local policies for healthy ageing.

The objectives of the strategic area n. 3, "People centred health and long-term care systems fit for ageing populations" are the strengthening of the response of health systems to ageing through high-quality services and financial and social protection by different suggested actions. Among these, contributing to research, documentation and spreading of good practices related to innovative models of healthcare delivery and access to information (including e-Health) and improving reporting systems can be described. Moreover, health literacy and the empowerment of the elderly and their caregivers are emphasized, as well as supporting home care and disease management programmes, promoting policies for financial protection to guarantee universal access to health and social care (e.g. cost-sharing regulations), strengthening cost-effective and evidence-based primary care interventions and promoting a proactive approach to chronic diseases prevention (primary, secondary and tertiary) beside an integrated healthcare approach.

The strategic area n. 4, "Strengthening the evidence base and research" aims to strengthen the capacity to assess and monitor elderly health and functional status and access to social and health care services.

Some suggested actions by WHO are dealing with the aim to carry the qualitative and the quantitative research that is needed to guide policy, to identify the gaps in evidence for policy and priority research for ageing and health and to promote existing tools in order to provide guidance on the production of health and ageing indicators for non-European Union countries. Actions by Member States mostly refer to monitor health and social care services and their utilization and access by older people, by improving the capacity of surveys and reporting systems, along with the creation of a centre of excellence for research and implementation of healthy ageing policies and strategies, to monitor the demographic, social and health situation.

Priority interventions are focused on 5 main areas, following their corresponding priority area for action under the Health 2020 framework (see below) [3].

Priority intervention n. 1, i.e. "Promoting physical activity", has the goal to promote elderly physical activity through social and community strategies.

Priority intervention n. 2, "Falls prevention", aims to reduce accidental falls, and their burden of disease, among older persons. Making the general population more aware of risk factors and effective falls prevention measures, along with implementing exercise programmes, physical therapy and home safety assessment, or including falls prevention measures in quality frameworks in all health and social care settings are some of the suggested actions.

"Vaccination of older people and infectious disease prevention in health care settings" is the priority intervention n. 3. Its goal is to reduce the gaps in vaccination against common infectious diseases that bring older people to have health risks (morbidity and mortality).

Priority intervention n. 4 identifies "Public support to informal caregiving with a focus on home care, including self-care". It means making informal care sustainable and improving health and well-being of those in need of care and their caregivers, for example by training older adults and informal caregivers in self-care, disseminating good practice, strengthening the evidence base for the improvement of international systems for reporting on the family situation and informal caregiving or making evaluation and trend analysis.

The last priority intervention, "Geriatric and gerontological capacity building among the health and social care workforce", tries to align training capacity in geriatrics and gerontology to the degree of health and social care needs of older people (e.g. people suffering from dementia) [2].

Health 2020. A European Policy Framework and Strategy for the 21st Century

In the first part of the paper, *Health 2020: a European policy framework supporting action across government and society for health and well-being* [3], four priority areas are identified. In the priority area n. 1, "Investing in health through a life-course approach and empowering people", healthy and active ageing is defined as a "policy priority and a major research priority", and the need to promote health programmes supporting healthy ageing is underlined.

In the second part, "Health 2020: policy framework and strategy", in the section referred to the evidence-based strategies to be applied and the key stakeholders, several solutions working for healthy older people are listed. Among them there are legislation and social and economic policies for social protection, e.g. income support, neighborhood and urban planning and supportive transport - such as adapting building design and transport systems to the needs of older or disable people - public health promotion, health and social services and support for informal care and social networks. The aim of these actions is to reduce health inequities and promote the empowerment of older people through health literacy and disease self-management.

1.2. The European Commission

The future of the European Union (EU) is widely believed to be connected to its power of innovation. In 2010, through the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions entitled "Europe 2020 Flagship Initiative. Innovation Union" [4], the strategy to create a new innovation-friendly setting in order to make it

easier the creation of products and services from great ideas and to bring our economy growth, also producing jobs, was presented as the solution. Innovation Union is now a part of the Europe 2020 strategy aiming to create competitiveness, societal challenges through research and innovation sustainable and inclusive growth. The Innovation Union contains more than 30 action points including the support by the Council, Parliament, Member States, industry and other stakeholders to innovation partnership initiatives (called European Innovation Partnerships), aimed at addressing weaknesses in the innovation system and European research (e.g. fragmentation and duplication or under-investment) [5].

The European Commission (EC), by identifying healthy and active ageing as one of the major challenges common to all European countries, and a potential area for Europe to provide innovative responses, gave life to the European Innovation Partnership on Active and Healthy Ageing. The partnership has the purpose to make EU citizens able to remain healthy, active and independent while ageing, to improve the efficiency and sustainability of health and social care system, to improve the competitiveness for innovative services and products facing the ageing challenge and finally to increase the average healthy lifespan by 2 years by 2020. The Partnership action plans and activities up to the present can be found at *http://ec.europa.eu/research/index.cfm*, by consulting the theme "Innovation" [6].

Since 1973, the EC established the *Eurobarometer*, a tool that measures and analyzes trends in public opinion in all Member States and candidate countries (www.*ec.europa.eu/public_opinion*). Knowing public opinion is important for the EC to prepare its legislative proposals, take decisions and evaluate its work. The surveys and studies are aimed at addressing issues of primary importance for European citizens, such as enlargement of the EU, Euro, defense, social situation, health, culture, information technology, environment.

On January 2012, the report on the survey "Active ageing" has been published as Special *Eurobarometer* n. 378 [7]. It states on its conclusion that, even if most Europeans are aware of demographic ageing, they are not concerned by it, unlike policy makers and experts. The survey reveals, among other things, some information about working, highlighting that more than 40% of Europeans are convinced that they could continue working up to the age of 65 and beyond, also believing that people should be allowed to continue working past the retirement age, if they want to, possibly combining part-time working and a partial pension.

From the survey, also it comes to light that older Europeans contribute to society through voluntary work in a wide variety of organisations. Many Europeans also believe that governments can do more to support carers (financial help or working flexible hours). Focusing on healthy ageing, most Europeans judge their country and local areas as 'age friendly', even if they point out the need of improvement in facilities for older people to stay fit and healthy, or in public transport and road safety. A major obstacle for older people seems to be the use of information technologies by public services and businesses to interact with the public.

The local level is perceived as the level of governance playing the strongest role in the challenges of ageing.

1.3. The Organisation for Economic Co-operation and Development

The Organisation for Economic Co-operation and Development (OECD) (*http://www.oecd.org/*) published in 2011 a document named *Ageing, health and innovation: policy reforms to facilitate healthy and active ageing in OECD countries* [8]. Referring to the policy reforms in ageing health and innovation in OECD countries, and in particular to Healthcare reform, it is underlined how Healthcare reform is driven in the majority of countries by a desire to control costs, constantly increasing because of several factors (e.g. advances in medical science - drugs, technology and procedures, population demands and demographic changes). The document shows how the main focus has been on cost-containment by cutting or limiting budgets, although attention has been also paid in some countries to increasing patient choice, improving quality through evidence based medicine and guidelines and implementing health technology.

The paper describes some examples of policies with the potential to support and facilitate healthy ageing, also by helping older people to continue to be active and productive. Policies are both related to health and social care, e.g. more prevention of chronic diseases, better treatment, e-health improvement, and other issues, such as flexible working, gradual retirement, adapting homes to older people needs. Moreover, new approaches and solutions to fund care and new ways of health and social care organization and supplying are described, targeted to guarantee solidarity between generations and economic sustainability. Policy reforms and interventions centred on active ageing would allow the elderly to remain independent and healthy and also allow to contribute to the financial sustainability of the whole system.

2. The National Observatory on Health Status in the Italian Regions and healthy ageing

The National Observatory on Health Status in the Italian Regions (*www.osservasalute.it*) represents a cooperation among the Section of Hygiene of the Department of Public Health of the Università Cattolica del Sacro Cuore and other Italian universities and several national, regional and corporate public institutions. This cooperative activity is multidisciplinary and involves around 230 public health care experts, clinicians, demographers, epidemiologists, mathematicians, statisticians and economists that, with different competencies, have as own scientific interests the individuals and collective health condition and the promotion of its improvement.

In 2012, the National Observatory on Health Status in the Italian Regions published 2 relevant documents concerning healthy ageing: the White paper *Health of the elderlies and healthy aging* [9] and the Decalogue *Ten rules toward Healthy Aging* [10].

2.1. Health of the Elderlies and Healthy Ageing

The White paper *Health of the elderlies and healthy aging* [9] was aimed to analyze the main issues related to the health care of the elderly, in order to outline the unmet needs, to highlight the regional differences and identify possible gaps between the delivered and optimal health care offer. The first part of the paper describes the elderly population, with indicators related to socio-demographic conditions, survival and

mortality rates, disability status and participation in social life. The second part, focused on health care risks, shows indicators related to social networks, main risk factors and lifestyles, prevention, neurodegenerative diseases and primary and secondary care.

The "snapshot" of the Italian situation, highlights both the progress achieved in the context of health status and health care quality of the elderly in our country, both intervention areas needed to be implemented in order to achieve satisfactory levels.

In fact, the analyzed data show a good overall picture of the health status of the elderly, pointing out heterogeneities among regions, as well as both gender and age classes, mainly related to lifestyles, behaviors and access to services.

In order to reduce these heterogeneities, a better coordination of national, regional and local policies would be required, together with the development of prevention and health education activities and services and the alignment of the supply to the demand, also by citizens involvement, to achieve a proper resources prioritization and allocation, especially in times of financial crisis and downsizing of public spending.

2.2. Ten rules toward Healthy Ageing

The Decalogue *Ten rules toward Healthy Aging* [10], list 10 recommendations, suggested by a team of experts, aimed at the adult population and the elderly, just to make elderly age synonymous of health, according to the 2012 EU commitment on active and healthy ageing.

I. Social Inclusion and Participation.
The greater involvement in social inclusion and participation is a protective factor for physical and mental health.
For the whole population and, in particular, for the elderly, participating in "social networks", based on family, friends and carers, protects against loneliness, isolation, by increasing opportunities for knowledge and support and improving the perceived quality of life, both in terms of physical and mental health.

II. Diet and Nutrition.
The WHO recommends eating a minimum of 400g of fruit and vegetables per day to reduce the risk of serious health problems such as heart disease, stroke, type 2 diabetes and obesity.
To get the maximum benefit, the "5 per day" rule (i.e. assuming 5 portions per day of fruit and vegetables) should be followed. The Italian Observatory on Health Status of the Italian Regions Report 2013 [11], shows that the percentage of people that takes at least 5 daily servings of vegetables and fruit has been decreasing in 2011-2012 period (4.9% and 4.7%, respectively).The 5 portions should include a good variety of such aliments, in order to take different combinations of fiber, vitamins, minerals and other nutrients.

III. Maintaining a healthy weight
Overweight and obesity facilitate the onset of chronic diseases such as cardiovascular diseases and diabetes, worsening both qualitatively and quantitatively the life expectancy. The body mass index (BMI) gives an estimate of the risk of overweight and obesity. Although genetic

predisposition is important in determining BMI, good habits also play a key role in maintaining a healthy weight.

IV. Physical Activity
According to scientific evidence, a regular physical activity of moderate intensity contributes to a healthy lifestyle. The exercise, preferably aerobic, does not need to be intense. In fact, 30 minutes of movement per day (walking, swimming, biking, etc.), for at least 5 times per week, are enough to enjoy many benefits (e.g. decreased risk of cardiovascular and metabolic diseases, increased self-esteem, stress management and reduction of symptoms of depression and anxiety).

V. Drinking less alcohol
Drinking alcohol is known to increase the risk of some cancers, including mouth, pharynx and larynx, esophagus, colon-rectum, liver and breast cancer. Abusing alcohol is not only resulting in chronic diseases and cancers. It is also associated with different adverse events, such as violence, road accidents and other, which may threat one's and other people's life.

VI. Stopping smoking
Smoking is associated, in some cases, to a 10 to 20 fold higher risk of contracting more than 40 different diseases such as cancer, respiratory failure (chronic obstructive pulmonary disease), vascular disease, gastrointestinal disease and osteoporosis.

VII. Protecting your skin from sun damage
Ultraviolet radiation (UV) can damage eyes and skin, leading to the onset of cataracts and skin cancers, such as melanoma. Risk/benefit ratio of sunlight, requires good timing and methods of exposure and appropriate protection, taking into account the age and the skin photo-type.

VIII. Using clinical preventive services
A proactive approach to chronic diseases prevention (primary, secondary and tertiary) leads to both an increase in life expectancy and in the number of life years free of disease. Moreover, many cost/effectiveness studies highlight how evidence-based prevention saves money and ensures, at the same time, a high-level health care assistance, avoiding unnecessary tests and procedures.

IX. Preventing elderly domestic injury
Domestic accidents kill twice than road accidents and 10 times more than workplace accidents. One-third of domestic accidents concerns the elderly (living alone or in health and social care institutions), who often are victims of falls.

X. Proper use of drugs
Elderly patients usually take several drugs, due to chronic comorbidities requiring continuous treatments. The increase of the number of ingested drugs also increases the risk of drug adverse effects [10].

3. The Research Activity and the Position of the Università Cattolica del Sacro Cuore

The Università Cattolica del Sacro Cuore has invested a substantial amount of its economic resources in the research field of ageing through projects involving 5 different research areas and researchers from 4 campuses.
The funded projects currently in progress on this topic are:

- *Diet and Animal Models of Aging*, coordinated by Paolo Ajmone Marsan, Faculty of Agriculture, Università Cattolica del Sacro Cuore, Piacenza;
- *Growing as older: activating resources for sustainable lifestyles*, coordinated by Alessandro Antonietti, Faculty of Psychology, Università Cattolica del Sacro Cuore, Milan;
- *"I do not retire": the lengthening of life, a challenge for generations, an opportunity for the society*, coordinated by Fausto Colombo, Faculty of Social and Political Sciences, Università Cattolica del Sacro Cuore, Milan;
- *Impact of nutritional status on longevity and ageing-related diseases*, coordinated by Claudio Grassi, Faculty of Medicine, Università Cattolica del Sacro Cuore, Rome;
- *Mathematical modeling of the impact of nutritional and environmental factors on physiological parameters during ageing*, coordinated by Alessandro Musesti, Faculty of Mathematics, Physics and Natural Sciences, Università Cattolica del Sacro Cuore, Brescia.

The Università Cattolica has developed tools, procedures and methodologies on the issue of active ageing, to recognize and increase the potential of the elderly by using the know-how of medical doctors, psychologists, nutritionists, economists, sociologists. Other opportunities, which are offered by the lengthening of lifespan, are being investigated, related to the management of time off from work after retirement for the maintenance of good living conditions.

The current research on active ageing has a leading position in the European research and it is perfectly in line with the trends of Horizon 2020 regarding the establishment of trans-national consortia for knowledge and innovation (Knowledge and Innovation Communities - KIC) at European level.

In 2014, the year of the start-up of Horizon 2020, a call has been opened for the creation of a new KIC with the aim of stimulating innovation for healthy living and active ageing. In this context, the Università Cattolica is collaborating with leading academies and industries at national and European level. In particular, the 2 key words of the proposal of the Università Cattolica will be: "patient engagement", that is the active involvement of the patient in the care process, and "good technology", i.e. the use of technology to improve patient's experience [12].

4. Conclusions

Population ageing is a major challenge for the EU society and economy, particularly for Italy, which is the oldest country in Europe. The EU Member States spend, on average, more than a quarter of their gross domestic product on social protection (mainly on pensions, health and long-term care). The current economic crisis is

resulting in huge financial difficulties while the large cohorts of "baby boomers" are entering their third age and begin to retire from the labor market.

In our country, the process of population ageing is quite advanced, as the proportion of young people in the total population is extremely low, while the weight of the elderly population is increasingly consistent. In fact, at the national level, there is a person aged 65 years and over every 5 residents and a little more than a 75 years and over person every 10 residents. This implies the need to adopt, in the short term, strategies and measures to deal with the consequences of the increase in the elderly population, including the increased frequency of chronic diseases typically associated with ageing. In general, these diseases impose a heavy weight to the affected population, both in terms of health and economics, due to the increased lifetime, decreased quality of life and to the treatment costs.

The key question is therefore how the current health and social systems can be sustainable not only for the survival of our welfare system, but for our own social life. The hope is that university research, as evidenced by the experience of the Università Cattolica del Sacro Cuore, through the constant and daily commitment of researchers, can help to overcome this challenge in the next future.

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Active and Healthy Ageing as a Wicked Problem: The Contribution of a Multidisciplinary Research University

Giuseppe RIVA [a,b1], Guendalina GRAFFIGNA [a], Maddalena BAITIERI [c], Alessandra AMATO [c], Maria Grazia BONANOMI [c], Paolo VALENTINI [c], Guido CASTELLI [c]

[a] *Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy*
[b] *Applied Technology for Neuro-Psychology Lab. Istituto Auxologico Italiano, Milan, Italy*
[c] *Research and Scientific Projects Directorate, Università Cattolica del Sacro Cuore, Milan, Italy*

Abstract. The quest for an active and healthy ageing can be considered a "wicked problem." It is a social and cultural problem, which is difficult to solve because of incomplete, changing, and contradictory requirements. These problems are tough to manage because of their social complexity. They are a group of linked problems embedded in the structure of the communities in which they occur. First, they require the knowledge of the social and cultural context in which they occur. They can be solved only by understanding of what people do and why they do it. Second, they require a multidisciplinary approach. Wicked problems can have different solutions, so it is critical to capture the full range of possibilities and interpretations. Thus, we suggest that Università Cattolica del Sacro Cuore (UCSC) is well suited for accepting and managing this challenge because of its applied research orientation, multidisciplinary approach, and integrated vision. After presenting the research activity of UCSC, we describe a possible "systems thinking" strategy to consider the complexity and interdependence of active ageing and healthy living.

Keywords. Università Cattolica del Sacro Cuore, Research University, Multidisciplinary Approach, Healthy Living, Active Ageing, Wicked Problem, Systems Thinking, Knowledge Mobilization

Introduction

European universities are crucial players in supporting European competitiveness, economic growth, and social cohesion, resulting in the need to focus on quality, efficiency, and excellence. In this process, however, university quality cannot be assessed only by using industrial quality models [1]. This approach works well for standardized services, such as ICT services or student administration, but not for assessing the real influence of a university on the key social and economic challenges.

In particular, we suggest that universities have to be evaluated for their role in the solution of wicked [2; 3] social and cultural problems that are difficult to solve because

[1] Corresponding Author: Department of Psychology, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: giuseppe.riva@unicatt.it

of incomplete, changing, and contradictory requirements. Typical examples of wicked problems are active and healthy ageing, poverty, immigration, unemployment, and social determinants of health, to name a few.

Wicked problems are different from classical socio-economic problems [4]. On the one hand, policy makers often discard them as being too complex to bother with, even if they plague our world and touch every one of us. On the other hand, traditional processes cannot resolve them.

As Rittel and Webber [3] noted, these problems have ten specific characteristics:

1. Wicked problems have no definitive formulation;
2. Wicked problems have no stopping rule or criteria upon which to determine "solving";
3. Solutions to wicked problems are not true or false; they can only be good or bad;
4. The list of applicable "moves" for a solution to a wicked problem is incomplete;
5. There is always more than one explanation for a wicked problem, with the appropriateness of the explanation depending greatly on the individual perspective of the designer;
6. Every wicked problem is a symptom of another problem;
7. No solution of a wicked problem has a definitive, scientific test;
8. Solving a wicked problem is frequently a "one shot" design effort, as a significant solution changes the design space enough to minimize the opportunity for trial and error;
9. Every wicked problem is unique;
10. A designer attempting to solve a wicked problem must be fully responsible for his/her actions.

As Bennet and Bennet [5] noted:

> "What sort of changes, what kind of knowledge is required to confront this unprecedented challenge to mankind? It is evident enough that changes in individual behavior… as well as changes in cultural and political frameworks that breed them are required. It may be less evident that in order to accomplish those changes our understanding of collective human behavior and our capacity to manage it are key factors. Knowledge about ourselves and the ability to innovate social organization at local and global scales are at the core of human destiny" (p. ix).

In sum, wicked problems are tough to manage because of their social complexity [2; 6]. First, they require the knowledge of the social and cultural context in which they occur. They can be solved only by understanding what people do and why they do it. Second, they require a multidisciplinary approach, as there is not just one solution for wicked problems, so it is critical to capture the full range of possibilities and interpretations.

The quest for an active and healthy ageing can be considered a "wicked problem." According to the European Commission [7]:

> "Demographic ageing is one of the most serious challenges Europe is facing. According to recent projections, the number of Europeans aged 65 and over will almost double over the next 50 years, from 87 million in 2010 to 148 million in 2060. This trend represents a challenge for public authorities, policy makers, businesses and the non-profit sector, especially as it comes at a

time of increasing pressure on public budgets, a steady decline in the number of health personnel and growing demands from older people for care products and services"

In this chapter, we suggest that Università Cattolica del Sacro Cuore (UCSC) is well suited for accepting this challenge because of its applied research orientation, multidisciplinary approach, and integrated vision that also includes Third Mission activities that facilitate their engagement with society and industry, After presenting the research activity of UCSC, the chapter describes a "systems thinking" strategy that considers the complexity and interdependence of active ageing and healthy living.

1. Università Cattolica del Sacro Cuore: A Multidisciplinary Research University

In 2012, UCSC invested more than Euro **27 million** in research activities, and it ranks among the first universities at the national level that devote their own resources. A strong commitment of the five national campus of a university that has **49** institutes, **24** departments, **79** research centres, **5** university centres, 6 spin-off and many laboratories at the cutting edge of technology. In the 2012-2013 academic year, the scientific activity involved **1,650** researchers from **10** macro-disciplinary fields: Mathematical and Computer Sciences - Physical Sciences - Life Sciences - Medical Sciences - Agricultural and Veterinary Sciences - Antiquities, Philological-Literary and History-Art Sciences - Historical, Philosophical, Pedagogical and Psychological Sciences - Legal Studies - Economics and Statistics - Political and Social Sciences.

1.1. The Dimensions of Research

Most of the 27 million of euros were invested in contracts and framework agreements with external partners. The main providers of funds are represented by private entities (businesses, institutions, foundations, associations) that cover almost 50% of total funding to research followed by the research institutes and other public authorities; the European Union and other international public organizations; the Ministry of Education, University and Research (MIUR); and regional or local authorities (Regions, Provinces and Municipalities).

Self-financing accounts for 16% of the total financing, is one of the most significant figures invested in the Italian university system.

1.2. The quality of research

In July 2013, the National Agency for the Evaluation of Universities and Research Institutes (ANVUR) announced the results of the most extensive process that has ever occurred in Italy regarding the **evaluation of the quality of scientific research** (VQR 2004-2010). Overall, 94 Italian Universities UCSC participated to the project, presenting and communicating scientific data and publications related to the research context and its effect on society and industry (the so-called "Third Mission").

With respect to the evaluation of the presented products (for the most part publications), UCSC ranks in the top quartile (25%) of the Italian universities in the areas of **physical, historical, philosophical, pedagogical and legal sciences**. Some other scientific areas - medicine, psychology and economics - also rank well on the national scene.

Overall, UCSC has distinguished itself by the good level of own resource, as well as co-financing of research; for the substantial revenue from direct contracting with enterprises, foundations, organizations and recruiting outstanding new human resources dedicated to research and training.

1.3. The Scientific Publications

The research quality is assessed through the publications of researchers. In 2012, the university released **4,127 publications**, with over **90%** published in the Physical, Environmental, Biological, and Medical Sciences. More than half of these publications were written **in foreign languages** (**57%**). Most publications were written in the areas of medical and biological sciences and various humanities. The data are recorded on *Publicatt*, the institutional repository of publications of the UCSC (http://publicatt.unicatt.it).

1.4. People Involved in Research

The UCSC employs **1,650** researchers as Full Professors (Professori Ordinari), Associate Professors (Professori Associati), and Assistant Professors (Ricercatori). The macro-sector of Medical Sciences employs a little more than one-third of the people involved in research, specifically, about 600 in the 2012-2013 academic year. Historical, Philosophical, Pedagogical, Psychological sciences, and Economics and Statistics comprise 200 researchers each.

1.5. University Spin-offs

The University participates in **6** spin-offs as a partner. Three of them are in the area of Agricultural and Food Sciences:

- **Horta Srl** (http://www.horta-srl.com/)
- **Aat Advanced Analytical Technologies Srl** (http://www.aat-taa.eu/)
- **Aeiforia Srl** (http://www.aeiforia.it/)

One in the area of the physical and environmental sciences:

- **Ecometrics** Srl (http://www.ecometrics.it/eco/index.php)

One in the area of the social sciences:

- **Arethe Srl** (http://www.arethe.eu/)

The sixth one was created in 2012 in the medical sciences field:

- **Ramazzini Work Team Srl** (http://www.ramazziniworkteam.com)

1.6. University Centres

In addition to the departments, centres, and institutes, the University has five University Centres, which serve as the structures for the conception, development, and implementation of research projects, training, and intervention on issues of particular strategic importance as a contribution to the Church and society as a whole.

- **University Centre for Bioethics**: For many years, the Centre has been conducting scientific research and post-graduate training to address the anthropological and ethical issues raised by the development of technology and the medical and biological sciences with reference to the issues of bio-politics and bio-law.
- **University Centre for Studies and Research on the Family**: The activities of the Centre focus on the most critical family transitions, such as the birth of the first child, development of autonomy in adolescence, prolonged youth, old age, separation, and divorce. The research, training, and intervention team of researchers at the Centre is divided into five macro-areas, i.e., family life cycle: teenagers and young adults; community, family associations, and social policies; family and cultural diversity; forms of parenting; and couple relationships.
- **University Centre for the Social Doctrine of the Church**: Recently, the Centre promoted research on the "Ethics and finance" topic that focuses attention on some issues capable of macroeconomic or more specifically sectoral coverage, including finance software in the economy, the banking economy, finance and business, finance and family, asset management, and ethical finance. Archive for the symbolic anthropology operates within the centre, which includes more than 8,000 volumes.
- **University Centre for International Solidarity***:* The Centre works on several international cooperation projects in various cultural and geographical contexts "of frontier", striving to spread the culture and practice of solidarity through the enhancement of the knowledge and expertise of the UCSC.
- **University Centre for Life***:* The Centre aims to deepen the reflection and promotion of advanced research in relation to the knowledge of life and its progress and to promote professional, human, and moral commitment of caregivers towards patients and their families. The research activities and initiatives undertaken recently have analyzed in detail the issue of humanization of care pathways and the dignity of life.

1.7. UCSC towards Expo 2015

The **UCSC Expolab Laboratory** was founded in 2011 with the aim to promote and implement scientific research on the subject of Expo 2015 titled "Feeding the Planet, Energy for Life", utilizing a multi-and interdisciplinary approach and the participation of students and teachers of the University. In the 2012-2013 academic year, the research work was based on the integration of different disciplines with a specific focus on the following areas: food security, food safety, and food-borne diseases; local development and international cooperation, the right for food and human development; and people's needs and environments with an emphasis on cultural representations of the relationship between man and food.

1.8. UCSC in the European Innovation Partnership on Active and Healthy Ageing

The UCSC is a member of the Action Group B3 (on Integrated Care) and Action Group D4 (on Age-friendly Environments) of the EIP-AHA (European Innovation Partnership on Active and Healthy Ageing) committed to the "Positive Technological Innovation as a Driver of People's Health Engagement" (PHE-project). The UCSC's commitment is listed in the Good Practices collection of the EIP-AHA.

1.9. UCSC in the Joint Programming Initiative on "More Years, Better Live"

The UCSC is the chair member (Chairman: Prof. Paolo M. Rossini, Director of the Neurology institute of the UCSC and author of the next chapter) of the Joint Programming Initiative (JPI) "More Years, Better Lives - The Potential and Challenges of Demographic Change". JPI seeks to enhance coordination and collaboration between European and national research programmes related to demographic change. The JPI therefore follows a transnational, multi-disciplinary approach bringing together different research programmes and researchers from various disciplines in order to provide solutions for upcoming challenges and make use of the potential of societal change in Europe.

2. Univesità Cattolica del Sacro Cuore: Ongoing Institutional Research Projects

2.1. Self-financing University Projects

For the 2012-2013 period, the UCSC has invested one million Euro of its own resources in research projects on two topics of great scientific value and strong social importance. All of them are characterised by strong interdisciplinarity involving a large number of researchers from different faculties.

- **Crisis time: Analysis of the causes and perspectives of solution.** Two specific ongoing projects on this subject have been financed: "*The challenges of the crisis: Rethinking the microeconomic and macroeconomic politics*" (Domenico Delli Gatti,) and "*The virtualization of the economy and its crisis. Practices and options of reconstruction between economy and society*" (Mauro Magatti).
- **Extension of life as an opportunity.** The following ongoing projects on this second subject have received financial support: "*Diet and Animal Models of Ageing*" (Paolo Ajmone Marsan); "*Growing older: Activating resources for sustainable lifestyles*" (Alessandro Antonietti); "«*I do not retire»: the extension of life, a challenge for the generations, an opportunity for the society*" (Fausto Colombo); "*Impact of the nutritional state on the longevity and ageing-related diseases*" (Claudio Grassi); and "*Mathematical modelling of the impact of nutritional and environmental factors on physiological parameters in the course of ageing*" (Alessandro Musesti).

The UCSC is financing many other small projects on different topics and across different scientific areas.

2.2. National Co-financed Projects

At the national level, the Ministry of Education, University, and Research (**MIUR**) financed **27** projects, **5** of which were **coordinated** by the university within the framework of **PRIN** (Research Projects of National Interest) **2010-2011 and PRIN 2012**. The financial support was offered to the humanities and social sciences (**13** projects), life sciences (**13**), and physical and analytical chemistry (**1** project).

The projects that the UCSC coordinated nationally included: "*Research of the genetic bases of new health-related phenotypes, the efficiency and the environmental sustainability of dairy cattle products* - Gen2phen" (Paolo Ajmone Marsan); "*Sustainable practices of everyday life in the context of the crisis: Work, consumption, participation*" (Laura Bovone); "*Regenerative Therapy with cardiac and spinal cord stem cells in severe heart failure*" (Filippo Crea); "*The treatment of deafness: Translational approaches*" (Gaetano Paludetti); and "*Functional brain connectivity and neuroplasticity in physiological and pathological ageing*" (Paolo Maria Rossini).

In the same period, the UCSC has been involved in **6** projects funded within the Italian framework programme for young researchers **Future in Research 2012 and 2013**. The winning projects were:

- "Evaluation of the modulation of gene expression of myocardiocytes in response to the abuse/dependence of new psychoactive substances (Smart Drugs) and anabolic steroids" (Fabio De Giorgio);
- "Classical paradigms and theoretical foundations in the contemporary research in formal and material ontology *(OntoForMat)*" (Lorenzo Fossati);
- "Building inclusive societies and global Europe online: Information and political participation in social media from a comparative perspective" (Giovanna Mascheroni);
- "Ultrafast thermodynamics at the nanoscale" (Francesco Banfi);
- "Healthy reasoning. Strategies and mechanisms of persuasion in chronic care" (Sarah Bigi);
- Building and integrating advanced language resources for Latin (Marco C. Passarotti).

2.3. International Projects

At the international level, the main research financing instrument for the UCSC was represented by the **Seventh Framework Programme for Research and Technological Development** (2007-2013), through which the European Commission aims to achieve several objectives, including strengthening the scientific and technological bases of industry, encourage a high level of international competitiveness, promote and encourage research activities in the European Union with a particular focus on small and medium-sized enterprises, research centres, and universities. Since 2008, the university has received funding for **74** projects totalling approximately €**19** million.

3. A "Systems Thinking" Approach to Active Ageing and Healthy Living

The previous description of the research activity currently carried out at the UCSC clearly suggests an integrated approach in which Humanities, Life Sciences, and Physical and Mathematical Sciences work together within a "Systems Thinking" vision that considers problems, including wicked problems, as the sum of different interrelated parts or components (structures) that cooperate in processes (behavior) [8].

In this view, the research conducted at the UCSC is aimed at understanding how systems behave, interact with their environment, and influence each other.

As Kreuter and colleagues [9] underlined, the main characteristics of "Systems Thinking" are (p. 448):

- *The focus on the entire problem*: Systems thinking looks at the whole, the parts, and their interconnectedness;
- *The focus on interdependencies*: The language of systems thinking focuses on closed interdependencies where x influences y, y influences z, and z influences x;
- *The focus on multidisciplinary examination and inquiry*: Systems thinking can be a powerful means of fostering collective understanding of a problem.

What makes systems thinking such a potent strategy for addressing a problem like active ageing? One reason is that systems thinking helps us understand why all the systems and actors involved in ageing and its consequences behave the way they do over time. Specifically, this approach requires researchers to construct and examine models, particularly our "mental models" or assumptions about how the ageing experience works. By exploring our mental models, we deepen our understanding of a problem and through an iterative process, conduct experiments to discover high-leverage solutions. For example, by analyzing the research outcomes related to ageing produced by the many researchers working at the UCSC, it is clear that the mental model of ageing differs according to the specific background. According to researchers working at the Faculty of Medicine, active and healthy ageing requires the prevention of physical frailty and sarcopenia (a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength). Moreover, researchers at the Faculty of Economics connects healthy ageing directly to the financial well-being of elderly people. Finally, researchers working in the humanities describe healthy ageing as the outcome of social ties, self-esteem, and subjective well-being.

These examples clearly suggest that fragmentation is a critical risk for any strategy related to active and healthy ageing. As Conklin [10] clearly explained:

> "Fragmentation, for example, is when the stakeholders in a project are all convinced that their version of the problem is correct. Fragmentation can be hidden, as when stakeholders don't even realize that there are incompatible tacit assumptions about the problem, and each believes that his or her understandings are complete and shared by all. The antidote to fragmentation is shared understanding and shared commitment." (pp. 2-3).

To avoid this risk, the UCSC uses the "knowledge mobilization" approach [5; 11]. The main goal of "knowledge mobilization" is to combine the sources of knowledge and the beneficiaries of that knowledge to interactively move toward a common direction, such as meeting an identified community need.

In this view, detailed in Table 1, the key in addressing active ageing is a planned process with input from multiple sources in an atmosphere where scientific certainty is balanced by the perspectives of community stakeholders, including elderly people themselves [10]. This book is the first attempt to reach this goal.

Table 1. The competences required for addressing active ageing successfully (adapted from [9])

Required Competence	Description of Competence
Understanding the problem (or problems) that constitute the focus of ageing and active ageing.	A working knowledge of ageing and active ageing, including what is known about the factors and conditions that influence the presence (or control) of ageing and the way in which ageing and its multiple determinants may be linked to other health and social issues.
Conducting an appropriate health and social assessment related to ageing and its consequences.	The ability to identify and assess population health needs, taking into account cultural and historical idiosyncrasies, availability of economic and human resources, and the views and perceptions of multiple stakeholders.
Planning theoretically sound health promotion programs	The ability to define integrated strategies (shown to be effective in previous applications/contexts) to address the needs of elderly people based on evidence from the health and social assessment.
Applying appropriate health promotion strategies	The ability to implement and/or direct the effective implementation of the integrated strategies by the stakeholders involved in health promotion, including (1) community development and community organization; (2) health education programs tailored to the needs of those in multiple settings; (3) specific education of health care providers; (4) social marketing and health engagement; (5) innovation for age friendly buildings, cities, and environments; (6) targeted health communication; and (7) the use of policies and the enforcement of existing regulations.
Applying appropriate health management strategies	The ability to implement and/or direct the effective implementation of the integrated strategies by the stakeholders involved in health management, including (1) prevention, screening, and early diagnosis; (2) health literacy, patient engagement, ethics and adherence programs; (3) ICT solutions for independent/remote/integrated care; (4) acute health care and long-term care; and (5) the use of policies and the enforcement of existing regulations.
Multidisciplinary cooperation	The ability to (1) identify common ground in priorities and unique contributions of different sectors and stakeholders, (2) actively engage those stakeholders in aspects of the program relevant to them, and (3) maintain transparent communication with stakeholders.
Monitoring and evaluating processes and outcomes related to active ageing and healthy living	The ability to (1) routinely monitor relevant health status indicators and their multiple determinants; (2) assess program progress, including the effectiveness of intervention components; and (3) document, disseminate, and use monitoring and evaluation results to publicize achievements and improve efforts.

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SECTION I

VISIONS

Active ageing depends on a variety of influences or "determinants" that surround individuals, families and nations.

Understanding the evidence we have about these determinants helps us design policies and programmes that work.

Active ageing policies and programmes recognize the need to encourage and balance personal responsibility (self-care), age-friendly environments and intergenerational solidarity.

Individuals and families need to plan and prepare for older age, and make personal efforts to adopt positive personal health practices at all stages of life. At the same time supportive environments are required to "make the healthy choices the easy choices."

WHO, Active Aging, A Policy Framework. 2002

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Demographic Changes and the Challenge for a Healthy Ageing

Paolo Maria ROSSINI [a], Camillo MARRA [a1]
[a]*Department of Geriatric, Neuroscience and Orthopedics , Università Cattolica del Sacro Cuore, Rome, Italy*

Abstract: Demographic changes bring about a wide range of new research fields including policy topics, health, social welfare, work & productivity, urban & rural development, communication tools, and mobility. This new situation requires a new multi-disciplinary approach bringing together different research programs in order to provide solutions for the upcoming challenges. National Health services are now facing a huge shift in the population structure with a predominance of older generations in the total number of citizens. Good health is the most important factor to live independently in old age. A better understanding of ageing processes and the related "plasticity" of individual performance for environmental adaptation, the prevention for age-related illnesses and healthcare strategies are the basis for keeping very old people healthy and active throughout the course of their lives. We will face mainly the biological, cognitive and psychological dimensions of ageing. Afterwards, we will focus on the relationships linking various biological and lifestyle factors -such as nutrition- that are crucial to obtain a comprehensive picture of ageing and to promote preventing strategies against degenerative neurological diseases. Finally we will investigate which interventions - nutritional and physical - could help in keeping people healthy, in particular which factors could promote people's physical, social and psychological functional abilities and the systemic multilevel consequences induced by a healthy ageing.

Keywords. Demographic Change, Healthy Ageing, Innovation, Research, Healthcare Strategies, Elderly, Health

Introduction

In all industrialized and more advanced countries the "Demographic Change" of the population is one of the most important societal challenges that Governments will have to face in the next future.

The Demographic Change is a direct consequence of the simultaneously rise in life expectancy and of the decrease in birth rates leading to a huge shift in the population structure of communities and to a prevalence of older generations in the total number of citizens. Epidemiological studies [1-2] report that at the beginning of the 20th century the average life expectancy of a woman born in Western Europe was 48 years, and that of a man was 45 years; today, they can expect to live 82 and 77 years, respectively.

[1] Corresponding author: Institute of Neurology, Department of Geriatrics, Neurosciences & Orthopaedics, Università Cattolica del Sacro Cuore, Policlinic A. Gemelli, L.go A. gemelli 8, 00168-Rome, Italy, E-mail: cmarra@rm.unicatt.it

Around 1900, 60-year-olds had another 13 to 14 years to live on average, whereas today, they can expect about 23 further years, 25 among women and 21 among men.

This demographic trend has an exceptional impact, with only few exception (Ireland), mainly on Europe.

It is clear that most societal field will be impacted by this change significantly with unpredictable consequences on structures of society, social cohesion and equity, productive systems, mobility, connection changes, services needs, communication systems, economic policy and distribution of resources. Researchers of all scientific fields should provide an analyses of the biological, social and economic consequences of ageing to cope with these changes and in order to supply the technical and societal adaption, the economical and policy adjustments, and finally the adequate prevention strategies in order to contrast the impact due to lack of validity, decrease of productivity and of all general abilities in the population.

Meanwhile, ageing does not represent per se a burden, but it can also represent an opportunity to be explored; within this frame a positive vision of ageing in Europe requires joining forces in ageing-related research and establishing coordination and collaboration between the national research programs in several key areas.

Indeed, several research fields are involved ranging from health, welfare, education and social programs, to financial reforms, to technology improvement. Health care programs aiming at developing prevention strategies for a optimized ageing will have a pivotal role in reducing the needs of social and financial interventions and in reducing the general costs of the societal policy for the elderly people in the future.

High relevance must be addressed to the research in the field of prevention and in the studies aiming at delaying the onset of degenerative diseases in the elderly. The plan of interventions requires a transnational, multi-disciplinary approach, bringing together different research programs and researchers from various disciplines to approach crosscutting topics in order to understand the different facets of the phenomenon of individual and societal ageing as well as to provide solutions for the upcoming challenges.

1. The Challenge of Healthy Ageing

Good health is the most important factor to live independently in old age. A better understanding of ageing processes and the related plasticity of individual performance, the prevention for age-related illnesses and healthcare strategies are the basis for keeping people healthy and active throughout the course of their lives. In spite of these premises oldest-old people (aged > 85 years) has been the most rapidly expanding fragment of the population in developed countries in the last decades. This group is also the most susceptible to disease and disability; as a consequence an increase of costs for health services should be expected with fundamental effect on the future sustainability of modern society [3-5].

The multisistemic physiological ageing involving sensorial abilities (hearing, vision, taste, proprioception etc.), motor system (for both neural loss and muscle sarcopenia), and cognition for a progressively longer period of time increases the need of health and social services as well as of technical aids in a progressively larger percentage of population.

The main challenge in this situation is to intercept as early as possible the "grey zone" separating the physiological from the pathological ageing in order to counterbalance the development of degenerative diseases by means of dedicated health policies, prevention, early diagnosis and strict monitoring and follow-up in those people "at high risk" (i.e. with a familiarity for degenerative disease or carrying genetic modifications, susceptibility or polymorphisms, with personal history –for instance severe head trauma- that could lead to the onset of degenerative disease).

Some encouraging data stem from the evidence that in several epidemiological studies, concerning older people up to age 85, the trend of delayed disability is increasing but at a lesser extent than the increment of chronic diseases [6]. Some factors could influence the reduction in disability in younger and older people. Better accessibility to care and treatment has also played a role in delaying disability, together with increasing levels of educational attainment and increased income level in large segments of society. Better occupation, workplace conditions, physical activities, nutritional changes, and the reduction in poverty may have all contributed to the decline in disability in the last decades.

For the oldest-old group the situation is less clear. The prevalence of disease in the elderly population has generally increased disability over time [6]. Neurodegenerative diseases such as Alzheimer's disease and other types of dementia, as well as Parkinson's disease typically recognize age as the main risk factor. Neurodegenerative disease all share the same lifestyle and related risk factors common to the major chronic diseases. In all neurodegenerative diseases there is a balance between the various environtmental/lifestyle risk factors and the genetic predisposition. Thus considering nutrition, lifestyle and environment is crucial to obtain a comprehensive picture of the boundaries separating an "healthy" from a "pathological" ageing. The investigation of which factors keep people healthy, in particular which factors promote people's physical, social and psychological functioning is crucial for the correct application of preventive strategies This also includes greater knowledge about potentially reversible processes that might be used to preserve or restore lost capabilities.

An example of this state of affair has been provided for Alzheimer disease (AD) in recent epidemiological report on the incidence of AD in American population [7]. The major evidence is that in the last years, an inverted trend with a reduction of incidence/year of AD in the population over 80 years has been observed; thus suggesting the possibility that some environmental factors could have positively interfered in the previous decades with the onset of the disease in the oldest old people.

On this purpose researchers have to devote their efforts in multidisciplinary research aimed at exploring the biological basis of ageing and the modulatory effect of environmental factors (nutrition, exercise, inflammation amongst the others) on the biochemical and genetic basis of ageing. The final aim is to reach a better comprehension about how environmental interplay with genetic factors in modulating the onset of the degenerative processes in human populations. From this perspective we should pass from a research focused on the early diagnosis and treatment, to the study of those factors that could promote mental and physical health in older age, life expectancy and primary prevention.

2. Factors Promoting Healthy Ageing: the Basis for Preventing Strategies

At the present, the main issues that have to be investigated to increase the knowledge on how to promote good health in the elderly and to reach useful preventing strategies to increase quality of life involve the following areas:

a) Social role, lifestyle, socioeconomic, cultural, genetic, and biological determinants that produce an healthy ageing.
b) Research on the plasticity of human development and successful ageing in various domains of physical and cognitive functioning.
c) Role and efficacy of preventing strategies in age related diseases in order to investigate different strategies for successful ageing for maintaining good social contacts and independent living in the elderly.
d) The role of technological aids in reducing disability and replace the decline of functions in the elderly. In particular, research should focus on innovative technology, improved communication system, and Tecno-care assistance at home, as well as for indoor/outdoor mobility in order to provide technologies for dependent older persons to help themselves in coping with daily life in a way more similar to their original life styles.
e) Investigation on the effect of sensorimotor and cognitive rehabilitation in very old age in order to maintain social engagement and a productive life.

When examining possible preventing strategies in the elderly, several fields that have provided recent evidences of efficacy in counterbalancing the effect of the age correlated degenerative diseases can be identified. In particular, some key measures seem particularly effective in decreasing the development of neurodegeneration:

a) food quality and diet;
b) physical and cognitive exercise;
c) oligo-elements and oxidative stress

2.1 The Dietary Effect

Among the modifiable lifestyle related factors, associated with degenerative disease, in the elderly people, diet has been proven to interfere with the onset of degenerative disease in elderly people. Also in AD the preventing strategies are more successful in the late onset of the disease.

Diet, and in particular Mediterranean-type diet, has shown some interesting effect in the delay of AD onset [8] and reducing the incidence of AD [9]

Two nutrition-related links could connect diet and the development of AD, i,e., micronutrients and macronutrients. Deficiencies of some micronutrients, especially those related to antioxidant and amino acid metabolism mechanisms (e.g., vitamin B1, B2, B6, B12, C, copper and folate), have been associated with cognitive impairment in elderly people [10] (see 2.3).

As concern macronutrients, a high intake of specific dietary factors (e.g., saturated fatty acids) enhances the amyloid-beta (Aβ) deposition in the animal model brain and increases oxidative stress. Some preventing strategies have been proposed in order to limit the effect of 'wrong nutrients' on the developing of degenerative disease in particular some general warning have been proposed in order to limit the use of some nutrients

Among other information provided by the guidelines, a reduction in the intake of saturated and trans fatty acids (contained in meat, for example, those "red" in particular), which produce an increase in cognitive impairment, is desirable. A decreased intake of saturated fats and trans fats is a powerful preventing strategy for AD. Saturated fat is found primarily in dairy products, meats and certain oils (coconut and palm oils). Trans fats are found in many snack pastries and fried foods and are listed on labels as "partially hydrogenated oils."

On the other hand, it is advisable to increase the consumption of plant foods, especially vegetables: the metals they contain are indeed treated based on the needs of the organism. Vegetables, legumes (beans, peas, and lentils), fruits, and whole grains should replace meats and dairy products as primary staples of the diet. Another recommendation also relates to the consumption of foods containing vitamin E (seeds, spinach or other vegetable broadleaf), which is able to increase the resistance of neurons to degenerative processes and that instead it is not properly taken in the form of vitamin complex. Important for the production of neurotransmitters and the improvement of cognitive faculties are vitamins B12 and B6, also effective if taken as multivitamin complex.

The future fields of research activities should point at the exploration of the modality by which these nutritional factors act on ageing, in general, and on neurodegeneration, in particular, in order to determine:

a) the relationships between fatty acids, oxidative stress and developing of neuroinflammation in the brain

b) how the nutrients can modulate, increase or decrease the effect of some patterns of genetic susceptibility or also modify the effects of well known risk factors for AD (APOE; BDNF, etc)

c) which are the nutrients and other components of metabolism that could represent risk factors for neurodegeneration, or, at the variance, protective factors, is an issue that deserves further investigations. Moreover researchers should address their efforts in establishing what is the level of diurnal intake of nutrients potentially dangerous or protective, and how age and gender could interplay with the intake of these nutrients, triggering some patients, but not others, to a neurodegenerative process.

2.2 Physical/Cognitive Exercise

Lifestyle is strongly associated with the risk of dementia. One of the top prominent issue at the last G8 summit, held in London on December 2013, was the effect on European population of the longevity related increasing of degenerative disease and in particular of AD. As mentioned above one of the most important environmental factors able to modify the expression of AD in people affected by genetic susceptibility or genetic risk factors is the regular physical and cognitive exercise. In fact several researchers have demonstrated that not only longevity and genetic risk factors are the only cause for an increasing incidence of AD. There is evidence that different lifestyle factors including obesity, stress, smoking, physical inactivity and low level of education and of cognitive burden are associated not only with the risk of cardiovascular disease but also of increased incident late-life dementia [11]. In particular physical exercise during midlife seems to exert a neurobiological modification leading to a delay of neurodegeneration in general and AD onset specifically [12-14].

Although some studies indicate enhanced behavioural performances in AD patients after only three month of physical exercise [15] little is known about how this effect would be exerted on the progressive neuropathology of AD after disease onset.

One possible explanation is that regular physical/cognitive exercise acts also as a promoter of a healthy brain by the activation of restorative mechanisms, plasticity, and the production of neuroprotective factors including endorphins good for mood. In the last ten years the literature on the preventing strategies for AD has enormously increased. Researchers have focused their attention on the final outcome of the physical exercise both on the cognition and on the delay the onset of AD. In spite of these evidences there is poor comprehension about the modality of this effect on neurodegenerative processes. In particular researchers activity should be devoted in the future at exploring:

a) The neurobiological effects of physical/cognitive exercise on metabolism and on the reduction of risk factors linked to the diet.

b) The relation between physical/cognitive exercise and the reduction of inflammation patterns both in blood and in SNC of MCI (=Mild Cognitive Impairment, a prodromic stage of AD) and AD patients

c) The role played by physical/cognitive exercise in promoting neural/synaptic plasticity in the human cortex and in increasing connectivity between brain regions.

From an operational point of view, some other points need to be clarified, in particular:

a) The amount of physical/cognitive exercise able to exert a positive effect on the human health and the minimum and the maximum of motor and cognitive activities beyond which the effects are less evident.

b) What are the optimal physical/cognitive exercises needed to obtain favorable effects on the neurodegeneration?

c) The study of gender and race roles is of critical value to understand if the effect of the physical/cognitive exercise could be generalized or restricted to particular subjects, geographical areas or personal condition.

The clarification of these issues could provide the basic information to check which modalities of interventions could produce the best outcomes in planning preventive policy programs for a healthy ageing.

2.3 Oligo Elements and Oxidative Stress

In the last years several micronutrients have been demonstrated to interfere with degenerative processes in humans.

One of the most studied is the effect of some vitamins. Vitamin E has been proposed as supplement in diet to avoid o decrease neurodegeneration. However, vitamins should come from foods, rather than supplements.

Healthful food sources of vitamin E include seeds, nuts, green leafy vegetables, and whole grains. The RDA for vitamin E is 15 mg per day.

A reliable source of vitamin B12, such as fortified foods or a supplement providing at least the recommended daily allowance (2.4 mcg per day for adults) should be part of any daily diet. Blood levels of vitamin B12 and folate should be checked regularly as many factors, including age, impaired assimilation.

A general warning should be made when using vitamins supplements. If using multiple vitamins integrators, is advisable to choose those without iron and copper, and consume iron supplements only when directed by a physician.

While aluminum's role in Alzheimer's disease remains a matter of investigation, those who desire to minimize their exposure can avoid the use of cookware, antacids, baking powder, or other products that contain aluminum.

In a similar way, copper is a micronutrients that works as a cofactor in several basic enzymes of the cell. Some of these are the cytochrome C oxidase (involved in energy generation), copper-zinc superoxide dismutase, or SOD (responsible for detoxification), lysyl oxidase (responsible for the connective functioning). In particular copper counterbalance iron mobilization by ceruloplasmin activity. If the presence of copper is too high, its uncontrolled redox activity can lead to the harmful generation of free radicals and to the increase of oxidative activity, thus compromising cellular function and causing oxidative damage to the body. Moreover one other unsafe effect of copper is due to its implication in inflammatory conditions and in the interactions with the productions of many cellular growth factors, interleukins, and pro-inflammatory cytokines, such as TNFalfa and C-reactive protein.

The role of copper seems to be central in the regulation of several patterns of ROS activity, and metals clearance, and its unbalancing in plasma could lead a cascade of harmful events. [16-18]

One of the most relevant new research fields in the future could be the exploration of the relationship between copper and the onset of Alzheimer disease and its pathophysiological mechanism.

Recent studies have clearly shown a role of "free" Copper (non-ceruloplasmin bound) in the cascade leading to Beta Amyloid plaques formation in excess as in the AD brain [19]. This excess is partly determined by being genetically a "good" or a "bad" Copper metabolizer [20-21]. It is noteworthy that such copper excess can be modified by an appropriate diet poor in Copper as well as by chelating drugs [22].

On these premises, a wider comprehension of the modality that determines the increasing production of Beta Amyloid in human brain, mediated by copper and the study of the antioxidant patterns in the brain could provide relevant information on the mechanisms triggering the onset of AD from one hand and the potential preventing strategies to inhibit the disease onset from the other.

Another crucial field of research could be devoted to the potential use of Zinc that is copper's primary antagonist. Zinc helps to reduce copper toxicity and also removes excess copper from the body naturally so people could maintain a proper zinc-copper balance. According to a National Health and Nutrition Examination Survey, an extensive cohort population study, aimed at explore if zinc dietary supplementation could modify the prevalence of AD, could have an enormous relevance for the health policies in the future.

3. Perspective and Conclusion

Very long lives is no more a mirage of future generations, but represent the probable destiny of most people alive now in developed countries. Increasing numbers of people at old and very old ages will be a major challenge for health-care systems, economic policy, and public health plans in the western countries. However elderly people can also be a new "resource" for future societies. From this point of view is critical for public administrations to promote healthy lifestyles among populations in order not only to avoid premature morbidity and mortality due to chronic diseases but also to

prevent or postpone mental and physical disability among elderly people. Unfortunately less is known about the further potential of reducing disabilities and diseases among elderly. Therefore, it is a key challenge to understand the contribution and interaction of the determinants that shape ageing across the life course and develop strategies and interventions to improve and extend cognitive and physical functions and quality of life at an older age.

The new knowledge, that environmental preventing factors could play an epigenetic role in inducing modification of the phenotype of degenerative diseases, provides the evidence that ageing is no more a permanent and unstoppable decay process leading to a progressively disabling condition. These data stress the importance of maintenance of physical and mental performance of older people through prevention and interventions which ensure that the additional gained years result in healthier, more active, productive and enriching years.

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Food for Healthy Living and Active Ageing

Paolo AJMONE MARSAN [a1], Pier Sandro COCCONCELLI [a], Francesco MASOERO[a], Giacinto MIGGIANO [b], Lorenzo MORELLI [a], Daniele MORO [a], Filippo ROSSI [a], Paolo SCKOKAI [a], Erminio TREVISI [a]
[a] *Faculty of Agriculture, Food and Environmental Science, Università Cattolica del Sacro Cuore*
[b] *Faculty of Medicine and Surgery, Università Cattolica del Sacro Cuore*

Abstract. The link between diet and health has been recognized since the Grecian period; as Hippocrates said, "Let food be your medicine and medicine be your food". Although the primary goals of diet are meeting nutritional requirements and providing energy, there is increasing awareness that a correct and balanced diet may prevent the insurgence of diet-related pathologies and/or improve well-being and life expectancy, also reflecting on the ageing process. Research on the interaction among nutrients, gut microbiota and host metabolism is presently unravelling the molecular mechanisms underlying the positive and negative effects of traditional diets on health and ageing, providing useful information for the design of innovative foods targeting specific needs and segments of the population. The food supply chain plays a key role in ensuring quality and safety through both comprehensive quality management and inspection systems and a focused innovation process mainly devoted to the creation of functional foods. However, innovation and scientific development pose a problem of information asymmetry towards final consumers; thus, regulatory aspects and private and public communication strategies must be efficiently developed.

Keywords. Diet, Food, Innovation, Research, Communication, Elderly, Health

Introduction

Europe is growing older. To remain fully independent and actively engaged in their communities, elderly people (aged over 60 years [1]) must address physical and psychological changes that reduce their efficiency and often their well-being. With age, organs and apparatuses (e.g. bones, muscles, cardiovascular and respiratory systems) become progressively impaired and cognitive abilities decrease. Body composition also changes. Muscle mass, body density, immune function, nutrient absorption and metabolism decrease, and nutrient requirements vary accordingly. These changes, together with environmental and socio-economic factors, affect the lifestyle of individuals. In this context, a proper diet contributes to preventing the onset of a

[1] Corresponding Author: Institute of Zootechnics and Nutrigenomics and Proteomics Research Center - PRONUTRIGEN, Faculty of Agriculture, Food and Environmental Science, Università Cattolica del Sacro Cuore, via Emilia Parmense, 84, 29122, Piacenza, Italy. E-mail: paolo.ajmone@unicatt.it.

number of age-related diseases and fosters healthy, active ageing and a longer life (Figure 1).

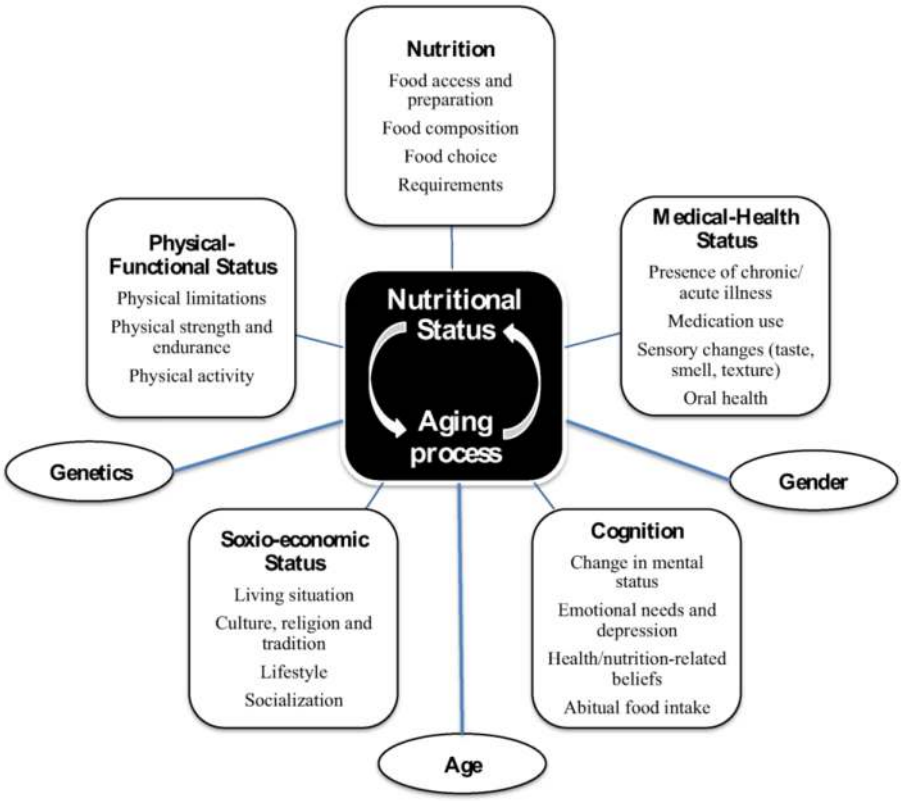

Figure 1. Factors that influence the nutritional status during ageing ([1] modified).

Ageing people often suffer from either reduced food and water intake due to economic, psychological and physical distress, such as depression, digestive health problems and sensory changes [2] or from a monotonous and unbalanced diet, e.g. high in energy and lacking high biological value proteins, minerals and vitamins (Figure 1). These, combined with reduced physical exercise, increase the risk of premature ageing symptoms and syndromes (e.g. metabolic syndrome and diabetes).

The link between diet and health has been recognized since the Grecian period. For a long time, the scientific community has investigated this topic, mainly focusing on the effects of and recovery from a deficiency of specific essential nutrients and on the consequences for metabolism of an excess/deficiency of large categories of nutrients (e.g. carbohydrates, lipids, proteins; [3]). Only recently have research teams taken to the forefront of research the concept that nutritional well-being is a fundamental component of human health [4]. As a consequence, research in food science addressed to human health has increased exponentially and in recent years thousands of papers on this topic have been published in peer-reviewed journals, many of them addressing the needs of the elderly.

In the third millennium, publication of the human genome project and the consequent development of high-throughput molecular tools in human and model species have opened new roads for investigating the effects of diet and nutrients on metabolism, funding the new science of nutrigenomics and boosting the collection of new knowledge in the field [5].

Despite a number of important discoveries regarding the intake of saturated and trans-unsaturated fatty acids and cardio-vascular diseases [6], energy intake, oxidative stress and cancer [7] and the protective effects of fruits and vegetables on cancer [8], research has so far only scratched the surface of the complex relationships between diet and human health, well-being and quality of life. Complexity arises from the genetic variation in individuals, variation in nutritional requirements with age and health status, variability of food in terms of nutrient components and safety and to the intriguing and still under-investigated role of the gut microbiota as mediator between nutrients and human metabolism [9]. In short, much is still to be discovered and an internationally coordinated and multidisciplinary research effort is needed to shed light on the full potential of nutritional strategies for the improvement of human health and well-being in populations of different ages. This has particular importance for older adults, who have life conditions that are more critical. As Hippocrates said, “Let food be your medicine and medicine be your food”.

1. Consequences of insufficient, unbalanced or excessive diet

Malnutrition is defined as a state of deficiency, excess or imbalance of energy and nutrients. It causes adverse effects on body form, function and clinical outcomes [10] and it is recorded at increasing frequency in the elderly. About 16% of people aged 65 or older and 2% of people aged 85 or older are classified as malnourished [11]. The prevalence of malnutrition is increasing in Westernized populations and is often associated with a decline in functional status, impaired muscle function, decreased bone mass, immune dysfunction, anaemia, reduced cognitive function, poor wound healing, delayed recovery from surgery, higher hospital readmission rates and mortality [12]. Overall, the aetiology of malnutrition for older people can be considered multifactorial [13]. In particular, it is hypothesized that a common mechanism exists at the origin of the main pathologies associated with ageing (e.g. Alzheimer's, Parkinson's, type 2 diabetes, atherosclerosis), in which free radicals trigger an inflammatory process through oxidative stress. The elderly’s immune system is in fact characterized by deregulation of the inflammatory processes with a reduction in longevity through mechanisms of accelerated immune-senescence and chronic inflammation [14]. Nutrition can exert a significant influence in the control of these phenomena.

Undernutrition is frequently not recognized in the community, and in older persons in particular [15]. Older people often have reduced appetite and energy expenditure. Coupled with a decline in biological and physiological functions such as reduced lean body mass, changes in immune response and hormonal level, as well as changes in fluid electrolyte regulation, the reduced appetite and energy expenditure delay gastric emptying and diminish the senses of smell and taste [13].

Overnutrition is also a critical problem in older people [13]. The prevalence of overweight older people in Westernized countries is increasing. In 2000, 58% of US citizens aged 65 years had a body mass index (BMI) of 25 (normal BMI values range between 18.5 and 24.99), and the prevalence of obesity (BMI over 30) in the US

increased by 36% from 1991 to 2000 [16]. Since a high BMI is associated with conditions such as diabetes, hypertension and cardiovascular disease, the risk of death in older people with high BMI increases. Also, older people with high BMI suffer from symptomatic osteoarthritis, increased rate of cataracts, mechanical urinary and bladder problems and sleep apnoea and other respiratory problems [17]. Intentional weight loss through correct diet management by overweight older people is highly advisable. However, diet should be combined with a physical exercise program to preserve muscle mass, which decreases rapidly in the elderly.

2. Diet in old age

A healthy balanced diet for the elderly should match the physiological needs of old age and hence contribute, together with an active lifestyle, to a long and healthy life.

In the case of undernutrition, nutrients most often deficient in the diet of older people are vitamins (especially A, C, thiamine, riboflavin and pyridoxine) and some minerals (calcium, iron and zinc). Sometimes protein intake is also insufficient.

Ageing is also partially caused by oxidative damage to cells and tissues. In addition to contributing to the disease condition, the severity of this oxidative challenge is directly proportional to food intake and food quality. However, some foods (functional foods) contain antioxidant and bioactive components that help in reducing oxidative stress and preventing some diseases, e.g. cardiovascular diseases, and some types of cancer. Nevertheless, the recommended antioxidant-enriched diets (e.g. with vitamin E, polyphenols) are sometimes ineffective [18], indicating that knowledge about the mechanisms of action of many nutrients potentially affecting longevity and active ageing is still incomplete.

One of the most debated aspects of elder nutrition is protein undernutrition or malnutrition. This is frequently caused by reduced animal product consumption and age-related conditions such as tooth loss, reduction of taste and smell and diseases that affect the gastro-intestinal tract. The demand for protein increases in the case of febrile diseases, burns, bedsores and fractures and also after surgery. Dietary proteins play a vital role in maintaining homeostasis, muscle mass, skeletal integrity and a reactive immune system. Reduction in muscle mass in the elderly may be partially prevented by adequate protein intake and physical activity. In a balanced diet the protein should be both of animal and plant origin.

Even if ageing induces a progressive increase of glucose intolerance, carbohydrates remain the main source of energy in the diet (at least 50% of daily needs). In the elderly, despite a general decline in taste sensitivity, a sweet taste is appreciated and associated with good sensations and feelings as well as enjoyment and pleasure. High-carbohydrate foods are also easy to chew and, therefore, are preferred by the elderly.

However, ageing is also associated with an increased risk of insulin resistance, metabolic syndrome and diabetes. The consumption of low glycemic index (GI) foods and an increase in resistant starch (RS)[2] daily intake help in controlling these risks. In fact, the consumption of low GI foods has been related to reductions in the risk of

[2] RS is the "the fraction of ingested starch that escapes enzymatic digestion by endogenous enzymes in the upper gastrointestinal tract and passes into the colon where it can be fermented by caecal and colonic microbial communities"

coronary heart disease and type 2 diabetes [19]. Metabolic studies have also revealed that replacing high-GI carbohydrates with low-GI sources improves glycemic control and reduces hypoglycemic episodes [20], as foods rich in RS fraction.

Fat must be included in a balanced diet for the elderly to provide essential fatty acids needed for maintenance of the organism. To satisfy these requirements, fat should be included to provide 2% to 6% of total calories. Essential fatty acid content is low in lipids of terrestrial animal origin, while sea foods and some plant products (e.g. olive oil) are much better sources. Dietary fat, whose primary function is to provide energy, is also necessary to absorb fat-soluble vitamins: A, D, E and K. Minerals and vitamins are chemical compounds needed in small amounts (micronutrients) in many biological processes. Therefore, a healthy diet for the elderly should provide adequate amounts of minerals. Finally, a shortage of water-soluble (rapidly excreted) and fat-soluble (slowly excreted) vitamins causes severe hypovitaminosis syndrome at all ages.

Assessment of diet quality for the elderly (including amount consumed) is the first step in planning corrective interventions. Correct information and education on the advantages of diversification in food consumption, inclusion of functional foods in the diet and an active lifestyle are urgent needs because they hold the potential to decrease the risk of occurrence and the severity of many chronic diseases of the elderly and to improve their quality of life.

3. Tradition and innovation for better food

Through the centuries, Italian cuisine has developed worldwide recognition for high quality, simplicity in cooking and ease in preparation. In 2013, CNN ranked Italian cuisine as the best in the world (http://travel.cnn.com/explorations/eat/worlds-best-food-cultures-453528). However, Italians' ability to use their traditional recipes as starting points for innovation in food is not always apparent.

Pizza, one of the most popular Italian foods throughout the world, may be an example. Pizza ingredients are very simple: flour, water, a little bit of salt, olive oil and another essential ingredient, tomato sauce. The first known reference [21] to the term "pizza" appears far earlier than Columbus travelled to the Americas, in a Latin text dated 997 AD, probably the *focaccia,* a flat bread known since ancient Roman times as *panis focacius* to which toppings were added but, obviously, no tomatoes.

The tomato arrived in Europe from the Americas in the 16th century, but it was believed to be unhealthy. However, by the late 18th century, it was common for poor people in the area around Naples to add tomato to their yeast-based flat bread. The innovation that turned flat bread into pizza was the use of tomato (a *novel food* at that time) as a topping, in a recipe that stems from ancient Rome.

This process of turning traditional foods into something new still holds today; according to statistical analysis of the website www.gopubmed.org, Italy is ranked very high among the countries publishing research papers in the area of functional food (see Figure 2a). Italy scores an even better ranking in the area of scientific research dealing with human ageing (see Figure 2b).

Accordingly, one of the main topics of Padiglione Italia, the Italian pavilion in EXPO Milan 2015 (the universal exposition with the theme "Feeding the Planet, Energy for life" focused on agriculture, food and nutrition) deals with traditional foods and excellence in Italy. This topic points out the evolution of the Italian food industry, which is exploiting the traditional food to promote a better and healthier life.

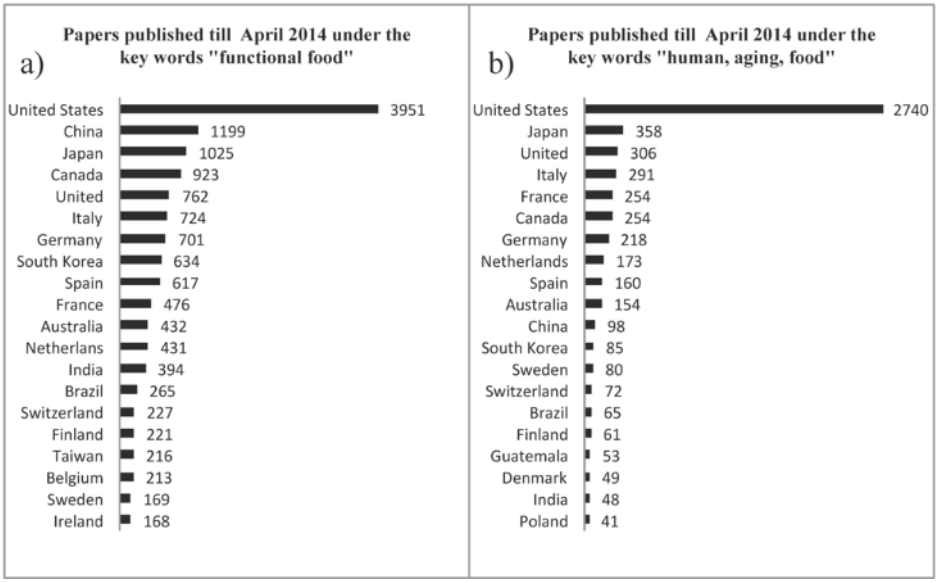

Figure 2. Papers published through April 2014 under the key words (a) "functional food" and (b) "humans, ageing, food" (source:www.gopubmed.org).

The quest for better food capable of promoting a healthier life is therefore a strategic research area for a country in which eating is a substantial component of the life style. This research must be multifaceted to address the four Ss related to food production and consumption: i) Security; ii) Safety; iii) Sustainability; iv) Socio-cultural components.

Several challenges in Europe are associated with these four Ss; climate changes are endangering our crops and food losses related to bad weather are increasing. In the meantime, it is mandatory to maintain a very high level of food safety with a minimal use of chemicals; a simple example is the ban, active from 2006 in European Union (EU) countries, on antibiotics as growth promoters in livestock. The ecological impact of the food chain must be reduced without reducing the production potential.

In addition, the exploitation of certain foods in supporting health, the so-called functional foods, may play a role in the European society of the third millennium by establishing a new role for food. European food companies have developed health-supporting ingredients (e.g. cholesterol-controlling phytosterols) and since 2006 the EU has regulated food health claims. If supported by synergic efforts of research, industrial development and regulations able to support innovation, this scenario may open an exciting range of opportunities for the EU.

4. The health role of "innovative" PDO products

Some traditional foods are well known for their excellent taste and, in many cases, as sources of important nutrients, although they can also contain less desired components, such as cholesterol and saturated fatty acids. PDO cheeses are good examples: they are

good sources of high-quality protein and minerals, like calcium, but have a high content of cholesterol and saturated fatty acids, nutrients considered less positive due to their relationship with cardiovascular diseases.

In recent years, the discovery that some milk peptides have a positive effect on blood pressure [22] boosted research on the effect of cheese consumption on controlling hypertension. The consumption of small amounts (30 g/day) of Grana Padano cheese significantly reduced systolic blood pressure compared to a diet with the same sodium content but lacking Grana Padano [23]. Sour milk-enriched milk anti-hypertensive peptides also produced positive effects [24]. Specific strains of *Lactobacillus helveticus* increase the content of these peptides in cheese during fermentation, thus increasing the nutritional value of a PDO cheese without altering the traditional hand-making process of this dairy food. Although the positive effect on human health of probiotic bacteria included in fermented milk is still not recognized by the EFSA, the potential of this approach to improve gut health remains high.

The positive effects on human health of eating whole grains has been acknowledged for a long time; however, in recent years, research has demonstrated that pasta and bakery products enriched with specific fiber fractions (β-glucans, arabinoxylans) reduce glycemic index and positively modulate human gut microflora [25].

Other technological processes can be used to increase the content of resistant starch, a very slowly digestible carbohydrate fraction that has a positive effect on human health. As a matter of fact, resistant starch reduces the rise in blood glucose after a meal and can act as a prebiotic fiber. The RS content in food can also be increased with technological processes (e.g. retrogradation after cooking or chemical reaction with organic acids) or by using ingredients naturally rich in RS (native amylose-rich starch).

Improvements in livestock hygiene and adoption of bacterial culture starters have sharply reduced the use of nitrate and sodium chloride (NaCl) in the manufacturing of typical Italian PDO salami. Since nitrate is a risk factor for colorectal cancer and excessive sodium intake increases the risk of blood hypertension, improvement in the nutritional value of cured pork meat is evident.

The pork fatty acid profile has also changed in recent years. The amount of saturated fatty acids (SFA) and cholesterol has decreased and the quantity of poly-unsaturated fatty acids (PUFA) is becoming closer to the most up-to-date dietary recommendations.

Advances in animal breeding and nutrition are now producing eggs, milk and meat with less cholesterol and SFA, more PUFA, more conjugated linoleic acid (functional molecule produced naturally during the rumen fermentation) and higher content of antioxidant molecules (e.g. vitamin E).

Therefore, innovation derived from the application of research output produces novel food, but also greatly benefits traditional food, maintaining the taste and culture and improving health.

5. The economic role of PDO products

The adoption of innovative production techniques in the area of PDO products, targeted to improving their health-enhancing properties, can also be a winning strategy from an economic point of view. In fact, the role of PDO and protected geographical indication

(PGI) products in the Italian agro-food system is crucial and the above potential health-related innovations may bring large economic benefits to all actors in the supply chain.

Italy is first among EU countries in number of PDO-PGI registered products (262 in 2013, with 25 new applications under evaluation), as well in terms of total market sales [26]. In fact, in 2012, the turnover for PDO and PGI products in Italy amounted to around 7 billion euros at the wholesale level (+2.1% with respect to 2011) and 12.3 billion euros at the retail level (+5%). At constant prices, production volumes increased 5.3% in 2012, with stronger growth rates for fruits and vegetables (+7.2%) and cheeses (+5.5%). Exports of PDO-PGI products accounted for almost 30% of total turnover (2.1 billion euros at wholesale prices) and increased by 4.8% in 2012, much more than domestic consumption (+0.8%). Thus, while the Italian economy was experiencing the worst economic crisis since World War II (the GDP fell by 2.5% in 2012), the market trend for PDO-PGI products was clearly countercyclical, especially for exports, signaling that despite the crisis consumers are sensitive to the quality of what they eat.

The above market data, which were collected according to the classification of the European Commission (EC), do not include wines. In Italy, adding PDO/PGI wines implies doubling the figures above (i.e. the total turnover reaches 14 billion euros), but in this case France becomes the leading EU country in terms of market size.

The peculiar feature of the Italian PDO-PGI market is that, while most PDO-PGIs are niche products (as is the rule in other EU countries), some key products are actually consumed by a very high proportion of Italian households (in some cases, above 90%) and their turnover is extremely relevant in absolute terms. This is especially true for dairy and meat products, which account for 59% and 37%, respectively, of the total PDO-PGI turnover. More specifically, the first six PDO-PGI products account for almost 80% of total turnover (i.e. 5.6 billion euros at the wholesale level) and their production involves a huge number of farmers and processors. These products (i.e. Prosciutto di Parma, Prosciutto di San Daniele, Grana Padano, Parmigiano Reggiano, Gorgonzola, Asiago) can be considered mass market goods since they reach final consumers mainly through super and hypermarket chains, rather than through specialised shops and, given their incidence in food retail sales, they are a key element of large retailers' offerings.

In this market context, improving the health-enhancing properties of PDO-PGI products while maintaining their traditional handcrafted features certainly offers an attractive opportunity for the Italian agro-food system. In fact, several studies in recent years have shown that consumers are willing to pay a price premium for functional foods (see, among others, [27]), as well for products of certified origin (see, among others, [28]). This means that producers may benefit from such improvements in health-related attributes, as long as the unit cost of production does not increase more than the potential price premium. Moreover, producers must count on a fair distribution of the value added along the chain since recent studies have shown that for the most important PDO-PGI products retailers may exercise some form of market power toward processors as well as consumers [29].

6. Communication

Innovation and scientific development strengthen the problem of information asymmetry towards final consumers; regulatory aspects and private and public communication strategies must be efficiently developed [30]. Thus, understanding of

the determinants and mechanisms by which information is conveyed to and processed by consumers plays an important role in any communication strategy. Indeed, communication is not always the best option available; policy makers may resort to other instruments, such as taxes (e.g. a fat-tax) and subsidies or standards.

Although, the EU is the area in the world with the lowest incidence of foodborne diseases, it is unavoidable that to any food consumption is associated a risk for consumer health. Food risk is the consequence of a hazard in food. A *hazard* is a biological, chemical or physical agent that may be responsible for a health problem (i.e. a contaminant), while *risk* is related to the probability of the consumer incurring a problem related to the hazard. As a consequence, food risk is associated with the level of consumption of the *risky* food and thus to habits and lifestyles. The main international organisations (the Food and Agriculture Organisation and the World Health Organisation through the Codex Alimentarius) developed a protocol for risk analysis which is also applied by the European Union after the food crises of the late '90s. Risk analysis is a three-step procedure that includes *risk assessment*, *risk management* and eventually *risk communication*.

The *risk assessment* is a scientific process, and in the EU it is coordinated by EFSA, which collects the body of scientific knowledge, estimates the food-associated risks and provides scientific support to policy makers. The EFSA has defined five categories of risk: none/negligible, low, medium, high, and unknown. Neutrality and scientific excellence are guaranteed by the scientific panels, made up of independent researchers from universities and research centres. Since 2002, the EFSA has produced more than 2,400 scientific opinions. The EFSA is also involved in the approval of nutrition and health claims, including those concerning functional foods, under Regulation (EC) 1924/2006.

Risk management refers to the process of defining intervention measures with the objective of reducing the risk to the *as low as reasonably achievable* (ALARA) level, ensuring the consumer an *adequate level of protection* (ALOP); economic issues, life styles, consumption behavior and technical aspects are also considered. The European approach to risk is largely founded on the so-called *precautionary principle* (Article 191 of the Treaty on the Functioning of the European Union), which states that when scientific evidence is not conclusive, a rapid and drastic response, including a complete ban and/or withdrawal of a product from the market, can be undertaken. Furthermore, to make the process of risk management more efficient, the Rapid Alert System for Food and Feed (RASFF) was established within the EU.

Risk communication is the process of informing the public; communication regarding food risks must be transparent, consistent, not alarmist, appropriate and easily accessible. The risk is not always clear, and uncertainty should be acknowledged, together with the steps undertaken to address the uncertainty. Thus, communication should raise awareness in consumers and spread the results of the EFSA's scientific work, assisting consumers in reaching informed judgments. Unfavorable or negative information is normally weighted more heavily than favorable information. Unfavorable information usually produces a rapid change in behavior, while the recovery, if ever possible, is often slow. Also conflicting messages, mainly when experts change their advice, augment consumers' uncertainty and hamper their decision-making process.

Communication may influence individual behavior. Changing behavior is a complex and multidimensional process that results from the interaction of personal (e.g. attitudes, norms, education, beliefs) as well as socio-economic and environmental

factors. It will then depend on the way information is conveyed (e.g. communication media) and the way consumers process it. From consumers' perspective, information is required to improve their well-being; consumers ask not only for quality, safety, pleasure, nutritional content, but also for environmental, ethical, social and technical conditions of production and processing (e.g. organic production, place of origin, fair trade). Product innovation may be a profitable strategy, and communication plays a key role in increasing and maintaining reputation (i.e. brand image) and consumers' trust.

Information theory treats communication as a process in which a sender communicates to a target, and feedback will depend on the way information is processed; this simplified scheme should be integrated with other elements from consumer psychology and behavioral models that will help in understanding the stages (hierarchy) by which consumers respond to information. Consumers' processing of and reaction to perceived information are not conducted in a rational manner. Thus, it is necessary to employ both analytical and cognitive processing and simple decision rules with low in-deep treatment and the use of external clues, such as trust in the information source.

Consumers seek information on the most common media (newspaper, television, internet, social media), but also referring to direct contacts with acquaintances. More information does not necessarily translate into more informed consumers. An excess of information may induce consumers to discard it, thus making it ineffective and useless; consumers often pay attention to just a few cues (brand image, price, origin). Subgroups of the population may react differently to communication strategies relating to food safety/risk and health issues. Specific care should be devoted when vulnerable groups (e.g. children, elderly, pregnant women) are the target of the communication. Communication can be further complicated by age. The elderly constitute a largely heterogeneous group due to the very wide range of experiences that may affect their perceptions. As previously stated, the proportion of elderly in the population is increasing and the elderly constitute a vulnerable segment of the population in terms of health, economic status, cognitive abilities and access to information.

As a result, information on food issues for the elderly must be conveyed in a specific way. Some traditional media channels may have low direct relevance (e.g. internet and/or social media); in addition, information processing may be hampered in the elderly. Thus, beyond traditional media, communication of information should favor indirect routes, mainly through primary care physicians, younger relatives and care-givers. A successful strategy for food diet enhancement in the elderly must include tailored communication and education interventions for care-givers, together with other policy instruments acting on psycosocial factors.

7. Conclusions

Although food availability and use have relevant country-specific aspects, many drivers and issues related to elder malnutrition are common across Europe and call for intensification of a coordinated international and interdisciplinary research effort to address the four Ss related to food production and consumption:

Food Security:

- Increase crop and livestock resiliance to climate changes, particularly to drought and high temperatures.

- Decrease food losses and wastes along the production chain, from farm to fork.
- Grant access to proper food at a just price.

Food Safety

- Maintain a very high safety level of food of animal and plant origin, with minimal use of chemicals.
- Exploit functional food in supporting health.
- Understand the relationship between diet and health in old age, with particular attention to malnutrition, foodborne infections intoxications and degerative diseases.
- Unravel the relationship between diet and longevity and identify individual nutrients responsible for the effects observed.
- Explore new tools provided by modern technologies and suitable cell and animal models to shed light on the complex interaction between diet and health, particularly in old age.
- Understand the interactions between gut microbiota and the host genome, metabolism, inflammation and immune response.

Food Sustainability

- Reduce the ecological impact of the food chain without reducing productivity.
- Estimate the consumers' price premium for "innovative" PDO-PGI products.
- Evaluate the potential impact on farmers' and processors' profits of introducing health-related innovations in PDO-PGI production technologies.
- Analyze the role of market power in the PDO-PGI supply chain to reach a fair distribution of the value added among the actors of the chain.

Food as Socio-Cultural Component

- Improve the synergic efforts of research, industrial development and regulations able to support innovation.
- Design diets suited to elder needs as a function of lifestyle and health status.
- Define communication means aiming to educate the elderly in food choices that promote a long, active and healthy life.

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Active Ageing and Healthy Living
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Positive Technology for Healthy Living and Active Ageing

Giuseppe RIVA [a,b1], Andrea GAGGIOLI [a,b], Daniela VILLANI [a], Pietro CIPRESSO [b]
Claudia REPETTO [a], Silvia SERINO [b], Stefano TRIBERTI [a],
Eleonora BRIVIO [a], Carlo GALIMBERTI [a], Guendalina GRAFFIGNA [a]
[a] *Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy*
[b] *Applied Technology for Neuro-Psychology Lab. Istituto Auxologico Italiano, Milan, Italy*

Abstract. Information and communication technologies are widely and rapidly spreading in people's daily lives. But what is the possible role of the mass proliferation of digital devices in supporting healthy living and active ageing? Are they useful in fostering personal growth and individual integration of the elderly, by promoting satisfaction, opportunities for action, and self-expression? Rather, do they enhance automation, impose constraints on personal initiative, and result in compulsive consumption of information? In this chapter, we suggest that possible answers to these questions will be offered by the "Positive Technology" approach, i.e., the scientific and applied approach to using technology so that it improves the quality of our personal experiences through its structuring, augmentation, and/or replacement. First, we suggest that it is possible to use technology to manipulate the quality of experience with the goal of increasing wellness and generating strengths and resilience in individuals, organizations, and society. Then, we classify positive technologies according to their effects on these three features of personal experience - Hedonic: technologies used to induce positive and pleasant experiences; Eudaimonic: technologies used to support individuals in reaching engaging and self-actualizing experiences; Social/Interpersonal: technologies used to support and improve the connectedness between individuals, groups, and organizations. Finally, we discuss the possible role of positive technologies for healthy living and active ageing by presenting different practical applications of this approach.

Keywords: Positive Technology, Active Ageing, Healthy Living, Engagement, Resilience, Positive Psychology, Intergenerational Reminiscence, Well-Being

Introduction

The development of new communication technologies has changed the way many of us interact and live. Internet communication systems and social networking sites, such as Facebook, Instagram, and WhatsApp, have revolutionized the way younger people communicate. However, this is not the case for people over 65; recent research has shown that they have been largely excluded from this revolution and the benefits it brings [1].

[1] Corresponding Author: Department of Psychology, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: giuseppe.riva@unicatt.it

But what is the possible role of the mass proliferation of digital devices in supporting healthy living and active ageing? Are they helpful in fostering personal growth and individual integration of the elderly by promoting satisfaction, opportunities for action, and self-expression? Rather, do they enhance automation, constraints on personal initiative, and compulsive consumption of information?

In this chapter, we suggest that possible answers to these questions will be offered by the "Positive Technology" approach, i.e., the scientific and applied approach to the use of technology for improving the quality of our personal experience through its structuring, augmentation, and/or replacement [2-7]. Specifically, in the following paragraphs, we discuss the possible role of positive technologies for healthy living and active ageing [8] by presenting different practical applications of this approach.

1. The Relevance of Positive Technology for Active Ageing and Healthy Living

Ageing is associated with decline in physical health, mental well-being and functional abilities. Fortunately, age-related declines can be delayed by improving the quality of the personal experiences of the elderly [9, 10]. A common approach that can be used to reach this goal is lifestyle interventions that promote well-being in older people [9]. In this paragraph we suggest that technology, too, may play an important role in this process.

1.1. From Well-being to Personal Experience

According to the World Health Organization, "Mental Health" is defined as follows [11]:

> "Mental health is a state of well-being in which the individual realizes her or his own abilities, can cope with the normal stresses of life, can work productively, and is able to make a contribution to his or her community."

This definition clearly identifies both well-being and positive functioning as core elements of mental health. But what is well-being?

It is possible to define "subjective well-being" as the cognitive and/or affective appraisal of one's own life as a whole, while the term "psychological well-being" refers to the optimal functioning of the individual and includes concepts such as flow, hope, and resilience [12]. Both definitions, however, have their starting point in the personal experience of the individual: high well-being means that, in some sense, the individual's personal experience is positive.

According to Merriam Webster's Collegiate Dictionary (http://www.merriam-webster.com/dictionary/experience), it is possible to define experience both as "a:) direct observation of or participation in events as a basis of knowledge" (subjective experience) and "b: the fact or state of having been affected by or gained knowledge through direct observation or participation" (personal experience).

However, there is a critical difference between subjective experience and personal experience [6]. If subjective experience is the experience of being a subject (experience as subject), personal experience is the experience that affects a particular subject (experience as object). This simple shift suggests that, independently from the

subjectivity of any individual, it is possible to alter the features of our experience from the outside [5-7].

Cognitive psychology has shown how the characteristics of our personal experience are influenced by the degree of sensory stimulation, sensory perception, and the meanings and values attributed, and the emotions elicited by the experience itself [13]. So, we can have relevant experiences, positive or negative, that, then, we remember for a lifetime and we can have experiences that we forget as soon as they end. Further, most of our experiences are cultural and interpersonal activities in which individual experience is connected to and/or mediated by collective experience [13].

Finally, clinical psychology has clearly shown that personal change occurs through an intense focus on a particular experience [14] By exploring this experience as thoroughly as possible, the subject can relive all of the significant elements associated with it and make them available for reorganization [15].

In other words, personal experience becomes the dependent variable that may be manipulated by external researchers.

2. Positive Technology for Improving the Quality of our Personal Experience

The characteristics of personal experience suggest that it is possible to manipulate its quality with the goal of increasing wellness, and generating strengths and resilience. But how is it possible to achieve this goal?

The emerging discipline of Positive Psychology, which focuses on the bio-psycho-social aspects of cognitions, emotions, and positive experiences [16, 17], provides a useful framework for guiding our efforts. Positive Psychology can suggest how to develop technological systems and applications that foster positive emotions, promote personal growth, and support creativity, thereby contributing to social and cultural development.

Martin Seligman, who is considered the father of the Positive Psychology movement, identified the "three pillars" of the good life in his book "Authentic Happiness" [18]:

- *the pleasant life*: achieved through the presence of positive emotions;
- *the engaged life*: achieved through engagement in satisfying activities and the utilization of one's strengths and talents;
- *the meaningful life*: achieved through serving a purpose larger than oneself.

More recently, Seligman introduced the PERMA model, an acronym for the five pillars of well-being, i.e., positive emotions, engagement, relationships, meaning, and accomplishment [19].

Starting from a similar perspective, Keyes and Lopez posited that positive functioning is a combination of three types of well-being, i.e., 1) high emotional well-being, 2) high psychological well-being, and 3) high social well-being [20].

To summarize, Positive Psychology identifies the three characteristics of our personal experience that serve to promote personal well-being, i.e., affective quality, engagement/actualization, and connectedness.

In the proposed framework, positive technologies are classified according to their effects on these three features of personal experience (Figure 1):

- *Hedonic*: technologies used to induce positive and pleasant experiences;

- *Eudaimonic*: technologies used to support individuals in reaching engaging and self-actualizing experiences;
- *Social/Interpersonal*: technologies used to support and improve social integration and/or connectedness between individuals, groups, and organizations.

For each level we will try to identify critical variables that can be manipulated and controlled to design and develop a positive technology.

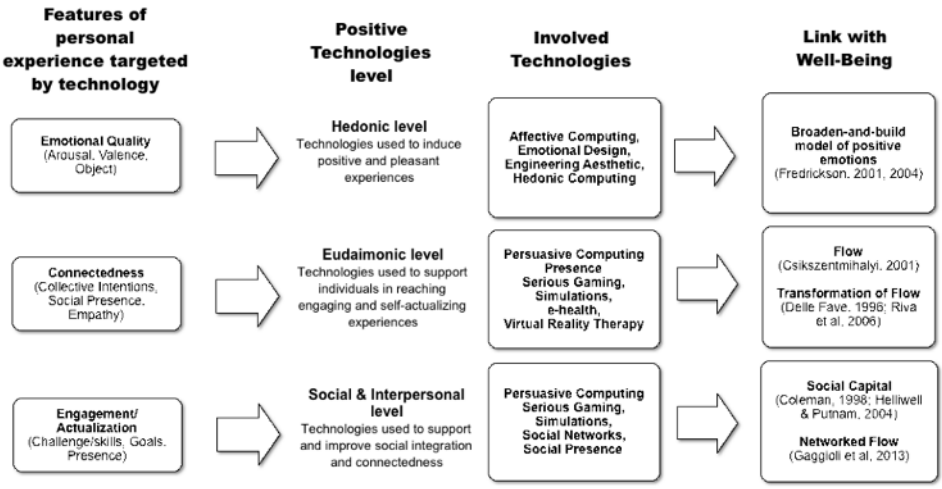

Figure 1. Positive Technology levels (Adapted from [8])

2.1. Hedonic level: using technology to foster positive emotional states in the elderly

The first dimension of Positive Technology concerns how to use technology to foster positive emotional states. According to the model of emotions developed by James Russell [21], it is possible to modify the affective quality of an experience through the manipulation of "core affect," a neurophysiological category corresponding to the combination of valence and arousal levels that endow the subjects with a kind of "core knowledge" about the emotional features of their experience.

The "core affect" arise from a free-floating experience or a specific cause, thus, giving rise to an emotional experience or event. In this view, an emotional response is the attribution of a change in the core affect given to a specific object (affective quality). Simply put, a positive emotion is achieved by increasing the valence (positive) and arousal (high) of core affect (affect regulation) and by attributing this change to the contents of the proposed experience (object).

Key arguments for the usefulness of positive emotions in increasing well-being were provided recently by Fredrickson [22, 23] in what she called the "broaden-and-build model" of positive emotions. According to Fredrickson, positive emotions provide the organism with nonspecific action tendencies that can lead to adaptive behavior [22]. The second proposition of Fredrickson's model concerns the

consequences of positive emotions, i.e., by broadening an individual's awareness and thought–action repertoire, they build upon the resultant learning to create future physical, psychological, and social resources [23].

Different studies have shown that a possible path for improving positive emotions is the use of meditation, in particular mindfulness [24-26]. Mindfulness is a psychological mindset that is focused on being aware of novelty in personal experience and perceiving differences in contexts and events, disrupting stress pathways and possibly having direct beneficial effects on physiological arousal systems [27].

Epel and colleagues, in their review of the effects of mindfulness, suggested that meditative practices improve the endocrine balance toward positive arousal (high DHEA, lower cortisol) and decrease oxidative stress, slowing the rate of cellular aging [24]. They concluded:

> "Thus, meditation practices may promote mitotic cell longevity both through decreasing stress hormones and oxidative stress and increasing hormones that may protect the telomere." (p. 49).

In this process, the role of technology is quite simple, i.e., to facilitate meditation. Our team developed different immersive (computer-based) and non-immersive (tablet-based) virtual reality experiences to improve meditation abilities in untrained individuals [28-32]. The feeling of presence and the immersive visual cue provided by virtual reality (VR) are known to facilitate relaxation, reduce stress, and improve positive emotional states [33-36].

For example, in the "Green Valley" experience, different narratives were presented together with a very relaxing virtual environment showing a mountain landscape around a calm lake. After being immersed in the Green Valley, participants were asked to walk around the lake, to observe nature, and, after few minutes, to virtually sit on a comfortable deck chair and relax[28; 29; 37].

When aimed at relaxation, VR lends itself to be associated with biofeedback training [38, 39]. Biofeedback is a coaching and training technique that helps people learn how to change their physiological response patterns in order to improve their mental and emotional functioning [40]. The person is connected to psychophysiological biosensors and uses the information provided as feedback to increase awareness or consciousness of the changes in the functioning of the body/mind [41].

As recently suggested by different authors [42-44], meditation and biofeedback have the potential for enhancing the functioning of the frontal lobe, which is usually reduced in the elderly.

2.2. The Eudaimonic Level: Using Technology to Promote Engagement and Self-Empowerment in the Elderly

The second level of Positive Technology is strictly related to the eudaimonic concept of well-being, and it consists of investigating how technologies can be used to support individuals in reaching engaging and self-actualizing experiences.

The theory of flow, developed by Positive Psychology pioneer Mihaly Csikszentmihalyi [45], provides a useful framework for addressing this challenge. As discussed in the first chapter, flow or optimal experience, is a positive and complex state of consciousness that is present when individuals act with total involvement. The basic feature of this experience is the perceived balance between high environmental

opportunities for action (challenges) and adequate personal resources in facing them (skills). Additional characteristics are deep concentration, clear rules in and unambiguous feedback from the task at hand, loss of self-consciousness, control of one's actions and environment, positive and intrinsic motivation.

A recent study [46] demonstrated that older adults have the capacity to experience flow when cognitive capacity and intellectual demands are synchronized. Specifically, the older adults who are generally resource-rich have the capacity to be more absorbed by activities of higher cognitive demand as opposed to resource-poor individuals, who are more absorbed with activities of lower cognitive demand.

Here, too, interactive and immersive technologies, such as serious games, robots, or VR, are considered to be the most capable of supporting the emergence of this experience [47-52]. The research that has been conducted to date highlights some key characteristics of technology as a possible source of flow, i.e., (a) *opportunities for action (goals and rules)* – due to its flexibility and interactive and immersive technologies, it provides designers with the possibility of creating a wide range of increasingly challenging situations and tasks; (b) *feedbac*k – interactive and immersive technologies can offer multimodal feedback to individuals' actions and behavior [49, 53]. A study by Belchior and colleagues [54], in which older adults' levels of engagement with a video game training program were investigated, supported this vision. In the study, subjects were more engaged in games that could be adjusted to their skill levels and that provided incremental levels of difficulty.

Starting from these theoretical premises, Riva and colleagues [38, 47, 55] suggested the possibility of using VR for a new type of applications in positive mental health for the ageing based on a strategy defined as "transformation of flow." This strategy is based on a person's ability to draw upon an optimal experience induced by technology and use it to promote new and unexpected psychological resources and sources of involvement.

The proposed approach consists of the following activities (Figure 2). First, using positive technologies to offer an enriched environment that contains *functional*, real-world demands (e.g., finding objects, assembling things, and buying stuff); second, using the technology to provide tasks (challenges) that are to matched to the cognitive capacity of the individual (skills) and to enhance the level of Presence (the feeling of being "inside" the technological experience [56, 57]) to induce an optimal experience; third, allowing cultivation by linking this optimal experience to the actual experience and skills of the subject [55]. The expected effect is a functional reorganization of the brain produced by the broadening of the thought-action repertoire associated with improved self-esteem and self-efficacy.

The first proposed claim, i.e., the possibility of using positive technologies for creating enriched environments offering real world demands, is demonstrated by the Virtual Multiple Errand Test (V-MET) [58, 59]. The V-MET is a VR version of the Multiple Errands Test [60]), which is usually performed at a real shopping mall or in a hospital environment and involves the completion of various tasks with rules that must be followed within a specified time frame. The VR version enables the active exploration of a virtual supermarket in which individuals are requested to select and buy various products presented on shelves. Correlations between Virtual Multiple Errands Test variables (e.g., errors and execution time) and some traditional executive functions measures provide preliminary support for the ecological and construct validity of the VMET. In addition, the performances obtained with the Virtual Multiple

Errands Test provided the ability to distinguish between clinical and healthy populations and between two age-related control groups [58, 59].

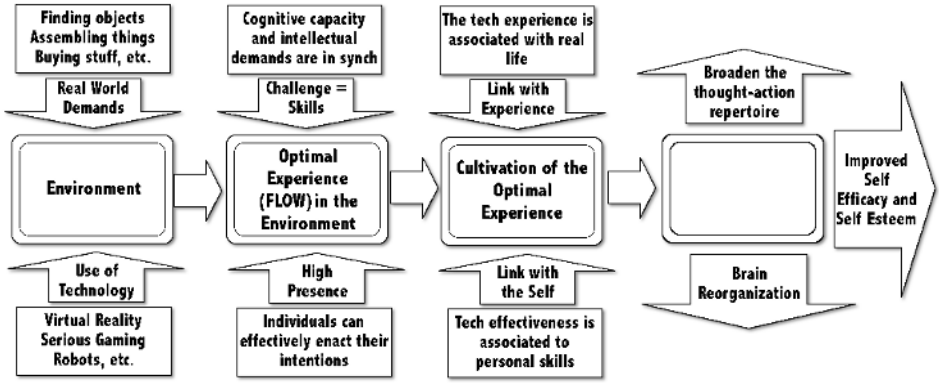

Figure 2: Transformation of Flow

The second proposed claim – the possibility of using positive technologies for fostering optimal experiences in the elderly – was demonstrated by the "V-STORE Project" [61, 62]. The researchers investigated the quality of experience and the feeling of Presence in a group of 10 patients with frontal lobe syndrome involved in VR-based cognitive rehabilitation [61]. They used the ITC-Sense of Presence Inventory Test [63] to evaluate the feeling of Presence induced by the VR sessions. The findings highlighted the association of VR sessions with both positive affect and a high level of Presence.

The third claim – the use of transformation of flow for producing some form of functional reorganization in the elderly who are able to improve their cognitive abilities – received preliminary support by the work of Optale and his team [64, 65]. These authors investigated the experience of elderly individuals with memory deficits engaged in a six-month, virtual-reality, rehabilitative experience, including auditory stimulation and path-finding. The study also included a control group that had equivalent, face-to-face training sessions using music therapy. Only the VR group showed significant improvements in the memory tests, especially in long-term recall with an effect size of 0.7 and in several other aspects of cognition. Thus, the results that were showed that this approach was able to improve memory function [64, 65].

2.3. The Social and Interpersonal Level: Using Technology to Promote Social Integration and Connectedness in the Elderly

The final level of Positive Technology, i.e., the social and interpersonal level, is concerned with the use of technologies to support and improve the connectedness between individuals, groups, and organizations.

Despite the fact that creating and maintaining social relationships is considered a major indicator of well-being and a protective factor for health [66], Western society is characterized by increasing levels of loneliness and lack of social integration. The need for social integration is higher in elderly people. As a consequence, healthcare policies have become increasingly interested in supporting mental health and rehabilitation

programs aimed at overcoming social isolation. Information and communication technologies can have a key role in improving such programs.

An open challenge is to develop an understanding concerning how technology can be used to create a mutual sense of awareness, which is essential to the feeling that other participants are there and to create a strong sense of community at a distance. However, different authors have suggested that it is possible to manipulate the technological experience to enhance social presence, i.e., the feeling of being with others.

Recently, Riva and colleagues [67, 68] suggested that a subject is present within a virtual group if he or she is able to put his or her own intentions (presence) into practice and is able to understand the intentions of the other members of the group (social presence). This implies that, to sustain experiences that are optimal socially (networked flow), the technology must provide the virtual group with the possibility of expressing itself and of understanding what each individual member is doing [69]. In addition, Gaggioli and colleagues [70] posited that the optimal state of the group is achieved when the team develops a "we-intention," in which the actions of the individuals and of the group are merged, and the group acts as an autonomous, self-organizing entity [71].

An interesting example of this approach is the use of technologies to improve inter-generational reminiscence [72]. Inter-generational reminiscence offers the potential for reducing existing barriers between generations by transmitting the heritage of folk traditions and by triggering the interest of younger people concerning their roots [73]. To facilitate this process Gaggioli and colleagues used an interesting approach: a) the elderly narrated their life experiences they liked most or that they found more meaningful to share with their young audience; b) during storytelling, children were encouraged to express their interest towards specific aspects of the reminiscence and ask questions; c) the older adults were asked to collect material (photographs, letters, newspaper articles, etc.) that could help them document the aspects of their memories selected by the young audience; d) to allow further discussion and sharing, older and younger participants reported the content of the most interesting reminiscences in a website, by integrating texts with multimedia objects. Different examples of collected reminiscences are available on the project's website Nostalgia Bits (http://nobits.it/).

Analyses of pre- and post-intervention measures showed that even three two-hour sessions of group reminiscence activities had a positive impact on elderly psychosocial wellbeing: they reported significantly over values of loneliness and an increase in perceived Quality of life. Further, results indicated that following their participation in the program the children's attitude towards the elderly positively changed in a positive way [72].

In a different study, Auburn University's Harrison School of Pharmacy created a Facebook page – Countryside Diabetes (http://goo.gl/ZPqsSE) - to provide ongoing education and support for elderly people affected by diabetes. As reported by the authors, membership and participation to Facebook page continue to grow among the senior population [74].

Following this vision, Morris [75] described how social-networking and pervasive computing technologies can be used effectively to help reduce feelings of social isolation and depression in elderly people. In the approach Morris presented, sensors were introduced into selected elders' homes and used to measure data concerning the numbers of phone calls and visits that occurred. These data were viewed as indicative of public displays of social interactions with relatives and friends. The findings indicated that this strategy was effective in reducing the feeling of social isolation of the elderly [75].

3. Conclusions

Due to advances in treatment and people's living longer, chronic diseases are becoming more common among our population. This is a leading contributor to the increasing burden on our current healthcare system. In fact, over 83% of the money spent annually by the European Union on healthcare is used for the treatment of chronic diseases, such as heart disease, stroke, and cancer [76]. To reduce this burden and sufficiently meet the needs of this growing segment of the population, healthcare organizations must encourage the elderly to take a more active role in caring for their own health and well-being. Technology may offer a solution to this shortcoming. "Positive Technology" [7] focuses on the use of technology for improving the quality of our personal experience, and it suggests specific strategies for modifying/improving each of the different dimensions involved and for generating motivation and engagement in the process [77]. In this chapter, first, we classified positive technologies according to their effects on the features of personal experience (Figure 1):

- *Hedonic*: technologies used to induce positive and pleasant experiences;
- *Eudaimonic*: technologies used to support individuals in reaching engaging and self-actualizing experiences;
- *Social/Interpersonal*: technologies used to support and improve the connectedness between individuals, groups, and organizations.

In addition, we identified critical variables for each level, i.e., regulation of affect (Hedonic); flow and presence (Eudaimonic); and social presence, collective intentions and networked flow (Social/Interpersonal). These variables can be manipulated and controlled to guide the design and development of positive technologies for the elderly. Different examples were presented and discussed.

The use of Positive Technology tools and strategies allows the expansion of healthcare beyond the traditional doctor's office and the hospital to include advanced simulation technologies, such as virtual reality, serious gaming or augmented reality, and spontaneous peer networks that encompass and utilize the properties of Web 2.0, e.g., blogs and online communities, which are among the main fixtures of 21st century living [78]. Prompted by positive technology, the change from a "disease-centered" to a "citizen/client" model based on the engagement of patients in the management of their care will benefit elderly people who are not as mobile as other people. Also, it will benefit those who cannot easily obtain proper care from a doctor's office or a hospital, where healthcare is commonly administered. This change will make the lives of the elderly population easier and more fulfilling as well as reduce the economic burden on our stressed healthcare systems.

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Active Ageing: Intergenerational Relationships and Social Generativity

Giovanna ROSSI [a1], Lucia BOCCACIN [b], Donatella BRAMANTI [b], Stefania G. MEDA[b]
[a] *Centro di Ateneo Studi e Ricerche sulla Famiglia, Università Cattolica del Sacro Cuore, Milan, Italy*
[b] *Università Cattolica del Sacro Cuore, Milan, Italy*

Abstract. This contribution is a reflection on the concept of active ageing from the perspective of relational sociology. At the same time, it offers practical implications and outlines possible future courses of action, in the face of demographic and relational scenarios rapidly changing, and the challenges that each day people of all generations are called to cope with. Active ageing is quite a recent concept and indicates an attitude towards ageing that enhances the quality of life as people become older. The goal of active ageing is to enable people to realise their potential for physical, social and mental well-being and to participate in social life also in the last stage of the life cycle. In this phase, the presence of a network of support, security and care adequate to the possible onset of problems and criticalities is crucial. Relational sociology frames the phenomenon of an ageing population in a dense network of social relations, primarily at the level of family and community. For this reason, as supported by the most recent sociological literature and evidence from studies conducted in Italy and abroad (cf. SHARE), it is extremely important to investigate the link between active ageing, intergenerational orientation (solidarity and exchanges) and practices of pro-sociality (i.e. engagement in third-sector activities and volunteering in later life).

Keywords. Active ageing, Ageing, Relationships, Agency, Family, Third Sector

1. Defining Active Ageing: a Sociological Approach

Active ageing is "the process of optimising opportunities for health, participation and security in order to enhance quality of life as people age"[2]. The goal of active ageing is to enable people to realise their potential for physical, social and mental well-being and to participate in social life also in the last stage of the life cycle. In this phase, the presence of a network of support, security and care adequate to the possible onset of problems and criticalities is crucial.

The dimension of *activity* is today indicated as the means to prevent mental and physical decline, to the benefit of both the individual (who will thereby succeed in maintaining a significant level of quality of life) and the entire social context [1-3].
In the concept of *activity* applied to the condition of the elderly there lie both an individual and a social dimension. As regards the former, choosing to play an active

[1] Corresponding Author: Centro di Ateneo Studi e Ricerche sulla Famiglia, Università Cattolica del Sacro Cuore, Milan, Italy; E-mail: giovanna.rossi@unicatt.it.
[2] See Decision No. 940/2011/UE of the European Parliament and of the Council of 14 September 2011 on the European Year for Active Ageing and Solidarity between Generations (2012) www.eur-lex.europa.eu.

role also in old age presents itself, first of all, as a subjective option which calls into play the full range of the physical, psychological, relational, ethical and value-related resources available to the individual. Dilution of professional constraints can indeed allow one to approach dimensions of personal commitment and engagement not accomplishable during one's working life, in a framework of physiological "rejuvenation" produced by the biological revolution that pushes forward what can be defined as "the oldest age." The origin of the propensity for *activity* is therefore to be sought in the individual motivations and resources of the elderly person resulting from the experiences of a lifetime.

This personal option assumes, however, specific social significance because, through *activity,* it is possible for the individual to experience that intersubjective and associative dimension that has so large a part in the perception of being playing a satisfactory social role [4]. In this perspective, the past, the expertise and the experience of the elderly provide consistency to the social dimension of *activity,* becoming actual resources for everyone.

The capacity for action of the individual (*agency*, see [5]) is viewed as a combination of both the cultural and structural emerging properties of the relational networks.

1.1. The Perspective of Relational Sociology: Active Ageing and Family Relations

In our studies we embrace the perspective of relational sociology [6], which observes the individuals as included in networks of significant relationships[3]. From this point of view, the family is seen as the basic social relation, the spring of society, capable of establishing alliances between genders and generations. Furthermore, the family – insofar as it fully expresses its social subjectivity - creates forms of sociality and promotes forms of prosocial belonging for its members.

According to this approach, one can analyse the different ways of living this stage of life on the part of the active elderly by combining the (referential) components of meaning with the resources available to them and the rules (structure) that underlie intergenerational exchanges.

From this perspective, one can observe the presence / absence of a generative dimension understood as the capacity / possibility of individuals to contribute to the common good and to experience a good quality of life.

The family – insofar as it embodies a relation of full reciprocity between genders and generations [7] – has always been the privileged place of encounter / clash or, in other words, of comparison between generations.

In effect, if at the physical, biological and psychological levels, differences regard the psycho-physical conditions of individuals, at the relational level it is indeed the inclusive abilities [8], the primary forms of belonging that involve one's family, as well as friendship and informal networks that exert an influence.

As known, the demographic changes taking place over the past few decades have altered the living conditions of the elderly [9].

In particular, the self-sufficient elderly represent today an increasingly larger share of the over-65 population. They mainly live in families of rather limited size from the

[3] The expression "social relationship" is defined by three fundamental semantics (modes of conceptualization): referential, structural and generative semantics.

point of view of the number of members[4], characterised by the simultaneous presence of several generations (multigenerational families, involving three or more generations) although not cohabiting.

According to some scholars, increase in longevity and delayed childbearing have contrasting effects on the generational structure of European families [10]. If, on the one hand, an increase in life expectancy results in the co-presence of more living generations than in the past – up to five generations in some cases --, on the other hand, a low birth rate leads to a relatively large generational gap thus reducing the probability of the co-presence of multiple living generations.

Multiple generations families – the so-called "*beanpole families*" [11] – display relatively few horizontal (intragenerational) ties and numerous vertical (intergenerational) relationships [12]. The data collected through the SHARE research *(Survey of Health, Ageing and Retirement in Europe)*[5], and specifically in the third weave, revealed a rather varied distribution of those families including three or four generations in the eleven European countries involved in the survey. In a context in which, as inferable from the demographic picture outlined above, individuals and generations share a greater number of years of life, multigenerational families constitute support networks [13], both manifest and latent, which are frequently activated in critical moments. In this sense, the intergenerational ties that intertwine in these new realities have assumed increasing significance and importance in the advanced industrial societies. In a context marked by increased marital instability, it is for instance worth reflecting on the role of grandparents and on the relationship between these and their grandchildren in the event of parents' separation and divorce. In particular, studies have evidenced the crucial role played by the figure of grandparents in coping with the needs of the family, as they embody the matrix of strength and resilience of solidarity between generations over time. As highlighted by the American sociologist Bengtson [14], intergenerational relationships in multigenerational families, marked by solidarity and increasingly important in the life of the individual and the family, display different characteristics and functions, and entail obligations that nowadays seem more relevant to the well-being and support of individuals and families than the obligations underlying the reality of the nuclear family. In particular, Bengston relates the importance of intergenerational relationships in contemporary North American society to three fundamental motives, namely demographic change (the change in the age structure of society and of the family, resulting in a greater number of "shared" years, which has increased opportunities for interaction and exchange between generations); the greater strength and variety of ties over time; and increased marital instability in recent decades, which has weakened the ability of the nuclear family to cope with the socialising task of children and with the support of its members.

[4] In Italy, the average family size is below three units (2.4 components per family).

[5] The survey was conducted in different "waves" (respectively in 2004, in 2006-07, in 2008-09 and in 2010-11) in a number of European countries that increased over the years. The survey is designed to investigate the health and economic conditions, the family realities and the support networks of over 45,000 individuals aged 50 or above. The third survey (SHARELIFE, 2008-09) focused on the life histories of 30,000 men and women, interviewed in thirteen European countries; as a result of this phase, it was possible to cross-examine micro-data drawn from individual life histories and macro-data relative to the institutional context and the welfare state.

1.2. Active Ageing and Prosocial Relationships

A further viewpoint on active ageing, according to the relational perspective, is represented by the prosocial and solidarity relationships that the elderly can experience in organisations of different types (such as those pertaining, for example, to the third sector, see [15]), and by the elderly's social generativity.

By participating to third-sector organisations, the elderly respond to a strong push for solidarity that gives rise to networks of mutual help. At the same time, associative relationships, *i.e.* relationships that can be experienced and performed in associative realities, allow the elderly involved to draw from them a certain level of personal well-being.

Socialising assumes a positive meaning for the elderly because it stimulates the activation of the behavioural, material, relational and communication resources available to them. In the group, the elderly feel they are members of a community and of a collectivity in which they play a particular role, and through the mediation of associations they can assume or reinforce a specific social identity. In the group / association, the elderly rediscover the value of dialogue, and find satisfaction to their needs of expression, sociality and, in some cases, solidarity.

In brief, with reference to prosocial orientation and participation of the active elderly in third sector associations, three characterising social elements can be detected:

- A first element relates to the reinforcement of basic principles, such as participation and self-realisation of the elderly. Through social action provided by associationism, the skills, *know-how* and specific interests of the elderly do indeed find social expression.
- A second element, which is closely related to the former, concerns the process of consolidation of the social identity of the active elderly, which, through associative activity and life, occurs both at the individual and the intersubjective level. In effect, the elderly, through the experience of associative belonging, discover a social position for themselves, which is not imposed but rather chosen on the basis of their own personal values of reference (subjective level). Moreover, the presence of a new social actor, represented by associationism promoted by the active elderly, introduces a *quid* of relational, organisational, structural, cultural and value-related resources that flow through the different levels of social life – from the local, which is closer to associations, to the national and international levels, which have less chances to be experienced in everyday life but are present as the horizon within which one can position one's social action, or as a paradigmatic framework for comparison and for the construction of one's identity (intersubjective level).
- The third element that emerges as a distinctive trait of the forms of associationism promoted by the elderly refers to the multiple process of social identity construction, which occurs associatively. In other words, the associations promoted by the elderly constitute a multipurpose entity, that is, capable of serving and interacting at multiple levels – from that of the experience of the elderly person, to the local, national, European and international levels – using different tools and resources and introducing a specific product in each of these areas.

In a phase of life that for the over-65 sees an increase of personal time not prescriptively saturated with professional commitments, self and mutual help as well as associative engagement represent significant options of life.

1.3. Active Ageing and Intergenerational Orientation: the Exchange Dynamics

The importance of a broad perspective of observation of the condition of the elderly, which allows delving into its different specifications, is also highlighted by the choice made by the European Union to declare 2012 the European Year for Active Ageing and Solidarity between Generations.

This denomination includes a significant interpretive key, namely intergenerationality that allows the interpretation of the relationships between members of different generations as a fundamental step to proceed towards a society in which all ages rightly belong.

At this point, it is important to observe closely the functioning of the give-receive-return dynamics between generations and in the different stages of the family life cycle. This means identifying the generations directly involved in the exchanges, the polarity from which and to which proceed the exchanges themselves, as well as the opportunities and moments in which these are accomplished, and their content. Under this last point of view, we shall bear in mind that between generations there can be material, psychological, emotional and relational support and help. In particular, relational support can be exemplified by the relationship between grandparents and grandchildren in the event of parents' separation. In this situation, grandparents become indeed key figures also for the construction of the networks of relationships of their grandchildren, especially if the latter are very young.

In the exchanges enabled by intergenerational relationships, the dimension of gratitude is especially important, which, from the psychological point of view, is understood as the feeling of surplus and positive recognition of limits.

Those who are grateful feel that their life was benefited by someone, that their being and well-being do not merely depend on their own abilities and potential but are also the result of the benevolent action of others in their favour. In particular, for the active elderly a link can be hypothesised between gratitude, personal well-being and prosocial behaviours.

2. The State of the Art

Existing studies and research on active ageing of the population have been mainly conducted, both nationally and internationally, within specific disciplines, such as economics, demography and epidemiology, with a particular focus on the prolonged and nowadays problematic permanence of the elderly in the labour market, on health conditions, on the onset of specific diseases.

In the debate, sociology has introduced conceptual categories and dimensions relative to the use of free time, to consumption styles, to modes of media and new media usage.

A specific dimension introduced by relational sociology is, as illustrated above, the focus, in the transition towards old age, on the family dimension and - more specifically - on the generational dimension, in terms of care and solidarity.

Furthermore, the perspective of "active ageing", investigated not only through the evaluation of structural (presence/absence of disease conditions) and economic (lengthening of production and consumption age) parameters but also through cultural (symbolic and value-related level) and social (civic and prosocial engagement)

parameters offers reflections and factual information for sustainable and innovative *welfare* management.

2.1. A Relational Approach to Well-Being in Later Life

The belief that well-being manifests a relational dimension, and the view that such well-being can be pursued through participation in associative forms and relationships do often intertwine. In this perspective, the intersubjective relational processes that occur in specific organisational contexts become fundamental interpretive keys of emerging social phenomena like associationism by the elders as aimed to the involvement of their peers.

As several studies have indeed documented, the well-being of the elderly is multidimensional, in the sense that well-being brings into play a number of factors: psycho-physical, socio-economic, relational, and participative ones [16,17]. In other words, the well-being of individuals in general - and of the elderly in particular - tends to present itself as a set of needs, elements and relationships that can be increasingly more integrated socially, and increasingly less integrated systemically [18]. In effect, those well-being factors that can be systemically controllable, accumulated and distributed do lose importance, whereas in wellbeing-generating processes it is the different and articulated forms of sociality, both informal and associative, that gain importance. Nowadays, well-being in complex societies, in those cases in which it can regenerate itself and assume forms that are neither narcissistic nor privatistic, is, and is increasingly becoming, a social relationship. The idea that well-being more and more often manifests a relational dimension, and the notion that this well-being is to be produced by new associative relationships and forms go hand in hand.

There is a close link between *agency, activity* and both personal and intersubjective well-being: therein play a crucial role the attributions of meaning that occur in and through relationships, as Donati explains pointing to "l'esigenza di rendere riflessive le relazioni sociali, oltre gli individui in se stessi, perché sono le relazioni a fare la qualità sociale del *welfare*"[6] [8, p. 276].

The propensity for *activity* of the elderly tends to fall within a double interpretive scenario: it can be both a time for oneself and a time for the benefit of others.

The first approach is explicitated by a conception marked by expressiveness and the pursuit of one's personal autonomy.

The second approach, relative to the prosocial propensity of the elderly, refers to both primary and informal networks and to unrelated third parties, and highlights the crucial role played by these both as care-givers *(providers of care)* and helpers (*recipients of care)* in different situations [15]. In particular, the contribution of the elderly in primary networks becomes increasingly essential with the spreading of dual-career *(dual breadwinner)* family models, as some surveys have documented [11,19]. Specifically, the care of grandchildren by grandparents is a crucial intergenerational relationship within which occurs an important transmission of material and symbolic exchanges. From the point of view of the *modus vivendi*[7] of the people, in the context

[6] "the need to make reflective the social relationships, as well as the individuals themselves, because it is the relationships that shape the social quality of welfare".

[7] According to the English sociologist Margaret Archer, the lifestyle of people is to be understood in terms of a constellation of interests shaped on the basis of the ranking that individuals attribute to their priorities. The author argues that we are what we take care for, that is to say, our personal characteristics are the mirror and the consequence of what we attribute the highest value to.

of family relationships and of the hierarchy of priorities, different trends become visible: a closeness between generations, as evidenced by a dense network of exchanges and support and by interesting differences at the European level [20], which is however not immune to a certain degree of ambivalence.

2.2. Different Profiles of Active Elders: Evidence from the SHARE Data

In a specific discussion conducted on a multivariate analysis of the SHARE data [21], three different profiles emerge as related to *active ageing* and intergenerational exchanges:

- "Individualistic withdrawal": the individuals in this category, representing most young elderly, display a situation that is definitely "at risk". Reluctance towards active ageing is indeed closely correlated with low quality of life.
- "Competitive ambivalence": for the individuals in this category, active ageing means selective commitment to either family or society. What is of concern is that when the ambivalence resolves towards the support between generations, there emerge stress indicators as well as, consequently, negative implications on life quality. With respect to this group, appropriate policies to support exchanges between generations would allow the elderly to recover a better quality of life, as also to avoid living competitively the double opportunity of engageing in social work, putting to use the experience of a lifetime, and of answering the needs of support of sons/daughters and grandchildren, especially in the current economic crisis.
- "Socio-generativity": the individuals in this category are able to combine positive commitment to family and society (full active ageing). They show indeed a high quality of life perception, which suggests that they could be more likely to keep it high in the future.

The focus on the relationships between generations that recent research [22] has again brought to the fore enables a more adequate understanding of the ways in which people live, keep alive their fundamental ties and articulate their lifestyles [5].

The observation of the ties existing between generations is sociologically relevant as it allows the identification of what results from them in terms of generativity, that is, the constructive results of relational surplus [23] that prompt those belonging to different generations to assume active social behaviours, and that can give life to interventions that are innovative in form and, at times, in substance.

In intergenerational relationships occur material and symbolic exchanges: in other words, generational transmission takes place.

The intergenerational relational perspective [8] wishes to emphasise the quality of the relationships between members of different generations as a crucial step for people to realise their potential for physical, social and mental well-being and their participation in social life in all its aspects. Living longer in effect corresponds to a longer period of (real or "distance") cohabitation of at least three generations (grandparents, children, grandchildren), and this enables relational exchanges, whose presence or absence and corresponding subjective positive or problematic perception have to do with the quality of life of the elderly as also of all the other generations [24-27].

However, focussing on intergenerational relationships inevitably entails identifying their ambivalence.

2.3. The Challenges of Ageing: Intergenerational Relationships and Ambivalence

Ambivalence is a complex quality of relationships: this category, applied to intergenerational relationships [28], allows one to identify the aspect of risk inherent in them. Ambivalence is generated by the remarkable plurality and fragmentation of the elements involved in intergenerational relationships, which combine according to opposing strategies [29].

This aspect of risk – sometimes inherent in intergenerational relationships – seems to find no room in most part of post-modern reflection, which tends to flatten out on a unique and deterministic conception of intergenerational relationships which prescinds from focussing on their ambivalence.

Construing the relationships in this way not only prevents one from observing the existence of possible generativity between generations, but also contributes to thwart it at the social level [30].

In brief, a pattern of active ageing emerges that provides a representation of the final stage of existence as a "second life", in which one can benefit from good physical and mental efficiency in order to realise personal and social interests that one was not previously allowed to cultivate.

2.4. Our Current Research Activities on Active Ageing

Starting from these theoretical considerations and the analytical review of the state of the art, we realised a new research (cf. chapter written by F. Colombo and colleagues for preliminary results) pivoted on the relational dimension. Here relationships are intended as intergenerational support and significant elements to build sense of belonging and loyalty between the generations. They are also conceived as forms of engagement, and civic and voluntary participation. All these aspects are crucial to understand the concept of *activity* in later life. The first data available allow to attribute to the later stage of life a non-marginal role within our society.

In particular, voluntary activities are seemingly declined according to a personalized and non-conventional way, including civic orientation: 21.3% of the sample take part in block reunions, 61.4% give money for charity, and 83.9% voted at the last political elections. Participation to community initiatives (such as church or parish activities) is also practiced but not always according to the conventional ways and innovative and differentiated activities are often carried out.

A further analysis was conducted on the relation between intergenerational exchange and the active position of the elderly, starting from the hypothesis that the first is a significant causal determinant of the latter. The hypothesis is that the intergenerational context, where the active position can express itself, is more likely to be contingent (that is linked to the chance of engagement/socialization offered by the social context) or somehow "almost compulsory" (as the case of the intra-family care.) Vice versa, there might be an association between the generative quality of the intergenerational exchange and the active position assumed by the elderly, especially when the active engagement assumes a clear and relevant prosocial characteristic (voluntarism).

The theoretical and conceptual basis is that (personal and family) generativity transcends almost naturally in forms of social generativity. In the case of the elderly then it cannot be limited to a generic activism, or an activism mainly oriented to

maintain a vital and significant sense of self, nor it can be confined in a compensative aspect of the loss on social and relational centrality.

These premises are grounded also in the most recent psycho-sociological literature [31,32].

3. Operational Impacts

Observing how the population ages becomes thus crucial in order to understand the state of health of a society, test the tightness of its ties and put in place, also with a preventive view, strategies and measures of social inclusion and cohesion.

Our research group is therefore committed to theoretical reflection and empirical research so as to explore the dimensions of active ageing according to the equation that relates propensity for *activity* to *agency* of the individuals, and therefore to quality of life.

From these studies we expect to achieve a more extensive, and at the same time more in-depth, understanding of how the generations closer to passing on their 'generational leader' baton, namely the young elderly aged between 65 and 74, prepare to face the last phase of the life cycle. It is crucial to outline their profile at a national level, taking into account the essential steps of one's biographical background (marriages, separations or divorces, any reconstituted ties, presence of children and grandchildren, work and study paths and so on). For this reason, and always from a relational and family perspective, we expect to reconstruct the family types in which these generations live, yet without flattening out on a purely structural dimension, that is, aiming instead to also detect the circuit of any exchanges and gifts in which they participate. Care between generations is expressed not only within the narrow or wide family circle, but originates and is also reflected in relationality present in associative contexts and in active participation in the life of one's own community. For this reason, the survey currently conducted devotes much attention to the exploration of the activity of the young elderly in the social context through organised forms of prosociality. Intergenerational solidarity, the care of the younger and of the older generations are powerful indicators of a propensity of the young elderly to express their *activity* and their *agency* in the context of reference, with positive effects on themselves and the others. The survey we are conducting is thus expected to verify this hypothesis through an exploration of prosocial engagement of the elderly both with young people (forms of *mentoring* at the workplace, intergenerational programmes and activities at school, etc.), and with the 'oldest age' elderly, who are often not self-sufficient (supported through forms of associationism).

At the same time, through the investigation currently conducted, we expect to better delineate the profile of the generation of people aged between 65 and 74 in relation to their cultural consumption, *leisure* and entertainment opportunities, and - most importantly - access to the new technologies.

Once these key elements are outlined, a better knowledge can be achieved of the factors that facilitate or hinder active ageing, and of how it is related to a higher quality of life, which will ultimately allow one to devise, plan and implement interventions, measures and policies in favour of an inclusive and cohesive society in which any age can find room to express its social subjectivity.

Operationally, speculative investigation and empirical research that we are conducting can be employed as a platform to dialogue with other experts in the field, but also, and

above all, with other *stakeholders* actively engaged in family care and care of and with the elderly. In other words, speculative investigation and empirical research could be used as a *baseline* to interact with *policy makers* and public decision makers, with the third sector, with service providers and the families themselves, in order to concert strategies of enhancement, promotion and support that be increasingly participated, inclusive and effective.

We therefore expect to acquire key knowledge about ageing in Italy today and about the conditions that make people's lives better, from a relational perspective. The idea is thus to capitalise expertise and disseminate expected results, so as to promote a culture of good ageing that may entail the relational design of good practices aimed to reach conditions of material, psychological and relational well-being for all generations.

3.1. Expected Impact

In brief, the impact that we expect to produce through ongoing study and research can be articulated in the following points:

1. Providing a solid contribution about active ageing and intergenerational solidarity not merely in terms of academic debate but also with respect to practical implementation and policy advice.
2. Facilitating knowledge dissemination and networking among different stakeholders.
3. Fostering participation and knowledge sharing/organisation through a web portal (www.anzianiinrete.wordpress.com) which aims to enhance information and collective intelligence about active ageing, volunteering in later life and generating solidarity between generations.
4. Sensitising and raising awareness on the issue of active ageing.
5. Proposing, organising and activating training activities on active ageing, as well as best practices in intergenerational initiatives.

3.2. Expected Outcomes

The expected outcomes of our studies and research are:

1. Deepening the understanding of the role played by volunteering in later life and participation in prosocial activities in achieving better life and ageing conditions.
2. Organising evolving knowledge about active ageing and intergenerational initiatives, and making it more accessible to agents of change for public policy and effective programme devising.
3. Facilitating access to cutting-edge analysis, innovative methodologies, and multidisciplinary knowledge.
4. Making knowledge about active ageing and intergenerational solidarity operational as well as replicable.
5. Increasing the visibility of existing activities that promote active ageing.
6. Increasing the opportunities for networking and collaboration.
7. Fostering dialogue between different stakeholders.
8. Sensitising and raising awareness on issues concerning active ageing and intergenerational solidarity.
9. Capitalising experience and activating new experiences, reflections, and practices able to maximise benefits in view of shrinking resources.

3.3. Potential Applications and Future Actions

Potential applications of this project are: activating initiatives to promote active ageing and the quality of the relationships between the elderly and the young (intergenerational perspective).

In particular, we hypothesise to put in place the following lines of action:

1. Implementation, within our web platform, of an area dedicated to the involvement of the active elderly, with a view to promoting exchanges between generations in terms of care and *mentoring* on career paths, and to incentivising voluntary action within third sector associations.
2. Activation of training programs for the young elderly and for adult children with a view to intergenerational *enrichment*.
3. Design of good practices at the local level aimed at the creation of Intergenerational Laboratories, through the method of mutual help groups and direct activation of networks.
4. Support actions aimed at using the new media both for socialisation and health promotion.

At the methodological level, four steps will accompany the actions described above:

First step: involvement, through a sort of *call for action,* of the formal (public bodies, third sector organisations, trade unions and market entities, *e.g.* productive enterprises) and informal (spontaneous groups of grandparents and parents, groups of volunteers, parishes, etc.) actors in the various territories, so as to prompt their self-candidature through which also actions in partnership may be carried out. In this phase, particular relevance will be granted to the dissemination of the results of research conducted, with the aim of spreading and problematising its findings, proposing useful comparisons between different territorial contexts, in order to understand the strengths and weaknesses of the context in which intervention is suggested.

Second step: drafting of joint projects through participated planning methodologies with the *stakeholders* present in the different contexts.

Third step: implementation of training and action projects at the local level.

Fourth step: evaluation of the results in order to arrive at the formulation of guidelines for action in favour of the elderly.

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Financial Well-being in Active Ageing

Federico RAJOLA [a1], Chiara FRIGERIO [a], Monica PARRICHI [b]
[a] *Department of Management - Università Cattolica del Sacro Cuore, Milan, Italy*
[b] *Faculty of Education - Free University, Bolzan, Italy*

Abstract. In developed countries, economic and financial well-being is playing a crucial positive role in ageing and inclusion processes. Due to the complexity and pervasiveness of financial economy in the real life, more and more social as well as individual well-being are perceived as influenced by financial conditions. On the other hand, the demographic circumstances drive scholars as well as politicians to reflect on ageing dynamics. Bridging the two domains, the following research focuses on the role of the financial well-being as a mediating role of general well-being in elder people. The assumption is that elderly people have specific financial needs that sometimes are not covered by financial providers' offers. The motivation is mainly on the role of information asymmetries between elder consumers and financial institutions. On the dynamics of these asymmetries, the research will specifically investigate the role of financial literacy, as the ability of comprehension of elder people of their needs and of financial information. The applicative implication of this research work consists in finding the determinants of financial well-being for elders and the definition of their specific financial competencies, in order to 1) identify educational and regulatory guidelines for policy makers in charge of creating financial market transparency conditions, and to 2) support design of organizational mechanisms as well as financial product/services for this specific target of client. The following chapter presents preliminary explorative results of a survey delivered on 200 elder individuals (65-80 yrs.) leaving in Milan. Findings show that active elders consider the ability of managing personal wealth as one of the core determinant of well-being, although the economic and financial literacy is limited. Furthermore, the chapter proposes a research agenda for scholars interested in exploring the relationship between financial well-being and ageing.

Keywords: Active ageing, Financial Literacy, Well-being, Elder Consumers.

Introduction

The literature on financial education agrees that financial dynamics are influenced by the degree of understanding about both financial risk and objectives that individuals define [1,2]. However, just a few studies have described how this hypothesis might vary with ageing.

Following this domain, this research is composed by two main phases. The former aims at defining the role of age in the perception of financial well-being, through the analysis of older consumers' financial needs and the sense-making process of financial well-being in their ageing process. The main hypothesis is that age is influencing the perception of well-being when financial education cannot overcome the cultural gap that oldest perceive. During the latter phase, our study aims at analysing the conditions for developing financial products and services for oldest consumers, fostering their

[1] Corresponding Author: Department of Management, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: federico.rajola@unicatt.it

well-being dynamics. Due to the role of IT innovation in financial services, the research will focus on the role of digital divide in financial service delivery. The hypothesis is that IT can improve or decrease the cognitive distance between older consumers and the financial products, influencing the perception of well-being.

The paper is organized as follows: the first section gives an overview of the notions and concepts of financial literacy and well-being in elders; paragraph two shows preliminary findings of the survey deployed, while the third paragraph outlines a research agenda for scholars who want to deep investigate this relevant theme and want to contribute to make active ageing better.

1. The role of financial literacy in well-being

The specific needs of ageing people, related to their life changes as well as health and economic conditions, make their understanding of the rapidly evolution contemporary consumption scenario. This is specifically known in some EU countries, such as Italy, facing a demographic revolution, with people over 60 years of age representing the largest population segment, in constant growth.

According to an traditional and old conception [3, 4], the elderly have been considered mentally and physically slow, with problems in the adaptation to the evolution of the working environment and the philosophy of the companies; losing flexibility, they are considered rigid in terms of opinions and attitudes, invisible and alienated representatives of the past. However, more recently, market research [5] shows that they represent a segment of the population very articulate, in terms of needs, expectations, and consumption behaviours, representing an important cluster both numerically and socially.

Considering their attitude towards the use of money, literature argues that these people have availability of time and money to seek the best opportunities, and appreciate the TV and other media advertising [6, 7]. Of course, their spending habits are related to the amount of savings collected during their life. It is very important that young and old people learn to independently manage their own finances to activate sustainable lifestyles, to plan an appropriate time horizon, income and expenditure, to take a realistic view of their economic situation with respect to the future, to choose the options proposed by social security and insurance systems, and to live without anxiety the evolution of the financial world. From an economic perspective, the elderly need to know their financial needs and the opportunities that the financial system offers to manage economic and financial resources.

Starting from this point of view, this paper focuses on the well-being of elderly people, in order to discover the correlations with financial conditions. To recent decades there has been considerable increase of interest in the concept of "well-being" and of controversial attempts to define it. The concept of individual and social well-being is polysemic and subjective, and is used mainly in the contemporary era. There are many constructs and models proposed to define its nature, characteristics, and the stimuli required for its achievement [8].

Over the centuries, the philosophical literature has mainly expressed the concept of good and peaceful life with the word “happiness”. However this was influenced by sociocultural factors, which change the priorities in the course of the historical time.

At the beginning, the psychological research has studied the absence of well-being. Studies were mainly focused on unhappiness and suffering and the well-being was

implicitly understood as the absence of negative emotions. Recently the focus has been shifted to a positive dimension, although "Happiness", "Well-being", "Quality of Life" are subjected to personal interpretation and it is therefore difficult to identify indicators of subjective well-being. For instance, an individual could evaluate her/his status with regards to the level of fulfilment in the social, working and personal environment, while another could measure the achieved success based on parameters that can differ profoundly from the objective conditions.

Also economic scholars focus on individual and social well-being and welfare. At the end of the nineteenth century, studies on microeconomics and political economy consider universal and rational human choices so, ageing was not a condition that could change the subjective preferences of decision makers. In these context, irrational economic behaviour was explained by arguing that the economic theory is an abstract model that does not consider the influences that play a role in the real setting. *Homo economicus* is not a real man, because psychological, emotional and irrational factors play a role in deviating the action from the rational path [9]. It is questionable that per capita income might be a good indicator of well-being, since personal choices made to increase well-being are not always right and sometimes cause effects different than expected.

Over the decades, social indicators, alternative or complementary to the economic ones, have been differentiated, starting initially with environmental aspects and then adding new indicators that have become increasingly important, such as health, working conditions, etc. [10].

In the '70s, a quantitative analysis on happiness started from the self-assessment that people made about their overall happiness. Data were then correlated with other economic variables, highlighting that the relationship between happiness and per capita income was very complex, since the time variable came into play: if the correlation between income and happiness is statistically significant at a given moment in the life of a person, the same empirical analysis carried out over a longer period of time doesn't support this thesis [10]. This is also called "paradox of well-being" .

This phenomenon has been described in 1974 by Easterlin [11], who was seeking the reasons behind the limited spread of modern economic growth and showed that people happiness limited depends by life changes in income and wealth. This paradox, according to the Author, can be explained by observing that when income –and thus economic well-being-increases, human happiness increases up to a certain point and then starts decreasing. Happiness is positively influenced by current income and negatively influenced by aspirations regarding future income. The material aspirations may change during life proportionally to the income and therefore the well-being may remain steady.

The "paradox of well-being" is also confirmed in psychological studies aimed at understanding the phenomenon of materialism, i.e. the tendency of people to assign greater importance to material wealth than other values. It appears that materialistic people often feel worse than non materialistic ones [12].

It is undeniable that from a personal point of view, a minimum level of security, also financial, is essential to the well-ness building. This entails earning a salary that allows to cover basic needs and realize some material desires with freedom and serenity, accessing goods and services.

So, try to build a life path where the good money management and investments are balanced can lead to increased satisfaction and thus functional well-being [13].

The common concept of well-being is generally associated with money only in terms of possession: upstream, as a pre-condition for the realization of being in a state of "well". But we must also think about the ability to manage money as "investment for the person" as an element to be considered for the construction of well-being through reflection and formation of appropriate skills. Financial literacy is defined as the ability to make informed judgments and to take effective actions regarding the current and future use and management of money. Therefore, people who do not have the ability to make informed decisions and take effective actions regarding the current and future use and management of money, end up as victims of the new financial order.

Financial education plays an important role in the growing of the individual well-being's and in the social one and a financial education process helps to responsible individuals to the money protection [14]. It is important to understand that financial education is more important today than ever before for several reasons. The first reason is that financial responsibility has moved from employers and government to individuals and families. The second reason why financial education is more important than ever before is that there are a lot of financial demands placed on individuals and families. Families have to prepare for their children's education, take care of medical bills, invest in the purchase or building of a house and take care of financial needs when they retire. The third and final reason why financial education is more important today is the complexity of the money market. There are just too many complex financial products on the market which are being offered by too many financial institutions, adding to the confusion.

The issue of financial literacy has been also studied with a gender perspective. In fact, women tend to have lower levels of financial literacy than men: this is consistent with a domestic division of labor in which men manage finances. However, women tend to outlive their husbands, and eventually find themselves having to take on these responsibilities or delegate them to other family members [15].

The society should establish flexible forms of education related to these specificities and peculiarities related to the band more mature population [16, 17], whose aim must be to make the "senior citizen " in a leading aware of their needs on the one hand and on the other the "pitfalls" of the market, in order not to be excluded from the consumer world.

2. Preliminary results of the research activity

Following the literature on financial education and the specific research interests on elder people, we had the possibility to take part of a explorative research on Active Ageing that involved 200 active citizens, resident in Milan city, aged between 65 and 80 years[2].

The research team has developed a qualitative multiple-choice questionnaire with the goal of identifying what is role of financial knowledge for active elders, and to what extent they felt covered with their financial needs. Elderlies have been achieved through the collaboration of associations, churches or informal groups operating in

[2] The field research reported in this chapter is part of a wider two-years project on Active Ageing supported by the Catholic University of Milano and coordinated by prof. Antonietti (see his chapter in the book).

Milan. We deliberately did not involve hospitals or social welfare facilities, due to our intention in investigating active elders.

The sample has an average age of 74 years, and 16% is more than 80 yrs.. 64% of the respondents is composed by women, while 42% lives alone (widowed or singles). The 75% of the sample is retired and 22% are housewives. Accordingly to the National average, the level of education is quite low: just the 36% owns an high school degree or higher. The respondents declare to be quite aware (40% of them declares to often read newspapers), while 50% of them declares to participate to meetings, events, associations and church groups at least 1 or 2 times a week. Internet is used by the 34% of the respondents, who accesses to the Net through own devices. Although the sample is not representative of the Milan elders, we can assume that it has some relevant features of active ageing, as the attitude of participation, the use of media and the technology orientation.

The first aim of the research was to investigate the well-being concept among active elders. For the majority of the panel, the well-being sources are personal affections, such as family nearness, money management, that is the ability to use appropriately the saved money, and education. Moreover, the appropriate use of money is perceived as more important than the richness per se. In order to improve the current condition of well-being, the elders consider most important the role of the family, followed by the ability to improve the money management. By these first evidences, we can deduce that financial conditions play a crucial role on the general perceived well-being of older people.

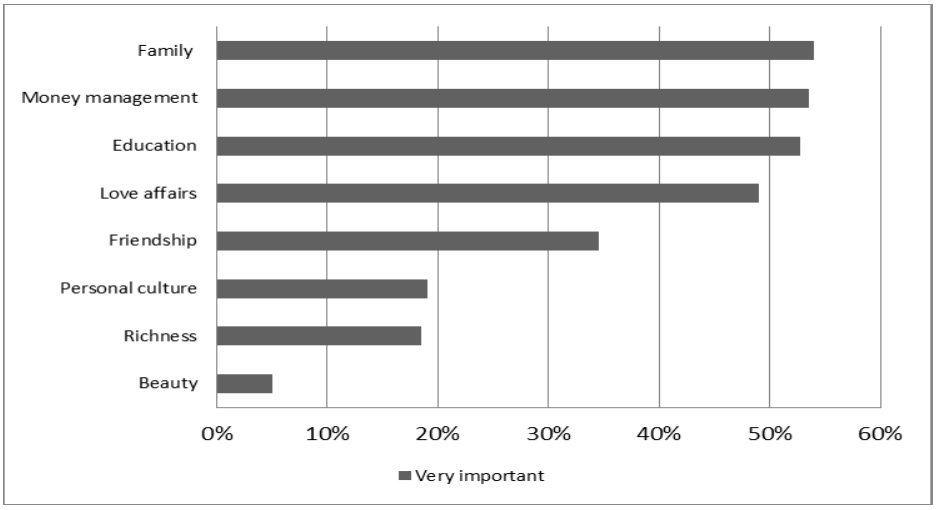

Figure 1. The source of well-being for active olders.

Regarding the financial attitudes and habits, 77% of respondents declares to be satisfied with their monthly income and 32% of them is very satisfied also with their personal financial assets. Moreover, the majority declares to save money: 60% of respondents is very prudent in spending, and 18% is parsimonious. Just the 14% prefers spend money instead of saving and 91% balances the real adequacy of each outlay. Although they prefer to save, almost 3 out of 4 respondents agrees in using

money to fulfil a wish. They save but they do not invest especially if it is unsafe: more than 70% of the elders is risk adverse, and 75% of them do not make any expenditure if they perceive financial risk.

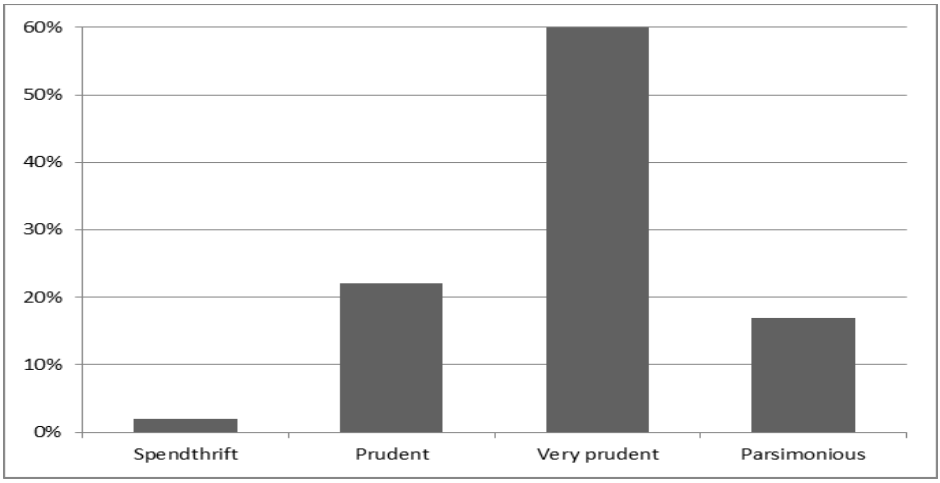

Figure 2.. The financial attitudes of elders.

The respondents are autonomous in financial decisions: they usually make ordinary expenses or financial investments alone or together with their partner. Less than 10% delegates a family member for financial decisions. 58% of them continuously monitors the financial assets.

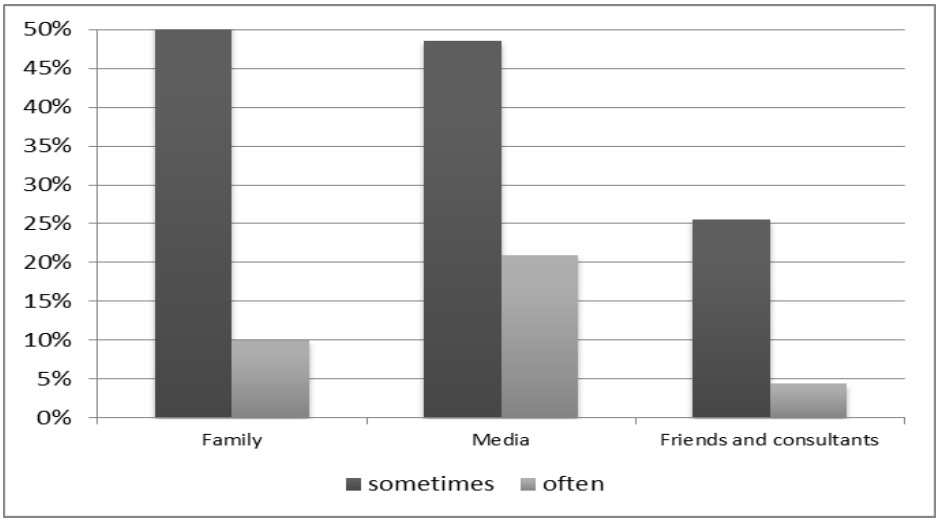

Figure 3. Financial information source for elders.

Around 35% of the respondents does not trust banks and financial institutions, and it relies on other information sources such as family and media. Specifically, sons and TV programs are the most exploited. They usually prefer personal advices, and less than 10% often uses financial products sheets for learning about these topics. Moreover, it is very rare that participants give information to others on financial topics.

Regarding the financial competences, almost 80% of the panel consider crucial the ability of family budgeting and controlling expenses during the time and they feel quite capable of doing it. What appears definitely less widespread is the capability of finding alone solutions to financial problems that can occur in a given period of time (i.e. level of expenses above budget/target) and legal competences for managing debit situations.

Concluding, these first evidences show that active elders consider the ability of manageing personal wealth as one of the core determinant of well-being. Accordingly they pay attention to spend money and to risk taking, preferring safe save. Albeit they are usually autonomous in financial decisions, the level of financial education is not high. They thus have basic knowledge on finance and, when the complexity of the problem is higher and higher, they trust in family and consulting advices, as well as advertising.

The research project is now starting a second phase, aiming at analysing the supply side of the financial market. The first ten Italian banks and financial institutions will be surveyed to gather information about (1) existence of specific product/services and/or distribution policies for elders, (2) features about communication dynamics and process used for interacting with elders, and (3) the use of ICT-based distribution channels for elders. At the end of the second phase, the research team will be able to compare results on the demand and on the supply side and make some considerations.

3. Financial well-being and active ageing: a research agenda

As stated, this preliminary study mainly focuses on investigating the role of financial well-being by older people and the relative knowledge and financial education. We can sum up that our initial hypothesis on different financial dynamics in older people is confirmed. Following this research, we are now developing further the research, in order to analyse the dynamics of interaction among older customers and financial institutions. The scope of this field research is to identify political, social, as well as managerial implications for designing a better context for the financial well-being.

Referring to the design practices, our contribution provides a framework for scholars, policy makers and practitioners who are interested in the financial education contribution to the ageing domain. Specifically, our framework encourages researches on three main areas of designing.

The first regards the design of organizational structures and operating models. In order to improve relational and interaction dynamics among banks, financial institution and older customers, we encourage researches that prove the relationship among service models and perceived performance for older people. The aim is to analyse the organizational artefacts that create the sustainable relationship among the institutions and their customers. In particular, we encourage the study of distributions channels and their characteristic layout and usability. From an organizational and technological perspective, the issue of usability and layouts is relevant in order to identify the possible barriers on communication and comprehension of financial topics by customers and, on the other hand, of specific needs of bank employees.

The second is about the products and services design. Older people require specific products which consider their cognitive as well as life dynamics. We encourage two main perspectives: the former is on the features of products in terms of risk adversity and risk taking. Scholars who study financial risk models should consider how specific customers may require different risk models and processes. The latter is on communication processes for older customers. These processes require different ways of assessing the financial needs of older people (in terms of assessment tools and procedures, communication competences) and different transparency policies for older customers. Products and services design is also a matter of interest for layer scholars since EU regulations have strongly defined the aims of transparency policies and risk management procedures. We encourage contributions that support EU institutions to identify the need of specific regulation for financial inclusions for older people.

The third main perspective regards the design of educational as well as cultural processes. We encourage deep investigations that will eventually lead to the design of effective financial educational programs for older people. The focus is not just on creating new and effective financial curricula, but more on innovating the learning experience and tools. In particular, we should encourage the social perspective of learning through the use of educational tools, improving the participation and the experience exchange (knowledge) of individuals. The research should focus on cognitive as well as engaging dynamics.

The intense literature on this topic and the research agenda show that the research field of ageing and well-being is wide and complex. Thus, multidisciplinary approaches and backgrounds, as well as epistemological and ontological perspectives, can contribute to the development of the field studies. Despite the literature mainstream underlines a positive approach, oriented to define the best practices in financial research, we encourage different approaches focusing on the construction of social artefacts such as financial education, risk preferences and risk adversity. For this reason, research can employ alternatively qualitative and quantitative methods

In conclusion, we believe that economic and financial conditions can improve the lifestyle and inclusion processes of citizens. Ethical and social issues in the financial domain represent a research field for scholars who are keen to contribute to the development of EU policies and managerial practices to better understand and design the active ageing.

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Frailty, Physical Frailty, Sarcopenia: A New Conceptual Model

Roberto BERNABEI [a1], Anna Maria MARTONE [a], Davide L. VETRANO [a], Riccardo CALVANI [b], Francesco LANDI [a], Emanuele MARZETTI [a]
[a] *Department of Geriatric, Neurosciences and Orthopaedics, Università Cattolica del Sacro Cuore, Rome, Italy*
[b] *Institute of Crystallography, National Research Council (CNR), Bari, Italy*

Abstract. In the literature, different criteria have been validated to identify frail older subjects, which mainly refer to two conceptual models: the cumulative deficit approach proposed by Rockwood and the Physical Frailty (PF) phenotype proposed by Fried. Both models have received empirical validation. Nevertheless, the frailty phenotype is the most widely used and presents a characterized pathophysiologic background. The PF condition depicted by the frailty phenotype has shown to be predictive of major negative health-related outcomes, including mobility disability, disability for activities of daily living, institutionalization, and mortality. At the same time, it cannot be ignored that the PF phenotype presents substantial overlaps with sarcopenia, "a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death". In fact, many of the adverse outcomes of frailty are probably mediated by sarcopenia. Therefore, sarcopenia may be considered both as the biological substrate for the development of PF and the pathway through which the negative health outcomes of frailty ensue. Although PF encompasses only a part of the frailty spectrum, the identification of a definite biological basis (i.e., skeletal muscle decline) opens new venues for the development of interventions to slow or reverse the progression of this condition. Here, we present a novel conceptualisation of PF which will possibly promote significant advancements over the traditional approaches to this syndrome by enabling the precise operationalisation of the condition, a clear identification of the affected population and the rapid translation of findings to the clinical arena.

Keywords. Ageing, Disability, Skeletal Muscle

Introduction

The demographic transition Europe has experienced over the last decades poses an unprecedented challenge from both a societal and healthcare perspective. The existing healthcare systems built around the traditional medical paradigm of patients suffering from a single acute illness are largely unprepared to face the increasing demands for health services that can specifically address the medical needs of older, multimorbid people [1]. It follows that, on the one hand, a large and growing segment of the older European population is currently suffering from medical conditions that cannot be efficiently managed by the available healthcare services. On the other hand, although

[1] Corresponding Author: Department of Geriatric, Neurosciences and Orthopedics, Università Cattolica del Sacro Cuore, L.go F. Vito 1, Rome, Italy. E-mail: roberto.bernabei@rm.unicatt.it

prolongation of life remains an important public health goal, of even greater significance is that extended life would involve preservation of the capacity to live independently and function well. Indeed, disabling conditions have shown to be extremely burdening for the individual as well as for the sustainability of healthcare systems [2]. In this scenario, the geriatric syndrome of frailty gains special interest and importance.

1. Frailty as a Geriatric Syndrome

Based on a recent consensus definition, frailty consists in "a multidimensional syndrome characterized by decreased reserve and diminished resistance to stressors" [3]. Simplified, frailty is "an expression of the lack of adaptive capacity of the organism" [4]. From this perspective, frailty may be envisaged as a dynamic process of accelerated ageing [5], which, in its early phase, is characterised by the absence of disability [6,7].

According to the Survey of Health, Ageing and Retirement in Europe (SHARE) study, the prevalence of pre-frailty and frailty among 18,227 randomly selected community-dwellers aged 65+ years was 42.3% (40.5%-44.1%) and 17.0% (15.3%-18.7%), respectively [8]. In the absence of targeted interventions, the progression of frailty is marked by increased morbidity, disability, frequent and often inappropriate healthcare use, nursing home admission, and poor quality of life [9]. Detecting and contrasting frailty are therefore of outstanding importance for impeding the progression of the syndrome and preventing its detrimental consequences [10]. Indeed, once disability has emerged, the restoration of an adequate level of functioning is unlikely, especially when the age of the subject, the degree of disability or its duration increase [7].

Unfortunately, to date, no healthcare programs or pharmacological treatments are available for frail older people. This is largely due to the current lack of a precise, universal definition of frailty, which in turn is linked to the multidimensional nature of the condition [11]. It is therefore not by accident the syndrome is not yet nosographically considered (e.g., it is not listed in the International Classification of Diseases-10) [12]. Eventually, the existing gaps in knowledge are reflected by the absence of interventions (either pharmacological or behavioural) against frailty. Such a barrier may be overcome by developing and validating a robust conceptual framework of frailty to achieve a practical operationalisation of the syndrome [10]. This conceptualisation should also improve the definition of the pathophysiologic and clinical foundations of frailty to assist in the design and implementation of specific interventions aimed at restoring robustness or delaying the onset of adverse events (in particular, disability).

2. Frailty and Sarcopenia of Ageing: "Trapped into Causal Opacity"

In the literature, different criteria have been validated to identify frail older subjects, which mainly refer to two conceptual models: the cumulative deficit approach proposed by Rockwood et al. [13] and the physical frailty (PF) phenotype proposed by Fried et al. [14]. Both models have received empirical validation. Nevertheless, the frailty phenotype is surely the most widely used and possesses a better characterised pathophysiologic background [7,15]. The 5-item instrument proposed by Fried et al.

[14] is also particularly useful for the clinical screening of frailty and in the context of preventive strategies [16]. The PF condition depicted by the frailty phenotype has shown to be predictive of major negative health-related outcomes, including mobility disability, disability for activities of daily living, institutionalisation, and mortality [7].

At the same time, it cannot be ignored that the PF phenotype presents substantial overlaps with sarcopenia, "a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death" [17]. In fact, many of the adverse outcomes of frailty are probably mediated by sarcopenia [18].

Since the beginning (roughly about 15-20 years ago), sarcopenia and frailty have been studied in parallel. Being organ-specific, sarcopenia was more frequently object of research in basic science, whereas the concept of frailty tended to be more easily applied in the clinical setting. Nevertheless, it was quite inevitable that the two would have sooner or later started converging because both conditions are dealing with the common subclinical and clinical manifestations of ageing. Unfortunately, the definition of a clear framework in which sarcopenia and frailty can be accommodated and studied has yet to come. One of the major issues in this context is indeed the long-lasting, tiring, and potentially pointless controversy about the causal relationship existing between the two. Determining whether frailty is due to sarcopenia or sarcopenia is a clinical manifestation of frailty is consuming considerable efforts, but (from a very practical viewpoint) rather resembles the problem of "the egg and the chicken".

Deconstructing the inner foundations of these "twin" conditions and trying to focus on shared and clinical relevant features might represent a pragmatic means to solve the dilemma.

3. Frailty, Physical Frailty, Sarcopenia: a New Conceptual Model

For the construction of a pragmatic conceptual model, sarcopenia may be considered both as the biological substrate for the development of PF and the pathway through which the negative health outcomes of frailty ensue (Figure 1).

Although PF encompasses only a part of the frailty spectrum, the identification of a definite biological basis (i.e., skeletal muscle decline) opens new venues for the development of interventions to slow or reverse the progression of this condition. In this regard, it is noteworthy that all of the components characterising PF and sarcopenia (PF&S) are measurable and quantifiable. Hence, the implementation of this conceptual model will possibly promote significant advancements over the traditional approaches to this syndrome by enabling the precise operationalisation of the condition, a clear identification of the affected population and the rapid translation of findings to the clinical arena. It is worth noting that such a conceptualisation renders PF&S similar to other common geriatric conditions, with the great advantage of making the syndrome more easily acceptable by healthcare professionals, public health authorities and regulatory bodies.

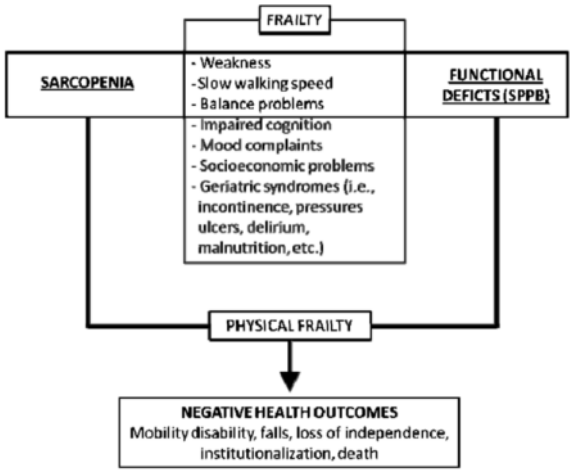

Figure 1. The grey areas highlight the operationalisation of the three components defining physical frailty and the adverse outcomes associated with this condition. SPPB, Short of Physical Performance Battery

4. Possible Strategies for Intervening Against PF&S

The recognition of sarcopenia as a major component of PF implies that interventions specifically targeting the skeletal muscle may provide therapeutic and preventive advantages against frailty and its clinical correlates. However, although observational studies and some randomized clinical trials (RCTs) have suggested a positive effect of regular physical activity (PA) and nutritional interventions on improving physical function and/or reducing symptoms of disability in healthy older individuals and those at risk for mobility disability, definite evidence from high-quality, large-scale clinical trials is still lacking.

The largest and longest study in this field is the Lifestyle Interventions and Independence for Elders (LIFE) study [19], a multicentre RCT conducted in the United States comparing a PA program with a successful ageing educational program in more than 1,600 sedentary older persons, over a follow-up of approximately 3 years. The primary outcome of the study is the incidence of mobility disability as expressed by incapacity to walk 400 metres.

Results from the LIFE pilot (LIFE-P) study showed that over 1 year of follow-up the Short Physical Performance Battery (SPPB) [20] score was significantly improved in the intervention group compared with controls [21]. Similarly, the 400-m walk speed was significantly increased by the intervention. The beneficial effects of the intervention on the SPPB score and the 400-m walk test were fairly uniform across subgroups defined by age, gender, race, baseline physical performance, and comorbidity.

Secondary analyses in the LIFE-P study database have shown that the PA intervention is able to significantly reduce the prevalence of PF and the number of frailty criteria over 1 year of follow-up compared with controls (unpublished results). Remarkably, the beneficial effects of PA on the frailty score were greater in participants who were frail at baseline. More in depth analyses show that the positive

effects of PA are exclusively due to the reduction of the sedentary behaviour criterion, while non-statistically significant variations were reported for the other frailty features. Although the LIFE study was not designed to operationalise a conceptual model of PF nor was the PA intervention specifically targeted against PF&S, these results suggests that behavioural interventions could positively impact PF&S.

Apart from small RCTs such as the FRAilty Screening and Intervention (FRASI) study [22], no large-scale intervention studies specifically targeting frail European older persons have yet been conducted. Given the complexity of the PF&S syndrome, it is likely that the implementation of multi-component intervention (MCIs), combining PA, nutrition and eventually drugs, might provide the greatest benefits in terms of prevention of incident disability and major negative health-related events.

The implementation of multi-component preventive interventions in older persons is particularly useful when dealing with age-related syndromic conditions requiring an immediate translation into clinical practice. Indeed, the simultaneous targeting of multiple and heterogeneous mechanisms underlying the disabling cascade may enhance the intervention effects.

Conversely, a monodimensional intervention may be insufficient at reversing the complex frailty status. At the same time, MCIs allow translating more easily the study results into clinical practice for the overall older population, thus reducing the well-known limited generalisation of "evidence-based studies". It is noteworthy that such multi-component approaches resemble what is commonly done in usual clinical practice, in which the intervention is designed around the needs and resources of the individual.

5. Conclusions

The ongoing demographic transition is accompanied by substantial changes in medical needs and nosographic scenarios, which imposes major actions against common disabling conditions. Frailty and sarcopenia are highly prevalent, but not yet nosographically recognised geriatric syndromes that impact dramatically on the health status of older adults.

The lack of a widely accepted operationalisation of these conditions hampers the design of effective preventive and therapeutic strategies, which amplifies the socioeconomic burden associated with their detrimental consequences (e.g., disability). Not surprisingly, the need of refining the assessments of sarcopenia and frailty is perceived as a high priority by the scientific and medical community as well as by health authorities and regulators.

The core of the two conditions represented by the impairment in physical function in the absence of disability may optimally serve for (1) defining a novel target for interventions against disability, (2) facilitating the translation of the two conditions in the clinical arena, and (3) providing an objective, standardised, and clinically-relevant condition to be adopted by public health and regulatory agencies. Such conceptualisation might eventually encourage key stakeholders to join their efforts for approaching the sarcopenia and frailty conditions.

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Patient Engagement: The Key to Redesign the Exchange Between the Demand and Supply for Healthcare in the Era of Active Ageing

Guendalina GRAFFIGNA [a1], Serena BARELLO [a], Giuseppe RIVA [a,b], A. Claudio BOSIO [a]
[a] *Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy*
[b] *Applied Technology for Neuro-Psychology Lab., Istituto Auxologico Italiano, Milan, Italy*

Abstract. The last decades' changes in the epidemiological trends of chronic disease - also due to the ageing population - and the increased length and quality of life among the majority of Western population have introduced important changes in the organization and management of the healthcare systems. Consequently, health systems throughout the world are searching for new and effective ways to make their services more responsive to new patients and the public's health needs and demands. The idea of patient engagement – borrowed from the marketing conceptualization of consumer engagement - moves from the assumption that making patients/clients co-producers of their health can enhance their satisfaction with the healthcare system as well as their responsibility in both care and prevention by improving clinical outcomes and reducing health delivery costs. To make people aware of their health services options by supporting them in the decision-making process and to engage them in enacting preventive and healthy behaviors is vital for achieving successful health outcomes and preventing waste of resources. In this chapter, we outline a model (PHE model) that explains the patients' subjective experience with their health management process and the levers that may enact the passage from one phase of the process to the other. Based on this conceptual model of patient engagement will be proposed a tool kit of priority actions that may sustain the patient in its process of engagement.

Keywords. Patient Engagement, Chronic Disease, Health Management, Active Ageing, Healthy Living, Patient Empowerment, Patient Activation

1. Tackling the Challenges of Ageing and Chronic Disease

Tremendous changes in medical science and technologies combined with significant shifts in lifestyle and demographics have resulted in a rapid increase in the number and proportion of individuals living longer [1]. Unfortunately, the increased age of the population often correlates with the occurrence of chronic conditions. According to the European Chronic Disease Alliance [2], over 100 million European citizens above the age of 15 are affected by a chronic condition. This figure rises progressively with age

[1] Corresponding Author: Department of Psychology, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: guendalina.graffigna@unicatt.it

and, according to the World Health Organization (WHO), Europeans reaching retirement age are more likely than not to suffer from at least one chronic condition [3].

A high incidence of chronic diseases in older people is in contrast with people's growing demand for wellbeing and with the need to guarantee enhanced quality of life in all life stages. This rising tide of chronic illness – and the economic burden linked to the long-term management of chronic condition - also threatens the viability of European healthcare systems, which are ill equipped to cope financially, operationally, or strategically with this increasing numbers of long-term chronic patients [4]. The ongoing management of conditions over a period of years or decades thus calls for an urgent clinical, economic, and organizational reform.

In line with this need, in the long term, Europe's healthcare systems are required to reorient their focus from merely treating illness to promoting health according to a life-course approach. Furthermore healthcare delivery processes need to be revised in order to become more cost-effective and sustainable. In particular, the latter goal implies a shift in medical policies and practices in order to help healthcare organization lead an efficient dialogue with the "outside" of their institutional boundaries [5]. Precisely, the patients affected by a chronic disease cannot be hospitalized for a long time because of the costs of care management. To cope with the problem of the lack of resources, it becomes fundamental to create a virtuous connection between the healthcare organization and the patient's social context, facilitating the sharing of information and communication in the long, and sometimes complex, process of chronic disease management [6, 7]. In other words, the social context in which the patient is embedded plays an increasingly crucial role in the management of chronic illness, even if not yet fully exploited by healthcare organizations. With the expression "patient's social context," we indicate the "outside of healthcare organizations", which represents a context that is conceptually not only limited to the classic notion of territorial medicine, but also inclusive of the network of patient's families and peers. In this revision of the healthcare boundaries, it is important to consider the potential role of new technologies in enabling communication and at distance exchanges between the patient and the sources of care supply (just think of the information portals, social networks, applications of technology to educate and monitor the patient in the process of care, telemedicine) [8-11]. Developing connectivity via electronic or other information pathways that encourage timely and effective exchange flow between the inside and the outside of the healthcare organization may also allow us to capitalize on the resources and potentialities intrinsic to both the "expert system" (the healthcare services and provides) and the "lay system" (the patient-consumer, the social network, and community organizations) by favoring a productive exchange between the supply of health services (the "inside") and the demand ("the outside").

2. Giving (Back) a Role to Patients to Address the 21st Century's Challenges: The Relevance of Patient Engagement

The goal of achieving a better dialogue with the "outside" of health organizations requires new ways to approach patients in order to make them active participant in their health management and informed health consumers able to make appropriate choices and avoid economic waste. Nowadays, patients appear to be more willing to be informed about their disease and treatment [12]. Patients are also increasingly aware of their rights, and they are becoming more demanding in the fruition of healthcare

services. They are better aware of their own needs and preferences, they are more critical in expressing judgments about the quality of received health services, and they have clearer criteria guiding their decision in the disease management [13]. However, healthcare organizations do not always recognize and accept patient's active role. This is because today's healthcare systems are still far away from establishing a true partnership with their customers.

Thus, in the present era, giving (back) a role to patients and allowing them to become protagonists of their care have become a priority to promote the sustainability of healthcare. In this framework, the goal of engaging patients in their health management appears to be the key. Precisely, the concept of engagement may be conceived as a qualifier of the exchange between supply and demand of healthcare services. The English verb "to engage" is polysemous from the point of view of language. It refers to the ability to attract someone's attention, but also to emotionally binding a person to a contract that is long lasting and strongly affective, and finally to "take over" someone to "get him on board," that is, to make someone part of something [14]. Borrowed from the marketing literature, the concept of engagement refers to the relationship that a consumer can experience with a brand or product. In particular, the concept of "consumer engagement" describes and qualifies the complex exchange dynamic between brands/products and the preferred consumer in the domain of a fluid and changeable economic and social context (i.e., the "liquid modernity" described by Bauman, 2000) [15]. In the present era, consumers are more conscious of their preferences and rights. They are more willing to negotiate with companies the contents and the forms of services delivery. Thus, it is very difficult for companies to be successful in satisfying consumers and in maintaining their loyalty in the long term. In this framework, the concept of consumer engagement attempts to offer insights regarding the different components (organizational, relational and psychological) that play a role in the complex exchange between product supply and consumer demand and that can make it more successful [16, 17]. When applied to healthcare, the concept of engagement is conceived as an attempt to describe the complex process of exchange that occurs between the patient (with his/her peer and family support system) and the health system (healthcare organization, health professionals). The goal is to encourage greater empowerment of the patient in disease management within the context of a good partnership with the health system [18]. Indeed, an engaged patient becomes not only more compliant with medical prescriptions [19], but also more aware of his symptoms and diagnosis. He is able to activate the healthcare system properly at the first symptoms of the disease, to contact the physician only in case of emergency, and to use the services offered by the health care system in a more satisfactory way [20]. Moreover, an engaged patient is also a good ambassador of good care practice related to the efficient and effective management of the exchange between "demand" and "supply" of healthcare among the peers and his/her network [21].

3. Modelling Patient Engagement: A Starting Point to Innovate Healthcare

A more in depth patient engagement may be defined as a multidimensional psychosocial process resulting from the conjoint cognitive, emotional, and behavioral enactment of individuals towards their health condition and its management. According to the framework – *Patient Health Engagement* model (PHE) - developed by Graffigna and colleagues [12], patient engagement is a dynamic and evolutionary process that

involves the recovery of life projectuality - even with the disease. This process also features peculiar ways of interaction and decisional negotiation between the patient and the healthcare that depends strongly on the phase of the process through which the patients is passing. The patient engagement process features four experiential positions (blackout, arousal, adhesion, and eudaimonic project). This evolutionary view of the patient engagement process suggests that a fully engaged patient results from a series of emotional, cognitive, and behavioral reframing of his/her health condition and that the success of the patient in advancing along the process depends on how he/she succeeded in the previous phases. The last position of the engagement process (i.e., eudaimonic project) culminates in a patient that has gained a positive approach to health management and has recaptured an active role in society by re-establishing plans for wellness. Such patient has succeeded in incorporating disease management into his/her life. In the following paragraphs, we will discuss the specific features of each phase of the engagement process (see Figure 1).

3.1. Blackout

The onset of the disease condition makes patients fall in a state of emotional, behavioral, and cognitive blackout, which is described as unexpected and out of their control. They feel like "in suspension," as they are looking forward to obtain a ruling from someone.

Patients describe the disease onset as distressing and unacceptable because they have not yet acquired effective coping strategies to manage their new health condition, and they are not aware of what is happening to their body. This patient's status determines the diagnosis, often minimizing the signs and symptoms (*emotional denial*); moreover, patients cannot easily elaborate the received information about the disease (*cognitive blindness*). In this phase, patients also feel blocked in acting (*behavioral freezing*) and managing their diagnosis, as they are generally uninformed about its nature and exacerbating causes. They are completely absorbed in their illness experience and often experience difficulty attending to the needs of their life due to a focus on the management of their disease and its treatment. In this phase, the patients' quality of life strongly depends on the effectiveness in controlling/reducing the side effects connected to treatments and clinical stability. In this phase, the patient has a passive attitude towards the healthcare system and expects to be a «recipient» of care («end user»). In other words, patients have a top-down vision of the healthcare interventions.

Thus, to overcome the emotional confusion connected to the disrupting critical event, the patient needs to delegate to the doctor all decisions regarding the treatment and disease management. In this scope, a trusted relationship with the healthcare provider is crucial for overcoming the blackout phase. The physician is asked to scaffold patients and offer solidarity by making an empathic response and educating patients about their health. This informative action is expected from the referential doctor who becomes, since the moment of the diagnosis, the privileged spokesperson for the patient along the care process. If patients fail to build a solid relation with the healthcare provider, their emotional behavioral responses may become dysfunctional, often leading to patients' dropout.

3.2. Arousal

In the position of "arousal", patients are hyper-attentive to every signal in their bodies (*emotional alert*). Symptoms are perceived as an "alarm" that worries the patient and may cause overwhelming emotional reactions. Patients are equipped with more information about their health condition compared to the previous phase, although their health literacy is still superficial and fragmented (*superficial knowledge*).

Moreover, they feel behaviorally unable to manage their disease and treatment prescriptions effectively (*behavioral disorganization*).

In line with this perspective, the patient's quality of life depends mainly on patient's finding an emotional balance as well as the intrusiveness of the disease in their daily life. In this phase, the patients perceive the physician as someone who help them manage events and emotions related to their illness experience with which they have difficulties coping. This allows the patients to begin to learn and test behavioral caring patterns to effectively cope with the disease. Unlike the previous phase, patients start to become aware of the treatments options available to them, and they have matured some first choice criteria for healthcare services decision making.

3.3. Adhesion

In more advanced stages of the medical course, patients finally acquire a broad spectrum of knowledge (*cognitive adhesion*) and behavioral skills (*formal adherence*) to effectively comply with medical prescriptions and feel sufficiently confident in their own emotional strength to cope with their illness and accept their condition (*acceptance*). However, patients are not quite autonomous in managing the rules necessary to be healthy (i.e., healthy life style and correct medication regimen).

These rules are challenged when the patients have to temporarily change their daily routine (i.e., when going to holiday, when travelling for work…). This happens when patients do not fully understand the reasons behind the medication regimen but merely adhere to it. Consequently, patients rely on continuous physician counseling to manage their condition. Accordingly, patients revealed the need to hang on the physicians' authority and prescriptions, which they conceive as «lifeline», waiting for the time when they will be able and self-confident to self-manage.

The physician is perceived as an authoritative expert, and this allows patients to feel confident and not alone. It generally leads them to employ positive coping strategies and accept the guidance of an authoritative figure as a reliable point of reference. Rather than seeking knowledge to support self-care, participants still prefer to relinquish the responsibility for the disease management to the healthcare. However, in this phase, patients start to become aware of their power to influence their health care. In other words, patients start to perceive themselves as members of a collaborative team of care. This paves the ground for a virtuous mechanism by which the patient learns about how the health care system works. Patients, in turn, inform the health system. According to the specificities of this status, the patient's quality of life depends mainly on the fulfillment of the patient's healthcare needs and on the responsiveness of the healthcare provider. The patient's wellness is closely associated with the experience of a healthcare system that is truly attuned to the care expectations of the patient.

3.4. Eudaimonic project

Finally, in the "eudaimonic project" position, patients have fully accepted their condition and their patients' identity is only one of their possible selves (*elaboration*). They are also able to recognize internal resources that are useful for projecting satisfactory life trajectories for their future. Patients gradually become co-constructors of their health and capable of enacting a meaningful health management, which allows them to improve their quality of life. Patients are able to effectively search for appropriate information about their disease conditions and medications. This allows them to give full sense to their health experience (*sense making*) and effectively enact healthy behaviors, in due time, even when contexts change (*situated practices*). Patients have also developed a new perspective about their disease, which can now be thoughtful and integrated in a wider life project. The patients in this phase described their doctor as a "trusted ally" on whom they can rely and whom they asked for counselling in order to tailor their care according to their needs. According to this experiential position, patients are the managers of their own care, and they can mobilize healthcare services proactively when there is a need. Moreover, they can advocate for the health of their community (e.g., raising concerns to policymakers, helping others navigate the health care system, and advancing healthcare quality and equity). The patient in this phase becomes an experienced testimonial of good self-care practice
who is able to become a caregiver of others similar to him/her. Given the patients' reconquered possibility to consider themselves as whole persons despite their disease condition, their quality of life depends strongly on their renewed ability to make realistic life decisions that are consistent with the influence of their disease on their life.

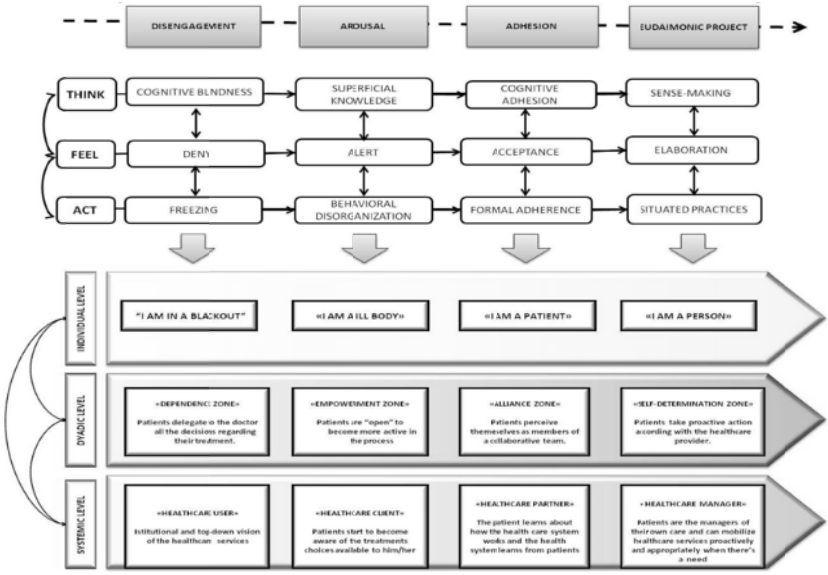

Figure 1. The process of patient engagement: a qualifier of the exchange between demand and supply.

4. Innovating the healthcare delivery in order to sustain patient engagement

As described above, the disease onset has a great influence on the patient psychological functioning. In order to move along the process of engagement; thus, to be able to better dialogue with the healthcare system and receive better satisfying services, the patient need to be sustained in a process of reframing and meaning-making that produces a better balance among the three experiential dimensions implied in his/her health management process (see Figure 2). These dimensions are *think (cognitive level), feel (emotional level), and act (behavioral level)*.

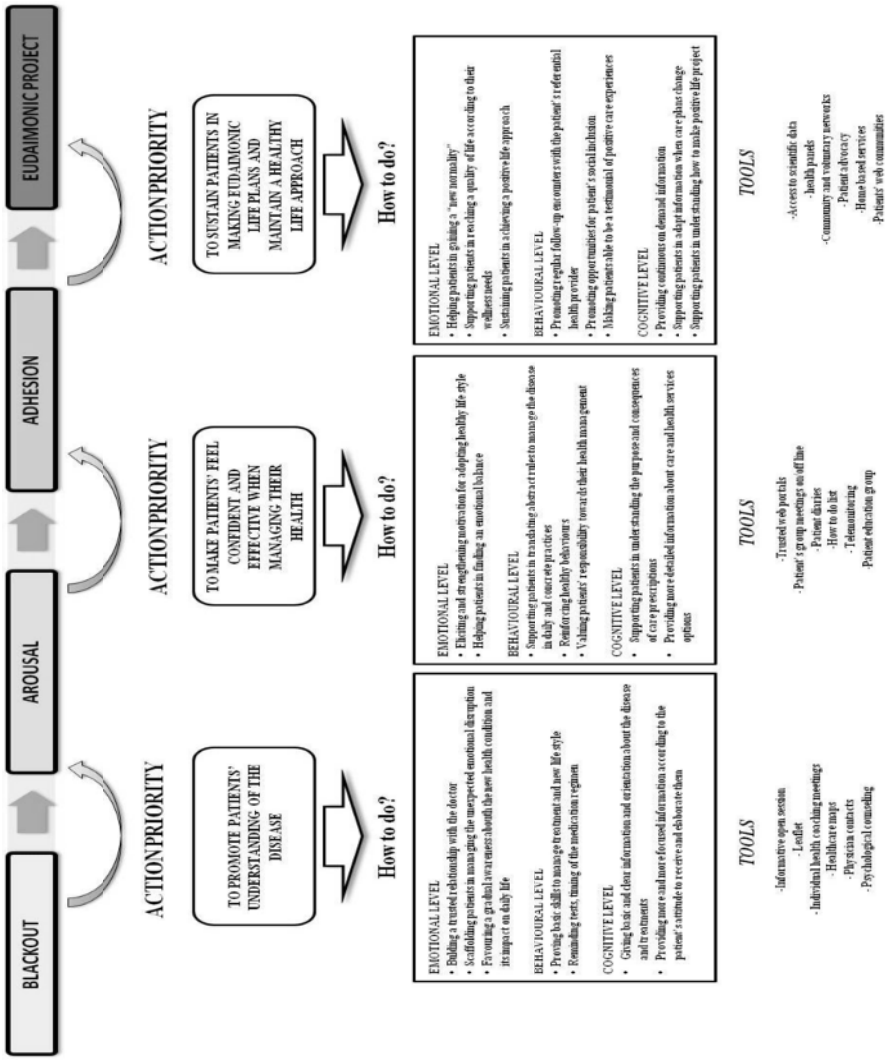

Figure 2. The positions of patient engagement and corresponding action priorities.

4.1. From the Blackout to the Arousal Position

As seen before, in the first instance, the patient has to accept and understand his new health condition, which disrupts and de-organizes the structure of knowledge and beliefs he has about him or herself. In particular, to pass from the position of blackout to the position of arousal (a first step forward in the process of becoming better engaged in health management), the individual has to accept that now he is also a patient, a person with a disease, through health literacy. To overcome the emotional confusion related to the loss of identity, the patient needs to promote the self-reframing by understanding the nature of his own body changes as well as the nature of his own psychological status. There is the need to improve the patient's understanding of his health and related conditions. To address this need, it is necessary to create a safe care environment by fostering the patient-health provider relationship, which may function as the catalyzer of the care process. Moreover, it is necessary to help caregivers understand the patients' reactions to their illness experience.

4.2. From the Arousal to the Adhesion Position

In this phase, patients are emotionally activated and experience loss of control over their body and emotional reactions. Consequently, they feel a reduced agency and power over their disease management and over their daily life. To favor the patients' advancement along the engagement process, the patients need to improve their self-confidence regarding their self-management. They also have to experience a better scaffolding relationship with the healthcare provider, and they have to feel empowered regarding their ability to comply with medical prescription and new lifestyle regimes. To achieve these goals and to become more motivated, patients need to be reinforced in their positive health behaviours. In particular, patients should learn to prioritize their goals, identify obstacles, and build a trustworthy relational care network.

4.3. From the Adhesion to the Eudaimonic Project Position

Patients going through the adhesion to the eudaimonic project position have to overcome the reduction in their life horizons produced psychologically by the critical event. In other words, at the beginning of their engagement path, in order to manage their disease, they have been confined to their patients' role and consequently, they have reduced their daily life spheres, thus often experiencing limitations in daily living due to disease implications. Moving through this state successfully entails patients gaining a positive approach to health management and recapturing an active role in the society by making wellness plans that consider the disease management a part of the patient's life. In other words, patients need to be sustained in re-achieving some form of life projects, even if confined in the next future.

Furthermore, the patients have to be able to incorporate their "new self" and their experience of the disease management into the broader domain of their daily life. In other words, patients need to be able to focus again on another more satisfactory and positive sphere of their private life in order to reframe the influence of the disease on their existence. They need to feel as protagonists of their life again. This delicate psychological process has to be legitimized by the healthcare system and sustained by the society that needs to reframe its vision of the patient not only as a disease carrier, but also as a person with different meaningful experiences that include the disease.

5. In conclusion: Roadmap for the Future of Healthcare Innovation

Nowadays, the increased complexity of healthcare demands due to the increase in chronic conditions and due to the reduction of economic resources call for a more virtuous exchange between the demand and supply of health services. The aim is not only to guarantee the achievement of good clinical outcomes and of improve clients' satisfaction, but also to increase sustainability of a healthcare organization in the process of care delivering. In this context, the patient/consumer of health services is to be considered not only as an active partner, but also as a potential resource for the healthcare system. The individual must be considered as a key player in the dialogic exchange between the inside (i.e., the health authority, the community of care providers) and the outside of care organizations (i.e., social context, the network of peers, the surroundings). In this framework, a marketing approach, conceptualized as a set of activities aimed at facilitating and achieving the exchange between demand and supply [39,40], presents a real heuristics and practical opportunity to orient healthcare innovation. In particular, the concept of patient engagement - borrowed from the marketing tradition applied to brand management [41] - seems to offer interesting opportunities for reflection and action in the era of active ageing.

To promote patient engagement in disease management indicates a more sustainable exchange between healthcare services and demand. However, despite the growing debate in both the academic and professional arena, there is still a lack of shared definition of patient engagement and guidelines to practice.

In this paper, we proposed to model the engagement experience based on the in-depth analysis of chronic patients' experience with the healthcare system in the management of their disease. This model may be the base for the innovation of healthcare delivery that is able to face current societal challenges and make healthcare organizations more sustainable at the economical, relational, and psychological level.

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SECTION II

WORK IN PROGRESS

Population ageing raises many fundamental questions for policy-makers.

How do we help people remain independent and active as they age? How can we strengthen health promotion and prevention policies, especially those directed to older people? As people are living longer, how can the quality of life in old age be improved?

Will large numbers of older people bankrupt our health care and social security systems? How do we best balance the role of the family and the state when it comes to caring for people who need assistance, as they grow older?

How do we acknowledge and support the major role that people play as they age in caring for others?

WHO, Active Aging, A Policy Framework. 2002

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Active Ageing and Healthy Living
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Lifestyles and Ageing: Targeting Key Mechanisms to Shift the Balance from Unhealthy to Healthy Ageing

Claudio GRASSI [a1], Francesco LANDI [b], Giovanni DELOGU [c]
[a]*Institute of Human Physiology*
[b]*Department of Geriatrics, Neurosciences and Orthopaedics*
[c]*Institute of Microbiology,*
Università Cattolica del Sacro Cuore, Medical School, Rome, Italy

Abstract. The increase in life expectancy has dramatically enhanced the prevalence of age-related chronic diseases resulting in growing costs for both society and individuals. Identification of strategies contributing to healthy ageing is thus one of the major challenges of the coming years. Lifestyle has a primary role among non-genetic factors affecting health and lifespan. In particular, nutrition, mental and physical activity impact the molecular and functional mechanisms whose alterations cause the major age-related diseases. A better understanding of mechanisms underlying the beneficial action of correct lifestyles is useful to develop interventions aimed at preventing and/or delaying the onset of chronic degenerative diseases, to identify high-risk populations who could be targeted in intervention trials as well as to identify novel biomarkers of healthy ageing. A multidisciplinary team of basic scientists and clinicians operating at the Catholic University Medical School in Rome is actively working on this topic to determine the ability of healthy lifestyles to promote active ageing and counteract the major age-related diseases affecting brain health, musculoskeletal function and gut microenvironment. This chapter summarizes our strategic approaches, the major results we obtained so far and the main experimental and translational perspectives.

Keywords. Sarcopenia, Cognitive Decline, Dysbiosis, Insulin Resistance, Inflammageing

Introduction

Over the past decades advances in diagnostic and therapeutic strategies have contributed to an increase in life expectancy that has progressively led to a growth of the older population. Individuals nowadays live longer, the life expectancy at birth for the 53 countries in the World Health Organization (WHO) European Region being over 72 years for men and around 80 for women [1]. The increase in life expectancy has been paralleled by an increase in the prevalence of non-communicable, chronic diseases such as cardiovascular, metabolic, respiratory and neurodegenerative diseases, as well as cancer. These represent a social and economic problem that is steadily

[1] Corresponding Author: Institute of Human Physiology, Università Cattolica del Sacro Cuore, Largo F. Vito 1, 00168 Rome, Italy. E-mail: grassi@rm.unicatt.it

growing, imposing a large burden on European societies and individuals. As such, it is pivotal to implement strategies aimed at improving not only the "quantity", but also the quality of life and health status of elderly individuals. Active ageing, defined by the WHO as "the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age [...]", allowing people to "[...] realize their potential for physical, social and mental well-being throughout the life course" [2], has therefore become a key priority for the future sustainability of health and social policies in Europe.

It is widely known that "healthy" lifestyle (e.g. diet, cognitive training and physical activity) may lead to a postponement of initial disability and decreased lifetime disability [3, 4], ultimately resulting in a healthier ageing process. It is the responsibility of the Governments to implement large-scale healthy ageing policies aimed at increasing the awareness of the benefits brought about by a healthy lifestyle. In this chapter we will describe how, using a translational, multidisciplinary approach, a number of basic and clinical research groups of our Faculty of Medicine are characterizing in detail the pathophysiological mechanisms underlying "unhealthy" ageing and the complex interactions among them to identify the mechanisms to target in order to ameliorate the physical, mental and social well-being of elderly people.

1. The Relevance of the Research Topic for Active Ageing and Healthy Living

Ageing may be seen as a chronic condition characterized by progressive functional decline in organs and systems of the body. As we grow older, the functional capacity of the body to maintain homeostasis and to respond adequately to physiological needs deteriorates. Ageing results in a progressive loss of muscle mass and strength (sarcopenia) that is closely related to increased morbidity and mortality in healthy individuals and patients, and has been identified as an important risk factor for injurious falls and hip fractures in the elderly. Age-related conditions affecting the brain such as mild cognitive impairment (MCI), i.e., a cognitive decline greater than expected for an individual's age and education level but that does not interfere notably with activities of daily life, are also associated with variable clinical outcomes including dementia, depression, cardiovascular diseases, and respiratory disorders. Sarcopenia and cognitive impairment should be considered as hallmarks of unhealthy ageing, since these two conditions deeply affect the functional capacity of the individual and are risk factors for the development of chronic diseases.

Shared pathophysiological mechanisms may underlie both sarcopenia and cognitive impairment: mitochondrial dysfunction and oxidative stress, insulin resistance and a number of epigenetic changes all appear to contribute to these hallmarks of ageing. Interestingly, most of these mechanisms can be influenced by lifestyle.

Ageing is associated with a progressive mitochondrial dysfunction, which leads to an overproduction of reactive oxygen species (ROS) that sustains and further deteriorates mitochondrial dysfunction, thereby inducing global cellular damage [5]. At a systemic level, the cascade of events secondary to oxidative stress triggers an inflammatory response, thus contributing to additional oxidative stress and eventually to the functional and structural modifications associated with advancing age such as cognitive decline and sarcopenia [6]. Additionally, alterations in mitochondrial dynamics could be involved in the development of sarcopenia, and are known to play a

critical role in nutrient-induced pancreatic β-cell apoptosis and possibly in the pathophysiology of type 2 diabetes mellitus (T2DM) [7]. In turn, glucose intolerance and T2DM have been associated with deficits in cognitive functions and with an increased risk of developing dementia [8]. This is in agreement with the notion that age-related cognitive decline does not depend only on neuronal mechanisms and intrinsic factors within the brain, but is also influenced by important hormones and neuromodulators that are released from peripheral organs and endocrine glands.

Interestingly, it has even been suggested that Alzheimer's disease (AD) may be a form of type 3 diabetes, based on the evidence for insulin resistance and impaired insulin response pathways in the Alzheimer's brain [9]. On the other hand, loss of skeletal muscle, i.e., the largest insulin-responsive target tissue, produces insulin resistance, which may eventually contribute to the development of the metabolic syndrome and T2DM [10]. It has also been proposed that common pathways may underlie both muscle insulin resistance and sarcopenia. As an example, serum magnesium status is an independent correlate of muscle performance in the elderly, and alterations of magnesium metabolism associated with ageing could contribute to the pathophysiology of insulin resistance and cardiometabolic syndrome in the elderly [11, 12]. Finally, it should also be underscored that metabolic regulation, genome maintenance mechanisms as well as genetic and epigenetic factors (i.e., the "mark" of the environment on our genes) all cooperate to drive the ageing process.

Lifestyle represents a central factor able to influence several of the common players involved in the ageing process. As such, lifestyle factors appear very relevant not so much to determine how long we will live, but rather because they can influence how healthily we will age. A growing body of evidence supports the role of healthy diet, cognitive training and physical activity in slowing the progression of cognitive impairment and sarcopenia associated with ageing [13-16]. Given the pivotal role of nutrition in health, it is also important to understand how nutrients "interact" with the body. In this light, gut microbiota - a complex ecosystem consisting of trillions of microorganisms and thousands of bacterial species - has emerged as a key factor that may play an important role in the development of several chronic diseases via modulation of the host metabolism and inflammatory/immune pathways [17]. Diverse forms of neuro-immune and neuro-psychiatric disorders appear to be correlated with or modulated by variations of microbiota, microbiota-derived products and exogenous antibiotics and probiotics [18]. A role for gut microbiota in the onset and progression of sarcopenia and T2DM has also been proposed [17, 19].

Based on these premises, we aim to characterize the close relationship among lifestyle, microbiota, brain and muscle health through an integrated approach encompassing experimental, clinical and translational studies, in order to identify common mechanisms that could be the target for interventions specifically designed to shift the balance from unhealthy to healthy ageing (Figure 1).

2. Our Actual Research Activity

2.1 Impact of Diet and Microbiota on Ageing

The gut microbiota is involved in the regulation of multiple host metabolic pathways and, through the gut-brain axis, interacts with brain health and mood, thus playing a pivotal role in the process of ageing [20].

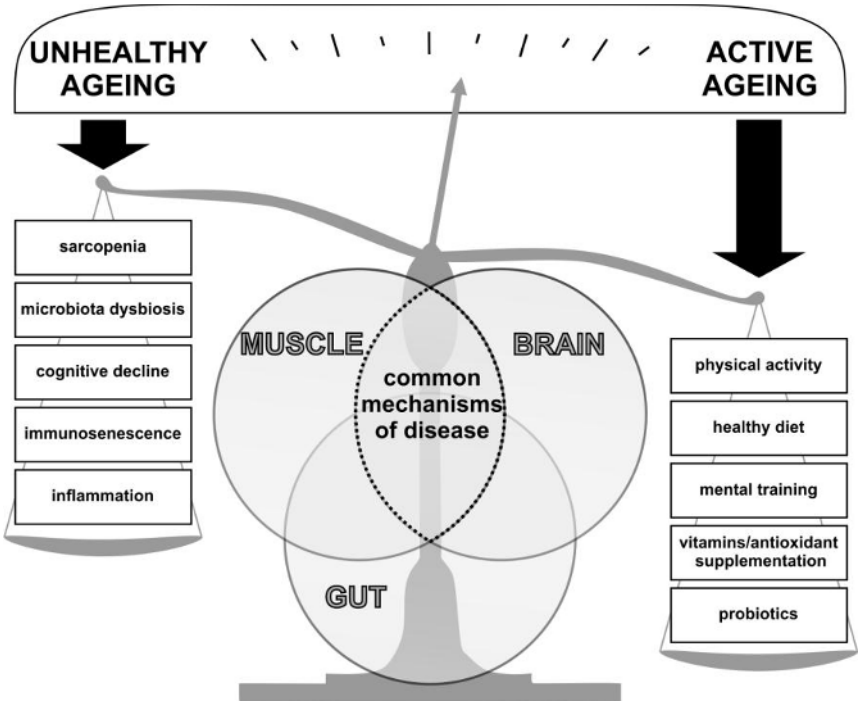

Figure 1. Overview of the common mechanisms that, by acting in key target organs such as muscle, brain and gut, may shift the balance from unhealthy to healthy ageing.

The gut microbiota shows a relevant degree of plasticity in response to environmental changes resulting in modification of its phylogenetic and functional profile, which allows the host to rapidly optimize metabolic and immunological performances to preserve health and homeostasis. In this context, the preservation of a correct and balanced gut microbiota-host mutualistic interaction is a key for healthy ageing. Clinical and experimental studies are unravelling the main features of the gut microbiota in the elderly and the pathophysiological consequences associated with age-related changes in its composition. Although the gut microbiota exhibits a high degree of inter-individual variability, during ageing it appears to be associated with a trend toward reduced biodiversity and compromised stability, with a decrease in the prevalence of certain relevant anaerobes and a bloom of facultative anaerobes such as Streptococci, Staphylococci, Enterococci and Enterobacteria. These bacterial species, also termed “pathobionts”, can prosper and accumulate in the inflamed gut, overtaking mutualistic commensals and further boosting inflammation. Changes in nutrition, diet and lifestyle, together with the physiological process of immunosenescence, are among the most relevant causes underlying the changes in gut microbiota composition that lead to dysbiosis.

In this context, our multidisciplinary research group aims to gain insights on the impact of diet and microbiota on ageing by addressing different points.

Among the well-documented consequences of age-related alterations of gut microbiota is the reduced intestinal level of short chain fatty acids (SCFAs), which are microbial metabolites known to play a pivotal role in several aspects of human

physiology. In the elderly, a decline in SCFAs can be detrimental for wellbeing as it can compromise nutrition, immune function, signalling, appetite and behaviour and more in general the nervous system, as suggested by recent findings showing that certain age-related gut microbiota dysbioses can be involved in cognitive decline and depression that are typical of the frail elderly. Moreover, an altered production of SCFAs from bacterial fermentation could be responsible for a reduction in the secretion of glucagon-like peptide 1 (GLP-1), a gastrointestinal hormone involved in the regulation of glucose-stimulated insulin secretion. Researchers from the Institutes of Clinical Biochemistry, Human Physiology and Neurology, and the Endocrinology and Metabolic Diseases Unit, are actively working to clarify the underlying mechanisms and to identify novel biomarkers of diet-induced ageing and metabolic diseases. Their research questions stem from the fact that the abnormal dietary patterns (e.g., high glycaemic index, saturated fat content and caloric intake) affecting the main mechanisms regulating glucose metabolism (i.e., insulin sensitivity and insulin secretion), cause functional alterations that are reminiscent of ageing. Indeed, nutrient excess induces cellular metabolic stress, and altered cellular metabolism observed in diabetes is associated with accelerated ageing of almost all tissues and organs. Dietary habits and their impact on cognitive, muscular and metabolic functions are being assessed in a large cohort of subjects at risk for T2DM. The diet-induced functional alterations found in humans are further characterized by reproducing the nutritional/metabolic environments associated with human unhealthy diets in cellular models (blood, skeletal muscle cells) and mice models of metabolic derangement (insulin-resistance, T2DM, high glucose variability). Finally, the molecular data obtained from cellular and animal models are being validated in a selected and accurately characterized subgroup from the original cohort of subjects at risk for T2DM, in order to identify novel biomarkers of age- and diet-related early target organ damage to be routinely used in clinical practice.

The investigators from the Endocrinology and Metabolic Diseases Unit have also undertaken a clinical trial on *Lactobacillus acidophilus* and *Bifidobacterium lactis* supplementation to study the effects of these probiotics on glycaemic control, gastrointestinal hormones such as GLP-1, inflammatory markers and quality of life in elderly patients with T2DM. Specifically, haemoglobin A1c (HbA1c), fasting blood glucose levels, insulin sensitivity, plasma levels of GLP-1, inflammatory cytokines (TNF-α, IL-6) and self-perceived health status are being evaluated at baseline and after three months of probiotic supplementation.

An interventional study to assess whether faecal microbiota transplantation in conjunction with lifestyle changes may lead to a greater reduction in insulin resistance as compared to that achievable with lifestyle modifications alone is also being implemented by the same group.

Hypomagnesaemia is another pro-inflammatory condition that exacerbates inflammation-driven diseases and as such may play a role during the ageing process. Intestinal mucosa and kidneys are the natural access routes for magnesium into the blood stream. Magnesium absorption and re-absorption through these two epithelia regulate whole body magnesium. Two distinct mechanisms are involved: passive paracellular absorption, which relies on tight junction permeability, and active transcellular transport, which involves cation channels and transporters among which transient receptor potential melastatin (TRPM) channels 6 and 7. In particular, the TRPM6 channel is expressed at high levels in the distal small intestine and colon, where Mg^{2+} absorption mainly takes place, and in the renal distal convoluted tubule,

where the "fine-tuning" of Mg^{2+} re-absorption occurs. TRPM6 has been defined as the gatekeeper of systemic magnesium homeostasis, since mutations in the TRPM6 gene or in genes regulating TRPM6 cause rare genetic diseases characterized by severe hypomagnesaemia and related symptoms.

Researchers at the Institute of General Pathology aim to assess whether magnesium absorption through the colonic mucosa, associated with other stimuli, has a role in determining chronic inflammation and carcinogenesis in the gut, i.e., two disease conditions frequently found in ageing [21]. They are measuring TRPM6/7 expression in epithelial cells in *in vitro* and *in vivo* systems under experimental conditions that mimic inflammation. Another membrane transporter, the organic cation transporter 1 (OCTN1), which is expressed by epithelial and inflammatory cells, may play a role in the absorption of diet-derived anti-inflammatory and antioxidant compounds. Importantly, a common variant of OCTN1 has been found to be associated with inflammatory bowel disease (IBD) in humans, and researchers from the Institute of General Pathology have shown that such association particularly applies to IBD patients progressing to intestinal malignancy [22]. Studies are ongoing to investigate the impact of OCTN1 on the inflammatory processes and autophagy following exposure of epithelial cells to faecal bacteria. These investigations will shed light on the inflammatory processes favouring cancerogenesis in colitis-associated cancers.

2.2 Impact of Lifestyle on Muscle Function

The pathophysiology of muscle loss during the ageing process is complex, involving muscle and associated neural and hormonal regulation [23]. With normal ageing, the quality of muscle fibres slowly deteriorates and peak power, shortening speed and elasticity decline slowly. The weakness of muscle fibres can be explained by the interaction of several age-related changes, including loss of anabolic stimuli due to both a decline in the concentration of anabolic hormones and age-associated subclinical inflammation. Reductions in the number and activation of satellite cells, especially those associated with type IIA fibres, also occur in older people, which may reduce the regenerative capacity of muscle fibres and compensatory capacity. Myostatin levels also increase with age. As myostatin is a negative regulator of muscle mass, an increase in its circulating levels may lead to muscle atrophy. Changes in regulation of the myostatin gene may also contribute to age-related changes in the protein profile of muscle [23].

Nutrition and physical exercise are the cornerstones of management in sarcopenia. Resistance exercise training increases muscle strength and mass and improves protein accretion in skeletal muscle. Aerobic exercise training may also benefit ageing skeletal muscle and improve insulin sensitivity. Exercise has to be prescribed, and is most probably beneficial when properly supervised and sustained over time [15].

Correction of nutritional deficits is also needed. Caloric intake should be increased to cover increased demands posed by exercise. Protein requirements are also increased, therefore the recommended protein intake in sarcopenic patients is >1.2 g of protein per kilogram of body weight per day, except in patients with significant renal failure. Leucine, β-hydroxy β-methylbutyrate, creatine and some milk-based proteins may have beneficial effects on protein balance in skeletal muscle. Correction of vitamin D deficiencies is needed for proper muscle function, but the role of vitamin D in the presence of normal blood levels is yet to be determined [24].

In this regard, researchers from the Institute of Internal Medicine and Geriatrics and from the Institute of Histology and General Embriology highlighted the importance of sarcopenia as a common, complex and costly syndrome impairing health in older individuals and resulting from incompletely understood interactions of disease and age on multiple systems producing a constellation of signs and symptoms.

Epidemiological studies demonstrated that sarcopenia is highly prevalent among older subjects and it is correlated with highest risk of death, regardless of age, gender, and other confounding factors. Malnutrition, poor diet and sedentary lifestyle are the most common risk factors for the onset and progression of sarcopenia [25, 26].

The age-dependent loss in muscle mass and function, namely sarcopenia, has been identified as an important risk factor for injurious falls and hip fractures. Noticeably, a significant amount of muscle mass is lost following a hip fracture due to immobilization, surgical stress and poor nutrition. Recently, a great emphasis has been placed on alterations in myocyte quality control (MQC) processes as possible factors involved in the pathogenesis of sarcopenia and acute muscle atrophy. Evidence suggests that dysfunctional autophagy may be the result of derangements in mitochondrial dynamics (i.e., fission/fusion) upstream of the autophagic/lysosomal pathway. The study currently ongoing in the Geriatrics Unit aims to investigate for the first time relevant MQC pathways in the skeletal muscle of hip fracture patients and to determine the relationship between MQC and functional recovery in this patient population. The specific aim is to investigate MQC signalling pathways (autophagy, fusion and fission) in hip fractured patients in comparison to elderly subjects undergoing total hip replacement for osteoarthritis. This study will reveal whether specific alterations in cellular housekeeping processes are linked to the disabling process in older subjects [27, 28]. Novel therapeutic strategies (i.e., specific nutritional interventions) are being developed to counteract physical function impairment that will be tested in future interventional studies.

Similarly, the studies (human and animal) that are being conducted in the Gastroenterology Unit aim to assess whether and how sarcopenia occurs in IBD and how and whether it could be counteracted by specific therapeutic interventions. Ulcerative colitis and Crohn's disease are characterized by clear alterations in bowel physiology, involving absorption, bowel habit, food intake and also microbiota composition and function. Weight loss and malnutrition are a common finding in IBD, particularly in the active phases of the disease. Researchers from the Gastroenterology Unit are investigating the presence of sarcopenia in a cohort of IBD patients stratified by other risk factors (including age, state of disease, disability, etc.) and are seeking to correlate sarcopenia with intestinal or serological markers. Furthermore, a mouse model of dextran sulphate sodium (DSS) colitis is being used for experimental studies. Animals are exposed to 2.5% DSS in drinking water for either 7 days or three 5-day cycles separated by a 2-week exposure to regular water, in order to induce acute or chronic colitis, respectively. During the induction of colitis and during the recovery phase, muscular strength of each animal is assessed with special treadmills that allow measuring time to “fatigue” for each animal. Specific modulation of cytokines, microbiota composition and inflammatory markers are being tested to verify whether they directly affected muscle homeostasis.

Using animal models, investigators from the Institute of Histology and General Embriology are determining whether specific nutritional strategies may counteract the loss of muscle mass and function in senescent muscle. Interestingly, injured tibialis anterior (TA) muscle of mice which received intra-peritoneal injection of taurine show

enhanced regeneration response as demonstrated by the presence of central nucleated fibres, less amount of inflammatory cells and fibrosis, if compared to control muscles.

To better analyse the inflammatory status of TA muscles from control and taurine-treated mice, the expression level of the transcription factor NF-kB, one of the most important players in inflammation, is being examined. Preliminary results indicate that NF-kB expression is strongly up-regulated in injured muscle of control mice, while its expression is only slightly increased in injured muscle of taurine-injected mice. These results suggest a role of taurine in the down-regulation of inflammation and the enhancement of regeneration in skeletal muscle.

2.3 Impact of Lifestyle on Brain Functional Decline

Human studies have provided intriguing evidence for positive effects of proper lifestyle on neurocognitive function in older adults. In particular, healthy diet, cognitive and physical training are able to slow down brain ageing, at least in part by counteracting mitochondrial dysfunction and insulin resistance. Conversely, physical inactivity, poor diet and even more metabolic diseases (i.e., obesity and diabetes) accelerate the ageing process. Although the mechanisms underlying the pathological cognitive decline in the elderly are not yet fully known, it is recognized that changes in metabolism and redox state may influence the onset and progression of age-related neurodegenerative diseases. In this regard, researchers from the Institute of Neurology highlighted a close relationship between an altered copper metabolism and the progression of AD [29, 30].

Alterations of copper homeostasis lead to ROS production, either directly or via inhibition of antioxidant activities [31]. In particular, patients with adequate copper plasma concentrations showed better performance when evaluated with memory tests.

Changes in the availability of oligoelements such as copper can determine an increase in inflammatory cytokines and impact on oxidative stress and cellular metabolism. Researchers from the Institute of Pharmacology have developed enzymatic assays to measure markers of oxidative stress (e.g. 8-isoPGF2α) that they have already validated in atherothrombotic disease [32]. The above mentioned research groups are working in synergy on this project, in order to identify novel biomarkers of age-dependent cognitive decline and to validate their diagnostic and/or prognostic role in a large cohort of patients with MCI or early to advanced AD. In particular, this study is comparing the redox state measured in cerebrospinal fluid with systemic oxidative stress, with the aim of using these tests as predictive tools to identify patients at increased risk for progression from MCI to AD. The same researchers are also prospectively studying, by means of clinical and laboratory tests, a group of patients with MCI in whom they are evaluating the impact of an antioxidant-enriched and copper-deficient diet on the progression of disease. The concept that common mechanisms associated with lifestyle-dependent ageing may affect different organs and tissues is also at the root of another project involving researchers from the Institutes of Clinical Biochemistry, Human Physiology and Neurology, and the Endocrinology and Metabolic Diseases Unit. As already mentioned, they hypothesized that abnormal dietary patterns affecting the main mechanisms regulating glucose metabolism may cause functional alterations that are reminiscent and predictive of unhealthy ageing. Correlations between unhealthy dietary habits (e.g., high glycaemic index, high fat, high caloric intake, low fibre) related to and predictive of glucose metabolism alterations, markers of oxidative stress and functional alterations in target organs such as the brain are being investigated in a large cohort of subjects at risk for T2DM.

To characterize the molecular mechanisms underlying diet-induced functional alterations, researchers from the Institute of Human Physiology reproduced the nutritional/metabolic environments associated with human unhealthy diets in cellular (neural stem cells and neurons) and mice models of metabolic derangement (insulin-resistance, T2DM). The ability of exercise and novel enriched environment (NEE, a paradigm of mental and physical training) to counteract the damage caused by metabolic unbalance is also being assessed. Evaluating the effects of diet and exercise in animal models has the advantage of reducing some of the inherent confounding variables that often complicate human studies. The animal studies mentioned below are being used to evaluate the potential of lifestyle to affect neurocognitive plasticity by analysing: i) behavioural performance on learning and memory paradigms; ii) neural activity and long-term potentiation (LTP), a cellular model of memory; iii) the growth and differentiation of newborn neurons; iv) expression of molecular factors associated with brain plasticity. The researchers from the Institute of Human Physiology used a high fat diet (HFD, 60% fat, for 8 weeks) alone or in combination with chronic hyperglycaemia induced by intraperitoneal injection of streptozotocin (STZ) as models of altered lipid and carbohydrate metabolism, respectively. Their findings suggest that overnutrition and dysmetabolism alter the physiological cell signalling in the brain and affect central nervous system plasticity by influencing neuronal activity and synaptic transmission, as well as adult neurogenesis. Mice exposed to HFD ± STZ showed alterations of learning and memory recognition ability, but the simultaneous exposure of animals to NEE prevented the impairment of cognitive functions. Moreover, in mice fed with HFD a significant reduction in adult neurogenesis and decreased expression of key neuronal genes (HES-1, nNOS, PGC-1α, SIRT1) in their hippocampi were observed.

These data are consistent with the results generated by the researchers of the Institutes of Anatomy and Cell Biology and General Pathology, who showed that HFD reduced hippocampal neurogenesis by a neuroinflammatory mechanism that might involve the transcription factor CREB. One attractive possibility is that fat-induced inflammation and insulin resistance also occur in cognitive areas of the brain, thus promoting neurodegeneration. Recently, researchers of the Institutes of Human Physiology and General Pathology identified the CREB-SIRT1 axis as a critical player that mediates the response to nutritional signals in the brain [33]. They discovered a novel role of CREB as a metabolic sensor in the brain, and brought to light one of the molecular mechanisms by which the nutrients modulate behavioural, functional and gene expression responses in both neural stem cells and differentiated neurons. In conclusion, nutrient excess seems to act in the brain on both the stem cell compartment and differentiated neurons by interfering with CREB, a key factor for the development and function of the nervous system, and the transcriptional machinery attached to it.

3. Our Future Research Activity

The network of studies set out by our multidisciplinary group delves into a topic of great relevance to healthcare through a highly integrated approach encompassing basic, clinical and translational research. Our project is characterized by a strong intra-faculty integration that will allow to develop an increasing number of multidisciplinary lines of investigation, and to understand the impact of lifestyles on ageing from the molecular, cellular and functional point of view. Our preliminary findings, along with extensive

evidence from the literature, emphasize how changes in the composition of the gut microbiota influence normal physiology and contribute to the development of inflammatory and metabolic diseases. Pre-clinical and clinical studies are also being carried out to assess the impact of interventional strategies on the gut microbiota that may prevent or subvert inflammatory processes. A therapeutic intervention aimed at counteracting intestinal inflammation in a cohort of IBD patients will be implemented, and its effect will be assessed by characterizing the gut microbiota and by measuring relevant inflammatory markers at baseline and at study end.

It has recently become evident that microbiota, especially microbiota within the gut, can greatly influence all aspects of physiology, including gut–brain communication, brain function and even behaviour [34]. Our future research will focus on delineating the relative contributions of immune, neural and endocrine pathways through which the gut microbiota communicates with the brain. Further work is also needed to reveal the key factors and molecular mechanisms involved in this complex network. We will investigate whether different microbial strains or metabolites released by gut bacteria (such as nitric oxide or GABA) are able to influence learning and memory or to affect the mood in animal models. We will also analyse the relationship between microbiota alterations and neurological diseases in selected cohorts of patients from the Institutes of Neurology and Psychiatry and Clinical Psychology. One of our future research projects aims to identify the mechanisms and mediators underlying the obesity-related cognitive decline and the improvement in memory function related to bariatric surgery. It is well known that gut hormones (in particular GLP-1 and ghrelin), adipokines and proinflammatory mediators are influenced by bariatric surgery. GLP-1 and ghrelin may play an important role in synaptic plasticity and are involved in memory formation.

The “Sarcopenia and Physical fRailty IN older people: multi-componenT Treatment strategies” (SPRINTT) project – coordinated by the Department of Geriatrics and recently funded by the European Community (IMI- Innovative Medicine Initiative) - is geared to produce significant advancements in the management of frail elders by promoting a consensus among academia, regulators, industry, and patients’ representatives over i) clear operationalization of the presently vague concept of frailty and sarcopenia; ii) identification of a precise target population with unmet medical needs; iii) evaluation and validation of a new methodology to implement preventive and therapeutic strategies among frail elders at risk of disability in Europe; iv) definition of an experimental setting serving as template for regulatory purposes and pharmaceutical investigations; v) identification of biomarkers and health technology solutions to be implemented in clinical practice. In this respect, the SPRINTT project represents the first attempt to identify a precise subset of frail elderlies with unmet medical needs and to implement a multi-component intervention (based on physical activity, nutritional intervention and ICT implementation) aimed at preventing incident disability and major negative health-related events.

Finally, in recent years early life stress and environmental exposure have become one of the major topics of research in biology. The idea that not only the lifestyle that we adopt during adulthood, but also the environment to which we are exposed in the early stages of life or even our parents’ experiences can definitely affect our wellbeing and susceptibility to the diseases in the later stages of life is fascinating. We aim to study the epigenetics of ageing to discover how early-life experience influences the age-related decline and the susceptibility to diseases. It is hypothesized that the degree of vulnerability to changes in epigenetic patterns is high during early embryonic

development, a period of life in which epigenetic patterns are established and cell differentiation is intense. An upcoming project aims to reveal the impact of parents' dietary habits or that of the environment to which an organism is exposed in the early stages of life (stress, microbiota alterations, mental training) on its cognitive, muscular and metabolic function in the adulthood.

4. The Practical Value of this Research Activity for Active Ageing and Healthy Living and Conclusions

To summarise, science has the potential to identify the most rational and cost-effective approaches to enhance healthy ageing, in an effort to improve the efficacy of strategies implemented by governmental organisations to promote healthy lifestyles in the overall population. In this direction, the main endeavour of research is to determine the most useful and sensitive biomarkers of healthy and unhealthy living, with the aim of identifying populations at higher risk for unhealthy ageing, and of developing appropriate therapeutic tools and intervention plans (Figure 2).

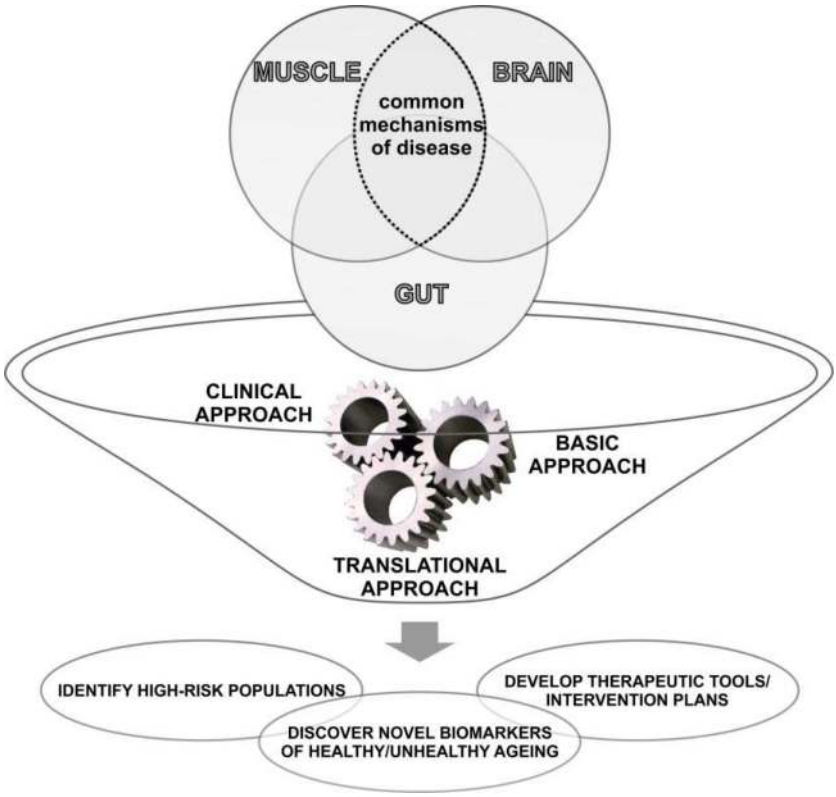

Figure 2. Schematic representation of our multidisciplinary network that, by using basic, clinical and translational approaches, is characterising the common mechanisms underlying unhealthy ageing in key target organs such as muscle, brain and gut in order to identify high-risk populations, develop novel therapeutic tools/intervention plans and discover novel biomarkers of healthy/unhealthy ageing.

While most scientists adopt individual and competitive approaches, our unique group harmoniously blends basic, clinical and translational scientists who work in concert, combining several diverse experiences with the shared aim of promoting healthy ageing. Several original research projects have been undertaken in which an innovative strategy, i.e., the characterisation of the common mechanisms underlying unhealthy ageing in brain, muscle and gut, has been implemented. Our preliminary results have already laid the foundations for a significant progress of science and public health.

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Nutrition and Ageing

Andrea MINUTI [a], Vania PATRONE [a], Gianluca GIUBERTI [a], Giorgia SPIGNO [a], Amedeo PIETRI [a], Paola BATTILANI [a], Paolo AJMONE MARSAN [a1]
[a] *Faculty of Agriculture, Food and Environmental Science, Università Cattolica del Sacro Cuore.*

Abstract. The world elderly population is rapidly increasing. This demographic change represents a new challenge for the society and demands for a multi-sectorial intervention to promote a long, healthy, and active life span. Between the factors that contribute in fostering a long healthy life, the nutritional regime plays a central role and is recognized as a major factor in the onset of chronic diseases. A better understanding of the interaction between nutrition and ageing is essential to unravel the mechanisms responsible for these positive/negative effects and to identify diet components promoting the quality of life in the old age and to contribute to the prevention of late-life disabilities. At Università Cattolica del Sacro Cuore, the research activity in food science is focusing on four main objectives: food quality, food safety, functional foods and diet balancing. These objectives are the target of multidisciplinary ongoing and future research activities for a better understanding of the link between diet and ageing. Briefly, the different activities are addressed to the study of the following subjects: the most relevant factors affecting food choices and habits of old aged persons; the effects of long term low dose supplementation of conjugated linoleic acid in mouse; the use of low glycemic index and high resistant starch foods to prevent diabetes and obesity; the adjuvant effect of food bacteria for vaccination; the role of food ingredients in disease; the immunosuppression effect of mycotoxins, and its relevance in ageing people; the production of sustainable and natural antioxidant ingredients to encourage a healthy diet. Our research projects emphasize an holistic and integrated approach that, by bringing together complementary research groups, can combine the collective expertise and thus provide a comprehensive assessment of the role of nutrition in healthy ageing people.

Keywords. Nutrition, ageing, diet, elderly

Introduction

The proportion of the global elderly population (> 65 years) is increasing rapidly and is set to rise further; it is estimated that, by 2025, there will be a total of about 1.2 billion people aged over of 60 [1]. Like the rest of the world, the European Union is characterized by an ageing society. This demographic change implicates new challenges involving different areas of intervention (e.g. social, psychological, economic, medical, physiological, nutritional). A long and healthy life span involves many factors, such as diet, genes, exercise, productive pursuits and social activity. The

[1] Corresponding author: Institute of Zootechnics and Nutrigenomics and Proteomics Research Center - PRONUTRIGEN, Faculty of Agriculture, Food and Environmental Science, Università Cattolica del Sacro Cuore, via Emilia Parmense, 84, 29122, Piacenza, Italy. E-mail: paolo.ajmone@unicatt.it

knowledge of these factors and their interaction can contribute a long and high-quality life. Among the different factors involved, it is well established that diet plays a central role for health, having long-term consequences throughout life. It is one of the lifestyle components that contribute to the development and progression of chronic diseases, including cardiovascular diseases, diabetes, and cancer. A greater understanding of the interactions between nutrition and ageing is essential in order to develop new approaches to improve the quality of life of elderly people and prevent later-in-life diseases.

Human biology is quite complex. Networks of biochemical reactions interact to maintain cell, tissue, organ, and organism homeostasis in a changing environment. After the age of fifty, many physiological changes occur in the body. The metabolic rate slows down, and it can decline by as much as 30% over a lifetime. The body composition changes with a reduction in lean body mass and an increase in fat mass, which facilitates the onset of systemic inflammation, insulin resistance, and metabolic syndrome. The digestive system efficiency decreases, due to lower gastric and enzymatic secretion, and reduced absorption ability. A balanced diet maintains the functionality of the gut mucosal barrier, a proper intestinal microflora that contributes to homeostasis and decreases the risk of alterations associated with chronic disease conditions.

Older people might not be getting a balanced diet for a number of reasons; these may be psychological, physiological, or simply economic. Therefore, it seems relevant to consider a whole range of socio-economic and cultural factors that influence the food choices of old persons, and affect active ageing in order to ensure a healthy diet.

1. Diet, Active Ageing, and Healthy Living

Willet [2] emphasized that genetic and environmental factors, including diet and lifestyle, both contribute to cardiovascular diseases, cancer, and other major causes of mortality. Hence, environmental factors may certainly have the strongest influence on life expectancy and hence lifespan [2, 3]. Nutrition is coming to the foreground as a major modifiable determinant of chronic diseases, with scientific evidence increasingly supporting the view that alterations in diet have strong effects, both positive and negative, on health throughout life. Most importantly, dietary adjustments may not only influence current health, but may also determine whether or not an individual will develop chronic diseases much later in life [4]. Obesity in humans, influenced by poor dietary choices and inactivity, is significantly associated with an increased risk of chronic diseases such as diabetes, high blood pressure, high cholesterol, cardiovascular diseases, asthma, arthritis, some cancers, and overall poor health status, which can significantly decrease an individual's life expectancy [5]. For instance, it has been estimated that, in 2000, there were approximately 150 million individuals with type-2 diabetes, and this number is likely to double by 2025 [6].

Based on the above statements, the role of nutrition appears to be fundamental for a high quality of life and healthy ageing.

2. Our research activity

At Università Cattolica del Sacro Cuore, research in Food Science is focusing on four main objectives, briefly described as follows.

- *Food quality*. Health conditions and well-being of individuals are strongly influenced by food choices. Excess intake of sugars and saturated fats represents a major dietary concern as well as under-consumption of fruits and vegetables.
- *Food safety*. This is an important public health issue and a major concern for elderly people. Normal ageing is associated with a general decrease in immune function, which is further impaired by specific disabling conditions such as chronic diseases, need for medication, and malnutrition, which are more frequently experienced by older individuals. As a consequence, older people may face increased susceptibility to foodborne illness as compared to other population subsets [7]. In addition, they are more likely to experience serious or long-term infection complications that may result in prolonged hospitalization and eventually death.
- *Functional foods*. People can optimize the health-promoting capabilities of their diet by supplementing and consuming foods that have been formulated or fortified to include health-promoting factors. Functional foods are components of the usual diet that may have special disease-prevention attributes. According to the Food and Nutrition Board of the Institute of Medicine, a functional food is "any food or food ingredient that may provide a health benefit beyond basic nutrition" [8]. Unlike dietary supplements that can claim only general health benefits, functional foods may claim specific health benefits since they are considered part of the diet [8].
- *Diet balancing*. Understanding the effects of dietary macronutrients on ageing remains a fundamental challenge, with profound implications for human health [9]. Often, the focus of nutrition research is on the effects of individual macronutrients (fat, sugar, and protein). However, studies on a wide range of species provide growing evidence that macro-nutrients' interaction (i.e., their balance), in addition to their individual dosage, is important for health and ageing [9–11]. Defining what represents a balanced diet, and the consequences of not attaining such balance, is of high priority in nutrition research.

These objectives are the target of multidisciplinary research activities currently underway or planned in the near future for a better understanding of the link between diet and ageing.

2.1. Factors affecting a healthy diet for the elderly.

The elderly are a segment of the population that is rapidly growing; policy makers are seeking interventions to guarantee high health status and quality of life and to individuate care-giving practices to meet the needs of the elderly. The quality of diet (nutritional content, food safety) is a key element of older people's well-being, and addressing the issue of food choices for the elderly may provide valuable information for policy makers and care givers. For elderly individuals, inadequate nutrition can increase the incidence and severity of disease, thus hastening the loss of independence.

The choice of a healthy and a varied diet is challenging for people aged 60 or above, because the ability to choose a diet which meets their nutritional needs may be adversely affected by the pathological, physiological, economic, and societal factors that accompany ageing [12]. Thus, to better understand and solve the nutritional problems of the elderly, it is important to identify these factors and how they affect food choices [13].

The objective of the study is to analyse the most relevant factors affecting diet in the elderly (health-related, socioeconomic, cultural, bio-legal and ethical, life-style), and individuate the causal relations among collected variables and food habits.

2.2. Diet and Animal Models of Ageing: The effects of long-term low-dose supplementation of conjugated linoleic acid in mice.

Ageing leads to a reduction in lean body mass and an increase in fat mass facilitating the onset of systemic inflammation, insulin resistance, and metabolic syndrome. Inflammatory processes, no longer controlled by the immune system, cause accelerated immunosenescence. The condition of progressive loss of skeletal muscle mass and strength is termed "sarcopenia". On average, ageing individuals lose muscle mass at a rate of 1–2% per year after the age of 50, resulting in a significant decrease of muscle strength [14].

Conjugated Linoleic Acid (CLA) refers to a mixture of positionally and geometrically conjugated dienoic isomers of linoleic acid [15]. Over the last several years, interest in CLA has increased due to its many bioactive properties related to health. The benefits seem to be very clear, especially in some experimental animal models. The health effects attributable to CLA include anti-carcinogenic and anti-tumorigenic effects [16]; reduction in the risk of atherosclerosis, hypertension, and diabetes; improvement in food efficiency; promotion of energy metabolism and body weight [17, 18]; positive effect on immune function [19]; and musculoskeletal health [20].

The general objective of the study is to investigate the effect of a long-term low-dose supplementation of two CLA isomers (c9t11 CLA and t10c12 CLA) and their mix in a mouse model. In particular, will be investigated the effect of CLA on metabolism, inflammatory response, and the immunity status and gene expression modification in different tissues (liver, abdominal fat, cardiac muscle, skeletal muscle, brain) as well as in tissues composition and in mitochondrial activities.

2.3. Use of low glycemic index and high resistant starch foods to prevent diabetes and obesity in elderly people.

One of the consequences of ageing is the increase of body weight and body fat percentage. Both of these conditions facilitate the initiation of chronic inflammation, insulin resistance, and metabolic syndrome. For instance, epidemiological and experimental studies reveal that the prevalence of type 2 diabetes may increase with age, although the patterns of incidence vary noticeably [21]. A wide range of lifestyle-related factors has been implicated, including early-life events and physical inactivity, several dietary attributes (i.e., quantity and quality of dietary fat and carbohydrates), and the subsequent development of overweight and obesity. Metabolic studies have shown that food sources of carbohydrates vary greatly in the rate of absorption and effects of blood glucose and insulin concentration, with several implications in the

physiological response and overall health status [22]. One way to quantify this variation in response to dietary carbohydrates is the glycemic index (GI), pioneered by Jenkins et al.[23]. Consumption of low GI foods has been related to reductions in the risk of coronary heart disease and type 2 diabetes [22, 24]. A similar benefit has also been shown with high-resistant starch (RS) foods [25]. This fraction shares several common properties with soluble dietary fibre, and a significant number of studies have indicated that RS-rich foods release glucose slowly, thus potentially resulting in a lowered insulin response, greater access to and use of stored fat, and potentially a muted generation of hunger signals [26–28]. Accordingly, it has been proposed that eating a diet rich in RS may potentially increase the mobilization and use of fat stores as a direct result of the reduction in insulin secretion [29]. In addition, the consumption of high-RS food can increase the production of volatile fatty acids (especially butyrate) and therefore may help to improve colonic health with possible implications in the treatment and/or prevention of disease such as colorectal cancer [30].

Since a positive correlation between GI and food intake is well established, the development of low-GI and high-RS foods can be a suitable tool in reducing the risk of ageing-related illness. Low-GI foods can be obtained by the use of specific ingredients (sources of RS) or by technical treatments or combining the two approaches. The innovative aspect of our proposal is the use of a new source of RS, combined with technical treatments, to favorably reduce the GI of foods.

2.4. Adjuvant effect of food bacteria for elderly vaccination

Among the dramatic physiological changes experienced by human individuals during ageing are the alterations in the structure and functions of the human gut microbiota. In elderly subjects, such shifts of the intestinal microbial populations might be linked to immunosenescence and inflammaging; i.e. the decline of immune response that occurs with age and the concomitant increase in inflammatory status [31]. Recent data suggest a correlation between diet, gut microbiota, and frailty status in the elderly [32], thus supporting the potential health benefits of a dietary intervention targeting the gut microbiota. In this context, it has been suggested that probiotics, through their effect on immune regulation, can influence a number of common conditions typical of advanced age, such as increased susceptibility to infection. Moreover, the effectiveness of vaccinations in preventing illness is lower among the elderly, and this represents a public health problem, causing a considerable societal cost. There is promising evidence that bacteria usually incorporated into fermented foods (yoghurt) or used as active ingredients in food supplements have an adjuvant effect in supporting the effect of vaccinations in the elderly. This effect includes the influenza vaccine, which is provided for free to the elderly by some European national health services. This effect seems related to specific bacterial strains and is not widespread among the so-called probiotic bacteria. The scope of the proposed investigation includes providing solid clinical support to the existing data as well as a pharmacoeconomics evaluation of the use of these bacteria within the national vaccination programmes. Additionally, the research activity will focus on developing reliable in vitro assays to explore the molecular mechanisms at the basis of this effect.

2.5. The role of food ingredients in disease; i.e. sodium chloride in processed meat and cheese

Ageing brings a dramatic increase in the prevalence of hypertension associated with a greater risk of stroke, heart attack, and other heart-related diseases [33]. Scientific evidence accumulated in the last decade indicates that a diet high in salt can cause raised blood pressure, and changes in diet are recommended to lower it [34]. Salt is traditionally used as a natural ingredient in the making of preserved food such as processed meat and cheese to add flavour and extend the shelf life. As a result, health-related food quality characteristics such as low levels of salt are increasingly demanded by consumers; on the other hand, consumer concerns about food quality can significantly reduce the demand for traditional food products. The specific challenge in traditional food production is the improvement of the safety and the nutritional value profile of European traditional foods such as processed meat (salami and sausages) and cheese in the frame of typical food (Protected Designations of Origin [PDO]) products. The scope of this investigation includes identifying support of the health status of the ageing European population while allowing them to consume the traditional (PDO) food products to which they are accustomed. The goal is to improve the health status of ageing people without changing their nutritional habits, and to support the European food industry, mainly formed by small and medium enterprises (SMEs), to "restyle" traditional food products.

2.6. Immunosoppression effect of mycotoxins and its relevance in ageing people .

Human food can be contaminated with mycotoxins at various stages in the food chain [35], even if the mycotoxins that are likely to be encountered by human populations differ between countries [36]. The EU regulation sets limits for the most toxic compounds, defining stricter values for baby food. When ingested, mycotoxins may cause mycotoxicoses that can result in acute or chronic disease episodes [37]. The toxic effects of mycotoxin ingestion depend on a number of factors, including intake level, duration of exposure, toxin species, mechanism of action, metabolism, as well as defence mechanisms [38]. In Europe, concern is mainly due to chronic effects. In fact, it is well known that some mycotoxins cumulate in time and have relevant persistence in organs like liver and kidney.

Mycotoxins are confirmed/potential carcinogens; they have several undesirable effects, but one of the less-studied toxic effects is immunosuppression [39]. The multi-mycotoxin exposure and their synergistic effect is a further matter of concern.

It is expected that older people are more at risk of adverse health effects caused by mycotoxins, both as a result of the high accumulation in organs and their higher susceptibility compared to younger adult people. In this context, it is important to study ageing people's exposure and determine how mycotoxins can influence their well-being in order to plan counter actions, if necessary.

The general aim of the study is to understand the role of mycotoxins on ageing people's health in order to (i) suggest a more suitable diet, leading to lower exposure to mycotoxins, and ii) propose stricter limits on mycotoxin content in food products, similarly to those in force for baby food. In addition, the definition of appropriate biomarkers should help in better evaluation of mycotoxin exposure.

2.7. Production of sustainable and natural antioxidant ingredients for a healthy diet for the elderly.

Antioxidants, particularly the polyphenolic forms, may help lower the incidence of disease, such as certain cancers, cardiovascular and neurodegenerative diseases, and DNA damage, and may even have anti-ageing properties [40]. A diet rich in polyphenolic forms of antioxidants can promote healthy ageing [41]. If the definition of both the required pharmacological doses and bioavailability of phenolic compounds is required, the production of functional foods rich in polyphenols is also required.

Wastes and residues from agriculture and food processing are often still rich in polyphenolic compounds. Antioxidant polyphenols that have been recovered from residual sources represent potential low-cost functional ingredients provided that a low-cost recovery process is applied. Extensive research has been done in the last decades on the recovery of polyphenols from residual sources, thus revealing the feasibility of such processes. The recovery process needs to be completed through purification and encapsulation steps which need to be tailor made for specific applications (such as bakery products, rather than beverages or dairy products). However, the recovered compounds are to be further processed in order to deliver stable and efficient formulations to be incorporated into functional foods. The final formulations have to be characterized by high antioxidant activity, stability in the target food product, and release in the human body (following the digestion process or also as a probiotic/prebiotic effect).

The project aims to develop different innovative functional foods through the addition of antioxidant ingredients produced from agri-food residuals. The conducted research will contribute to advances in the state-of-the-art research related to the encapsulation of polyphenolic compounds for their protection during food processing and, at the same time, for a suitable stability and release into the human body after ingestion.

3. The practical value of this research activity for active ageing and healthy living

The various ongoing and future research projects at Università Cattolica del Sacro Cuore focusing on nutrition and ageing are expected to yield multiple and significant practical benefits.

Nutrition research will produce new knowledge about how nutrients affect human physiology, the connections between food and human health, and their significance in the development of late-in-life diseases. Risk-assessment research will help to characterize the specific nature and magnitude of risks for elderly people's health associated with foodborne hazards such as mycotoxins. The results of these works of research will provide information and resources to guide dieticians and healthcare professionals in decision making and professional practice regarding food and input into local and national-level nutrition policy decisions that may reduce disease risk and/or promote good health in elderly people.

Research in food science will contribute to the development of new methods and combinations of ingredients in food preparation and preservation to be applied in traditional food production systems aimed at preserving the quality and typicality of the products while at the same time meeting the nutritional needs and dietary recommendations for healthy elderly population, such as lower salt intake. The transfer

of such technologies to traditional food producers will contribute to the support of this industrial sector and increase their competitiveness through innovation without affecting senior European consumers' attitudes towards traditional food. At the same time, the applied research will design new functional food and nutrition solutions to provide specific health benefit for older people over and above their basic nutritional value. This includes the development of foods with a low glycemic index, which promotes satiety and improves blood glucose control for weight management and better metabolic health, as well as food enriched with antioxidants, which may support physical performance and cognitive function in seniors. The possibility of using agri-food residuals for this purpose will encourage environmentally responsible practices that conserve natural resources, reduce the quantity of waste generated, and support the ecological sustainability of the food system.

In the context of delaying adverse health conditions, the output of the research will offer new possibilities and nutrition strategies to improve established preventative care measures in older people, above all vaccinations. Effective primary prevention in older individuals results in significant reductions in hospital admissions and net healthcare costs, with positive economic and social implications for society as a whole.

Making effective recommendations for healthier nutrition in elderly people entails understanding the influence of economic factors, physical conditions, personal perceptions, and household characteristics on the dietary choices of older adults. The comprehensive collection and analysis of data concerning these aspects will shed new light on the issue of food choices among the elderly, with main reference to the quality of the diet and food safety, and will allow the use of new knowledge to assess specific interventions targeting the elderly and mainly among caregivers such as family doctors and physicians.

4. Conclusions

Scientific research into the complex interactions between nutrition and health as part of the ageing process is of great significance in light of the current worldwide growth of the elderly population. Such research offers a challenging opportunity to develop evidence-based strategies to enhance healthy ageing through diet, with an emphasis on preventing chronic disease, minimizing physical and mental impairment, and improving the overall quality of life in late adulthood.

To address these issues nutrition science must take into account the development of innovative technologies and processes and their impact on food systems on one side and the social, economic, and cultural dimensions of older individuals' nutrition behaviour and habits on the other.

Our research projects emphasize a holistic and integrated approach that, by bringing together complementary research groups, can combine the collective expertise and thus provide a comprehensive assessment of the role of nutrition in healthy ageing.

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The Role of Psychogeriatrics in Healthy Living and Active Ageing

Enrico MOLINARI[a,b], Chiara SPATOLA[a,b], Giada PIETRABISSA[a,b], Francesco PAGNINI [a], Gianluca CASTELNUOVO[a,b1]
[a] *Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy*
[b] *Psychology Research Laboratory, IRCCS Istituto Auxologico Italiano, Italy*

Abstract. A healthy and active life is a key issue for elderly citizens, above all when psychological complications such as depression and anxiety disorders, late delusion or loneliness can be observed. Moreover, medical pathologies in elderly patients often have a multi-factorial etiology and many psychopathological dimensions and psychosocial risk factors are underestimated. From the perspective of clinical health psychology, psychogeriatrics could play an important role in promoting active ageing and a healthy lifestyle in elderly persons through tailored clinical approaches based on specific research and advanced professional training in this area. More research is needed in order to study which determinants affect the process of an active and functional ageing. Possible research ageing areas are: 1) evaluation of psychosocial risk-protective factors related to the individual's biography and personality. 2) Evaluation of enrichment programs and clinical protocols focused on the management of different topics such as health system areas, behavioral areas, social and physical environment areas, psychological factors and economic determinants. The goal of Psychogeriatrics endeavors to develop and evaluate interventions designed to stimulate improvement in friendship, self-esteem and subjective well-being, as well as to reduce loneliness among older citizens. 3) Evaluation of self-management programs in chronic disease conditions (such as obesity, diabetes, hypertension, poor nutrition, physical inactivity, alcohol abuse and tobacco smoking), that could enhance risk factors for health in elderly citizens. Typical key elements of self-management, such as decision making, problem solving, motivation, self-efficacy, resource utilization, and citizen's empowerment have to be studied.

Keywords. Psychogeriatrics, Health Psychology, Clinical Psychology, Active Ageing, Healthy Living, Self-management Programs

Introduction

Around 10% of the worldwide population is above 60 years of age and this proportion is expected to significantly increase by 2050. In the European Union this trend is changing the demographic features and progressively moving towards an ageing population: 17.4% of around 87 million people was aged 65 or over in 2010 and in Europe the age group of 80 and over is increasing more rapidly than in non-European countries [1]. 2012 has been proclaimed as the *European year for active ageing and solidarity between generations* [2].

[1] Corresponding Author: Department of Psychology, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: gianluca.castelnuovo@unicatt.it

Clinical health psychology, and particularly psychogeriatrics, plays an important role promoting healthy ageing in the lives of older adults [3]. Healthy and active living is an important value for elderly citizens. Depression and anxiety disorders, late delusion and loneliness are often observed psychological problems. Moreover, many psychopathological dimensions and psychosocial risk factors, traditionally underestimated, could contribute to a multi-factorial etiology of several medical pathologies in elderly patients.

Psychological research could shed light on which determinants affect the process of an active and functional ageing. Future research ageing areas are indicated below.

Evaluation of psychosocial risk-protective factors related to the individual's biography and personality. Typically protective factors are higher education, regular physical exercise, a healthy balanced diet, cognitively and intellectually challenging leisure activities and an active lifestyle with integrated social components. It is also important to evaluate personal independence, productivity and debilitation in relation to quality of life. Variables such as gender and culture have to be considered.

Evaluation of enrichment programs and clinical protocols focused on the management of different topics such as health system areas (health promotion and disease prevention, long-term care, mental health treatments, chronic care models, etc.), **behavioral areas** (physical activity, nutritional profiles, alcohol and tobacco use, etc.), **social and physical environment areas** (loneliness, role of caregivers, social support, logistic barriers, etc.), **psychological factors and economic determinants** (work, retirement, social protection). Psychogeriatrics endeavors to develop and evaluate interventions designed to stimulate improvement in friendship, self-esteem and subjective well-being, as well as to reduce loneliness among older citizens.

Evaluation of self-management programs in chronic disease conditions (such as obesity diabetes, hypertension, poor nutrition, physical inactivity, alcohol abuse and tobacco smoking), that could enhance risk factors for health in elderly citizens. Typical key elements of self-management, such as decision making, problem solving, motivation, self-efficacy, resource utilization, and citizen's empowerment have to be studied.

1. Definition and General Characteristics of Active Ageing

A typical definition of active ageing was proposed by Rowe and Kahn [4] using the term "successful ageing":

> "We define successful ageing as including three main components: low probability of disease and disease-related disability, high cognitive and physical functional capacity, and active engagement with life." (p. 433).

"Successful ageing" refers to situations where elderly people do not have (acute and chronic) diseases, do not suffer from disability and are cognitively capable, possess good physical fitness and actively use these capacities to have a functional integration with other persons in their society. Other terms have been used in psychogeriatric research such as healthy ageing, productive ageing, ageing well, optimal ageing and active ageing [2]. The main characteristics of ageing processes are life course perspective, heterogeneity, plasticity, contextuality, and social change [2].

The process of ageing is part of the life course. Even though negative and traumatic events could happen in the elderly (e.g., the onset of dementia), childhood, adolescence and adulthood shape and influence the biographical trajectories that will affect the third and fourth phase of life. It is important to take into account that the distinction between "third age" and "fourth age" is somewhat arbitrary.

> "In gerontology, the beginning of the "third age" is often defined as the transition into retirement and/ or the age of 65 years; the beginning of the "fourth age" is sometimes defined as the age of 85 years. While the majority of individuals in the "third age" have sufficiently good health to live independently in private households and participate actively in society, the prevalence of people who are frail, dependent and in need of care increases in the "fourth age"." (p. 2, [2]).

Ageing processes are heterogeneous. There are significant inter-individual differences among ageing persons due to the many variables during the life course: different life-styles could generate several trajectories producing cumulative inequality. The most important differences are related to health, physical features, cognitive abilities and social integration [2] .

Ageing processes are characterized by plasticity. Even if there are important genetic and biographical determinants in the ageing processes, psychogeriatrics has noted that there is no determinism towards a negative or falling scenario, but the course of ageing can be modified and improved by effective and adequate interventions, taking into account that efficiency of treatments decreases in very old age [2; 5; 6] .

Ageing processes are evolving in a multilevel context. Even if ageing processes happen within an individual dimension, factors about different levels (environmental, cultural, societal and familiar) have to be investigated. Interventions for successful ageing can be "tailored" with consideration for the best appropriate level [2; 7].

Finally, **Ageing is part of a changing social and cultural context**.

> "The process of ageing takes place within historical time. As societal conditions change over time so does the process of ageing ... Not only the average life expectancy has changed (and the fact that more members of a birth cohort grow old), but also living circumstances like health care systems and social networks." (p. 3, [2]).

2. Psychosocial Risk-Protective Factors in Active Ageing.

Evaluation is necessary to assess psychosocial risk-protective factors in elderly patients related to the individual's history and personality. The potential risk role played by organic disorders (e.g., obesity, dyslipidemia, diabetes, etc.) is well known and considered, but avoiding psychopathologies and preserving cognitive function are key measures, not always appreciated, in elderly treatment and rehabilitation, to ensure independence, productivity and quality of life.

Moreover, the potential protective role of psychosocial factors (e.g., higher education, regular exercise, healthy diet, intellectually challenging leisure activities and active socially integrated lifestyle) is vital in active ageing. In order to promote well-being and to minimize disability by reducing risk and increasing factors, it is necessary to adopt strategies that protect health throughout the life course [8; 9].

There is a significant variability in the elderly population with respect to health, functioning and psychological status [10] due to the presence of different patterns or

"profiles of ageing" in several areas of functioning and health which influence successful or dysfunctional ageing processes [10]. In order to better understand the role of psychosocial factors in ageing profiles, an up-to-date and well done cluster analysis has been conducted:

"A cluster analysis produced three within-person psychosocial profiles characterized by distinct patterns of functioning: highly successful elders demonstrated to be healthy, highly confident in their own resources and very active in daily life; moderately successful elders demonstrated average functioning across domains, although they expected decreases in the future; and highly impaired elders were ill and stressed, at a high risk for future health problems and depression, and tried to compensate for their status mainly through social support." (p. 489, [10])

These results are novel and interesting because the authors found different psychosocial profiles in older adults, including several diverse psychosocial functioning domains such as current perceived health, physical health, mental health, absence of anxiety, daily functioning, absence of depression, general self-efficacy, social self-efficacy, optimism, social support from friends and relatives, leisure activities, desired leisure activities, monthly frequency of leisure activities, leisure satisfaction, major life stressors, average stress, average coping and total stress impact. Considering these variables, the psychosocial profiles identified by the cluster analysis fall into three categories: a first group is composed mainly of highly successful older adults; a second group is characterized by highly impaired elders; the third cluster is composed mainly of moderately successful elders (as reported in [10]). These results shed light towards a better understanding of the relationship between subjective well-being and psychosocial profiles, showing differing "ageing trajectories".

"The present study represents an attempt to move beyond the description of average ageing trajectories toward a person-centred, multidimensional, empirically defined consideration of differential ageing ... Our findings also add some insights on the well-being "paradox" in old age, which suggests that older persons maintain a sense of well-being in the face of increased risks, losses and declines [11-13]. Research on clustering elderly trajectories has demonstrated the heterogeneity and differential development which occurs in old age, with many of the elders showing "desirable" and positive health status, functioning and well-being. For many elders, ageing is not associated with negative outcomes, most likely due to the existence of powerful psychosocial resources for a positive and successful ageing process...; thus, the paradox may be true for some but not all elderly persons." (p. 500, [14]).

Clinical health psychology must focus on studying and improving the psychosocial resources available, taking into account the differences in each ageing profile. Specific and "tailored" psychogeriatric interventions are needed to increase the subjective well-being and quality of life in elderly people [14].

3. The Healthy Ageing Model: Promoting Behaviour Change in Elderly Persons

An interesting perspective about how to better support older adults in adopting healthy behaviours has been proposed by Potempa et al. [15]. According to these authors, it is well known that the health of older adults, especially those with chronic health conditions, is significantly dependent upon behavioral choices that have to be made

each day on a long-term basis. Such changes are not always easily accomplished due to lack of motivation and other barriers.

Older adults and their families and caregivers aim to ensure prevention of morbidity and improve quality of life in the later years. So more resources will be spent not only for physical health, but also for a wide concept of "quality of life", defined as

> "A general sense of happiness and satisfaction, meaningful activity, and the ability to express culture, beliefs, values and relationships." (p. 52,[15])

The Healthy Ageing Model was developed to create useful future guidelines for ageing research and practice, where the model of health promotion is mainly characterized by the support of positive behavioural changes. The most important and validated theoretical models of health behaviour change in a population of ageing individuals are implemented, considering varying states of health and illness,, In particular, a client-centered approach [16; 17] is used with motivational interviewing techniques [18-24] providing reflective listening to and solutions discussed with the patient, improving the personal sense of autonomy and working on the readiness state of clients in the change cycle [25-27]. The Healthy Ageing Model also focuses on goal setting, establishing targets according to each current patient's readiness and activity level, another important variable to consider when working with elderly patients [28-30]. Goals have to be credible, individualized and tailored for each patient in terms of time and space [31]. The Healthy Ageing Model is characterized by four elements: (1) a client-centered perspective, (2) a goal-driven approach, (3) an individualized "coaching" strategy of health behaviour change and (4) a Personal Health System, an approach that recognizes the importance of the broader health context that surrounds clients [15].

- *Client-centered perspective*
  The Healthy Ageing Model takes into account that the individual care needs are of vital importance, and health and illness experiences are very personal. To give continuous attention to the client's perspective and to their view of their support systems is fundamental. Clinical health psychology can train professionals to use an empathetic, manner at a communicative and relational level, listening to the client's story with a non-judgmental approach [15; 32-34].

- *Goal-driven approach*
  The Healthy Ageing Model focuses primarily on goal setting. Goals have to be articulated by the client; those which are individualized, specific, meaningful and achievable are the most effective.

  > "Goals may or may not be directly related to health, or at least health in this context is very broadly defined. It is another premise of the model that even modest progress toward a specific goal accesses clients' desire to engage further action toward other desired behaviour change. Confidence or self-efficacy is built specific behaviour by specific behaviour." (p.53, [15])

- *Health professionals' coaching*
  Due to the American context of the Potempa's contribution, the term behavioural coaching has to be adapted to the European traditions, where the "health coach" role could be played by a multiprofessional team: the mental health and behavior change

components could be performed by a clinical health psychologist or a psychologist with a deep experience in psychogeriatric topics. This "behavioral coach" has to clarify and enhance the health care goals discussed for the clients and coordinate with the clinical team to produce a behavioral change if necessary [15; 35; 36].

One aspect of successful Healthy Ageing Model oriented counseling is a methodology called Motivational Interviewing (MI). MI could be defined as a directive and client-centered counseling technique for helping clients to understand and resolve ambivalence about behaviour change [37]. This therapeutic approach is currently widely used in health settings, such as cardiac rehabilitation [38-44], and is clearly described by Larsen and Zwisler:

> "Psychologists William R. Miller and Stephen Rollnick developed motivational interviewing (or counselling) in the 1990s. This is used in health promotion and disease prevention initiatives in which health personnel attempt to motivate people to change their behaviour based on the stages of change model. Motivational interviewing mainly targets people who are motivated to change behaviour (action and maintenance stages) ... The technique of motivational interviewing is a form of guidance that places patients in the centre. Instead of directing patients towards a predetermined goal, patient centred health communication starts with the situation and resources of patients. The practitioner and the patient jointly prepare a strategy that optimally promotes the patient's action competence. This ensures that patients can process the knowledge they encounter and make decisions on a qualified basis. The practitioner begins the interview by investigating what patients already know. Patients who need knowledge are offered further information. This information must be based on facts and exclude the practitioner's assessment. Patients are informed about the effects of various forms of health behaviour. Information presented orally may be supplemented by written material. The purpose of motivational interviewing is not necessarily to get patients to change their behaviour but more to tailor advice and guidance to each individual. The starting point is that the motivation for change arises from personal clarity and liberation from an ambivalent attitude towards change. Health personnel can help patients to achieve clarity and perhaps change by using a motivational interviewing technique in a nonjudgemental atmosphere." (p. 29-44, [45])

- *Personal Health System*

  Another important component of the Healthy Ageing Model is the Personal Health System, defined as a complex system of relationships, behaviors, treatments, interventions, clinical practices in general and beliefs that can help clients in moving toward their personal goals. Traditional medical services and other clinical and health supports available for patients are considered parts of the Personal Health System. It provides tools to clients in order to be engaged and active in health ageing processes [46-50].

  > "Family and social network engagement and the ongoing creation and acknowledgement of activities, people and resources the client relies on for assistance and support is well-documented as a key contributor to positive self-care and well being..." (p. 54, [15])

4. Psychogeriatric Interventions for Healthy Living in Clinical Settings

Mental health and mental wellbeing are concepts used across the life span, but some factors are especially relevant to older people's context. Typically the mental health of an older person is linked to a positive context of active ageing, with a dimension of

control over the health and lifestyle choices [51]. Relevant risk factors for mental illness in the ageing processes are the loss of social relationships and roles, negative changes in lifestyle, presence of chronic conditions and comorbidities, physiological and neurocognitive decline [1; 51]. Mental health promotion endeavors to ensure healthy ageing, enabling older people to remain active and independent, strengthening and maintaining the environmental, social, and individual factors that preserve mental health [1].

An important systematic review and meta-analysis [52] was conducted to evaluate the most successful psychosocial interventions for mental health promotion, with a particular focus on treating depression among older adults aged 65 years or over. Compared to no-intervention controls, the evaluated psychosocial interventions had a statistically significant pooled effect on depressive symptoms, but no statistically significant effects could be found for the other measured outcomes, such as cost-effectiveness and acceptability of the interventions, quality of life, etc. [1; 52]. The interventions studied in this systematic review and meta-analysis [52] could be categorized into the following six groups [1]:

- *Physical exercise.*
  Physical exercise interventions include aerobic, yoga, or tai chi classes, targeting general older populations, as well as specific physical activity training programs, targeting frail older adults, taking into account that the older age groups contain individuals who generally suffer from more physical limitations than younger older adults and therefore may benefit less from physical exercise interventions [1; 53; 54].

- *Skill training interventions.*
  This category contains different interventions aimed at working on educational components, cognitive skills and management strategies. Typical training involves memory programs, mindfulness exercises and learning sessions about the use of new technologies such as Internet [1; 55-57].

- *Reminiscence.*
  Reminiscence-based interventions include various forms of life reviewing and recalling past events. This act of remembering, telling or "re-writing" about past experiences could be very useful in older age [58-62].

- *Group support provided to people experiencing loneliness.*
  Social support was considered within this category and consisted of groups for older adults living alone and experiencing loneliness. Social support groups enhance social networks and contacts, reducing feelings of loneliness in older adults, especially for those with a high risk of social isolation [1; 63-65].

- *Social activities.*
  Social activity interventions aim to rebuild an active role for elderly participants. These activities have a significant positive impact on reducing depressive symptoms and improving mental health in general [1; 56; 66-68].

- *Multicomponent interventions.*
  Some interventions could be characterized by the presence of different components taken from the previous categories; this typology is considered as "multicomponent intervention" [1; 56; 69; 70].

5. Conclusions

Many elderly persons and patients need to be monitored, managed and treated from both medical and psychological points of view, particularly in cases with chronic disease conditions (such as obesity diabetes, hypertension, poor nutrition, physical inactivity, alcohol and tobacco abuse), that could enhance risk factors for health in elderly citizens. Typical key elements of a traditional treatment or of a self-management approach, such as decision making, problem solving, motivation, self-efficacy, resource utilization, or citizen's empowerment, have to be studied and improved by clinical health psychology and psychogeriatrics [35; 36; 71].

Clinical interventions and social activities are effective in enhancing mental wellbeing in later life.

> "Based on the findings, meaningful social activities tailored to the older individual's abilities, preferences, and needs should be considered when aiming to promote mental health among older people. Duration of interventions should also be considered in practice, because longer interventions, lasting for longer than 3 months, exhibited positive effects on mental wellbeing and depressive symptoms. These findings should be taken into account and applied in the design and replication of interventions with evidenced positive effects. The heterogeneity within the older population should not only be considered in intervention planning and implementation, but also in the description of the study sample in research reports." (p.346, [1])

Further research is needed in psychogeriatric protocols to evaluate different clinical psychology-based program types, such as psychological interventions, psycho-educational programs, psychotherapies, educational training, counselling sessions and relaxation techniques [35; 36; 72-75]. As noted by Payman [76], many territories are awaiting for exploration and research. Theoretical frameworks, case studies, randomized controlled clinical trials, systematic reviews and meta-analysis, if possible, are necessary in the active ageing area in order to enhance the scientific and practical level of psychogeriatrics. Cognitive-behavioural therapy is the most validated approach in active ageing. Other psychotherapies, such as interpersonal psychotherapy and brief psychodynamic psychotherapy, are growing and need specific studies in the area of elderly research [76].

New approaches such as Acceptance and Commitment Therapy [77] or expressive writing [78], have to be tested for cases of multiple chronic disease conditions associated with elderly, There is a need to improve the study of rehabilitation programs on patients with well-known comorbidities such as obesity [71; 79], increasing the study of psychosocial and cognitive features related to medical complications [80-85], and opening the door to the growing opportunities provided by new technologies, mHealth approach and telepsychogeriatrics [86-92].

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Age Management and Sustainable Careers for the Improvement of the Quality of Ageing at Work

Francesco MARCALETTI[1]
Department of Sociology, Università Cattolica del Sacro Cuore, Milan, Italy

Abstract. Prolonging working careers by increasing the statutory age for retirement has become compulsory in most Western societies in order to tackle the shrinking of the labour force, preserve economic productivity, foster knowledge transfer and reduce the risks of financial imbalances in social security systems. This imperative currently results in working careers that already exceed 40 years and come to an end after the age of 65 (e.g. in Italy). Over the next few decades, both career length and retirement age are expected to rise. Thus, creating more inclusive workplaces by increasing their quality is the precondition of a win-win situation for both employers and employees, regardless of age. A request for support in the development of sustainable careers from both private and public labour organisations has led to innovating the mainstream methodologies and research tools in the field of age management. Based on the key elements of the mainstream "work ability concept" – i.e. health, competencies, motivation and work organisation – the Quality of Ageing at Work questionnaire (QAW-q), developed by a team from the WWELL Research Centre, broadens its perspective by surveying elements bridging intra-organisational dimensions and which affect employees' conditions and external socio-institutional constraints: i.e. work-life balance, economic stability, professional identity and relationships in the workplace. The QAW-q is designed to analyse the influence of the different meanings of age (chronological age, seniority within the company and in the labour market) and correlate them with the different dimensions at individual and organisational levels; all these dimensions are weighted by the effect exerted by the passage of time. The results of the QAW-q survey, taken by employees of both private and public companies, serve as a basis for the implementation of measures addressing all the relevant dimensions of the human resource management cycle.

Keywords. Ageing Labour Force, Work Ability, Age Management, Quality of Ageing at Work, QAW, HRM

1. Demographic Change Macro Challenges and their Implications for Work Organisations

The need to develop tools which support employers and managers in coping with the consequences of an older and more age-diverse workforce derives from crucial macro-level changes and challenges. The ageing population trend stems from two main tendencies which are affecting most Western societies – a huge increase in life expectancy since the last century and falling fertility rates from the early 1970s. The

[1] Corresponding Author: Department of Sociology, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: francesco.marcaletti@unicatt.it.

demographic ageing process is measured as the growth in the relative and absolute share of the older population. At the European level, the number of people aged 65 and over is expected to increase by two million per year over the next few decades [1].

Inevitably, these trends are reflected in the age structure of a labour force which is also growing older, challenging labour market regulation policies and consequently the sustainability of social security systems. Firstly, we consider the question of generational turnover, where problems could arise over the next few years due to the lack of younger people entering the labour market, and the need to maintain and improve the skills and competences of the labour force itself in order to support the competitiveness of production systems [2]. As far as sustainability is concerned, according to Eurostat [1], by 2060 in the EU27 there will be fewer than two people of working age (15 to 64) for each person aged 65 or over; today the ratio is almost four to one. The old age dependency ratios may be further influenced by underemployment or unemployment which reduce the number of persons actually active in the labour market and able to sustain social protection expenditure through tax and contribution payments.

Faced with these trends, the imperative identified by the European Commission [3] is to promote active ageing. The EC defines active ageing as a strategy to make the "ageing well" process possible in ageing societies, which implies working longer, retiring later and more gradually, learning throughout one's life, being active after retirement and engaging in capacity enhancing and health sustaining activities [4]. In particular, the EC puts the emphasis on activation in the labour market, based on a broad and diversified idea of activity. This includes prolonged productive activity achieved through an increase in the number of years spent in formal employment, as well as bridge employments towards retirement [5], and inclusion in socially (re)productive activities, such as voluntary work or providing post-retirement care [6; 7].

Although the concept of active ageing is multidimensional in itself, labour market participation still represents its most crucial dimension. Given that prolonging work careers is becoming increasingly crucial for the social and economic sustainability of Western societies, the inclusion of older workers in the labour market is necessary both from a social and personal perspective. Due to improved living conditions and increased well-being in old age, a growing number of workers want to remain active for longer in the labour market. According to OECD and EC, work participation underlies individual well-being and social inclusion [8], and represents – at the same time – the most effective contribution of individuals to the collective well-being and sustainable development. What emerges, therefore, is a need to keep people in work longer in order to expand the workforce, together with a need to promote more inclusive workplaces for people of every age. Better working conditions for older workers represent a pre-condition for achieving these goals.

These demographic trends, and the needs which arise from them, have the same implications throughout EU, although they affect member states to different extents and at different speeds. Italy (together with Germany) is one of the countries where the ageing process has been faster and has led to more significant consequences. The percentage of over-65s is expected to reach 25.5% by 2030, and the old age dependency ratio is expected to rise to 41.1% by 2030 and 56.3% by 2050. The situation is even more worrisome if we consider the occupational trends. In Italy the employment rate of people aged between 55 and 64 was only 36.6% in 2010, significantly lower than the expected Lisbon target of 50%, as formerly set by the EC.

Nonetheless, the data for Italy seem to describe a labour market that is more inclusive towards workers belonging to the age group 55-64 years than in other EU countries, and also more inclusive if compared to the situation affecting other age groups. In 2013, the employment rate of people aged between 55 and 64 rose to 42.7% while the unemployment rate was 5.7%, but 40.0% for the 15-24 age group, 22.1% for the 25-29 group and 14.3% for people aged between 30 and 34. This is a direct consequence of the specific features of an Italian labour market which remains strongly segmented into an "insider versus outsider" model; the well-protected insiders are those workers employed in medium-sized and large firms, and most are currently individuals in the final phase of their working lives who entered the labour market at a young age with contracts of unlimited duration. Furthermore, by adopting a longitudinal perspective, since the 1980s the labour force participation of those aged between 55 and 64 years has progressively declined, while their relative share of the total workforce has increased. The main cause of this phenomenon has been the widespread use of special early retirement schemes in the 1980s and early 1990s, in order to guarantee more flexibility to firms under economic pressures or in need of restructuring. In other words, labour legislation has permitted large and medium sized companies to let their older employees go before they reach legal retirement age, by channelling them into early retirement schemes. Older employees, for their part, found this economically attractive as they were offered conditions of high financial security. To some degree, the Italian pension system has thus represented a means to address intense labour market pressure and deal with the need for more economic flexibility in the face of inadequate labour market policies. From that time on, "the pressure on the Italian pension system, already affected by continuing demographic ageing, was further increased." [9]. Decades of labour market policies based on the "young in-old out" principle have led to a situation where, on the one hand, older workers are asked to retire early in order to leave room for the younger ones (especially during economic downturns and increased labour market pressure) while, on the other hand, they need to stay in work longer to preserve the financial sustainability of the social security system [10]. Although it may appear that the current labour market still includes older workers and excludes the young, by adopting a long-term perspective it is clear that the ageing process requires a reversal of labour market policies founded on the "young in-old out" logic, a goal which has become increasingly urgent.

Even though the urgency of the situation in Italy has been evident for decades, the Italian government has had to steadily intervene in order to adjust and correct the pension regulations (wide-ranging reforms in 1995 and 2004). The most recent significant intervention of this type was the recent pension reform, implemented as the very first act by the technical government led by Mario Monti in December 2011. The reform completed the transition towards a contribution-based pension system (versus the previous earnings-related pension system) for all workers starting from January 2012, and reinforced the pay-as-you-go elements. Furthermore, in January 2012 the legal retirement age was raised to 66 years for both men and women in the public sector and 62 for women in the private sector (66 in 2018). The reform also introduced financial disincentives for workers who retire before reaching the age of 62.

The pension reform acted at the macro level of labour market regulation in order to prolong working careers, although this objective has not been respected by other actions implemented to create more inclusive workplaces and better working conditions for older workers. The pension reform was followed by a labour market reform (June 2012) aimed at easing (flexibilising) entry into and exit from

employment. Controversially, it also facilitates the early retirement of late career workers in larger firms, in contrast with the previous modification of the pension system.

Indeed, creating more inclusive workplaces is a condition for the prolonging of work careers resulting in a win-win situation for both employers and employees. If retaining older workers has become compulsory, the need to act at the workplace level in order to transform this obligation into an opportunity becomes more and more crucial, in terms of possibility for the employees to maintain or improve their well-being at work – thus increasing motivation and productivity – and an advantage for the employers in getting the best from their employees, regardless of age, and saving costs due to sickness and/or low productivity.

The goal of promoting inclusive workplaces for workers of every age is mainly addressed through the promotion and implementation of age management policies and practices. In the first European guide to good practices in age management [11], promoted by the European Foundation for the Improvement of Living and Working Conditions (Eurofound), age management is defined as the set of measures that combat age barriers and/or promote age diversity within work organisations. In the second edition of the guide, Naegele and Walker [12] specify:

> "These measures may entail specific initiatives aimed at particular dimensions of age management; they may also include more general employment or human resources policies that help to create an environment in which individual employees are able to achieve their potential without being disadvantaged by their age." (p. 3).

According to Eurofound classification [13], age management refers to different fields of action and to different practices of the human resource management (HRM) cycle, i.e. recruitment, training and development, compensation, job design, workplace design, promotion of health at work, redeployment and transition to retirement. Despite the fact that age management practices may be varied and differentiated according to specific needs and contexts, combating age barriers is seen as the very first step towards the inclusion of older workers within work organisations. This implies a change in attitudes and behaviours towards age from both employees and employers/managers in terms of organisational cultures.

According to institutionalist [14,15] and neo-institutionalist [16] theories, the institutional contexts may influence and limit the possibility of action of institutions themselves when they face external pressures – in this case, work organisations facing the challenges posed by the ageing process. Labour market regulation and the pension system in Italy have encouraged employers to dismiss older employees before they reach legal retirement age. This has also led to an affirmation of clearly defined visions of older workers in the labour market and of the role they can play and contribution they can make in society. These visions are of course also reflected in work organisation culture. Nowadays, the institutional setting in Italy (as in many other Western countries) has completely changed, mainly because of the recent pension reform, and companies have found themselves subject to new regulatory pressures. Changing culture and attitudes is a long-term process, but what the new regulations require employers to do right now is change their behaviour; they must retain their older workers for longer. In order to achieve this, employers need to be aware of how the workforce is changing, the extent to which these changes affect their organisations, and how it is possible to rethink managerial practices in order to transform these

changes into opportunities. Work organisations need to be supported in the processes described above, and this requires the development of new research tools and methodologies in the field of age management, consistent with the features of the Italian socio-institutional and cultural context and its productive system.

2. Concepts and Method Underpinning the Quality of Ageing at Work questionnaire (QAW-q)

Within the domain of studies devoted to analysing the conditions of older workers, several different approaches have been used. On the one hand, most have concentrated – to varying degrees – on measuring changes in work performance correlated with the increase in chronological age of the worker. On the other hand, some other approaches (as mentioned in the first paragraph) have investigated the obstacles to older workers remaining in employment, hurdles which may be addressed by adopting different practices within organisations.

Within the first context, the "work ability" concept refers to its normal meaning – the general attitude towards work – and specific meaning (being able to work) – given that it came about as an analytical tool in the domain of occupational health. The work ability reflects not just an employee's performance but also the competences and competencies which older employees possess, and which have been accumulated over the years. According to this perspective, Ennals and Hilsen [17] have pointed out, within the scope of an action-research project promoted by the Norwegian National Insurance Service, that the wealth of experience and tacit skills (and tacit knowledge) possessed by the older workers still represent some of the strategic assets of companies. In today's knowledge economy, the worker's work ability is, itself, changing. For this reason, adequate intervention tools need to be defined in order to foster the intergenerational processes which can transfer strategic knowledge and skills.

In the second case, the properly-defined "work ability" concept presents several dimensions, sustaining in particular the balance between personal resources and work demands [18]. The search for this balance is characteristic of a whole working life, and the balance itself may vary considerably according to different stages or phases of one's working life. Ilmarinen describes this work ability concept via the image of a house with four floors and a roof. The roof represents the work ability itself, which is underpinned by four floors.

> "Health and physical, psychological, and social functional capacity create the ground floor. The entire weight of the rest of the building rests in the ground floor. [...] The second floor of the building represents professional knowledge and competence (skills). [...] Their continuous development are used to meet the demands of worklife. [...] The third floor contains values, attitudes, and motivation. This floor is all about the balance between work and personal resources, as well as the relationship between work and personal life. [...] The fourth floor represents work and its related factors. It is the larger and heavier floor. [...] On work floor special attention is paid to to supervision and management." (p. 132-133).

Directly drawn from this concept and its constitutive dimensions, the Work Ability Index [19] – WAI – represents a research tool geared to a practical use within the field of occupational health. At the same time, it constitutes a worker's self-evaluation tool concerning his/her work ability. The adoption of the WAI has spread increasingly since

its first application thirty years ago in its native Finland [20], and has subsequently spread across Europe, Latin America, Australia and the Far East [21]. Today, it still represents the mainstream tool employed to support age management practices, and has several interpretations – in combination with other assessment tools [22] – within diverse research fields (e.g. occupational health, psychology, sociology, organisational studies and economics). Over time the work ability concept has steadily evolved towards a more comprehensive concept of well-being at work, which tends to give a more complete representation of the quality and dimensions of work ability itself [20].

Based on the key elements of the work ability concept (health, competencies, motivation and work organisation), the Quality of Ageing at Work-questionnaire (QAW-q) broadens its perspective [23]. In order not to underestimate the organisational constraints, as often occurs when adopting the WAI as an analytical tool – the QAW concept introduces further elements aimed at bridging intra-organisational dimensions which affect the conditions of employees to their external socio-institutional environment and constraints. In particular, the motivation floor of the original work ability "house" has been replaced by "satisfaction"-related items, while the motivation-related items themselves have been spread across various other sections of the questionnaire. The new "work-life balance", "employment and economic stability", and "professional identity" dimensions have been introduced in order to maintain connections between what happens at the workplace level and the external constraints influencing individual perceptions. Furthermore, "relations" with supervisors and colleagues in the workplace have been introduced in order to evaluate the quality of the social dimensions derived from the organisational relational climate. As will be explained in more detail in the following paragraph, the QAW-q also aims at weighting the influence the different meanings that age can assume (chronological age, job seniority in the company and years of payments to social security schemes) on individual perceptions and on the assessment of the organisational performance related to the eight key topics mentioned above. In order to fulfil this objective, the QAW-q has been structured to encompass the "individual", "organisational" and "passage of time" levels.

3. Structure of the QAW-Questionnaire

In accordance with the goal of addressing the needs which have begun to emerge from Italian companies since the last pension reform of 2011, as described in the first paragraph, the study and initial results presented below are based on the use of the QAW-q as an age management tool focused on the analysis of the effects of the ageing process on the labour force, and at supporting companies in identifying possible critical situations and related solutions. Indeed, the questionnaire is intended to collect information on all the factors affecting working life which could be influenced by the employee ageing process. Consequently, we moved away from the already developed tools of age management (such as the Work Ability questionnaire, mainly focused on occupational health dimensions and work ability components) in order to broaden the range of factors to be included in the analysis. Information on these factors are collected from individuals but analysed by adopting the organisational perspective, so to be able to identify the links between what the employees perceive and what leverages could be identified at an organisational level in order to create better working conditions. As the collected data are interpreted by adopting the organisational

perspective, the QAW-q is conceived of as being addressed to all employees and not only the older ones. In our view, this choice is not in conflict with the general aim of the tool. Indeed, its aim is to understand the influence of chronological age – not only with the meaning of being older – on working life. In addition, expanding the sample within a company makes it possible to compare the situation of different age groups and to identify changes in perceptions which could be a result of the ageing at work process itself. Moreover, our focus is not only on chronological age but also on age measured both as seniority in the company and as years of payments to public pension schemes (in other words, working years left before retirement). The three meanings of age – chronological, seniority and years left before retirement – neither represent issues directly investigated nor the criteria for identifying the sample. On the contrary, age – with its three meanings – represents the lens adopted when analysing the collected data.

In more detail, the QAW-q consists of eight sections, each of which focused on the eight different factors identified as crucial in terms of the process of ageing at work, thus influencing the perception of the quality of work itself. These sections/factors are:

1. Health
2. Work organisation and workload
3. Employment and economic stability
4. Work-life balance
5. Satisfaction
6. Professional identity
7. Relations at work
8. Competences

A final section at the end of the questionnaire collects socio-demographic and organisational data, such as gender, chronological age, educational attainment, hiring year, year since which the employee has started to regularly pay contributions to the public pension system, company department and function. Each questionnaire section (except for the final one) comprises six questions focused on the perceptions of the employees regarding their personal situation, a comparison between past and present and future expectations and an assessment of organisational performance. In this way the structure of the QAW-q intersects the individual and organisational levels, and the influence of the passage of time. To be more precise, for each section/topic:

- the first three questions ask the employee how s/he perceives his/her personal condition concerning different sub-themes related to the main topic of the section;
- the fourth and fifth questions focus on the time effect - the fourth asks the employee to evaluate his/her current personal situation compared to five years previously, while the following question analyses future expectations for the next five years (assuming s/he is staying with the same company);
- the last question asks the employee to assess company performance in promoting good conditions at work as related to the topic of the section.

Each single item within each section uses rating scales, so that the questionnaire produces scores for each section/topic and a total which express a measure of the perceived quality of working conditions. The collected data are analysed via mono, bi, and multivariate statistical techniques by using socio-demographical and organisational variables as predictors: e.g. chronological age, seniority, gender, educational attainment and so forth, in order to enable comparison of conditions among different employee groups. The scores are used to identify and predict possible critical issues, defined as

such when analysed by adopting the three ages lens. In other words, it allows us to identify critical areas for different groups of employees, but also to predict situations that could become critical when considering the employees' ageing process and the increasing number of a company's older employees in the future. Moreover, from the scores taken from the final questions in each section, designed to assess organisational performance, it is possible to predict in what areas the company has most room for improvement (according to employee perceptions), and identify the leverages upon which the company could act in order to cope with the critical situations, as flagged up by the lower scores from, above all, the first three questions (personal/individual condition). Currently, according to the amount of individual data collected from private and public companies through the QAW-q (N. = about 3.000), a general benchmark threshold score has been identified, although the tool has been used to provide analysis at the single company level, and not to make comparisons between companies. A higher quantity of data from companies belonging to the same economic sector will allow us to establish more significant thresholds to be used for comparison in the future.

As the tool has been specifically developed in order to support the HR processes within work organisations, the use of the questionnaire as a survey tool is discussed with management (human resource managers or employers) right from the early stages and before implementation. The QAW-q is divided into sections which are designed to ensure an effective use of the tool; nonetheless, by keeping the same methodological framework (type of question within each individual sections) it is possible to personalise, include additional sections or exclude existing ones, and focus on new topics of specific interest for the company. The results produced from the questionnaire can be presented in a easily understandable format as the starting point for discussing emerging criticalities with the management. The idea underpinning the use of the tool is that it represents the starting point for a more complex process of analysis, which includes multivariate analysis of the scores, but also opens into new research phases addressed at deepening the questionnaire results, and possibly also encompassing the use of qualitative methodologies.

4. Discussion of Initial Results

The data collected through the QAW-q, in direct relation to its structure (as explained in the previous paragraph), produce different indices. For each of the eight sections/topics:

- an individual index (QAW-individual), calculated as the average of the scores of the responses to questions from 1 to 3 (1 to 10 scale); the individual index may therefore vary from a minimum value of 1 to a maximum of 10;
- an indicator of perceptions associated to past experiences and future expectations (QAW-past/future), calculated as the sum of the scores of the answers to questions 4 and 5 (1 to 5 scale); the past/future index may vary from a minimum value of 2 to a maximum value of 10;
- an index of organisational performance assessment (QAW-organizational), which is the score of the answer to question 6 (1 to 10 scale); the organisational index may therefore vary from a minimum value of 1 to a maximum of 10;

- an overall score (QAW-total), resulting from the sum of the first two indices, which can therefore vary from a minimum value of 2 points to a maximum of 20.

The mean value of the QAW total scores from the eight individual sections represents the general QAW-total index.

The analyses presented here are based on a total of ten work organisations where the QAW-q were administered between the end of 2012 and the end of 2013. One of the work organisations belongs to the manufacturing sector, five to the services sector and four to public administration (local authorities and municipalities). The surveys collected 3,023 individual questionnaires valid for the calculation of the QAW-total index (out of a total of 4,072 questionnaires). Currently, the QAW-q is still being carried out within several multinational companies belonging to different economic areas. It should also be noted that the calculation of the total index presented here excludes the scores from the "employment and economic stability" section, as some organisations deemed it inappropriate to collect opinions on this topic from their employees.

A preliminary look at the descriptive dimensions of the sample, based on the answers provided by the respondents from the ten companies, yields the following statistics:

- gender (No. = 3,365), male – 45.3%, female- 54.7 %;
- profession (No. = 3,351), clerks – 89.1 %, blue collar workers - 6.1%, and other operational professionals - 4.8%;
- economic branch (No. = 4,072), 7.1% of cases refer to manufacturing, 12.1% to services and 80.8% to public administration.

As far as age is concerned, with regard to chronological age (N. = 3,327), results show an average value of 46.18 years (mode 43, the first quartile at 40 years, the median at 47 and the third quartile at 53); with regard to job seniority (N. = 3,298), an average value of 17.71 years (mode 23 years, first quartile 9 years, median 17 years and third quartile 25 years); and finally, with regard to the contribution period (N. = 3,313), an average of 23.20 years (mode 26 years, first quartile at 15 years, median at 24 years and third quartile at 31).

The mean score of the QAW-total index regarding the 3,023 valid cases is 12.52, a score which can therefore be used as a benchmark, and has a higher value:

- among males (12.65) rather than females (12.41);
- among blue collar workers (12.8) rather than other operational professionals (12.58) and clerks (12.51);
- in services (12.90) rather than manufacturing (12.72) and public administration (12.42).

With regard to the scores at individual work organisation level, both the best (13.71) and worse (12.30) performers belong to the private sector (services branch).

The first general result that stands out from the collected data is the inverse (negative) relationship between the scores of the QAW-total index and all dimensions related to age factors. In particular, the closest association is found with chronological age, with a Pearson correlation coefficient r = -0.165 **, significant at 0.01 level, while less intense is the correlation with both the seniority (r = -0.134 **, significant at the

0.01 level), and with the contribution period (r = -0.146 **, significant at the 0.01 level). Moreover, linear regressions, in all the cases significant at $p < 0.001$ level, show that the QAW-total score decreases by 0.031 points per unit of chronological age increase, by 0.022 points per unit of seniority growth, and by 0.024 points per unit of contribution period increase.

5. Concluding Remarks

In the light of these initial results [23], age – and in particular the ageing process – seems to influence the perceived quality of the work experience following a negative trend; as workers grow older their perception of the quality of their work experience gets worse. In particular, the two topics of "competences" and "professional identity" are those where the older workers show the lowest scores while, to some extent surprisingly, the health factor does not display such large differences in scores between the youngest and oldest groups. Moreover, it is not only the chronological age which has such an effect, but also, and especially, age in terms of years of payments to the public pension schemes. The implication is that the more individuals are socialised to the work experience, the more negative is their perception of the quality of work they are experiencing. Indeed, this also reinforces the idea that we need to consider age not just as chronological age, but also in its multiple meanings within an organised social environment (as represented by a company).

From the methodological point of view, some of the characteristics of the QAW-q may represent both strengths and weaknesses of the research process. Above all, the questionnaire in its basic structure is composed of just 48 items and is easy and quick to complete. A second important point is that the questionnaire could be perceived as too generic by the employers. This may be a result of two of its main characteristics: the fact that the questions do not explicitly address the age issue (conversely, it represents the perspectives adopted while analysing the results) and that, despite being used as a tool for supporting age management, it is not directed solely towards the older workers. On the other hand, what we have presented as possible weaknesses are a result of specific research design choices. Indeed, age is a fundamental variable which influences everyday working life, but its being fundamental is grounded in the interaction between the age variable and other socio-demographic and organisational variables, namely the individual characteristics of the employee (e.g. age combined with gender, job seniority and educational attainment), the organisational structure of the company, the organisational culture and so on. The same is true for age management practices; they do not differ from generic HRM practices. What is mostly different is the focus adopted when management plans and implements specific measures to deal with criticalities related to the age factor. Moving on to the second point, the choice to develop a questionnaire directed at all staff and not just seniors, stems from a decision to avoid the risk of the tool being perceived as stigmatizing if used only in connection with workers belonging to a specific age group; we also avoided the possibility of worker apprehension regarding possible managerial decisions arising from the results of the questionnaire.

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"Stay Tuned": The Role of ICTs in Elderly Life

Fausto COLOMBO [a1], Piermarco AROLDI [b], Simone CARLO [b]
[a] *Department of Communication and Performing Arts - Università Cattolica del Sacro Cuore, Milan, Italy*
[b] *OssCom - Research Center on Media and Communication – Università Cattolica del Sacro Cuore, Milan, Italy*

Abstract. Ageing in western society has become a key issue in political and academic debate: politicians, sociologists, doctors, demographers, psychologists, economists are trying to understand how ageing will impact our future society. In this frame, media and communication technologies seem to be more and more relevant for the elderly, thanks to those services and devices helping people to grow old actively. Technologies, the Internet and ICTs could help the elderly to improve their quality of life, to be healthy and independent and to get better assistance. Our ongoing research investigates the relationship between the elderly and use of technologies, and explores the role played by media and ICTs in building a friendly and positive environment for the elderly, and in constructing and maintaining social relations and promoting healthy ageing. Specifically, the research will investigate the use of ICTs by the elderly by taking into account two different perspectives: a) Exchanges between generations: lengthening of life corresponds to a longer period of cohabitation between at least three generations (grandparents, children, grandchildren), and also of co-use of digital media. The research wants to investigate relations between two age groups (grandparents and grandchildren; young people and older people) to understand the dynamics of intergenerational mutuality in the use of technologies and ICTs. b) Media, ICTs, Health: the Western world is increasingly populated by elderly population. Technologies and ICTs can help elderly people to improve their quality of life, to be healthy and independent and to get better assistance. ICTs should encourage active ageing and, in the case of health technologies, new models of care. The project, lasting 1 year, is based on (1) a survey on young elderly (65-74 yrs) population in Italy, and (2) a field-work which consists of family interviews and ethnographical sections in natural contexts.

Keywords: Ageing, Active Ageing, ICTs and Elderly

Introduction

The paper aims to provide some insights regarding young elderly and their peculiar media use which comprises their media literacy and media habits but also their choices of privileging certain devices more than others. This issues crosses a wider debate concerning processes of mediatization [1] such as: how digitalization changes consumer behaviors and media habits; how social representation, information,

[1] Corresponding Author: Department of Communication and Performing Arts, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: fausto.colombo@unicatt.it

regulation and relation change in today complex societies; which public policy strategies , at national and European level, could be applied.

The paper is organized as follows: the first section gives an account of the main topic tackled (the young elderly) and of the theoretical approach addressed in the research here presented (the generational paradigm); paragraphs two and three show the first results of an extensive survey concerning the Italian young elderly and their technological devices, and present further research streams which will be carried out; fourth and fifth paragraphs aim to outline some interpretative hypotheses, specifically related to the research results and to the policy implementation at national and European level.

1. The Relevance of "Active Ageing and Healthy Living" as Research Topic

The research perspective and theoretical paradigm here presented assume that media are not external and autonomous agents to the entire social body. On the contrary, social identities are able to shape the role media play, although obviously interacting with the specific affordances of each communication device.

In this case, therefore, the young elderly (those aged between 65 and 74 years old) are considered by looking at the role played by their generational identity in shaping their media use. In particular, two factors need to be taken into account when considering this generation: the first depending on the stage of life; the second relating to the peculiar social experience that has characterized and characterizes this generation.

As regard the stage of life, it could be noticed that these young elders come as a result of a gradual lengthening of life expectancy (more than thirty years, since the beginning of the twentieth century), hence creating the third age (as a distinct age from the fourth), which is characterized by the double emancipation from family and employment bonds [2]. This third age has a significant demographic and social weight. Its demographic weight is very well expressed by the two following tables, which show the increasing percentage of the third age in Europe (both in the past and in the future), and the corresponding increase (at a national and European level) of old age dependency ratio, i.e. the specific demographic weight of the elderly (over 65 years old) over the whole active population (aged 14 years and over).

Table 1. Elderly population. EU27 and Italy. Source: Eurostat 2011

	Percentage aged 65+			**Percentage aged 80+**			**Old age dependency ratio* (%)**		
	1960	2010	2060	1960	2010	2060	1960	2010	2060
EU27		17,4	29,5		4,6	12		25,9	52,6
Italy	9,3	20,2	31,7	1,3	5,8	14,1	14	30,8	56,7

The data confirm in a striking manner the gradual ageing of European population. The demographic data need to be integrated with other equally interesting data related to the social relevance of the elderly: according to some surveys, there is a ever closer correlation between economic wealth and ageing, so as to assume in the near future a correlation between economic divides and generational divides.

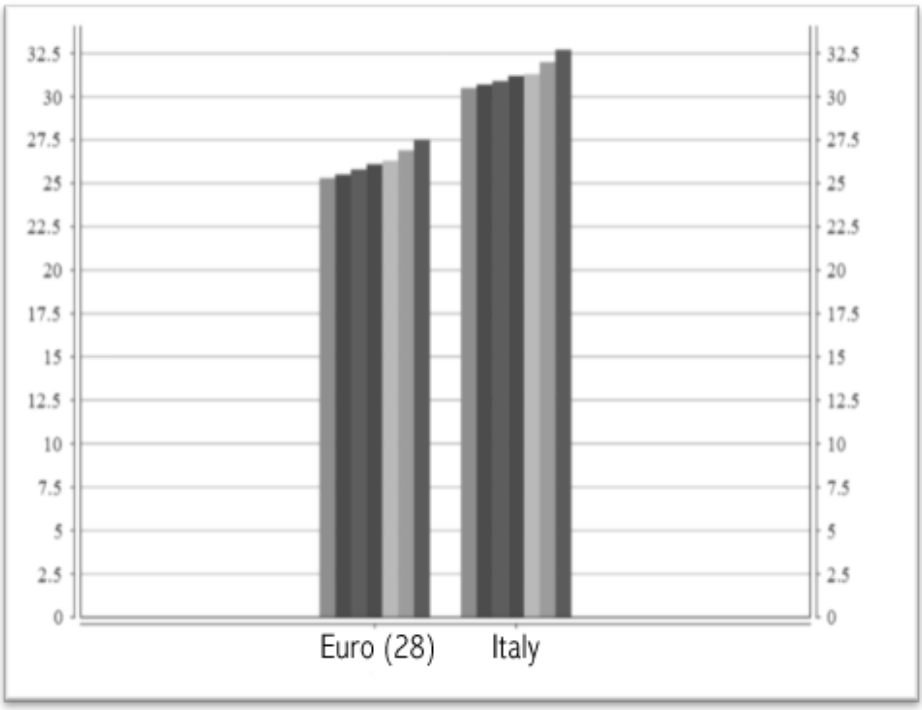

Figure 1. Old-age-dependency ratio (from 2007 to 2013). Italy and EU (28 countries). Source: Eurostat 2013.

These data sets show that the older generations are ever more than ever relevant in today society. In particular, the young elderly have something even more peculiar. They (the third age) still have a significant life expectancy (the entire fourth age), which puts them – according to Luhmann's categories [3] - in a specific situation: they do not only live in the present as the last stage of their life (as it was for previous generations who have lived this stage of life as the last one), but they also live in the present playing leading roles. Furthermore, because of historical and social reasons, the current young elderly can still enjoy a privileged status, and can also think in the future to continue to affect the society in which they will still play a key role in terms of consumption, prestige and power.

These key elements lead us to go beyond the notion of stages of life, to a more complex notion of generation, i.e. "an age cohort that comes to have social significance by virtue of constituting itself as cultural identity" [4], where biographical traits shall coexist alongside historical and cultural ones, and where age group belonging is connected to specific historical experiences, to the development of peculiar consumption habits or to the occupation of certain positions in the family chain [5].

Such a multi-dimensional category appears particularly useful for studying audiences who cannot be reduced to either individual socio-demographic traits (such as age, gender, education, job position) or to corresponding life styles (such as those codified by marketing), but have to be strictly and simultaneously related to several factors - such as stage of life, media biography, family and friendship networks as media experience environments, common shared values with other members of the same generation, historical development of media system, technological innovation in

its diverse steps, incorporation processes of technologies and media products, as well as the wider structural changes affecting the social and cultural system.

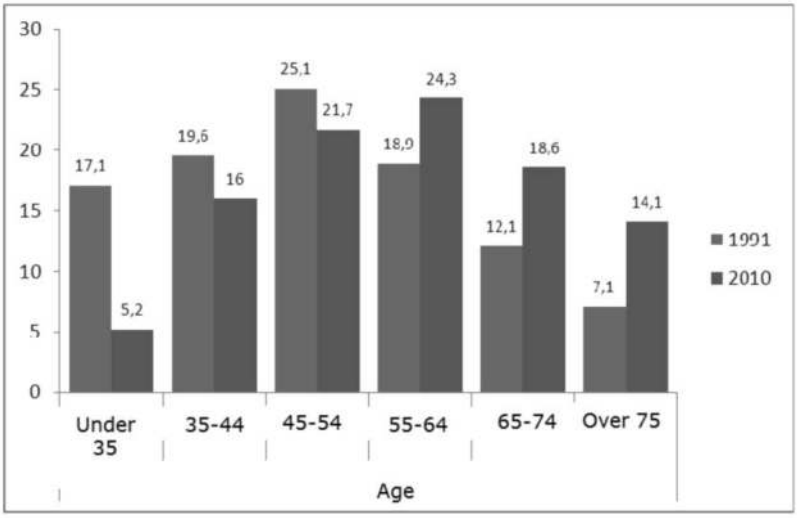

Figure 2: Distribution of wealth in Italian families, considering age of Head of Household (val %). Source: Censis 2013

In such a perspective, people who belong to this generation are people who:

a) Were born in the same period of time (1940-1949, during the WW2 and the post-war period) and spent their formative years in similar historical, social, cultural and political contexts (the economic boom, the so called "Italian miracle" and the birth of consumerism, but also the years of the student protests in 1968/69 and the terrorism in the Seventies), so as to share a common world of past and formative (some time traumatic) experiences.
b) Have the same age and are nowadays in the same stage of life (65-74 years old, retired or retiring).
c) Share a particular "generational semantic" [6], that is a dominant order of meanings continuously empowered through discourse practices and significant rituals among the members of the generation itself (a collection of themes, interpretative models, evaluation principles and values through which shared experience is transformed in discourse within the forms of daily interaction.
d) Share a sort of "habitus" [7], that is a system of durable dispositions to act and to choose, not strictly prescribed by formal rules, for example in the field of civic participation, of material and cultural consumption, of leisure: a sort of "collection of practices through which generational experiences are manifest" [4].
e) Share a certain set of choices, that more likely depends on a generational belonging than on simple socio-demographic attributes, and marks the "distinction" [7] between different generations.

This "Post-war Generation" [8] has been depicted as an "active generation" [4], characterized by some unique features: it was the first generation that "created" the youth as a cultural and social group, with its own habits, tastes and values (first of all the value of being – forever – young), separated from those of adults [9]; it was a

global generation, covering large parts of the world and showing a global consciousness, "demonstrated by the domino effect of the social protests and the extent of cross-national activism" [10] and sustained by a global media system that broadcasted the same music, images, fictions and values [11, 12]; it was also a strong generation earning for protagonism and willing to take history upon its shoulders [13]; and it was a generation open to technological innovation and media change, from the birth of Television in the Fifties to the first wave of digitalization of Italian society in the Eighties.

Therefore, media, both as technologies of the everyday life, as taken-for-granted tools, and as cultural institutions or communicative products, genres or texts (one-to-many or one-to-one), shape in many ways this generation's identity, as in the case of the advent of television and of rock music [14]. At the same time, media also constitute a sort of public arena where different generational identities can express and discuss about themselves, co-building each other through mutual representation and social discourses able to celebrate ritually [4] - in front and on behalf of their peers - their collective identities.

In this generational perspective, the media simultaneously are: a historical innovation that characterizes the everyday experience [15]; a source of common repertoires of narratives, characters, language and musical forms, stratified in the memory of members of a generation sharing only among peers [16]; a public space in which the awareness of belonging to a generation is claimed in its differences [13]; [17, 18]; and a tool to sustain and feed the present of this ageing generation, with its new needs, problems and resources.

2. Our Research Activity

As part of a wider research project regarding Italian adult generations, a multidisciplinary team of the Catholic University of Milan, made up of sociologists, psychologists, media and communication experts and demographers has recently launched a complex investigation combining the generational approach to media use analysis.

The research, entitled *"I don't want be inactive": the lengthening of life, a challenge for generations, an opportunity for the society*, lasting two years, investigates the opportunities given by life lengthening according to *active ageing*[2] perspective. It consists of a survey – its results will be reported later- and in several researches conducted using qualitative and ethnographic methods .

The survey was conducted (between December 2013 and January 2014) through face-to-face questionnaire administered to a statistically representative national sample of 900 Italian elderly aged between 65 and 74 years old (by using a random, proportional, stratified by region and by size of place of residence, built in two stages

[2] Following the latest sociological research debate and some European policy initiatives [23], active ageing is not understood solely in terms of structural (good/bad health) and economic (lengthening of working and leisure age) well-being, but also in terms of "quality" of life and as a subjectively and socially rewarding ageing. Hence the specific objective becomes to determine what "active ageing" means - from the point of view of the subjective, intersubjective and collective opportunities -, with regard to practices, ideas, values and cultural point of views: from this point of view, the relationship between intergenerational exchange and the elderly active ageing becomes especially relevant.

sampling). The questionnaire collected data such as information about family and intergenerational relationships (size of the network); health status; leisure time and cultural consumption; use of new technologies; any past or present connection to the business world; participation to any kind of volunteering or socio-political activities; the reaction to the current economic and financial crisis; social capital and social solidarity; family network and friendship (forms of exchange and support); orientation to intergenerational relationships such as fairness between generations; values; representation of the elderly condition, and finally the economic status of respondents.

As regards media use by the young elderly the questionnaire aimed to investigate :

- Technological devices (personal and domestic digital devices – smart-phones, tablets, e-book);
- Time spent and best time to use PCs and the Internet;
- Ways to use PCs and the Internet (chosen places, used platforms, people involved);
- Types of activities carried out using PCs and the Internet;
- Ways to learn how to use PCs, online services and the Internet (places and people involved in the learning activity);
- Reasons to use the Internet (changes in the lives of the elderly caused by the use of the Internet; fears, anxieties, enthusiasm in the use of PCs and the Internet);
- Use and attitudes towards health technologies.

Here follows some initial results of our research, which will be developed in following more extensive publications.

Table 2: Laptop computer or netbook according to age group and gender (% within these categories).

			Age group		Gender		
			65-69 years	70-74 years	Male	Female	Total
Laptop computer or netbook	owned and used	% within	24,0%	10,2%	22,6%	13,3%	17,5%
	owned and not used	% within	4,0%	2,4%	4,6%	2,1%	3,2%
	not owned but used	% within	,6%	,5%	1,0%	,2%	,6%
	not owned and not used	% within	71,4%	87,0%	71,9%	84,4%	78,7%
Total		% within	100,0%	100,0%	100,0%	100,0%	100,0%

Total: all the Italian elderly aged 65-74 years old

At first, it is significant to note that the use of digital media involves only a part of the sample. Only 17.5% of the elderly under study affirms to own a laptop and to use it, and only 16.7% to own and to use a desktop computer. The data can become more

interesting if related to age group (distinguishing between two age-groups: 65-69 and 70-74) and to gender.

Table 3: Desktop Computer according to age groups (% within these categories).

			Age group		Gender		
			65-69 years	**70-74 years**	**Male**	**Female**	**Total**
Desktop Computer	**owned and used**	% within	20,3%	12,8%	23,1%	11,3%	16,7%
	owned and not used	% within	2,1%	1,7%	1,4%	2,1%	1,9%
	not owned but used	% within	1,7%	1,2%	2,2%	1,0%	1,5%
	not owned and not used	% within	75,9%	84,4%	73,3%	85,6%	79,9%
Total		% within	100,0%	100,0%	100,0%	100,0%	100,0%

Total: all the Italian elderly aged 65-74 years old

It is clearly showed that men aged between 65-69 years old own and use significantly more the computer and the Internet than old women. Beyond the wider issue of *gender divide* (in the Italian population the use of computers and the Internet is historically more widespread among males than among females), this gap can be enhanced by the diverse working conditions: if it is true that over 20% of males over 65 years old works at least occasionally (compared to 7% of women), it is possible that some of these jobs involve the use of a PC. Moreover, the younger age group (aged 65-69 years) has grown into a more digitized labor market than the older one (aged 70-74 years), hence being more used, over the years, to communication technologies: 19.5% of older males declares to access to the Internet from work, 49.8 % of older users, in both age groups, affirm that they have learned to use the computer at work.

45% of the elderly who use computers today have started using it before being 50 years old, 28.2% between 50 and 59 years, 19.1% between 60 and 64 years old. Only 9.1% of users are "new" ICTs users (they have started to use the computer after the age of 64), with a significant difference between males and females: respectively with 6.8 % of men compared to 12 8 % of women.

Looking at data about Internet use is also possible to note that access to the Internet is rooted in the past of the young elderly (a recent past, considering the recent spread of the Internet in our country): 39.6% of users claimed to have started using the Internet between 50 and 59 years, 28.9% between 60 and 64, 14.2% after 64 years (with a gap between males and females by 5% in favor of the latter).

These data suggest that the elderly using the computer and the Internet have behind a wide biography of use; hence they are not "natives" to the digital world but rather long-

time "immigrants", and they may apply their skills, experiences and learning to future technological developments.

Conversely, the number of new elderly users is relatively low, with an interesting percentage of women who are starting to use ICTs in recent years, if not months.

Therefore elderly ICTs users world is far from being one-dimensional and it seems to be made of diverse layers of users with profoundly different biographical paths of adoption of ICTs, PC, tablets, Internet and Web 2.0.

Table 4: Internet use during the week (% within categories).

			Age group		Gender		
			65-69 years	**70-74 anni**	**Male**	**Female**	**Total**
Frequency of Internet use during the week	**Sometime a year**	% within	1,3%	4,1%	2,1%	3,4%	2,6%
	At least once a month	% within	5,1%	12,2%	4,9%	11,2%	7,4%
	At least once a week	% within	17,9%	20,3%	18,3%	19,1%	18,6%
	Almost every day	% within	75,6%	63,5%	74,6%	66,3%	71,4%
Total		% within	100,0%	100,0%	100,0%	100,0%	100,0%

Total: all the Italian elderly aged 65-74 years old

71% of the elderly accessing the Internet do so almost every day: a very interesting research data. The majority of the (few) elderly accessing the Internet are heavy users. Accessing the Internet is a common practice rooted in the everyday life of our sample: once crossing the threshold of accessing the Internet, users will become mature in all respects and not occasional. As further evidence, 58.8% of the elderly state that they access to the Internet in all times of the day, when it is probably useful to do so.

As regards the gender gap issue, differences become wider when taking into account data about Internet access: over 65 years old women without Internet use (who have never used the Internet) are 81%, compared to 65.6% of men.

Interestingly, the gender gap is less relevant as regards other technologies: if it is true that all devices (PCs, laptops, smart-phones, MP3, games consoles) are available and used more by males than by females (with a fork variable between the two genres), two devices are instead an exception.

Percentages of males and females among the elderly using tablets (including iPads) and eBook readers are very similar: respectively 6% of men versus 3.8% of women using tablets and 1.9% of men versus 1, 5% of women using eBook readers. If it is true that tablets, iPads and eBook readers are new technologies and if it is true that "new users" are more often women than men, this shows a likely phenomenon of leapfrogging: a significant part of elderly users who start to use ICTs over 65 years old

(especially women) do so by using a new generation of technologies and by skipping previous technologies (pc-laptops). 20% of old women user claims to access the Internet by mobile, compared to 8.5% of men, who are more often traditionally rooted and used to desktop devices.

As regards places of Internet access, home is regarded as the best place for Internet access, with 98.8% of domestic connections and, in second place, 15.3% of connections at work (among our sample with Internet access). The elderly mostly access the Internet by themselves, with a significant proportion of silver users accessing with the partner (19.2%), with their children (17.6%), with their grandchildren (4.7%). As regards learning processes, 49.8% of our subsample says they have learned to use the computer at work, with a significant difference between males (57.8 %) and females (37.6 %): if males have mostly learned at work, the proportion of women who have learned attending courses in organizations, or associations, or municipal courses is substantially more numerous (22.8%) than that of men (14.3%). Males seem to have a more solitary learning approach, either practical (45.5% vs. 40.6 % of women) or by using manuals (14.9% vs. 6.9%). Conversely, women are making more use, in addition to courses , of the help of younger friends or relatives (36.6% vs. 31.2 % of males) or peers (9.9% vs. 2.6%) .

As regards SNSs use, a limited number of elderly people joined Facebook and Twitter. In particular, 9.7 % of men and 5.5% of women use Facebook, while 3.7 % of males and 1.3 % of females use Twitter Even in this case, the user of these tools uses them very often: 46% of Facebook elderly male members and 73% of elderly women uses Facebook every day.

Hence there is a significant gender difference, with women who are particularly heavy users of Facebook. Furthermore, SNSs use is strongly influenced by the differences between the two identified age groups: if the 10.7% of 65-69 years old users use Facebook, the percentage drops to 3.9 % in those aged between 70-74 years. Hence SNSs are not so commonly use among the elderly over 70 years, while 31% of those aged between 65-69 years and is on Internet have a Facebook account.

Youtube is instead very widespread among the different age groups with 41% of the young elderly on Internet using it. Percentages are even more significant for the use of Wikipedia, with over 50% of users among the elderly connected.

In addition to the aforementioned data concerning devices and platforms being used, more interesting data regard the main activities the elderly do on the Internet. The search for information is transversely the most popular online activity in the subsample (79.2%), followed by email (74.9%) and the search for information about everyday life (63.9%). There is a significant proportion of people who are looking for information about their well-being: 53.1% of our the elderly connected claims to use the Internet to check for updates about health and 29.1% about their medical conditions. Internet seems to be, for our sample of old ICTs users, an crucial tool for these kinds of information. In addition, 44.5% of the "digital" sample says to use the Internet for administrative practices, with an interesting 16.5% of Internet users who booked medical checks and consult medical records online.

3. Our Future Research Activity

In the second part of the research we will investigate how media and ICTs consumption is spatially and temporally located and how these media uses and routines are shared

within the household and are enabled by processes of domestication [24]. We will take into account a categorization of households and the elderly on the basis of technological equipment and practices of ICTs use. In particular, the research will aim to verify whether processes of media literacy and appropriation are influenced by forms of intergenerational exchange [21, 22]

The sample will be chosen starting from family income, age of the elderly, family composition, geographical context (big or small city). A particular attention will be given to methodological issues concerning conducting research interviews with elderly people. The interviews will be useful to outlines different types of elderly as regards these three dimensions: 1) structural variables (education, income, ethnicity) 2) contextual variables (non-institutionalized cultural capital and social capital), 3) media and technological devices, media practices and routines, domestic, non-domestic, individual and collective media consumption.

Further, the interviews will take place and will be aimed to understand moral economies of the household [20] and processes of use and symbolic appropriation of the media and ICTs within domestic context. The research wants to investigate the role that digital age has carried out in the daily lives of older people and what are the factors that make the Internet and ICTs both near and far to the needs of this specific and unique segment of the population [23].

In summary, the second part of research aims to investigate the issue of ageing and the role that media and ICTs have in building a friendly and profitable environment for the elderly in the household, in developing and maintain social relationships and in general in being resources to promote healthy ageing [24]. The final goal of our research is to frame the role ICTs play in the life of elderly: How ICTs are used by elderly? Anxiously or enthusiastically? How ICTs and technologies change social and family relationships? How ICTs improve social inclusion, civic participation and social capital of elderly? In particular, how elderly use ICTs for personal management of their own health?

4. The Practical Value of this Research Activity for Active Ageing and Healthy Living

Use of technologies by the young elderly is an interesting subject of investigation not only from the scientific point of view, as a way to apply the generational paradigm to the analysis of media use. It is here also understood as a way of potentially promoting active ageing, from two different perspectives :

- The exchange between generations: lengthening of life corresponds to a longer period of cohabitation between at least three generations (grandparents, children, grandchildren). These relational exchanges are related to the quality of life of the elderly [25] and offer the opportunity to share leisure, cultural consumption, knowledge and skills between generations, with processes of mutual literacy, even in the case of the development of skills related to ICTs use.
- Media and ICTs: ICTs could encourage active ageing and, in the case of technologies and health-related information, new models of care [26]. Technologies and ICTs could help people to improve their quality of life and their leisure, to be more interested and cognitively active , better cared for and more independent [27].

5. Conclusion. Active Ageing and Technologies: Policy Advice

The first results of the here presented research highlights some very interesting evidence. At first, despite confirming a relatively low diffusion of ICTs among the Italian elderly, it clearly emerges a trend of progressive digitalization of the "new older generation", which is more evident in the younger age group.

Even some established trends, such as a male primacy in digital literacy, seems to be challenged by the growing popularity of tablets and smart-phones among women.

In essence, the research shows a developing trend, which can be very important in terms of analyses and also of policy strategies. The generational paradigm allows to understand that the distinction between digital natives and digital immigrants is still evident, even though gradually fading. The digitized elderly use technologies in a very "mature" way, incorporating them into their needs and lifestyles. However it is reasonable to assume that in the next few years, a growing number of ICTs elderly users will face different problems than the current.

In terms of policies, the aforementioned results therefore seem to be a warning to develop inclusive policy strategies by developing social inclusion through technologies which elderly people already use. In this respect, there is a need to use technologies of communication, information and health that suit the needs of the elderly as they are, from their actual ICTs literacy, which is derived in large part from their previous, working or not, experience. However, there is also a need to consider the elderly who are not yet ICTs users, by applying specific policies and integrating digitalized services with more traditional and less exclusive techniques. These policies need to be imagined as part of a wider program of inclusion, which does not only affects the elderly, but all the less privileged groups .

In this framework it becomes very interesting to observe the potential of mobile technologies use that seems to be able to bypass the traditional computer literacy. Hence it is necessary to develop an open approach to technological research and to development of services and apps in the field of health, well-being, as well as socialization.

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Empowering Skills for an Active Ageing and Healthy Living

Alessandro ANTONIETTI [a1], Michela BALCONI [a],
Patrizia CATELLANI [a], Antonella MARCHETTI [a]
[a] *Department of Psychology, Catholic University of the Sacred Heart, Milano*

Abstract. The chapter is aimed at describing four different approaches, each supported by experimental findings, which can be adopted to empower life skills in the elderly. The first approach consists in stimulating aged persons by asking them to carry out some tasks aimed at activating the brain and mental processes which are targeted by the intervention. In the second approach the elderly are hinted at thinking about their mental states to understand one's own and others' behavior to act as a reflective agent. The third approach is based on the assumption that the communication context can support and improve old people's skills, if the messages they receive are devised so to focus their attention on relevant information and to elicit relevant cognitive frameworks. According to the fourth approach, aged people can be engaged in activities which enjoy them so to express themselves in personal ways and to practice a wide set of mental functions. Becoming aware of the pros and cons of each approach enables us to choose the kind of intervention which is most suited to the elderly, taking into account the features of the context and the actual resources which can be employed. We also aim at integrating the different approaches so to devise a holistic intervention in which synergies among the methodologies to be applied occur.

Keywords. Empowerment, Cognition, Social Cognition, Skill, Health, Ageing, Elderly, Neurostimulation, Theory of Mind, Decision making, Food, Communication, Persuasion, Music, Enjoyment.

Introduction

The steady increase in life prospects and the on-going socio-economic level of our society call for reflection about the issue of ageing and the ageing process. The elderly person is more and more seen as the protagonist in a perspective of *active ageing* [1], defined as the process of optimizing opportunities for participation in paths of health, safety, and socialization, which improves the quality of life and implements the potentialities for physical and mental wellbeing [2].

The classical conception of old age as characterized mainly by losses and by a decrease in individual skills, often exacerbated by the onset of diseases, has been

[1] Corresponding Author: Department of Psychology, Università Cattolica del Sacro Cuore, Largo Gemelli 1, 20123, Milan, Italy. E-mail: alessandro.antonietti@unicatt.it

gradually replaced by more articulated concepts [3]. A distinction is now made between primary ageing (the changes due to ageing, without becoming ill), secondary ageing (characterized by the onset of chronic diseases, which affect the individual's adaptation to the environment) and tertiary ageing (the period immediately preceding the term of existence, characterized by a rapid decline of the skills of the individual).

As far as primary ageing is concerned, the recognition of the differences between physiological and pathological ageing has stimulated the study of the functional changes of the elderly person on the behavioral as well as on the neural levels, prompting some reflections about the possibility of supporting the person in this critical phase of the existence. The notion of "empowerment" [4] can serve as a framework to conceptualize the attempts to take care of old people in order to: a) help them to keep their current levels of mental functioning; b) prevent possible decay in cognitive and social skills; c) cope with adverse events and negative experiences; d) exploit latent resources. However, it is not yet clear which is the best approach to support and enhance elderly's capabilities [5].

In this chapter we describe four different approaches, each supported by experimental findings acquired through research programs currently in progress within the Department of Psychology of the Catholic University of the Sacred Heart of Milan. We highlight how such approaches can be integrated in a common framework which, on the one hand, takes into account the specific features of each of them and, on the other hand, suggests possible synergies among them.

The first approach consists in stimulating aged persons by asking them to carry out some tasks aimed at activating the mental processes which are targeted by the intervention. The proposed exercises can be executed in a condition in which brain stimulation should increase the modifiability of the brain networks involved in the task, so to enhance the effects of the training. Individuals, however, are not only mere executors of the activities in which they are involved, especially in the domain of social interactions. They can also reflect about the underlying mental processes. Meant as reflective agents, old people should be supported in maintaining the ability to develop an adequate Theory of Mind about both their own and others' cognitive and emotional processes. To do so, interventions rely on the individual's reflective attitude, which is the core of the second approach considered here. If we think to the elderly in their usual living environments, we realize that the context can also support and improve their skills, for instance through the communication which is addressed to them. If the messages they receive are devised so to focus their attention on relevant information and to elicit relevant cognitive frameworks, old people can be motivated to follow healthy habits in their life. This is the third approach, which is exemplified in this chapter by making reference to the case of nutrition. The last approach starts from considering that also leisure activities can provide the opportunity to promote an active ageing. Old persons have their own interests and talents which they express, for instance, in the field of arts. Thus, if we engage aged people in activities based on artistic languages which enjoy them, we can lead them to exercise a wide set of mental functions.

1. Cognitive and Brain Stimulation

1.1. The Background

The recognition of a differentiation between physiological and pathological ageing has stimulated the investigation of biological functional changes of the elderly person, soliciting some reflections on the possibility to support people in this critical phase of their existence. From the neurobiological perspective the old ageing is a specific life stage only apparently critical. Indeed it is also a powerful phase for maintaining and strengthening the quality of physiological, cognitive and emotional processes, as well as the stabilization of the existing relational networks. At this regard, the conception of *cognitive reserve* is crucial, being understood as a protected pool of resources from which to draw as a function of the demands of everyday life, not only in the case of difficulties or functional impairments [6]. This phase of the lifespan is characterized as a dynamic condition on which it is possible to intervene with a view of strengthening in order to adequately sustain the physiological process of ageing, which may also include a gradual weakening condition [7]. To support this functional process, one of the main challenges concerns the ability to adopt *proficient strategies*, both self- and hetero-induced. The former are based on virtuous self-managed "learning approach" that should become the objects of further "reinforcement" externally induced. The strategies of the second type provide for the intervention of external aids, such as specific cognitive training. Both of these strategies can engage on contextual supports, which facilitate the reinforcement of the cognitive wellbeing, in particular based on some appropriate environmental stimuli (social networks and caregiver support), as well as the best practices of life (consumption habits, physical activity and so on).

The contribution of neuropsychology in reference to cognitive functions is twofold: it concerns the possibility of early detection of prognostic markers of phenomena of decay and the possibility of specific intervention programs, through the stimulation or enhancement of *preserved skills*, with the intent to modulate the effects of the decay and to potentiate the functional "reserve". The idea at the basis of cognitive and neurophysiological stimulation is that, in the progression of the lifespan, the partial neuronal decay induces the weakening of the cognitive functions. In agreement with evidence relating to *brain plasticity*, the reactivation of the networks which mediate these functions can foster a sort of cognitive "re-empowerment".

Unlike traditional methods, the latest techniques combine the execution of tasks with the pre-potentiation of specific neuronal circuits. The experiential learning is thus facilitated by the availability of a more receptive brain, as well as a "selectively stimulated brain". The pre-enhancement of neuronal circuits is achieved thanks to new tools which act directly on the brain, by using magnetic and electrical stimulation, showing a positive impact not only on the fully preserved skills, but also on the residual abilities (*cognitive resilience effect*).

1.2. The Research Program

A study was recently conducted to test the effectiveness of treatment for cognitive and neurophysiological enhancement within the domain of some specific cognitive processes [8]. The project aims at defining opportunities for intervention in old population and at validating tools and good practices for assessing and empowering

the set of skills necessary to face everyday tasks. Specifically, our research focused on two main topics: the domain of global cognitive skills, which are pervasively used in various life contexts, and the domain of specific skills, which are relative to specific cognitive activities.

Going down to specifics, we tested the effect of neuropsychological and neuromodulation protocols for the empowerment of cognitive abilities. Thus the project pursues the interdependent goals of testing the efficacy of *empowerment pathways* in healthy elder population and, then, identifying potential intervention protocols to prevent or slow down cognitive decline and pathological ageing. More specifically it covers the following three objectives:

a) to investigate the effectiveness of *self- and hetero-induced mechanisms* which take advantage of brain plasticity and reorganization in the enhancement and/or maintenance of the cognitive reserve (physiological ageing);

b) to identify action plans for the prevention or slowing of cognitive impairment (pathological ageing) through capacity building to preserve and maintain a satisfactory degree of autonomy, in order to limit the risk of developing diseases associated with ageing (dementia, associated degenerative syndromes, depressive profiles and so on);

c) to use neurostimulation methods (transcranial Direct Current Stimulation, tDCS) [9,10] for the potentiation of the preserved functions in conjunction with the classical cognitive techniques. This methodology was applied in order to strengthen the mechanisms of brain plasticity underlying the maintenance of the main cognitive functions.

In order to evaluate the *short-term* and *long-term efficacy* of our target protocols we compared different treatment groups through the following research steps:

- *pre-intervention (T0)* (mean time duration: 1 week). The assessment procedure included in-depth *focused neuropsychological testing*, analysis of global functioning level, and *basic electrophysiological testing* by means of electroencephalography (EEG) recording at rest (eyes open/closed) and during a challenging attentional task.
- *intervention (T1)* (mean time duration: 3 months). This phase was devoted to brain stimulation. The sample (54 subjects, matched for the main statistical and demographic parameters) was divided into three experimental groups through randomization. The experimental groups were defined as follows: Group A, *control condition*; Group B, *cognitive stimulation* by computer-based tools; Group C: *electrophysiological brain stimulation* techniques using non-invasive neuromodulation (tDCS) with a concomitant twice-weekly application of selected tasks related to some cognitive functions.
- *follow-up (T2)* (mean time duration: 1 week). This phase was devoted to test the *long-lasting effects* induced by the treatments mentioned above. At 3 months after the conclusion of the treatments, a follow-up assessment was conducted which included a neuropsychological assessment and electrophysiological and functional evaluation technique (EEG).

Overall, preliminary evidence elucidated an improved performance in the experimental subjects (groups B and C) who completed the cognitive/neuromodulation process of empowerment in determined cognitive areas. Specifically, the cognitive and neuromodulation treatment produced a significant increased performance in memory and executive (mainly non-verbal) tasks. These effects are manily obtained by brain plasticity modulation. Consistently, in a final

interview the experimental groups B and C reported the subjective perception of an improvement in their overall functioning in daily life and described the training as challenging and not problematic [11].

2. Theory of Mind and Decision- Making

2.1. The Background

The psychological literature highlights the progressive decay not only of cognitive, but also of socio-cognitive skills which contribute to the ability to interact with others as, for example, the ability to understand one's own and other's behaviour through the inference of intentions, emotions, desires and beliefs (the so-called Theory of Mind: ToM) and the ability to make proper evaluations and decisions within social relationships.

The literature has widely documented the development of ToM both in physiological and pathological ageing [12,13], highlighting a decay of this ability through behavioral (performances in classical paper-pencil tasks) and neural evidences (brain activations detected through brain-imaging techniques). In particular, in healthy elderly engaged in a well-known task of attribution of mental states through the eye-gaze of the other person, the performance was identical to that of a control group of young adults, but with the presence of a significant difference in terms of activations of the brain areas underlying the performance [14]. Similarly, a group of elderly people diagnosed with Mild Cognitive Impairment of the amnestic type (aMCI) at high risk of progression in Alzheimer's disease showed in the same task a performance which was similar to that of a group of healthy elderly controls, although in presence of a lower activation of the neural areas involved [15]. A sort of "mismatch" between the two considered levels seems to emerge: the performance at the behavioral level is substantially preserved both in physiological ageing and in the condition at risk of clinical progression, compared to the changes at the neural level. Moving on the pathological side with senile dementia, the literature shows clear evidence of the decay in ToM [16] and, interestingly, an initial decay of this skill from the more complex levels (understanding of the 2nd order level of recursive thinking: "I think that you think that he thinks") at the onset of Alzheimer's disease [17,18].

The ability of decision making in healthy elderly has been poorly investigated although the knowledge of its functioning and the prevention of its deterioration may be crucial to maintain the autonomy of the elderly person and his/her sense of self-efficacy in real-life contexts. The theme has its own importance from a legal point of view for the legal protection of the elderly in situations of cognitive impairment.

The research program which is outlined in the next section aims to achieve two goals. First, socio-cognitive skills in the life-span are assessed so to identify possible changes in healthy elderly subjects so to figure out supporting and/or rehabilitative interventions that may provide an overall improvement in the quality of life. ToM, as a component of the broader socio-cognitive competence, is a relevant candidate for this purpose, as it is widely involved in the relational domain, and therefore it is potentially implicated in the maintenance of the personal and relational well-being, particularly with the caregivers. The possibility to promote the maintenance of the previous spaces of self-efficacy would have a significant impact in terms of

sustainability, as it would have a positive impact on the high social costs now necessary to take care of people diagnosed with senile dementia.

Secondly, we intend to explore some facets of decision making in elderly people as well as the representations of the financial and economic crisis which occurred in recent years. In fact, the changes that have affected the global scenario of the economic and financial markets have had an impact not only on the business world, but also on families and individuals. The present cultural-historical contingency puts in evidence the complexity of the choices and of the decisions that the individual performs in the economic and financial domain. In this perspective, the international studies have focused on the perspective of the individual as a consumer of financial products. In contrast, in a systemic view the economical and the financial skills of an individual should be considered not only in relation to his/her consumption, but also to his/her ability to understand the critical points of the economic and financial system. Therefore, it is of primary interest to investigate the decision-making skills and the representations of the economic crisis on the part of elderly individuals, a segment of the population who is particularly interesting in that it is engaged in the management and use of capitals resulting from the choices and decisions made in the course of life and with a time-horizon and, in some cases, socio-cognitive and decisional abilities different from that of the younger age groups.

2.2. The Research Program

In the light of the theoretical framework and of the main goals briefly presented so far, the research program involved individuals over the age of 65 in the phase of primary ageing.

Regarding the first goal, the assessment of ToM, participants performed the following tasks: the Eyes Test, which requires to label the eye-gaze of a person choosing between words with an emotional content (e.g., sad or angry) and an epistemic content (e.g., doubtful, thoughtful, concentrated) and a control task, the Gender Test, which simply requires to indicate the gender of the person; a self-report scale of mentalizing, that requires to express the degree of agreement with statements concerning the evaluation of one's own capacity of mentalization (for example, "I can read the intentions of others from their face").

Regarding the second goal (decision making and the representations of the economic and financial crisis) a questionnaire with open questions about the causes, consequences and possible remedies of the economic crisis has been proposed. Different components of decision making were also investigated, such as the sensitivity to fairness and the risk attitude. Behavior in decision making was assessed with the Ultimatum Game [19], an interactive game with a single-shot money exchange, where the subject decides how to divide an amount of money (10 euro) with an unknown partner, knowing that if the partner will accept, the exchange will be successful, whereas if he/she refuses, no one will gain anything. In this case, to assess the sensitivity to a social norm of fairness, the methodological structure devised by Bicchieri and Chavez [20] was adopted, in which the decision maker can choose between a fair option (5-5), an unfair option (8-2) and the coin toss to determine the outcome (head 5-5, tail 8-2). Risk attitude was measured through the completion of two questionnaires, relating to the perception of risk and to the propensity to act in a risky way [21].

On the basis of a preliminary analysis of the data we can say that ToM is substantially preserved in the age group considered, thus opening up interesting ideas for strengthening a skill that, as we know from literature, becomes subjected to decline in the later stages.

With regard to the representations of the crisis, we identified 34 types of causes, 16 possible remedies and 6 categories of consequences. The causes recognized by the experts as being the origin of the financial crisis are not mentioned. Instead, people privilege representations linked to the decisions and the inadequacy of the politicians.

At the level of decision making, subjects are strongly oriented towards a fair behavior in the decision of the division of money, whereas the analysis concerning risk attitude is still in progress.

In future works we will proceed to further studying the neural basis of ToM and of decision making, in order to enrich the understanding of these skills not only in terms of behavior, but also of the neural components, to foresee adequate interventions.

3. Communication

3.1. The Background

A healthy diet provides the energy and substances that are necessary for the proper functioning of our body and mind. The link between nutrition and health is particularly evident in the case of the elderly, as many problems typical of this stage of life – such as diabetes, hypertension, cardiovascular disease and various types of cancer – are closely connected to past and present unhealthy eating habits [22]. By changing and adjusting these habits, it is possible to avoid or reduce the need for expensive medical and pharmacological treatment in later years. As a result of the steadily increasing average life expectancy, people entering the third age (conventionally set at 65 years) will likely face another 20 or 25 years of life. Prevention therefore becomes important also in later stages of life.

Adopting healthy eating habits not only prevents illnesses and diseases, but also encourages the development and activation of specific resources in terms of autonomy and self-efficacy, allowing the elderly to maintain for a longer time their autonomy in daily living activities, as well as in life in general [23]. Such self-empowerment skills developed or improved by purposely changing eating habits can be applied also in other aspects of older adults' lives, allowing them to go through the ageing process in an active and successful way.

This goal can be achieved through targeted communication campaigns that promote awareness of the positive and negative effects of eating habits on health. In addition to promoting knowledge and awareness, communication campaigns should support the motivation and the intention to adopt the proposed healthy eating habits. Changing one's eating behaviour is a very hard and demanding task, especially after years or decades of established routine. However, effective communication on these topics can help activating the necessary skills and motivations to adopt a healthy, and at the same time rewarding, diet.

Numerous studies on health communication have shown that healthy behaviours and their consequences can be framed in different ways. For example, a persuasive message can provide information regarding the effects on health of a balanced diet by

emphasizing either the positive consequences of healthy eating (*gain frame*) or the negative consequences of unhealthy eating (*loss frame*). Message framing provides recipients with information about the context that guides their interpretation of the content of the message, ultimately affecting information processing and decision making. Research on health communication has shown that when the proposed behaviour concerns the identification of a possible disease (e.g., undergoing regular mammography), loss-framed messages may be more effective than gain-framed messages. Conversely, when the suggested behaviour concerns the prevention of possible diseases (e.g., delaying the onset of osteoarthritis by increasing physical activity), gain-framed messages can be more effective than loss-framed messages [24]. Similarly, in communication promoting healthy eating behaviour a loss-framed message might be more effective in conveying information of the negative effects of certain foods (e.g., those rich in animal fats or sodium) on health, whereas a gain-framed message might be more effective in promoting the adoption of healthy eating habits. So far, however, the effects of message framing in campaigns promoting healthy eating have been poorly investigated, especially in the case of messages addressed to the elderly.

The effects of framing in communication about health and nutrition are also likely to depend on several individual characteristics of recipients, including those related to age. Research on health communication, for example, has shown that personal interest and previous knowledge on the topic of persuasive messages influence the effects of message framing [25]. In particular, loss-framed messages are more convincing than gain-framed messages among people with less interest and knowledge of the topic, whereas those with stronger interest and knowledge tend to be less affected by the way messages are framed. Consistently, one might expect the degree of knowledge regarding nutrition facts and the effects of different foods on health to influence the effectiveness of messages promoting healthy eating among the elderly.

Another individual characteristic of recipients that might influence the effects of gain- and loss-framed messages promoting healthy eating is regulatory focus [26], that is, the individual orientation to regulate one's own behaviour to achieve positive states (*promotion focus*) or to avoid negative states (*prevention focus*). Past research found that ageing tends to shift people towards a stronger prevention focus than promotion focus [27]. Past research also showed that people with a prevalent prevention focus are more easily persuaded by loss-framed messages than by gain-framed messages [28]. This effect depends on the correspondence between the way persuasive messages are formulated and recipients' regulatory focus (the so-called *regulatory fit* [29]), which facilitates information processing and acceptance of the content of the message.

Framing effects of communication on healthy eating may also depend on the degree of self-efficacy of recipients, that is, the belief of being able to successfully perform a desired behaviour [30]. Some previous research [31] suggested that people with high self-efficacy are more easily persuaded by loss-framed messages than by gain-framed messages. Results of research on the link between message framing and self-efficacy have not been consistent, however, and the issue needs further exploration.

3.2. The Research Program

In our studies, we investigate framing effects of communication on healthy eating and nutrition, in order to identify which messages are more effective in activating behavioural intentions that can lead to better health and well-being among the elderly.

Participants read a short stimulus text where the positive or negative effects of a healthy or unhealthy nutrition are described in an accessible way (i.e., as a newspaper article or an interview to a physician). Depending on the experimental condition, the text describes the positive effects of healthy eating or the negative effects of unhealthy eating, describing either the effects on health (e.g., improving or deteriorating heart condition) or the effects on well-being (e.g., improving or deteriorating body fitness). Messages are manipulated also in their content, for example describing either the positive effects of a frequent vegetable consumption diet or the negative effects of a frequent meat consumption. In some studies, we also manipulate the linguistic style of the message, for example presenting the consequences of meat consumption either in *factual* (e.g., "A limited consumption of meat improves heart functionality") or in *pre-factual* (e.g., "If you make a limited consumption of meat, you will improve heart functionality ") terms.

After reading the message, participants answer a questionnaire reporting their judgments on the message itself and on its source, as well as their intention to eat certain foods (fresh and cooked vegetables, beans, white, red and cured meat, etc.) in the near future. The questionnaire also measures participants' current consumption of the same foods and their knowledge of nutrition facts (e.g., "Proteins can be found only in meat" or "Vegetable oils do not contain cholesterol"), participants' prevention or promotion regulatory focus and their self-efficacy related to eating behaviour. In particular, participants are asked to report to what extent they consider themselves able to follow a healthy diet, both generally and in some specific situations, such as when eating at home or when eating out or under emotional stress.

The initial results of our studies suggest that the participants' intention to eat more or less of each kind of food in the future depends both on the framing of the persuasive messages and on individual differences in self-efficacy and regulatory focus. Messages describing the positive consequences on well-being of limited meat consumption are more effective than messages describing the negative consequences of frequent meat consumption. The effectiveness of message framing, however, is moderated by eating-related self-efficacy. Among participants with low self-efficacy, messages describing the positive consequences of limited meat consumption reduce the intention to eat red meat more than messages describing the negative consequences of frequent meat consumption. Among participants with high self-efficacy both types of messages are associated with reduced intention to eat meat in the future, indicating that those who believe to be able to follow a healthy diet are easily motivated by both gain-framed and loss-framed messages.

In conclusion, our results suggest that the effectiveness of communication on health and nutrition aimed at the elderly depends on the fit between message framing on the one hand, and the needs and the resources of the recipients of the message on the other. Further research is needed to get to a better knowledge of how this mechanism works, assessing the effect of different messages on different categories of elderly people.

4. Enjoyment

4.1. The Background

The last approach which can be adopted to empower skills in old people consists in engaging the elderly in pleasant activities which match their interests and aptitudes so to enhance emotional, social and cognitive skills in an indirect, even though effective, way. Interventions based on music can serve as an example of such an approach.

Proposals to use the music to pursue preventive and therapeutic goals have a long history, but only recently a scientific approach has been implemented in order to assess the actual benefits derived from the involvement in musical activities [32]. A limited number of applications have been addressed to the elderly population, ranging from proposals developed to cope with problems of language, to those designed to recover motor function or the control of emotions to those aimed at the development, maintenance or rehabilitation of cognitive processes.

Within this framework it is possible to identify the specific aims of interventions based on music when they are addressed to the elderly [33]. Music enables older people to communicate through an alternative code than usual. This code typically is affected to a lesser extent than the verbal one by the effects of mental deterioration, allows a more direct access to the expressive resources of the individual and an easier emotional involvement, in partial independence from the cultural and intellectual level of the subject. It has been reported that music improves the quality of life of older people and has a motivating effect supporting the implementation of rehabilitative exercises, as it is evident in experiments conducted with patients suffering from Parkinson's disease. In stroke patients the speed of the flow of blood in the cerebral arteries increased as a result of listening to music for 30 minutes. Also, the systolic blood pressure in elderly people with dementia increased as a result of an intervention based on music. Improvements in postural stability in elderly people suffering from balance problems who had followed a musical training were found. In patients with brain injuries smoothness of gait improves thanks to exercises conducted with the support of music, as well as progress in motor coordination have been reported [34], especially if focused on acts involved in everyday life. The improvement of gait was also observed in patients with Parkinson's disease. Music was also useful in the treatment of dysarthria. In all cases in which music contributes to the recovery of motor functions, it provides a scheme of action that allows the patient to anticipate the movements to be performed.

Various musical activities proposed for elderly with dementia indicate that the experience with sounds produces positive effects on mood, restlessness, agitation, sleep disturbances and social interaction. Music can increase the production of autobiographical memories in the elderly suffering from Alzheimer's disease. Depressed patients improved relaxation, expression of feelings and emergence of reminiscences thanks to music [35]. Music is also indicated to improve social relations in stroke.

Regarding cognitive functions, it is noticed that the elderly perform better working memory task while listening to music [36]. Patients suffering from dementia, if they participate in activities of choral singing, improve their attentional capacity, as well as patients with brain damage. Särkämö et al. [37] found that daily listening to music brings patients who have suffered a stroke to improve intellectual efficiency.

4.2. The Research Program

A musical training aimed at leading older people to recover some basic mental functions has been developed [38] which is focused on the stimulation of attention, perception, memory and thinking. A set of exercises, consisting in the identification of sounds and silences or in the localization of sound sources, are aimed to stimulate the subject's attention. Exercises asking to listen to a piece of music accompanying it with the beat of the hands, with the beat of the feet or with a reciprocating motion of the hands and feet have been designed in order to improve perceptual-motor coordination. Exercises asking to provide answers according to numerical representation or to be engaged in musical dialogues have been devised to improve judgment and decision processes. A series of exercises consisting in assessing the intensity, speed, duration, pitch of the sounds were included in the training to improve perceptual discrimination and memory. To foster the ability to make associations, it was finally proposed a series of exercises consisting in linking sounds to objects, visual symbols, movements and connect musical elements with each other.

The results obtained in various applications of the training indicate that the elderly succeeded in improving their skills: significant increases were observed in the correctness of execution of the actions elicited by music and in levels of communication exhibited by the trainees. It is worth pointing out that these improvements have not been registered only in relation to the exercises included in the training, but also with different exercises: it seems that the learning outcomes produced by the training have been generalised. The overall level of attention, autonomy and participation during the sessions increased significantly as well. The modifications induced by the musical treatment do not appear to be related to the type of disease of the patients, as both psychotic, multinfartual and dementia patients benefited from the training.

The experiments carried out suggest that interventions based on music may promote improvements in the elderly. It seems that the cognitive advantages are not to be attributed to the creation of mere automatized responses, but to the development of skills that can be transferred from a domain to another one.

At present new training programs, in which music is integrated in activities based on other expressive languages (for example iconic or narrative), are under validation. Their goal is to link the leisure activities addressed at enhancing specific skills into the elderly's daily life so to be embedded in their ecological environments instead of needing a separate setting [39].

5. Conclusions

The interventions described in the previous paragraphs are clearly aimed at empowering skills which are crucial for a healthy and active ageing. Preserved cognitive abilities, as well as a reliable Theory of Mind, can help the individual to actively participate to the network of relationships in which he/she is engaged, with positive effects on the sense of self-efficacy. Therefore, figuring out trainings to support these skills in order to postpone the beginning of their decline may have a relevant adaptive value for the quality of life of the elderly population. Such skills should allow the person to explain and interpret the world around him/her and to

manage him/herself in adequate ways. For instance, in the economic and financial domain it is crucial to ensure that the individual avoids bad choices and decisions or, even worse, falls victim of ambiguous promotional messages about possible investments of money, if not actual frauds. The same is true in the field of food choice and health self-care. Training intervention involving old people can be useful to protect them from the risks of misguided choices. In order to achieve these goals, specific cognitive and social abilities, both general and domain-specific, are needed and the approaches previously outlined can empower them.

The elderly is exposed to social pressure which can undermine his/her ability to make autonomous and healthy decisions. Thus, the empowering of personal skills should be mirrored by actions in the environment aimed at providing cues signaling which are the proper behaviors to be held. In this sense, effective communication may contribute to the activation of cognitive and motivational resources in daily choices and activities that have positive effects on well-being. Results coming from the investigation of the effects of communication on health and nutrition contribute to highlight which characteristics of the source, the message and the recipients should be taken in consideration when designing communication on these topics. As an example, studies provide information on how messages regarding nutrition can affect recipients' intentions and behaviour depending on their framing. Furthermore, they provide information on individual differences that affect the reception and processing of messages. Thanks to the results achieved in this area of research, policy makers may be able to create effective communication campaigns to promote healthy behaviour among the elderly. In addition, guidelines developed for the creation of effective communication could be extended to a variety of contents and contexts in order to promote health and well-being using communication specifically designed for the elderly. Finally, it is worth noting that both the research aimed at enhancing personal skills and that addressing the interaction between the individual and the environment may inform clinicians and health care professionals on novel treatment protocols to promote well-being. It may also lay the foundation for effective prevention and early-intervention practices that might, in turn, lighten the health burden.

Each approach which has been shortly outlined relies on different grounds and implies different assumptions about how the target of the interventions has to be meant. In order to elucidate the differences existing among them, we can stress how each approach conceives *who* is the subject who should benefit from the intervention, *why* he/she is engaged in it, *what* he/she is asked to do in order to empower his/her skills and *where* the intervention usually takes place (Table 1).

Table 1. Sketch of the features of the four approaches

Approach	Who	Why	What	Where
Neurostimulation	executor	explicit goals	structured tasks	well-defined settings
Theory of Mind	reflective agent	explicit goals	structured tasks	well-defined settings
Communication	social agent	implicit goals	open jobs	ill-defined settings
Enjoyment	expressive participant	explicit goals	structured tasks	ill-defined settings

The elderly whose skills are to be empowered can play different roles within the interventions (*Who*). They may be asked to perform a series of activities according to given instructions (stimulation) or they may be prompted to reflect on the mental processes which are involved in the interactions they carry out (Theory of Mind); the degrees of individual autonomy can increase if, given some notions appropriately devised, he/she is let free to decide how to manage him/herself in everyday life (communication), having also the possibility to enrich the environment in which the intervention takes place thanks to personal contributions (enjoyment). In some cases the reasons underpinning the intervention (*Why*) are made clear to whom is engaged, whereas in other cases they are not explicitly revealed. The intervention can consist (*What*) of pre-established exercises or open tasks so to match the common life jobs to a different extent. Finally, the intervention may occur (*Where*) in places specifically addressed to the training (laboratories, ateliers and so on) or in the environment where the individual usually lives.

Each feature shared by a kind of intervention has its own strengths and weaknesses. Specific tasks, well-focused requests, clear-cut instructions and highly structured environments ensure that we are addressing the relevant mental processes and confounding variables should be excluded. There is, however, the risk that the trainees develop a dependence attitude and are prevented to express their potentialities in an individualized way. By converse, open-ended activities and ecological settings should elicit personal motivation and increase the likelihood of generalizing the beneficial outcomes of the empowerment programs. They may, however, lack of control of what is actually occurring across the training. Hence, the goal is not to identify the best practice in absolute terms, but rather to becoming aware of the pros and cons of each approach, so to choose the kind of intervention which is most suited to the elderly to whom the intervention has to be addressed, taking into account the features of the context and the actual resources which can be employed.

The further step of our program is to figure out how different approaches can be integrated so to devise a holistic intervention in which synergies among the methodologies to be applied occur. As an example, the consonance of the observed effects of treatment-induced cognitive enhancement with the perception that participants reported about the general improvement of their performance and their living conditions (life quality in term of relational activities and daily living) suggested that the stimulation of specific mental processes can result not only in the improvement of such processes, but also in a general increase of the level of motivation, self-efficacy and social participation. Furthermore, the possible positive effects of experiences aimed at enhancing Theory of Mind and decision-making skills not only on the subject directly involved in the intervention but also on his/her social partners supports the external relevance of future programs in such a direction.

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Work, Retirement and Health: An Analysis of the Socio-economic Implications of Active Ageing and their Effects on Health

Claudio LUCIFORA[a,1] , Lorenzo CAPPELLARI [a] , Elena COTTINI [a]
[a] *Università Cattolica del Sacro Cuore, Milan, Italy*

Abstract. In recent decades many industrialized countries experienced a substantial decrease in the working age population as a proportion of the total population. Demographic factors, such as declining fertility and increasing life expectancy, as well as institutional factors, such as the generosity of state-funded pension, both determined a change in the age distribution and a marked anticipation in retirement age. A lively debate among researchers and policymakers is currently taking place in Europe, as there are concerns that working longer may not be healthy for workers, or that it will be hard for older workers to get a job. Conversely, if working longer leads to higher employment rates and better health conditions, policies aimed at increasing peoples' retirement age may represent a "win-win" strategy both in terms of fiscal policies as well as in terms of healthy life expectancy. Unfolding this controversy is essentially an empirical matter which is also of paramount importance for public policy. In this study we first review the main findings of the socio-economic literature. Second, we highlight the main research avenues that are currently investigated in the area of Social Science and Health Economics at the Università Cattolica. Finally we discuss the policy implications and the prospects for future research.

Keywords. Work, Retirement, Health, Skills

Introduction

In recent decades many industrialized countries experienced a substantial decrease in the working age population as a proportion of the total population. A number of reasons have been advocated to explain these patterns. On the one hand, demographic factors, such as declining fertility and increasing life expectancy contributed to alter the age distribution of the population. On the other hand, institutional factors, such as the overall generosity of state-funded pension systems and widespread financial incentives to early retirement, both determined a marked anticipation, compared to previous decades, in retirement age. These trends occurred while life expectancy and healthy life expectancy were both increasing. In other words, while people being healthier could have worked longer, the institutional setting and financial incentives

[1] Corresponding Author: Department of Economics and Finance, Università Cattolica del Sacro Cuore. Email: claudio.lucifora@unicatt.it

were inducing them to reduce their working life, thus increasing inactivity rates. The effects of these patterns on the deterioration of public finances are well understood, and many countries have been reforming their public pension systems to induce people to work longer, conversely the wealth and health effects of individuals' transition from work to retirement, both on societies and individuals themselves, are much less clear. A lively debate among researchers and policymakers is currently taking place as there are concerns that working longer may not be healthy for workers, or that it will be hard for older workers to get a job (i.e. the well-known dilemma: "too young to retire, too old to work"). Also, if working in old age causes mental and physical strain, any attempt to address fiscal consolidation policies raising public pension retirement age might be misplaced (i.e. due to the increase in health spending and higher distress among the elderly). Conversely, if working longer leads to higher employment rates among older workers (as implied by the "Europe 2020 strategy") and better health conditions, policies aimed at increasing peoples' retirement age may represent a "win-win" strategy both in terms of fiscal policies as well as in terms of healthy life expectancy.

Unfolding this controversy is essentially an empirical matter which is also of paramount importance for public policy. Most research on the relationship between working in old age, retirement decisions and health has proved intrinsically difficult and has produced ambiguous results. This is essentially because work-retirement transitions are not randomly distributed across individuals, and individuals' decisions themselves are likely to be affected by health conditions (i.e. due to "reverse causality" retirement can influence health, and health is likely to influence retirement decisions). Moreover, data requirements for conducting empirical analyses are likely to be particularly demanding as individuals need to be followed over time (i.e. to control for unobserved heterogeneity), and information on health status, personal characteristics as well as work related attributes is also required.

Our research program intends to investigate the socio-economic implications of work and retirement patterns of older workers and their effects on health conditions. The first part will focus on the consequences of ageing on the labour market trajectories of older workers, and how these effects are mediated by the decay of workers competences. The second part will analyse how labour market outcomes and retirement decisions impact on the health of older workers. In particular, differences across countries and over time (i.e. due to reforms) in labour market institutions as well as in statutory retirement ages and financial incentives to retire, will be used to assess the health effects of policy changes that are currently debated in European countries.

1. Work, Retirement and Health: A Review of the Literature

1.1. Older Workers and Labour Market Outcomes

The share of older workers (age group 55–64 years) in EU countries is expected to increase over the next decades (from 2015 to 2025) by over 15%. This implies that not only the European workforce will be older but also that labour markets in European countries will experience an unprecedented increase in the working-age population. How would labour market respond to this epochal changes? How would

employment rates of young workers be affected and how hard would be for displaced older workers to find a new job? How do the employment trajectories of older workers will differ from those of prime age ones? What is the degree of employment and earnings instability of older workers, that is: Will older workers ending up in temporary jobs manage to get back to open ended employment contracts? Will the competences required to older workers be compatible with the available jobs?

All these questions focus on the growing concerns that European governments have on the quality of working life of older people and on the crucial role that active ageing policies will have to play in order to secure their well-being. While these topics have been extensively investigated for the general labour force, still little is known on the features of employment and earnings dynamics close to retirement. In Figure 1 we report labour market participation rates for older workers in OECD countries and life expectancy over the past 50 years. It shows that labour market participation of older generations (cohort 65+) remains lower in comparison with more recent generations (cohort 55+). Participation in the EU is astonishingly low with 67 per cent of people aged between 60 and 64 inactive. In this context life expectancy at 60 has been growing constantly.

Figure 1. Labour force participation and health of older workers in OECD countries (Source: OECD, 2012)

The economic literature has highlighted a number of stylized facts connected with the labour market of older workers. First, there is evidence that state pension retirement age has a positive impact on the employment rates of older workers [1]. This happens because higher retirement age provides stronger search incentives to unemployed old workers. Secondly, in the US the employment trajectories of older workers have been found to be more sensitive to business cycles fluctuations compared to younger workers [2].

Older workers' wages are less flexible downward if compared to younger workers' wages (because of longer tenures and implicit contracts), so that negative shocks tend to affect employment rather than wages. In turn, this suggests that

employment flows of older workers might be a special focus of policy design, with characteristics that differ from the general labour force. Cappellari, Dorset and Haile [3] provide evidence that this is actually the case: the employment trajectories of older workers appear to be much more persistent compared with younger workers, meaning that it is more likely for unemployed older workers to become long-term unemployed compared to younger workers.

Concerns about the labour market trajectories of older workers are also motivated by the possibility that productivity declines with age, which makes older workers less attractive to potential employers in the absence of downward wage flexibility. The evidence about the negative age-productivity gradient is, however, rather mixed. One main obstacle to the analysis of this phenomenon is the absence of representative data providing information on individual productivity over the life-cycle. In this respect, van Ours [4] finds evidence of a life-cycle productivity decline in sport but not in academic jobs. Castellucci, Padula and Pica [5] find strong evidence of an inverted U-shaped age-productivity profile in a sample of F1 drivers. Instead, Borsch-Supan [6] reports upward sloping age-productivity profiles for workers on an assembly line. In one of the few nationally representative studies on this topic, van Ours and Stoeldraijer [7] find only mild evidence of a wage-productivity gap with old age.

1.2. Older Workers and the Health Effects of Retirement

A growing concern is emerging among policymakers that policies that induce older workers to work longer may have adverse effect on their health, or alternatively that some attributes of the jobs, such as working conditions causing mental and physical strain, may be unsuitable for older workers. Is working in old age good or bad for individuals? What is the quality of the jobs held by older workers, and would these be compatible with their health status? Does retirement improves, or worsen, healthy life expectancy?

Most research on the relationship between health and working in old age has produced contrasting results. Some of the studies find a positive correlation with health [8], no correlation with health [9-15], or a negative correlation with health [16-17]. However, it should be noted that most of these studies are not able to identify any causal effects. As shown in the literature, precarious health conditions are likely to hurry retirement decisions leading to a finding of a "false negative" effect of retirement on health [18]. Another likely confounding effects originate from omitted variable bias, that is factors that affect both retirement and health which are not observed (and controlled for) in the analysis, may alter the true correlation between retirement and health: either showing a spurious correlation, or masking any effect of retirement on health. For example, retirement decision may be affected by the health status of spouses, or of other members of the family (i.e. the precarious health of a spouse may increase the likelihood of retirement). Some paper try to exploit the longitudinal nature of the data to solve some of the problems outlined above. Kerkhofs and Lindeboom [19] and Lindeboom et al. [20] used longitudinal data focusing on whether changes in retirement status generate changes in health, while controlling for all unobserved differences between individuals that do not vary over time (such as educational, genetic and gender related factors). Their results indicate that retirement has a positive effect on subjective measures of health, but no effect on objective measures of health.

Other studies use age-specific retirement incentives provided by the US Social Security system to capture changes in labour force participation [21-22], or employ age-specific retirement incentives of the UK Social Security system to gauge the effect of retirement on health [23], or retirement windows as an instrumental variable [18]. All these studies confirm that the cross-sectional association between health and retirement is positive; that is, those who retire later tend to be in better health.

However, when the endogeneity of retirement is accounted for, the results show a non-negative effect of retirement on health. Alternatively country-specific early and full retirement ages have been used as instruments for retirement behavior [24]. These statutory retirement ages clearly induce retirement, but are not related to an individual's health. Exploiting the discontinuities in retirement behavior across countries, this study finds significant evidence that retirement has a health-preserving effect on overall general health. Finally De Grip et al. [25] exploit a pension reform implemented in 2006 that induced a sharp discontinuous treatment of pensions rights, to measure the effect on mental health conditions of workers approaching retirement. They find that the reform had a strong impact on the mental health of workers affected by the reform. In particular those exposed to a pension reform that substantially lowers their pension wealth are more often depressed.

The underlying idea is that pension reforms (when unanticipated) alter individual behavior affecting the financial incentives to retire, while do not affect health through channel other than retirement. Conversely when reform are anticipated (i.e. due to public debate preceding reforms or because of delays in implementation), individuals may adjust their behavior before retiring taking into account their pre-retirement health status, in such cases the approach is not likely to produce unbiased results. Further problem arise when the standard pension eligibility age is perceived as an important landmark in the life-cycle of individuals, as it is most often the case. In such case, individuals, given their health status, are more likely to choose jobs with more favorable retirement conditions or jobs in which early retirement is more likely to be granted (i.e. such as public sector jobs). In this case, it is more difficult to separate selection effects originating from job shopping from the health effects of retirement.

A common problem to most studies is that they do not account for a varying impact or retirement on health over time. In other words, it is possible that retirement may improve health at first (particularly mental health) due to a lower stress and ability to carry out more satisfying and fulfilling activities (i.e. the so-called "holiday effect"), while as time goes on health may deteriorate for lack of physical activity and social interactions. Furthermore, undesirable lifestyle habits such as heavy eating, drinking and smoking may contribute to health deterioration but quite long after retirement. It is thus important to take into account the short- and long-term effects of retirement on health (i.e. need to control for the number of years spent in retirement).

2. A Review of the Main Findings: What do we Know?

2.1. Employment and Earnings Instability

Previous and existing research of the team of researchers based at the Università Cattolica has focused on employment and earning instability of workers over the

lifecycle and between cohorts. Cappellari et al [3] study the labor market transitions of older workers in the UK. Using data from the UK Labour Force Survey, they reconstruct individual trajectories of employment and non-employment over 5 consecutive quarters, using data between 1993 and 2003. They find that the labor market trajectories of older workers are characterized by pronounced persistence. Moreover, comparing results to those obtained with a younger sample they find evidence of a sorting process over the life-cycle whereby men's employment transitions are increasingly characterized by state dependence (i.e. the 'causal' effect of the past on the future) while, for women, old age employment dynamics appear to be driven by individual heterogeneity, with "good" ("bad") types persisting in employment (non-employment) over time. Their findings are of particular policy relevance. State dependence may occur for a number of reasons such as skill deterioration, reduced morale or the establishment of a pattern of daily life that does not accommodate paid work. The appropriate policy response is to help individuals avoid experiencing a period of non-employment, perhaps by providing support and incentives to remain in work during a period of occupational disability, for example. For those who do find themselves out of work, the role of policy should be to intervene early to help them find new employment as soon as possible.

Research on earnings dynamics has shown the existence of sizeable earnings variations over the life-cycle. In this area, the research team at the Università Cattolica has published several contributions showing that age has an impact on earnings through two distinct channel. First, age affects the so-called permanent earnings component, the one that captures long-term productivity. While on average earnings growth slows down when workers enter old age, such reduction of earnings capacity is heterogeneous across individuals, which induces an increase of wage inequality at old age (see the discussion on the working poor). Second, there is an effect on the so-called transitory wage component, that part of the wage process that reflects exposure to economic turbulence. There is some evidence that this instability increases prior to retirement, which is also of high policy relevance as it may increase the overall perceived uncertainty and affect retirement decisions. This evidence on instability is still scant and providing a thorough assessment of the issue is part of the future research agenda.

Finally, increasing wage inequality with age implies that an increasing share of (older) workers may fall below some decency threshold and into poverty (i.e., the so-called working poors). Lucifora and Salverda [26] provide a comprehensive discussion of the issues related with low pay employment and the policy options that are available. Cappellari [27-28] estimates transitions in and out of low pay showing that for older workers there is a working poor trap. Cappellari and Jenkins [29] find similar effects on household income poverty. All this evidence suggests that policy instruments such as wage subsidies need to be targeted also on older workers.

2.2. Lifestyle and Health

Another topic that has been widely investigated by economists at Università Cattolica is the relationship between lifestyles, job conditions and the health of workers. Cottini and Ghinetti [30] study whether employee's health is affected by both working conditions and individual's lifestyles. Results show that bad lifestyles over the life-cycle reduce self-assessed health, but the effects are different on mental and physical health. Bad working conditions are found to play a significant role, reducing health

whatever measure is considered. These findings suggest that bad working conditions and bad lifestyles are likely to impact negatively on the health of workers (especially with respect to mental health) and that specific policies should be implemented to reduce health deterioration after retirement.

2.3. Job Quality, Working Conditions and Health

Major changes occurred, in recent decades, in the functioning of labour markets which contributed to increase pressure for more labour flexibility and work intensification.

The link between job quality and the health of older workers has been investigated by researchers at Università Cattolica in a number of studies [31-34]. Using a wide range of health measures (predominately self-reported) including general physical and psychological health this literature shows that adverse conditions of the job (measured in terms of high job demands, bad job hazards, flexible contracts and low pay) impact on the health of workers (particularly of older workers) and that these effects might be mediated by national differences in health care systems. The implications here are that increasing the quality of jobs is important to improve the health of workers, particularly in their older age, thus supporting the priorities set within the Europe 2020 strategy.

Second, since health spending represents a major expense in most European countries, the relevance of job quality issues is not limited simply to well-being and general health considerations but also to the cost-effectiveness of public spending. Third, economic efficiency considerations should also be taken into account, since workers in good health are also more productive and more satisfied with their job at any age.

3. Future Research: What we (Still) Need to Know

Future research will focus on three main broad areas: first, the role of competences for older workers and labour market outcomes; second, the effects of job quality of older workers on their health; and finally how retirement decisions affect the health of older workers.

3.1. The Consequences of Ageing on the Labour Market Trajectories of Older Workers

The consequences of ageing on the labour market trajectories of older workers and how these effects are mediated by the decay of workers competences will be a key step of the future research agenda. Anecdotal evidence and the public debate often point to the fact that older workers may face higher risk of poverty or social exclusion when hit by adverse labour market shocks, but still significant statistical evidence on this is scanty (especially in Italy). At the same time, older workers (particularly men) play the main breadwinner role not only for their spouse but also for the offspring, which make their vulnerability to adverse labour market shocks a particularly worrying possibility.

While these topics have been extensively investigated for the general labour force, still little is known on the features of employment dynamics close to retirement. We will provide answers to these questions using longitudinal data on individual labour market trajectories coming both from the Labour Force Survey and from Social Security payrolls.

First individual transitions across states of the labour market for older workers and younger workers will be compared to understand the extent to which the design of active labour market policies needs an age gradient. We shall identify the determinants of job losing rates and of unemployment traps of older workers, in addition to the characterisation of the degree of churning between unemployment and temporary employment for older workers. In doing so it is important to distinguish amongst two alternative (though not necessarily mutually exclusive) explanations for unemployment persistence: heterogeneity and true state dependence. Under heterogeneity, workers persist in unemployment because of their personal attributes, which suggest that policies should be designed with the aim of affecting those characteristics, i.e. training programs for the unemployed. Conversely, under state dependence it is not heterogeneity that matters in affecting unemployment persistence, but rather the 'scarring effects' of unemployment per se irrespective of individual abilities, i.e. through human capital depreciation, signalling or search effort. In this case, policies should avoid individuals falling into unemployment, i.e. through employment subsidies. The ageing dimension of these two alternative scenarios is still under-researched and it is important to provide evidence on this.

After the work of Jacob Mincer, a well-known stylised fact in labour economics is that earnings growth slows down after a certain age. Less is known however on the degree of instability that characterises the earnings trajectories of older workers. Is the earnings process becoming more or less volatile during the earnings slow-down that precedes retirement? Providing an answer to this question is relevant because it would tell us whether the pre-retirement income process becomes more uncertain, which will affect saving behaviour, contributions into pension funds and retirement. Little is known on this fact apart from the findings of Baker and Solon [35] for the US, who indeed find that older workers face more unstable earnings profiles.

The traditional policy concern when it comes to wages is about low pay and working poors. More recently, these labour market descriptors have been complemented with measures of labour market volatility and earnings instability, which refer to yearly fluctuations of individual earnings around their mean over time. Earnings instability is relevant because it is a proxy of the degree of risk attached to income profiles. Often, this risk is not insurable, and in the absence of labour market institutions that smooth out income shocks, individual workers may end up experiencing welfare losses. Recently there has been a growing interest among economists and commentators on the increased risk brought about by labour market reforms in Europe in the form of reduced employment protection. For example, Cappellari and Leonardi [36] find that throughout the 1990s the spread of temporary employment in Italy has increased the earnings instability of younger cohorts, which are the most exposed to this type of reforms. With the upsurge of the great recession, however, temporary employment has become more and more common also for the older labour force, but an assessment of its impact on older workers earnings instability is still missing. Filling in this gap of knowledge and discussing its economic and policy implications is the main objective in this part of the project.

3.2. Older Workers Competences and Labour Market Outcomes

Human capital is probably the main engine of economic growth, both at the national and the individual level. Individuals normally invest in human capital in a life-cycle perspective, concentrating investments in the youth years through schooling, and then updating their stocks of human capital through training when working. The combination of schooling and training generates a set of adult competences which are the key for determining labour productivity.

Active labour market participation is a key ingredient of healthy and inclusive ageing, and in turn this depend on older workers capacity and competences. Ageing brings in a trade-off. On the one hand individuals become more and more experienced, which increases their task-performing ability. On the other physical and mental efficiency might decline, imparting a downward shift to workers competences. Cross-country evidence consistently indicates that wages start declining at age 50, which suggests that for workers approaching retirement the trade-off might well be on the negative side, and age associated with a decline of productive skills. Little is known on these issues due to data limitations, in particularly accepted measures of adult competences to be used for investigating age gradients. The recent OECD-PIAAC study provides a cross-country micro-level database that can be used for investigating these issues.

Using these data, first we plan to assess the age gradient of adult competences, in particular their evolution after the age of 50. We will do this in a cross-country which will enable us to understand how different institutional settings and different systems of educational and vocational training map into workers competences at old age.

Using these data, our second goal in this part of the project will be to study the wage effect of competences and to contrast it to more traditional returns to education. Do competences pay more than education? Answering this question is key for the active ageing of older workers because finding that competences are rewarded in the labour market on top of education would indicate that training programs for older workers are an effective policy tool for mitigating low pay in old age. There is evidence in the literature on these effects for the general labour force [37], but a focus on the old age population is still missing. Moreover, existing studies are based on correlations between earnings, education and skills that, as is well known, provide only spurious evidence about the causal effect of human capital on earnings. We will overcome this shortcoming by exploiting variation in skills and education across countries which may legitimately be assumed independent from individual ability within countries, providing the basis for estimating the causal effect of human capital, the one parameter which is relevant for policy design.

3.3. The Effects of Job Quality of Older Workers on their Health

The “decrement models” of ageing argue that physical and cognitive changes occur with age, and it predicts that these changes affect worker’s health negatively. In this view, a higher level of job hazards is expected to have a stronger adverse effect on health among older people compared to younger individuals. Existing evidence finds that risk of suffering from work related diseases increases monotonically with age. Older workers employed in jobs characterized by adverse working conditions, high

job demands or work intensity are more likely to change their job. Quality of work and employment strongly affect perceived health, and thus might contribute to people's motivation to depart from their jobs as early as they can. Protection against physical strain often operates through exclusion from the workforce, particularly through early retirement, rather than reassignment to other positions within the company. The EU's Active Ageing Strategy includes tax benefits for companies that recruit older workers and promotes adapting the labour market to the needs of older workers. In this context, it becomes of primary importance to advance existing evidence on the health and wellbeing of older workers, on how this it is influenced by their actual job conditions and understanding the implications of policies that encourage people to work longer.

The objective of this avenue of research is to analyze the effect of job quality on work-related health for European older workers (over the age of 50). We focus, in particular, on the work-related health of older workers as measured by a comprehensive set of indicators including perceptions of work-related health risks, mental (such as stress, anxiety, sleeping problems, irritability) and physical symptoms (such as respiratory difficulties, cardiac problems, skin problems) as reported by workers to be related to their jobs. The European Working Conditions Survey (EWCS) is a very good source of information: it covers approximately 30,000 workers between 50 and 65, in 34 European countries (i.e. EU 27 plus Norway, Croatia, the former Yugoslav Republic of Macedonia, Turkey, Albania, Montenegro and Kosovo). These data will be used to investigate the effects of job quality on the health status of older workers. The policy implications suggest that, if poor job quality reduces the health and wellbeing of older workers -- thus reducing their participation --, policy makers should target their interventions to improve healthier working conditions.

3.4 Retirement Decisions and the Health of Older Workers

There is no general consensus on the effect of retirement on health: on the one hand the view that retirement is harmful, on the other hand many believe that retirement is an health preserving state. The main reason for this lack of consensus lies on the credibility of the empirical strategy. To tackle this issue, stringent requirements on the data are necessary. The research group at the Università Cattolica intends to examine the relationship between health and retirement in a multi country setting using between countries and over time variations in statutory retirement ages and financial incentives to retire. The dataset is drawn from the first four waves (2004, 2006, 2008 and 2010) of the Survey of Health, Ageing and Retirement in Europe (SHARE).

Information is available on individuals over 50 on health, their socioeconomic status and family networks for more than 85,000 individuals (approximately 150,000 interviews) and 20 European countries (plus Israel). In SHARE different measures of health are collected, such as self-reported health (5 point scale), and individual objective health measures, such as grip strength, limitations in daily activities, chronic symptoms and a depression index (that includes sadness, pessimism, suicidal thoughts, sleep trouble, lack of interest, irritability, fatigue). In this context a matter of concern is that retirement could have different effects on health for different individuals, with SHARE we are able to control for this source of heterogeneity by means of characteristics of the last job (such if the job is physical demanding, entails long working hours, has bad prospects, heavy workload, lack of autonomy, presence

of high time pressure and support from colleagues) in order to identify the underlying distribution of health effects. Moreover, the panel dimension of the SHARE data might help in limiting problems arising from cohort heterogeneity in health measures that reflect differences in initial health conditions [38].

4. Policy Implications of Active Ageing

The results of the research undertaken at the Università Cattolica is expected to significantly improve our understanding of older workers behaviours and needs, and also to guide the design and implementation of policies in terms of older workers' participation in the labour market. Higher state pension ages, for example, might not just be possible (given longer life expectancy) and necessary (given the fiscal consolidation efforts) but later retirement may also lead to better average health in retirement. As such the government should allow more flexible retirement plans allowing workers to delay retirement when they health is good. It seems to be intuitively attractive from the point of view of the individual to have a smooth transition from work to retirement, gradually reducing the number of hours worked.

Gradual withdrawal from the labour force could take different forms: either phased retirement (reducing work hours in the same job) or partial retirement (changing to a less demanding job with usually fewer hours and lower earnings). In order to design successful plans that are attractive to both older workers and to society, it is essential to know the preferences of the workers as well as the considerations of their employers for offering or not offering gradual retirement. It is also essential to know the constraints imposed by state and occupational pension schemes. Institutional restrictions on combining earnings with pension income, or a pension system in which the pension level is determined by final earnings have been shown to severely limit the attractiveness of phased or partial retirement in the US [39]. Still, take-up of gradual retirement is rather low in most European countries. Where the mobility in the US labour market accommodates older workers who want to leave their career job to take up a bridge job as a form of partial retirement, this is much less the case in the Netherlands and other European countries. Of course, this does not mean that governments should force people to work, but rather that disincentives to stop working should be removed. Continuing some form of paid work (such as "mini-job" or bridge employment plans) in old age is one way to ensure a healthier population and a more economically viable work-retirement balance in the European countries. Clearly, the success of these policies will strongly depend on a better understanding of ageing in the workforce and the particular role of health in continuing work or withdrawal from the labor market.

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Predicting Ageing: On the Mathematical Modelization of Ageing Muscle Tissue

Alessandro MUSESTI [a1], Giulio G. GIUSTERI [a], Alfredo MARZOCCHI[a]
[a] *"Niccolò Tartaglia" Department of Mathematics and Physics*
Università Cattolica del Sacro Cuore, Brescia, Italy

Abstract. The ageing of biological tissues can be accelerated by many factors, mainly of physiological and nutritional nature. In the case of skeletal muscle tissue, one of the main consequences of ageing is a progressive loss of muscle mass and a worsening of the quality of muscle tissue, termed "sarcopenia". The correlation between the deterioration of muscle tissue and what we usually refer to as the "lifestyle", although being the subject of several studies, up to now has been considered only from a clinical and a statistical viewpoint. However, the construction of a sound mathematical model of the muscle tissue, accounting for the changes due to ageing, can provide a more refined quantitative tool. Such a tool could determine in an improved way the variations of some measurable physiological parameters, such as the mass and the electrical impedance of the tissue, caused by the variation of other controllable factors, such as diet, physical activity, pharmacological treatments, air pollution exposure. A specific mathematical model, once implemented on a computer, makes it possible to perform "virtual" experiments, facilitating the search for a suitable treatment of sarcopenia. Moreover, test situations can be studied which would not be reproducible *in vivo*, such as drug overdoses, extreme nutritional deficiencies, environmental overexposure to harmful substances, and so on.

Keywords. Mathematical Modeling, Sarcopenia, Differential Equations, Stochastic Analysis

Introduction

Mathematical modeling is at the basis of the technological achievements of the last two centuries. Not only engines, aircrafts, and buildings have been designed and produced with the aid and guidance of mathematical modeling, but also communication media, electric appliances, and the whole digital world of computers would not have been possible without the deep understanding of physical processes and the predictive control provided by mathematical models of those processes. More recently, medical appliances and digital image processing have offered additional evidence of the positive impact that mathematics can have on the quality of life. In all of the mentioned applications the key for the success of mathematical modeling is the controllability of the system under consideration. Indeed, such a controllability (typical of engineered systems) may well be viewed as a necessary condition for the mathematical models to be of any use, since mathematics seems to be pretty controllable, at a first glance.

[1] Corresponding Author: Department of Mathematics and Physics, Università Cattolica del Sacro Cuore, Via dei Musei 41, I-25121, Brescia, Italy. E-mail: alessandro.musesti@unicatt.it.

Luckily enough, this is a misconception: on one side, the mathematical theory of deterministic chaos has shown us that unpredictability is inherent to even very simple mathematical models; on the other hand, many complex and poorly controllable systems have been subject to an effective mathematical modeling.

What kind of system is complex and poorly controllable? In a word, we could say that any *lively* system displays those features. And what kind of mathematical tools are needed to model lively systems? Those related with probability and stochastic analysis. Indeed, the best we can hope for is, in many cases, to achieve a predictive understanding of the average behavior of a complex system and of the degree of conformity to that behavior shown by small parts (or individual realizations) of the system.

In the last 60 years it has become more and more fashionable to try and apply mathematical models to lively systems such as turbulent flows, financial markets, biologically interacting populations, socially interacting human groups, neurological systems, living cells and tissues. All of these systems exemplify the three main features of lively systems: (1) it is impossible to follow in detail the behavior of each constituent of the system; (2) the collective behavior of the system is not a simple upscaling of the individual's behavior; (3) the time-evolution of the system displays deep reorganizations and modifications of the collective behavior due to both internal and external factors.

In attempting to develop a mathematical model for the behavior of a biological tissue and for its evolution over a long period of time, bringing ageing into play, we must be aware of the aforementioned issues, to choose the most appropriate modeling strategy and mathematical tools.

1. The Modeler's Task.

One of the main features of science is *capability of prediction*, that is, the possibility, starting from a known situation, to predict the values of some measurable quantities, enabling the scientist to have a fairly satisfactory picture of the future evolution of the situation. But this is not completely true. Indeed, the evolution which is predicted by the scientist is that of her own picture of reality, and reality often betrays our forecasts.

We can then see the importance of making a picture of reality, a *model*, as faithful as possible, but we must also cope with the limited nature of our resources. To build up a model that properly balances those needs is the main task of a scientist.

For instance, consider the properties of a steel bar used to reinforce a building. In seeking for accuracy, we could try and take into account all the atoms constituting the bar and all their interactions up to a certain distance. In other terms, we could picture the bar as a grid of atoms, using the laws of Quantum Mechanics to predict a rather accurate picture of the motion or of the response of the bar to an external load. But in doing that, we would immediately see that this is possible only for a very limited number of atoms (two or three, indeed) if we are looking for *exact* solutions, and perhaps a few hundred thousands of them if we are satisfied with *approximate* solutions, by using a computer. Since a real macroscopic bar is made of a huge number of atoms (billions of billions of billions), we see that this way is completely unfeasible.

On the other hand, we could view the bar as a sort of “homogeneous material”, finding out what kind of response the bar has to an applied load, without deriving that

from physically established and detailed principles. Anyway, we have to use appropriate hypotheses: for instance, we may assume that a piece of bar behaves the same way if it is pulled in a direction or in another one, or that it recovers its initial shape whenever unloaded, and so on. In other words, we have to make a *model* of what our situation is, and proceed from it applying appropriate *hypotheses*. As we all know, a steel bar is not homogeneous at all if we magnify it enough (even long before getting to atomic scales), but we can assume that the inhomogeneities of the material are negligible if one aims at predicting the behavior of the bar, at least if the loads are not too heavy. Of course, leading physical principles such as conservation of energy may help in the construction of the model, but in general they are not enough for a complete description. Driven by a need for simplification, scientists have been able to deal with a great number of phenomena, just trying to minimize the number of necessary assumptions, using symmetry considerations, dropping negligible quantities, and so on.

It should be stressed that every model is not only a partial picture of the phenomenon, but also a choice, namely the choice of what features are negligible for the study that one has in mind. As we have said, the choice is usually made pursuing essentiality: for instance, if we picture our bar as a homogeneous material, we could describe it with a smaller number of parameters and perhaps end up with a simpler problem, easier to solve, even if it is far from being complete. Only the experience of the modeler may lead to the right amount of simplifications.

2. How to Model Living Systems

A living organism has a peculiar organization which makes it very different from both a bunch of atoms and a macroscopic material. Living tissues exhibit a great variety of self-organization mechanisms and show radically different pictures at different scales. A skeletal muscle, for instance, shows a very complicated (but not random) structure at smaller and smaller scales: from fascicles to fibers, to sarcomeres, to myosin and actin. Moreover, a living tissue is usually growing, thus showing a feature which is not shared with ordinary macroscopic materials.

Therefore, if one wants to predict a future situation, the type of models that she is been using may be crucial for the accuracy of the prediction. It is very important to remind that predictions may depend on the model used and some lack of matching with real life is not a matter of wrong basic laws, but rather of a wrong or insufficient modeling.

2.1. Deterministic and Non-Deterministic Models

Models may be, in essence, divided into two classes: *deterministic* and *non-deterministic* ones. Deterministic models usually lead to mathematical problems that are treatable only when a limited number of unknowns comes into play. Let us make a simple example: suppose that we want to describe bacteria on a substrate. Clearly, the number of living bacteria at a certain time is an integer number: they cannot be fifteen and half. But, if their number exceeds a million, or if their birth rate and mortality rate are sufficiently high, it could be even meaningless to consider the exact number of bacteria at a certain moment as an integer number: we may not be able to count them, since they die and are born too quickly. We therefore admit that an error of one part on a million will not affect the final picture that we would like to have, and then we can

assume the number of bacteria to be also non-integer. This is the starting point in setting up a *differential equation*, that is, an equation relating the speed at which a quantity increases or decreases with the quantity itself.

A differential equation is in general difficult to solve explicitly, but it is often easily approximated to within a given error, and then it may produce a nice prediction of the situation we want to model. However, suppose that we are dealing with several species of bacteria on the same substrate: each species, namely each individual, will interact with the others in a very complicated way, which has to be modeled itself. If the number of species of bacteria increases, the deterministic problem that comes out may rapidly become intractable, both because the mathematics is too complicated and because the number of interactions is difficult to describe.

In such a situation, a non-deterministic model may be more useful. We could speak of a sort of "bouquet" of bacteria and specify only the relative percentage of the species in a given point. In doing so, we only know the probability of finding one bacterium or another in a given point. We could alternatively speak of "many different bacteria in the same point", which evolve under laws to be modeled. The sentence "the bacterium is here now" becomes meaningless in this context, but the prediction may be easier to obtain.

Another important point is the *knowledge of the initial situation*. This is often taken for granted, but if the phenomenon under study shows *instability*, it is very likely that a small error in the initial conditions will produce a great error in the predicted situation, what is sometimes referred to as the "butterfly effect". This is the reason why, for example, it is possible to predict precisely a total eclipse of Sun many years before it happens, but it is very difficult to forecast the weather for the next week.

Besides the instability phenomenon, which is in some sense unavoidable, there is another, maybe less known, problem in modeling that influences scientists' attitude rather deeply. When complex, or to be more precise, lively situations are under investigation, such as those concerning living or economic systems, not only are the predictable values known within an error, but also some *laws* may be partially unknown. For instance, in the case of bacteria one may suppose that species A eats species B, but the rate of that can be very difficult to measure. Or, in an economic problem, even if it is plausible that the mean propensity to consume increases when the gross national product increases, and one can simply assume that the two quantities are proportional, it may be very difficult to estimate the proportionality constant.

2.2. Numerical Simulations

After achieving good theoretical stability results for the model, some simulations can be performed, trying to have a clue of the unknown constants which have to be chosen. Usually simulations are performed by implementing the model on a computer (the so-called *numerical simulations*, often referred to as *in silico*). For example, a simulation may be used to predict the private expenses with different values of the internal product and to determine a possible value of the unknown proportionality constant. Next, with that value, other simulations may be able to predict several features of the phenomenon. In this sense, modeling is useful to modeling itself, without being a circular procedure. But, for the same reasons, simulations of complicated or chaotic phenomena must be always used with caution, and the awareness of all the simplifications made must guide the interpretation of the results. Moreover, even if numerical simulations may lead to huge money savings, for example by replacing a

wind tunnel with a computer, and therefore they are very useful, sometimes they may be badly employed, especially when they are passively assumed as truth, as for some partial climate predictions.

Anyway, numerical models are often the unique way to discover and/or explain features which otherwise remain inaccessible, and they probably will be the major tool for predicting and decrypting our life in the next future.

3. A Model for Sarcopenia.

Finding the causes and the mechanisms which lead to the ageing of biological tissues has always been an important task for the medical research. Indeed, the quality of life of elderly people could be greatly improved by slowing down or blocking such mechanisms.

Among the various elements of human body, the one which is severely subject to ageing is muscle tissue, especially that related to skeleton. A significant degeneracy of such tissues entailing loss of muscle mass and reduced functionality of the muscular fibers, often associated with ageing, is a syndrome named *sarcopenia*.

3.1. What is Sarcopenia

Sarcopenia is a so-called *geriatric syndrome*, that is, a complex clinical situation which is quite common in the old age and which does not fit into the definition of a specific disease. Although there is no general agreement on the parameters defining the syndrome, primary sarcopenia refers to a progressive loss of skeletal muscular mass in adults, which can become dramatic (loss of 50% of muscular mass) after the age of 80. In the last ten years it has been suggested to use the term sarcopenia referring generally to the loss of muscle functionality, and not only muscle mass. In 2010 the European Working Group on Sarcopenia in Older People [1]

> "recommends using the presence of both low muscle mass and low muscle function (strength or performance) for the diagnosis of sarcopenia." (p. 413)

Someone proposed to use the term *dynapenia* for the loss of the sole muscle function, but the denomination did not achieve a widespread use.

Needless to say, sarcopenia has a great impact on the quality of life of elderly people: the loss of muscle functionality greatly reduces mobility and consequently reduces autonomy; moreover, the risk of injuries and bone breaking considerably increases, causing disabilities and hospitalization.

3.2. Diagnosis of Sarcopenia: How to Measure Some Quantitative Parameters

In order to describe and to diagnose sarcopenia, there is a strong need to find some quantitative markers of the disease, an obvious candidate being the actual amount of skeletal muscle tissue in a human body. However, measuring such a quantity in a reliable and not invasive way is not easy, and several techniques have been proposed in the last few years. Apart from MRI, which is quite slow and expensive, two tests have been considered as a widespread diagnostic tool: BIA (Bioelecrical Impedence Analysis) and DEXA (Dual-Energy X-ray Absorptiometry). Unfortunately, both of

them can measure only the mass and are inappropriate to evaluate the quality of muscle tissue: this is one of the main points which makes so difficult any clinical diagnosis of sarcopenia. The usual methods to test the efficiency of the muscles (hand grip strength test, six-minute walk test, knee extension strength test) are much less precise and must be adapted to elderly people. For instance, the six-minute walk test, which is quite demanding for an 80-year-old person, is usually replaced with the four-meter walk test, which is a lot easier and can be performed in any room, but it is even too quick and cannot precisely measure the performance of the leg muscles in a prolonged exercise.

3.3. Mathematical Models of Muscle Tissue

The first mathematical models of some of the functionality of muscles appeared in the scientific literature long ago. The pioneering work of the Nobel laureate A. V. Hill in the decade 1920-30 tried to describe some experimental results about the muscle contraction by using a few ordinary differential equations. Later on, in 1954, another Nobel laureate, A. F. Huxley, discovered the so-called "sliding filament" mechanism of muscle contraction and in 1971, together with R. M. Simmons [2], proposed a mathematical equation describing some quantitative parameters involved in the contraction of muscles. Since then, a lot of mathematical literature has been developed on the subject of muscle contraction. Recent important instances are the papers by L. Truskinovsky and coauthors [3-5], where it is proposed a refinement of Huxley's model which is capable to better fit the experimental data in a wide range of physiological situations. The model by Truskinovsky is based on a mathematical description of the behavior of a single cross-bridge between myosin and actin and takes into account also some stochastic fluctuations, which cannot be neglected at the molecular level, by inserting suitable terms in the equation. Then, many such equations (~2000) are coupled in order to describe the behavior of a single sarcomere, and, via some numerical simulation, the output of the model is related to experimental measurements.

Another approach to muscle modeling has been undertaken by using the tools of Continuum Mechanics: the muscle tissue is viewed as a homogeneous material and all the microscopic details are coded in the equations describing the material. With this approach one can hope to model a larger system, such as an entire biceps or triceps, taking into account also the typical orientation of the muscular fibers. Among the authors which followed this method, we like to mention Holzapfel and Ogden [6], who have proposed several models of the heart as a muscle, accounting also for the geometry of the ventricles.

4. Our Research Activity: Modeling the Quality of Muscles

The main goal of our research activity, which started a few months ago at the "Niccolò Tartaglia" Department of Mathemetics and Physics of the Università Cattolica del Sacro Cuore, is to produce a mathematical model capable of quantitatively describing the evolution of sarcopenia. In order to do this, we need two main ingredients:

- a sound model of the skeletal muscle tissue, which can keep into account also the possible loss of muscular mass;

- a descriptor of the quality of muscle tissue, that is, some quantity which can summarize the physiological changes due to the ageing into a quantitative parameter.

For instance, a possible strategy could be to introduce in an existing model, such as an adapted version of the model by Truskinovsky, a time-dependent parameter measuring the strength of the cross-bridges between actin and myosin. Tuning the value of the parameter by imposing an increasing weakness of the bonds as time passes could result in a sarcomere which is deteriorated and which has a worsening in the performance. In such a way we would have a descriptor of the quality of muscles, and the model could be coupled with other equations describing the evolution in time of the quality parameter. Clearly, those equations should account for nutritional and environmental factors, as well as drug assumptions and training activity of the subject.

As a starting point, we are looking for some quantitative parameters which can be used in the diagnosis of sarcopenia. The main parameter is the total skeletal muscle mass, but also the electrical impedance of the tissue, which is easily measured, can be a good indicator, as well as the muscle fat content, although this is much harder to evaluate. In doing this, we are studying the correlations between the electrical resistance of the muscle tissue and the muscular performance, in order to test whether the electrical impedance can be a good quantitative parameter on not. A good electrical model of the human arm or the human leg, capable to account for the electrical capacity of the cells and the geometry of the appendicular muscles, would be very useful at this stage.

4.1. The Role of Stochastic Phenomena

If we are interested in the mechanical properties of the muscle tissue, we can safely make use of deterministic continuum mechanical models, which only capture the collective behavior of the system. But, when it comes to assessing the quality of the tissue as it evolves with ageing, a number of "randomizing" phenomena influence the system. In particular, the degenerative process of ageing acts in a stochastic way on the individual cells of the tissue, and the macroscopic effects of that process can be traced and simulated only by a careful analysis of that stochastic process. Moreover, the response of each person to external factors (diet, medications, lifestyle, etc.), and even the response of different muscles, may be very different, and a probabilistic approach is necessary in assessing suitable parameters to diagnose sarcopenia.

5. Conclusions

Sarcopenia is a serious syndrome related to human ageing and one of the main causes of frailty and inability in elderly people. It shows up as a gradual loss of skeletal muscle mass and functionality. Far from finding a medical therapy, even the diagnosis of the disease is problematic, due to the scarcity of quantitative parameters (besides the total muscle mass and strength) and the difficulty to measure them. In order to help the active ageing and healthy living, we started an ambitious scientific project aiming to produce a mathematical model of the behavior of the human skeletal muscle capable to describe also the quality of the muscular tissue. Such a model would be very helpful in

the search for the mechanisms causing the disease and could suggest also possible therapies. As a starting point, we are trying to simplify the evaluation of the total skeletal muscle mass by comparing segmental BIA measures of the limbs with other anthropological measures.

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Healthy Reasoning: The Role of Effective Argumentation for Enhancing Elderly Patients' Self-management Abilities in Chronic Care

Sarah BIGI [a1]
[a]*Università Cattolica del Sacro Cuore, Milan, Italy*

Abstract. One of the biggest challenges for doctors working in chronic care is the correct management of the argumentation phases during the encounters with their patients. During these phases doctors should provide patients with acceptable reasons for being adherent to treatment and for changing certain unhealthy behaviors and lifestyles, something which is particularly difficult for elderly patients, for whom changing life long habits can be extremely hard. However, the medical literature on the subject of communication in the chronic care encounter shows lack of theoretical models and methodological approaches that can highlight which specific linguistic structures or elements in different communication styles favor or impede patient commitment, trust in the relationship and adherence to treatment. The contribution describes ongoing research on argumentative strategies in the encounter with diabetes patients. I describe one recently concluded research project on the argumentation phases of medical encounters in diabetes care, which highlighted critical areas in need of improvement. I also describe the design and aims of a new research project, aimed at testing the effectiveness and usability of certain argumentation schemes in the medical encounter.

Keywords. Doctor-patient Communication, Argumentation Schemes, Commitment, Shared Decision Making, Chronic Care

Introduction

Numerous studies have addressed the key factors in effective patient-provider communication with elderly and chronic patients, pointing out in particular the higher effectiveness of collaborative and proactive communication styles [1-9]. Indeed, evidence shows that more collaborative communication styles favor patient outcomes (such as satisfaction, adherence and health); on the other hand, some studies still report that it is difficult to understand precisely why and how such communication styles

[1] Corresponding Author: Dipartimento di Scienze Linguistiche e Letterature Straniere, Università Cattolica del Sacro Cuore, Milano, Italy. Email: sarah.bigi@unicatt.it

impact positively on patient outcomes. Some of the most relevant open questions are the following: which are the factors that improve or impede agreement on treatment goals and strategies [5]?; which are the 'success conditions' of a collaborative goal setting [8]?; how can physicians effectively help patients make their preferences explicit and then co-construct with them informed preferences to help them reach their therapeutic goals [9]?

The main challenge inherent in these open questions is the possibility to have a comprehensive model of the interaction in chronic care able to explain the correlations between communication styles and patient outcomes. The potential for meeting this challenge deriving from the collaboration between the medical field and the disciplinary fields dealing with communication (e.g. linguistics, argumentation theory, artificial intelligence, psychology) has inspired the design and development of the two research projects described in this contribution.

The first, the "Doctor-patient communication project", has been conducted between 2012-2014, involving a diabetes outpatient clinic near Milan. The second, "Healthy reasoning. Strategies and Mechanisms of Persuasion in Chronic Care", has begun in March 2014 and will involve a larger number of diabetes doctors and patients that will be recruited from different regions in Italy.

The fundamental research question in both these projects is to understand the specificities of the doctor-patient interaction in chronic care in order to develop an overarching theoretical model of this kind of interaction that will serve as a blueprint to explain in detail the positive correlations already observed in the literature between collaborative and participatory communication styles and positive patient outcomes.

The issue is challenging because the correlation between communication styles and patient outcomes has an inner complexity that cannot be dealt with through a merely empirical approach. It involves questions such as: what is a communication style 'made of'?; does communication impact on behavior directly or indirectly?; if indirectly, via which other features or phenomena?; how can patient outcomes be defined and specified in relation to communication styles? In order to answer these questions, the empirical approach needs to be complemented by a theoretical one. In other words, empirical data – which are now abundant – need models for their interpretation. In particular, the existing literature on communication in chronic care has pointed out the crucial role of shared decision making and patient engagement as a way of boosting patient commitment and obtain better therapeutic adherence and the needed changes in patients' lifestyles [1, 3, 5-9]. In the two projects mentioned above, the phase of decision making has been given particular attention, along with doctors' abilities to reason effectively with their patients. I refer to this ability as *healthy reasoning*, implying a set of communicative and relational skills based on valid reasoning, i.e. the ability to provide, in a licit way, reasons for taking action aimed at improving patients' health. It is important to stress the fact that also the reasoning practices used by doctors need to be *healthy*, in the sense that they should be logically valid and conversationally acceptable as opposed to manipulative practices.

1. The Relevance of *Healthy Reasoning* for Active Ageing and Healthy Living

The outline of a model that can effectively explain and predict the features of an optimal doctor-patient interaction in chronic care seems particularly important in view of the huge challenges health care providers will have to meet in the coming years.

The ageing of the European population and the complexity this will imply for social and health systems are being stressed more and more frequently. The European Commission foresees that "by 2025 more than 20% of Europeans will be 65 or over, with a particularly rapid increase in numbers of over-80s. Because older people have different healthcare requirements, health systems will need to adapt so they can provide adequate care and remain financially sustainable" [10]. The major burden on health systems and on the ageing population is the presence of multiple chronic conditions, which can have high clinical impact and lead to lethal outcomes if not managed properly. Diabetes, along with cardiovascular diseases, cancer, chronic respiratory diseases, and mental illness, represents one of the leading causes of mortality in developed countries [10].

According to the International Diabetes Federation, the most important risk factors for type 2 diabetes[2] are: unhealthy diet, physical inactivity, high blood pressure, and increasing age. Policy programs are rightly focused on prevention and early diagnosis, but once the disease has been diagnosed, it is crucial to work with patients on the prevention of complications. These range from cardiovascular diseases, to blindness, kidney failure and lower limb amputation [11]. Especially the treatment of these conditions is extremely expensive for health systems, seriously impairing for the individuals, and particularly problematic for elderly citizens.

To prevent complications, patients and doctors together can work on three areas: pharmacological treatment, nutrition, and physical activity. The combination of these three elements can be tailored on the specific needs of each individual patient, but in all cases diabetes requires patients to change certain habits and lifestyles. Patients also need to learn to monitor their condition by using the glucometer and to interpret the values they measure through the glucometer in order to be able to take action in case of acute episodes, such as hypo- or hyperglycemias. These are no easy achievements, especially in old age, when certain routines have become consolidated and learning new skills requires greater efforts.

In the case of chronic conditions, and diabetes in particular, the pivotal opportunity for patient engagement in view of preventing complications and creating the conditions for a higher quality of life is the medical encounter. In spite of this, chronic care doctors keep lacking adequate training to manage this crucial moment appropriately and the effectiveness of consultations is still largely resting on doctors' individual skills, charisma or non-canonical education [12].

Factors such as an ageing population, the necessity for health systems to become more sustainable, and the growing incidence of chronic diseases, make it crucial to develop new models for the interpretation of the evidence we have and for the development of innovative training modules for chronic care doctors. The projects described in the following section have been designed and developed to contribute to this line of research.

[2] There are two kinds of diabetes, called type 1 and type 2. The former is usually diagnosed at a very early age and its causes are still not clear; the latter typically arises in adulthood and is normally associated with unhealthy lifestyles. The projects described in this contribution both focus on type 2 diabetes.

2. Our Actual Research Activity

In what follows I describe two research projects – the first already concluded and the second just begun – developed in the field of medical communication, with a special emphasis on communication styles and argumentation strategies in a chronic care setting.

2.1 The "Doctor-Patient Communication Project"

The "Doctor-patient communication project"[3] is a pilot study that stemmed from an interest for communication in institutional settings, in particular in the context of the medical encounter between doctors and patients[4]. This kind of study implies necessarily an interdisciplinary approach: it was possible for me to design and carry out this project thanks to the collaboration with the medical staff at the diabetes outpatient clinic of the A.O. I.C.P. – Cusano Milanino[5].

As already mentioned, it is particularly important for elderly chronic patients to be involved and actively engaged in the management of their disease. This is particularly true for diabetes, which is constantly increasing also among the Italian population with skyrocketing costs for the health care system[6].

The aim of the "Doctor-patient communication project" was to provide a description of the most frequently used argumentation strategies in the medical encounter in diabetes care, in order to arrive at a proposal for a method of analysis of these interactions that would allow to identify critical or suboptimal situations and provide indications for improvement. Due to the small sample of collected data, the project did not aim at representativeness; rather, it was meant to provide a sound methodology that could then be applied to bigger numbers.

2.1.1 Material and Method

The research questions guiding the design of the project are the following: how and when do doctors use argumentation during the encounters with their patients?; what kind of arguments do they use most?; are these arguments effective in achieving the intended goal of the consultation or of a specific phase in the consultation?; is it

[3] Project website at: https://sites.google.com/site/docpatcommpro/.

[4] The project was actually the output of a few years of observations conducted on a sample of videorecordings from the Archive of Videorecordings of Medical Consultations, collected by the research group of Clinical Psychology, University of Milano (San Paolo Hospital) [13]. Publications referring to these intial observations are [14-18].

[5] The Azienda Ospedaliera [health care facility] Istituti Clinici di Perfezionamento (I.C.P., http://www.icp.mi.it/home) includes four hospitals and a number of outpatient clinics in the city of Milano and sorrounding areas. The project was approved by the Ethical Committee of the I.C.P. in January 2012.

[6] In addition to the facts concerning diabetes in Europe, the Italian Barometer Diabetes Report 2013 shows that, between 2000-2012, the percentage of diabetes in Italy has passed from 3.7% to 5.5%. Diabetes takes up 9-10% of the Italian health care system's budget. On average, the health care system spends 2,600 euros every year for each Italian diabetic patient, more than double the expense for other citizens of same age and gender, but not affected by diabetes. Only 7% of this expense is for anti-diabetes medications; 25% of it covers the cost of therapies for complications and related pathologies, and much more is related to hospitalizations and ambulatory care [19]. These data have already increased if compared to the 2012 Report [20] and they suggest that the costs of diabetes will be reduced by preventing complications and the hospitalizations connected to them.

possible to 'measure' the impact an effective use of argumentation has on patient outcomes?

The project has run from March 2012 through March 2014 with the collaboration of the medical staff at the diabetes outpatient clinic of the A.O. I.C.P. – Cusano Milanino. We selected randomly 20 patients among the ones already assisted at the clinic: 10 men and 10 women affected by Type 2 Diabetes Mellitus, whose ages ranged between 60 and 90. We obtained an informed consent from all the patients involved in the study and from all the members of staff at the clinic. Every time the recruited patients came in for a visit, their encounter with the health care providers was videorecorded. This resulted in an uneven distribution of the recordings for each patient[7]. The recording went on for 21 months and resulted in a collection of 60 videos, for a total of about 1.800 minutes of recorded material.

The interactions were analyzed by identifying all the argumentative phases and by describing the argumentation schemes [21-24] that were used by the medical staff.

2.1.2 Results

Regarding when and how health care providers used argumentation with their patients, the results are summarized in Table 1.

Table 1. Argumentative practices in the diabetes consultation.

Research questions	Results
When is argumentation used?	**Phases**: patient education and counseling (which includes: discussion of self-monitoring and evaluation of patient outcomes) **Topics**: patient non-adherence incorrect performance of self-monitoring patient negative outcomes
How is argumentation used?	**Who**: mostly health care providers **How**: mostly, argument from consequences or argument from cause to effects

As shown in Table 1, argumentation is used mostly during the phase of patient education and counseling[8], in which the health care providers consider and evaluate the quality of patients' adherence to treatment, self-monitoring of blood glucose and overall lifestyles. Those who actually use argumentation are mostly the health care personnel. When used, argumentation aims at providing reasons for adopting healthier behaviors, for improving adherence to therapy, or for performing the self-monitoring more accurately. Typically, argumentation is defined as a mode of discourse aimed at resolving a difference of opinion regarding the acceptability of a standpoint, in which

[7] Four patients were recorded two times; three patients were recorded three times; seven patients were recorded four times; two patients were recorded five and six times respectively. Of the remaining four patients, three dropped out and for the last one, we missed his subsequent visits due to organizational problems.

[8] For the denomination of the phase of the consultation, I am relying on the description provided in [25], where the typical medical visit is described as a five-phase sequence: opening, the history, the physical examination, patient education and counseling and the closing.

two or more parties put forward proposals and discuss them in order to decide which standpoint is the most reasonable [26]. The case of the medical visit resembles closely the deliberation dialogue type [22], in which two (or more) parties discuss to arrive at a decision regarding a certain course of action. What is striking about the argumentative passages in the collected data is that there is little or no discussion. Health care providers tend to observe incorrect behaviors or bad clinical values and start sometimes rather long argumentations in which they try to convince the patient that it is preferable to do certain things or to do things otherwise. Patients often remain silent, sometimes they offer justifications for their behaviors, other times – but seldom – they attempt to put forward a proposal of their own.

The argument schemes mostly used by doctors are those from consequences or from causes to effects [24]. Albeit being valid arguments, the problem with the use of these schemes is that health care providers often ground them on specialized knowledge, which may not always be completely shared by the patients. Another challenge posed by the argument from positive/negative consequences is the definition of what is considered 'good' and 'bad' by the interlocutors: when using this argument scheme it is very important that both parties agree on what is preferable, but this does not always happen in the analyzed interactions.

Concerning the issue of the correlation between the use of argumentation strategies and patient outcomes, as already mentioned recent studies highlight the difficulty of establishing clearly such correlation (among others, [5, 8-9]). Part of the difficulty derives from the concept itself of 'patient outcomes', which may include: adherence to treatment (a behavior), health (the consequence of certain behaviors, such as adherence to treatment or to healthy lifestyles), and satisfaction [27].

Of these three very different dimensions, perhaps the only one that can have a direct correlation with the use of argumentation strategies – i.e. reasoning – is adherence to treatment. As the whole tradition of rhetoric and argumentation theory shows, the correlation between reasoning and behavior change has to do with commitment. In other words, the more reasoning is able to impact on commitment and motivation, the more it is likely for behavior change to happen and to become permanent. Also the medical literature has observed this connection in relation to the phase of shared decision making (also called, collaborative goal setting) in which positive health outcomes seem to happen more frequently when doctors and patients decide together on what the patient needs to do and on the goals they have to achieve [1, 3, 8, 9].

Another important correlation highlighted in the literature is the one between communication styles and patient self-efficacy, defined as patients'confidence in their ability to complete self-management practices [5]. Healthy reasoning can come into play also in this correlation as the ability to help patients bring to light their difficulties and turn them from failures into challenges.

My observations regarding the correlation between argumentation and patient commitment and self-efficacy are summarized in Table 2.

Table 2. Correlations between argumentation and patient commitment and self-efficacy.

Triggers for behavior change	Results from the data
Patient commitment	Patients seldom participate in the phase of decision making regarding what actions to take until the next visit. A true phase of shared decision making is actually often lacking during the encounters.
Patient self-efficacy	Doctors and staff never use shame, sense of guilt or fear as behavior triggers. They also stress patients' achievements and tend to minimize their failures.

2.1.3 Discussion of Results

The results of the analysis combined with individual interviews conducted with the staff at the clinic revealed that doctors and medical personnel are not always aware of the potential of communication as an actual therapeutic tool, but at the same time they perceive the need for specific training in communication. The biggest challenge they reported was the difficulty of achieving patient engagement.

The use of scientific information by health care providers shows a strong influence of scientific thinking on the way they conduct their consultations with the patients. In other words, many times the interactions look like a conflict between rational and irrational modes of thinking. This is also revealed by the use of the argumentation schemes from negative/positive consequences and from causes to effects, which do not always obtain the expected responses from patients because the value hierarchies used by the interlocutors are very different.

The right preoccupation with saving patients' face by not insisting on their failures or poor results sometimes seems to leave health care providers unable to help patients describe fully and clearly the difficulties they had with treatment or self-monitoring and that might have caused their non optimal outcomes.

Finally, a significant observation regards the fact that a phase of shared decision making is almost always lacking in the encounters. Usually, doctors and staff tend to unilaterally suggest a proposal for action, which is generally accepted by patients. This kind of dynamics however needs to be improved if better patient commitment is to be achieved. It is also interesting that during the individual interviews with the doctors and staff no one reported perceptions of difficulties during the phases of decision making. Regarding this point, a paper has been submitted to a scientific journal, proposing a theoretical model of the decision making phase in the medical consultation. This model can be used as an analytical tool to identify cases of inappropriate management of the decision making phase, and at the same time it can become a normative tool for the training of medical personnel, by indicating the necessary elements to construct a truly shared decision making process with patients [28].

2.2 "Healthy Reasoning. Strategies and Mechanisms of Persuasion in Chronic Care"

The observation of the frequent disalignment between doctors and patients during the argumentation phases of the encounters was the trigger that led to the design of the "Healthy Reasoning" project. This proposal was submitted in early 2013 to the Italian Ministry for University and Research and received final approval in October 2013 for a period of three years. The project could begin in March 2014 and is now in its initial

phases. The aim of this research is to understand whether it is possible to integrate heuristic techniques in a long-term argumentative strategy, like the one chronic care doctors should pursue.

Within argumentation theory, recent studies have focused on the medical context [29-32], showing relevant research directions but without developing analytic models and criteria specifically related to the context of chronic care. On the other hand, a wide research trend describes a particular kind of arguments, called heuristics, that are probabilistic and presumptive [22; 33]. Important studies have shown that heuristics can contribute to modifying radically individuals' behaviors [34-36]. Moreover, experiments, which have inspired the ones that will be pursued in this project, have shown the clinical advantages of teaching health care professionals communication skills tailored on their therapeutic objectives [37]. Taking these studies as my starting point, my aim is to apply them to the context of chronic care to test the appropriateness and usability of certain heuristics.

In order to do this, the project foresees to carry out an experiment in which a sample of doctors will be recruited and taught certain heuristic techniques. They will be asked to use them with their patients for a limited period of time and the effects of this new communication style will be tested through questionnaires submitted to the doctors, and through personal interviews with the patients. The experiment will be run in two subsequent rounds with different but comparable samples of doctors in order to validate the results. The recruitment of the doctors will be possible thanks to the collaboration with the Italian Association of Diabetologists[9].

The observation underlying this project is that doctors' present training does not provide them with a complete set of 'communicative tools' to cope with different dialogical situations. If the provision of minimal specialized information to patients is necessary and unavoidable, it is also true that sometimes this is not sufficient to trigger crucial and needed behavior changes in patients. Arguing from specialized knowledge is not always the solution, because this kind of knowledge may be too difficult to process, sometimes it is presented in ways that are cognitively not easily accessible and it may not take into consideration other aspects of patients' lives that have nothing to do with agreeing or not with the doctor's point of view.

One important focus of the project will be in particular to understand how to enhance elderly patients' commitment to the chosen course of action, in order to turn new positive behaviors into permanent habits.

3. The Practical Value of Research on Healthy Reasoning for Active Ageing and Healthy Living and Future Developments of the Research

The research presented in this contribution is expected to yield important results that can be used to design communication protocols for clinicians working in chronic care and with elderly patients. In part, this is already happening.

The collaboration with the diabetes clinic in Cusano Milanino has continued after the conclusion of the "Doctor-Patient Communication Project" and, based on the project's results, together we are designing a new experiment to test the usability and effectiveness of strategies for the enhancement of clinicians' ability to conduct more effective shared decision making phases with their patients during the medical

[9] Associazione Medici Diabetologi (AMD), www.aemmedi.it.

encounter. This is particularly aimed at improving the engagement of elderly patients, who can less frequently be supported by telemedicine due to their often poor familiarity with ICT.

A further application of the results of the project conducted in Cusano Milanino is the development of an application for tablet and smartphone aimed at supporting patients' motivation and engagement in every day life. The variety and quality of applications for tablets and smartphones specifically tailored on the needs of chronic patients are increasing every day and their effectiveness is unquestionable [38]. We are studying the design of a prototype of application for tablet and smartphone particularly aimed at supporting diabetes patients aged over-65 in the prevention of complications and adherence to treatment.

Also the collaboration with the group of Clinical Psychology at the University of Milano has continued[10]. Together we are testing a theoretical model for the dialogical analysis of medical encounters in chronic care. We expect to arrive at initial indications for clinicians regarding optimal ways to manage the crucial phases of their consultations with the patients, namely: clinical decision of therapeutic treatment and patient engagement and counseling. The collaboration with this research group is particularly promising because of their specific interest in the enhancement of communication in the clinical practice also through courses taught as a post graduate continuing medical education and undergraduate training at the School of Medicine, Dept. of Health Sciences, University of Milano.

New collaborations are also developing with researchers and clinicians working on other chronic diseases such as: kidney disorders, hemophilia and epilepsy. The aim of these collaborations is to work together towards shared communication protocols for the improvement of clinicians' communication skills in chronic care, thus improving elderly chronic patients' engagement and quality of life.

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[10] An important product of this collaboration is the paper that has been accepted as oral presentation at the 12th International Conference on Communication in Healthcare (ICCH), September 28-October 1st, 2014, Amsterdam [39].

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