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The age of ageing.

Behavioural medicine and its contribution to precision
medicine in the context of elderly patients.

Bachelorthesis

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Abstract

Ageing trends show that in the following years global population will become more and more old. This structural change brings many consequences with it. To address this issue in the best possible way, it is necessary to ensure that old people can live a healthy and productive life even at older life stages. To achieve this, interventions that are specifically targeted for old people are needed.

This thesis explores the ageing trend, the definition of health in old age, and the interventions that promote it. In particular, the thesis focusses on behavioural and precision medicine approaches, exploring the similarities and differences between these two fields. Finally, it makes a proposal on how the multidisciplinary that is characteristic of behavioural medicine could be helpful in the development of a more successful precision medicine approach.

Keywords: Ageing, Successful Ageing, Precision medicine, Behavioural medicine.

1. Introduction

As reported from the United Nations' Economic and Social Affairs Department (2020), population ageing is a global phenomenon. Reduced fertility and health improvement are the main causes that drive this change. By 2050 it is expected that worldwide there will be 1.5 billion people aged 65 years or older, and 426 million people aged at least 80 years. This demographic change brings many social and economic consequences and considerations with itself; it is responsibility of the society and in particular of the health system to ensure that this growing population cohort can live a healthy and fulfilling life – the question is, how can this outcome be granted?

To answer this question, many theories and practical studies have been postulated and conducted (for example WHO, 2017, 2020, 2021; Fernández-Ballesteros, 2019; Rudnicka et al., 2020). Fernández-Ballesteros and Sánchez-Izquierdo's (2019) study about the elderly focuses on two main issues. The first one deals with a definition of health in old age. The authors explore how descriptions have changed over time and conclude that "active ageing" is the term they will use in their paper, as this encompasses all the relevant aspects they want to focus on. The second issue refers to the debate about determinants of ageing. The authors report that many definitions and studies merely focus on genetic or on environmental components, but few of them take into consideration the combination and the reciprocal influence of them.

The mutual influence between environmental and genetic factors is an important theme not only when associated to active ageing, but also in the general fields of precision and behavioural medicine. The National Institute of Health defines precision medicine as an

"Emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment, and lifestyle for each person" (<https://ghr.nlm.nih.gov/primer/precisionmedicine/definition>, 2015, last accessed 03.12.2021).

Environmental factors should therefore be relevant in the development of a precision medicine approach to a certain disease or patient, but still, nowadays most of the studies that use a precision medicine approach only focus on a molecular level, like for example cancer research and treatment (Pitini, Adamo, Gray, and Jani, 2020).

On the other hand, the International Society of Behavioral Medicine (ISBM) in 2020 has updated the definition of behavioural medicine. Behavioural medicine is therefore nowadays defined as

“A field of research and practice that builds on collaboration among multiple disciplines. These disciplines are concerned with the development and integration of behavioral and biomedical knowledge relevant to health and disease. [...] This knowledge is applied to prevention, health promotion, diagnosis, treatment, rehabilitation, and care. The scope of behavioral medicine is broadly inclusive of behavioral and biomedical science as well as clinical and public health practice”. (Dekker et al., 2020, p. 3)

This long definition aspires to “understand and integrate current cross-cultural and cross-disciplinary perspectives on behavioral medicine in a global context” (p. 2); notice that both environmental and individual factors are taken into consideration.

The purpose of this thesis is to discover to what extent behavioural medicine methods can contribute to improving precision medicine in the context of prevention and intervention programs specifically targeted for elderly people. To explore this subject, this thesis will be structured as follows: a first section will be dedicated to definitions. A definition of health and disease in old age will be given, exploring the many definitions that exist, like for example “successful-“, “active-“, “productive-“ and “healthy ageing“. Consequently, precision medicine and behavioural medicine will be introduced: the history of their definitions, pros and cons, methods, current application, and possible future uses. Based on these definitions, the thesis will focus on the state of research regarding existing studies which target old participants. The final part will be a discussion, where important points will be

summarized, leading to a conclusion regarding the contribution of behavioural approaches and methods to the precision medicine field, and how future work could be developed.

Each one of these topics would require a thesis of its own to be fully analysed. The focus of this work is that of bringing these three themes together and explore how they are connected and how each one of them influences our understanding of the two others. The chapters about precision and behavioural medicine will focus more on definitions and present-day theories, whereas the theme of aging will be dealt in a more practical way, focussing on interventions and real-world objectives. It is important to remember that the aim of the thesis is to explore theoretical and practical approaches of both kinds of medicine, in the context of an ageing population.

2. Towards an older future

Global population ageing is a reality and should be considered a result of the successful implementation of public health, medicine, economic and social development and their contribution to health improvement (United Nations' Economic and Social Affairs Department, 2020). Every country in the world is experiencing this phenomenon, where both size and proportion of older citizens is increasing (United Nations' Economic and Social Affairs Department, 2020). The next subchapters will explore this trend, its implications and how these can be addressed.

2.1. Ageing trends

The United Nations and other researchers commonly use chronological age to define who should be considered an "old person": people aged 60 or 65 years or older are considered "old" (United Nations' Economic and Social Affairs Department, 2020).

The statistics given by the United Nations' Economic and Social Affairs Department (2020) depicts a trend that will not stop in the next decades. In 2019, globally there were 703 million people who were 65+ years old. This number is projected to double by 2050, when there will be an estimate of 1.5 billion people aged 65 or over. This means that in 2050, one in six people worldwide will be aged 65 or over. Respectively, in 2019 there were 143 million people aged 80 years or over; this number is projected to triple until 2050, meaning that by 2050 there will be around 426 million people aged 80 years or older. Notice that the number of people worldwide who are aged 80 years or over is growing faster than the number aged 60 years or over (United Nations' Economic and Social Affairs Department, 2020).

2.2.The impact of an ageing population

These chapters will examine how global population ageing impacts several important aspects of everyday life. The demographic trends described in chapter 2.1. will bring a structural change. The health and economic system, and society as a whole, must be ready to adapt to this expanding cohort of citizens.

2.2.1. Politics and society

A structural change like the one of population ageing has many consequences, both for the individuals that are growing older, and for the people who interact with them.

A sign that the health and well-being of the elderly is taken into consideration at a global level can be seen for example in the 2030 Agenda of Sustainable Development: Goal number three is “Ensure healthy lives and promote well-being for all at all ages” (<https://sdgs.un.org/goals/goal3>, 2016, last accessed on 03.12.2021), and one of its concerns it’s the “Promotion of lifelong health and preventive care to maintain maximum functional capacity of individuals” (United Nations’ Economic and Social Affairs Department, 2020, p. 36). With this kind of goal, global attention about the issue can be driven, and both governments and people become more aware of the importance of addressing this issue.

People can adapt to population ageing in many ways: behavioural changes like an increased rate of savings, frequent more years of education, and work for longer years (Bloom, Canning, and Lubet, 2015). And in order to achieve these changes and prepare citizens of all ages, a common work is needed.

2.2.2. Health System

The health system takes care of people of all ages, during their entire lifespan. Nearly one quarter of the world’s burden of disease is attributable to illness in adults aged sixty and

over (Prince et al., 2015). It is a common misconception to think that the elderly need more treatment and care, but the correlation between health and age is not so obvious, and the access to treatment and care should not be based on chronological age alone (Prince et al., 2015).

In 2017, the World Health Organization (WHO) reported that “Unfortunately, there is little evidence to suggest that older people today are experiencing better health than their parents did at the same age” (p. 3). Especially in low-income countries, a dangerous trend is to be observed: as people grow older, they need more medical and social assistance, but they get least access to this kind of resources (WHO, 2017). This situation calls for aid both in the health and the political system, to ensure that access to meet health standards is provided to all the population.

A problem with the majority of diseases that often affect the elderly is that they are noncommunicable diseases, such as “cardiovascular problems, cancer, chronic respiratory diseases, musculoskeletal conditions, and mental and neurological disorders such as Alzheimer’s and dementia” (Prince et al., 2015, p. 549). Chronic conditions like these have a huge impact on patients’ life and on the health system.. Interventions that focus on healthy behaviours and environment can be effective in preventing or delaying the negative consequences of such diseases (WHO, 2017). Personal and social engagement are also of significative importance, as

“Even if chronic diseases do emerge, their consequences can be limited through integrated care to strengthen and maintain capacity or reverse declines. And for people with significant declines in capacity, supportive environments can promote dignity, autonomy, functioning and continued personal growth” (WHO, 2017, p. 4).

For these reasons, the health system should promote health at all ages, and during the late stages of life it should not only focus on diseases and their treatment, but rather prioritize the overall health of the older person as a whole (Beard, Officer and Cassels, 2016). This

requires an accurate study of every patient, to understand the physical, psychological and environmental factors that are influencing the health (and the unhealth) of this particular patient at this particular moment.

Moreover, to promote a long-term well-being of old citizens the healthcare system should provide interventions that are appropriate for the age and the individual history of every patient, and the focus should be this of maintaining the intrinsic capacity of older people, rather on the cure of diseases once they appear (United Nations' Economic and Social Affairs Department, 2020).

2.2.3. Economy

“Population ageing is having a profound impact on all sectors of economy, including labour markets, financial markets, demand-side of economics in terms of goods and services needed for their age (housing, transportation, leisure) up to social protection and the like. population ageing is having a profound impact on all sectors of economy, including labour markets, financial markets, demand-side of economics in terms of goods and services needed for their age (housing, transportation, leisure) up to social protection and the like” (Bokanic, 2017, p. 1007).

Old people still need to consume to survive, meaning that they need money to purchase the goods or services they need. Elderly consumption is financed mainly by three processes: 1) public transfers, like for example taxes introits that ensure pensions and health care; 2) private transfers from family members or other private sources; 3) asset-based reallocations, that involve two kinds of flows: older people's personal savings, and own labour income (United Nations' Economic and Social Affairs Department, 2020).

Elderly people still are part of society, and as they grow older their role of consumers in the economic system becomes increasingly stronger than that of producers. The United Nations' Economic and Social Affairs Department (2020) explains how this consumption is financed. To finance consumption in high-income countries, mainly public transfers and personal

savings are used. Public transfers are especially high in Europe and Latin America, and therefore old people who live there do not have to continue working in old age to secure additional income. These mechanisms could be a problem in the future: “In countries where public transfers are high, including many in Europe and Latin America, population ageing will increase the fiscal pressure on public transfer systems, especially if current patterns of taxation and benefits remain unchanged. In countries where public transfers are relatively low, such as in many countries of Southern Asia and South-Eastern Asia, individuals and families are under pressure to find means of financing consumption at older ages” (United Nations’ Economic and Social Affairs Department, 2020, p. 4). How countries will address this issue depends on various factors: how much can taxes be implemented; if the majority of the population agrees on capital redistribution and equity across different generations; and how is financialization at older ages seen in society: who should be responsible for it? (United Nations’ Economic and Social Affairs Department, 2020).

A possible solution, proposed by Bloom et al. (2015), would be to “adjust human resource protocols and implement technological innovations to assist and incentivize older workers” (p. 87). In this sense, old workers would still be able to participate in the economic system as active producers, and labour income could remain an important financial aid for the workers.

2.3. What is to be expected

The sections above depicts the image of a future where an ageing population can be seen both as a resource and as a problem. A key factor that will determine how much the elderly will contribute to society in the following years is health. If old people are given the opportunity to participate in the social and economic system, they must be able to do it in good physical and mental health. If instead, old age will be characterized by reduced abilities and an increased need for aid, the following decades will put our societies and health systems

under a huge pressure (Beard, Officer & Cassels, 2016). For this reason, societies need to implement “a coordinated response from many sectors and multiple levels of government to create age-friendly environments (housing, employment, transport, and social protection) to facilitate the ability of older people to age in a place that is best for them and to do what they value” (Beard, Officer & Cassel, 2016, p. 164). To achieve this goal, a change in the values we connect with old age is needed. Beard, Officer and Cassels (2016) emphasize how models of health care should focus on the maintenance of health and the functioning of old people as a whole, instead of only reacting to diseases once they have appeared. It is also important to consider the environment, the psychological and the physiological conditions that influence the well-being of the person as a whole (Beard, Officer & Cassels, 2016).

3. Successful ageing

Chapter 2. depicted a trend that needs to be addressed. To ensure that successful strategies and interventions can be developed, a definition of health in old age is needed. The question of what should be considered a “healthy old person” has a long history, and many institutions and authors engaged in giving a definition (for example WHO, 2002/2012; WHO, 2017; Fernández-Ballesteros, 2019; Rudnicka et al., 2020; Fernandez-Ballestros and Sánchez-Izquierdo, 2019). The following sections will explore the history of the term, and then focus on the most relevant influencing factors for a correct definition.

3.1. Definition and concept

Fernández-Ballesteros summarized the history of the term in his paper “The Concept of Successful Ageing and Related Terms” (2019). The history of the definitions began in 1972 with Neugarten, who first postulated the idea that successful ageing was a multidimensional process, and that personality played an important role as a determinant of it (Fernández-Ballesteros, 2019). The next decades are filled with new authors and definitions, that span from “successful-” to “healthy-” to “productive ageing”. Starting in the late 1990s, the WHO started to use the term “active ageing”, that was defined as

“[active ageing is] The process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age”
(WHO, 2002/2012, p. 12).

This definition aims to include many important aspects of life, not just physical activity or participation in the labour force; instead, the term “active” refers to engagement in social, economic, cultural, spiritual and civic affairs (WHO, 2002/2012).

In 2017, the WHO re-evaluated the definition, and came back to the term “healthy ageing” (WHO, 2017). A key factor was included in the renewed definition: this of “functional ability”. The definition reads as follows

“Healthy Ageing is the process of developing and maintaining the functional ability that enables well-being in older age” (WHO, 2017, p. 4).

Functional ability is therefore an important determinant of ageing well, and it constitutes of two processes: the intrinsic capacity of every person – meaning the result of all physical, cognitive, and psychosocial abilities of the individual – and the environment in which every person lives – meaning the historical, geographical and social context. The interaction between these two factors is also a factor of importance (WHO, 2017).

Intrinsic capacity is often referred to when speaking of cellular and molecular health. When cells, tissues or entire organs are compromised, there is an increased risk of diseases, and a general decline in capacity (WHO, 2017). For these reasons, a molecular medical approach like the one used in the context of precision medicine is useful in determining the risks and possible outcomes for every patient. But WHO (2017) warns about generalization: molecular changes and degradation are “neither linear nor consistent, and they are only loosely associated with age in years” (p. 4).

At the same time, as said before, also environmental factors play an important role in successful ageing. Shift in social roles and positions can modify the psychosocial environment in which a person lives. It is therefore important to account for a healthy social setting, that can help older people in maintaining or improving their psychosocial health (WHO, 2017).

Moreover, the interaction between these two factors is an important determinant during all life span. Physical health is strongly influenced by the environment in which a person lives. At the same time, the relationship that every person has with the environment that surrounds him or her is determined by personal characteristics such as gender, race and economical status (WHO, 2017). In this sense, healthy ageing is “a process that spans the entire

life course and that can be relevant to everyone, not just those who are currently free of disease" (WHO, 2017, p. 4).

Gender is an example of a physiological determinant that influences both physical health and how the person interacts with the social environment: women generally live longer than men, but they overall experience poorer health during all life course, and live in poorer economical situations compared to men (WHO, 2017).

A key component of all these definitions is the multidimensionality they strive to achieve. Successful ageing is a process that has many determinants, and therefore cannot be used when referring to one factor only, for example in studies that focus on phenotypical changes, a particular disease, or in general to a single component (Fernández-Ballesteros, 2019). For this reason, Fernández-Ballesteros (2019) requires that

"[...] any study supporting a definition related with ageing well, in order to fulfil certain standards, should meet three essential conditions: be multi-dimensional, be assessed multi-domain/multi-method, and take into consideration both objectives and subjective conditions" (p. 15).

In his conclusions, Fernández-Ballesteros (2019) underlines how "healthy-", "successful-" and "active ageing" are not synonyms. Healthy ageing is not a multidisciplinary concept, but is rather reduced to biomedical aspects, while successful and active ageing are multidimensional definitions, that include physiological aspects, but also health and functionality. The author concludes that

"In sum, returning to the antecedents of positive gerontology, successful ageing seems to be a technical term fulfilling the objectives described by Rowe and Khan in 1987, by Fries in 1980, or by WHO in 2002. Without doubt, given certain limitations, the concept of successful ageing, under different terms, is at the core of the global movement of an ageing society hoping and demanding to age successfully, which requires individual's commitment to this goal" (p. 19, 20).

For this reason, in this thesis the term “successful ageing” will be used when referring to a goal of health at an old age.

3.2. Influencing factors

Successful ageing is influenced by many factors, that will be discussed in the following sub-chapters. Each of them focusses on specific physiological, psychological and social processes. Consequently, to achieve successful ageing in all societies, these aspects must be taken into consideration.

3.2.1. Health and functionality

A healthy lifestyle helps a person live until an old age, and is usually helpful to reach such age in good physical and mental health. According to various meta-analyses, the most determinant lifestyles are: regular physical exercise, healthy diet, no smoking and drinking moderate amounts of alcohol (Fernandez-Ballestros & Sánchez-Izquierdo, 2019; WHO, 2002/2012; WHO, 2015/2018). Such behaviours are learned during all life stages. This means that they are not innate, and that health is something that must be achieved through voluntary acts (Fernandez-Ballestros & Sánchez-Izquierdo, 2019).

Why should people follow healthy routines? According to Fernandez-Ballestros and Sánchez-Izquierdo (2019), individual psychological and intellectual factors play a key role in this context:

“[...] adherence to behavioral routines and/or interventions regarding health and promotion of healthy lifestyles is mediated by psychological and intellectual factors: the understanding of health literacy, self-efficacy or conscientiousness, as well as networks of social support (for a review see Berkman, 1995)” (p. 10).

For example, low understanding of health literacy seems to have a huge impact in all mortality causes, even after adjusting the results for socioeconomic status, baseline health and health behaviours (Fernandez-Ballestros & Sánchez-Izquierdo, 2019).

The World Report on Ageing and Health (WHO, 2015/2018) shows how patterns of life satisfaction in old age are not universal: in some countries old people report to be more satisfied with life than younger adults, while some countries report the opposite. The WHO (2015/2018) reconducted these differences to the diverse environmental characteristics in which people live. These are crucial when determining how old people experience their age.

To determine if a person is experiencing a healthy and happy life phase, the WHO (2017) relies on the definition of “healthy ageing” that was given in chapter 3.1. The concepts of intrinsic capacity and functional ability are therefore crucial. An important detail that WHO (2015/2018) wants to emphasise is that healthy behaviours like physical fitness and a healthy diet, play a powerful role in the maintenance of intrinsic capacity, rather than in the reduction of the risk of diseases.

The Report engages in the research of what factors influence the maintaining of functional ability across different countries. Results show that “intrinsic capacity in someone with a low socioeconomic position peaks at a far lower level than it does in someone with a higher socioeconomic position, and this differential is maintained across the life course” (WHO, 2015/2018, p. 66).

As an example, nutrition is an important element of a healthy lifestyle; various factors can influence how, what and how frequently a person eats. In the words of the World Report on Ageing and Health, “Malnutrition has also been associated with diminished cognitive function, a diminished ability to care for oneself, and a higher risk of becoming care-dependent. However, malnutrition in older age often goes undiagnosed [...]” (WHO, 2015/2018, p. 72).

3.2.2. Physical and cognitive fitness

Physical activity is important for various reasons during all life course, and can bring many benefits also in old age. For example, physical activity improves physical and mental health,

it reduces anxiety and depression, and helps improving self-esteem; it can help in preventing various diseases like diabetes, coronary heart disease and stroke; and it improves social activity, by increasing social engagement and care for social networks (WHO, 2015/2018).

Cognitive fitness also plays an important role. Fernández-Ballesteros and Sánchez-Izquierdo (2019) define an intelligent person as someone who “in a given situation, selects the most appropriate alternatives to provide a satisfactory solution” (p. 8). It is therefore no surprise that results collected since the beginning of longitudinal studies on ageing show that people with higher scores in intellectual abilities die later than those with lower results (Fernández-Ballesteros & Sánchez-Izquierdo, 2019). The authors underline the importance of cognitive abilities as a protective factor against death, saying that “Meta-analytic results showed that a 1-standard deviation (SD) advantage in cognitive test scores was associated with a 24% (95% confidence interval 23–25) lower risk of death, during a 17- to 69-year follow up. The intelligence–mortality association was similar for men and women. SES does not seem to influence the intelligence-mortality association” (p. 8).

3.2.3. Affect and control

Emotions can play an important role as protective or risk factors. Fernández-Ballesteros and Sánchez-Izquierdo (2019) compare the role of negative and positive affect on self-reported health. The results they sum up show how negative affect is a risk factor for mortality and diseases, because it negatively influences both physical and psychological health. On the other hand, positive affect and general well-being are protective factors against mortality. Together, negative and positive affects account for 46.1% of variance in the self-reports of health. The impact that these emotions play on health is stronger in countries with low Gross Domestic Product (Fernández-Ballesteros & Sánchez-Izquierdo, 2019).

Another important emotional process, that plays a crucial role in the motivational field, is personal control. Personal control “reflects individual’s beliefs regarding the extent to which they are able to control or influence outcomes” (Fernández-Ballesteros & Sánchez-Izquierdo, 2019, p. 8). It is important, because it strongly influences behaviour, and therefore health. In the words of Fernández-Ballesteros and Sánchez-Izquierdo (2019):

“Positive attitudes and beliefs of control seem to influence the kind of behaviours necessary for adherence to stimulating mental activities and healthy behaviours for cognitive ageing (e.g., adherence to physician regimens and exercise programs, being active in everyday life). Moreover, high self-efficacy, the individual’s belief that he or she is capable of achieving a desired goal in a particular situation (e.g., Bandura, 1978) and high personal control, the individual’s beliefs about his or her control or influence in the outcomes (Skinner, 1996), strongly influence engagement in behaviours with effects on everyday functioning (Hertzog et al., 2008).” (p.8)

The last correlation between emotional processes and health outcomes that Fernández-Ballesteros and Sánchez-Izquierdo (2019) analyse is conscientiousness. More conscientious people have a lower risk of encountering health problems; in fact, they benefit from their behaviour.

3.2.4. Social participation and engagement

Humans are social animals, and therefore social relations are important over all life course. Fernández-Ballesteros and Sánchez-Izquierdo (2019) report how “the association between social relationships and the prevalence, incidence and recovery from disability has been well established. Results have yielded a robust cross-sectional association between social engagement and disability; more socially active persons reported lower levels of disability than their less active counterparts” (p. 10).

The World Health Organisation (2017) in its Global Strategy and Action Plan has developed a strategic objective that specifically focusses on enabling older people's engagement. The WHO finds this objective important, claiming that old people can be relevant in various social and economic activities. Older people are still part of the economic system as workers and consumers, and socially they play an important role as mentors for peer and younger people, within their families or not. To achieve this goal, the WHO promoted investments in community groups specifically targeted for older people. These groups can help older adults to engage in social activities, to give and receive help, and can also be very helpful in service delivery, as they can help in

“[...] identifying older people at risk of isolation and loneliness, providing information, peer support and long-term care, and ensuring that older people have the opportunity to continually build and maintain the skills they need to navigate, benefit from and influence a changing world” (p. 12).

4. Precision medicine

In the following sections a definition of precision medicine will be given, as long as an overview of its current application in medical issues, and the advantages and disadvantages of it. The aim of this chapter is to understand what precision medicine was originally intended to be, and to discuss how future medical and psychological fields could profit from such an approach.

4.1. A definition of precision medicine

The definition of precision medicine that was given in the introduction stems from the National Institute of Health (2015). According to that definition, precision medicine should integrate many different aspects: individual variability in genes, environment, and lifestyles. Always the National Institute of Health (2015) describes how such an approach should help researchers and the health system to precisely design interventions and predictions for specific cohorts of patients and diseases. In this sense, precision medicine is “in contrast to a one-size-fits-all approach, in which disease treatment and prevention strategies are developed for the average person, with less consideration for the differences between individuals” (National Institute of Health, 2015).

4.2. Current application of precision medicine

“[the primary goal of precision medicine is] To discover treatment rules that leverage heterogeneity to improve clinical decision making in a manner that is reproducible, generalizable, and adaptable as needed” (Kosorok & Laber, 2019, p. 280).

Even though this definition reflects a multidisciplinary approach, precision medicine is in practice widely used as a method that focusses on individualised genetic information (Pitini, Adamo, Gray, and Jani, 2020). This happens for various reasons. The first one is the high price of genomic technologies (Pitini et al., 2020). The second reason is that environmental and genetic factors are more difficult to modify (Pitini et al., 2020).

On the other hand, lifestyle habits are easier to change. Pitini et al., (2020) summarize the findings of Thomson, Camic and Chatterjee (2015)

“There are many examples of social prescriptions supporting management and prevention of chronic conditions through healthy living initiatives, e.g. healthy eating, physical activity and smoking cessation. Examples include exercise prescriptions, where patients are referred to supported exercise programmes, such as cycling, guided healthy walks, dance classes and team sports; and green activities prescriptions, such as gardening, horticulture, and walking in parks. The benefits of these prescriptions go far beyond the expected physical health improvements and cardiovascular diseases prevention. They allow people to learn new skills; structure their day; improve self-esteem, mood, socialisation and cognitive functioning, and thus also address mental health and general wellbeing. Moreover, specific social prescriptions have been developed to address non-classical lifestyle needs through initiatives such as arts on prescription, i.e. creative activities such as drama, film, music, painting and photography; and books on prescription” (p. 311).

To achieve the goal of implementing prevention and intervention programs targeted to specific patients or diseases, precision medicine needs a lot of data. Data is then analysed using statistical methods like the ones described by Kosorok and Laber (2019). To develop such statistical models, a strong scientific basis is needed. This knowledge requires a lot of work and time, and therefore the methods of precision medicine are difficult to apply (Kosorok & Laber, 2019).

4.3.Pro and Cons of precision medicine

Precision medicine is a rather new method, as the Precision Medicine Initiative was founded in 2015, and therefore its pro and cons are still being discovered and discussed.

One benefit of precision medicine is that it exists in a well-connected world. Data from a large number of patients can be collected, and doctors from all around the world can recognize a rare pattern or similar symptoms in patients when comparing their data to a large dataset (Ashley, 2015). In such cases, doctors can deliver targeted therapies and interventions to patients with novel syndromes (Ashley, 2015).

But these encouraging results must be analysed in perspective. Cutler (2020) reports that

“Surprisingly, at this point, personalized medicine has had less effect on both health and medical spending than either its strongest backers hoped or its most apprehensive actuaries feared. Oncology has been the primary focus of precision medicine [...] and yet, the overall effect of precision Medicine on care for patients with cancer has been modest. [...] Only 8% of patients with cancer are eligible for precision medications approved as of January 2018 and only 5% would actually benefit from them. Even among patients who respond, incremental survival provided by many drugs is measured in months” (p. 109).

Another point to take into consideration is the price of such a medical approach. The production of precision medicines is expensive. Doctors, and consequently patients, must pay a higher price for them, and that approach could discourage its use (Cutler, 2020).

A final remark from Kornigiebel et al. (2016), is that precision medicine is largely based on genetic data. Most of that data stems from subjects who come from northern Europe, and therefore could not be representative for patients who come from different populations.

4.4. Future applications

Despite all the theoretical benefits, the use of precision medicine in everyday healthcare system is not so broad. To achieve a more comprehensive use of it, numerous steps are to be taken.

One example is the implementation of research on human genome, that could be a huge help in the development of precision medicine (Ashley, 2015). To address the issue of genomic variance, this data should be gathered from people all around the world, with different ancestors and living conditions. In this sense, a comprehensive precision medicine approach should be developed, where “research and interventions on genes, environment and lifestyle can work in synergy” (Pitini et al., 2020, p. 312).

In particular, precision medicine should be applied in primary care (Pitini et al., 2020), because the people who work in that field are the first who get to know a patient’s specific genetic, behavioural, and environmental characteristics. In this sense, operators who work in primary care should receive a training that enables them to

“assess each individual’s biological and social background, understand how they influence the individual’s health status and use this information to provide tailored interventions. Moreover, they should learn how to coordinate the collaboration between individuals, families, community, government, other levels of care (i.e. specialist care, screening programmes, etc.) and all the other sectors needed to provide comprehensive care” (Pitini et al., 2020, p. 313).

Korngiebel, Thummel and Burke (2016) discussed the ethical considerations of precision medicine’s implementation. One important decision that researchers need to make is about certainty. When can researchers and doctors feel confident enough of a new precision medicine to introduce it in their practice? To reach a conclusion, the decision must be a result of a systematic process, and enough evidence must be gathered.

Another ethical concern, discussed by Korngiebel et al. (2016), is this of patient choice. To make an informed choice, patients need to be aware of the effect and possible outcomes of the usage of precision medicines. Doctors and patients should come to a shared decision. To gain enough knowledge, patients will “likely need education on precision medicine options and alternatives such that they can make informed choices not only about a precision medicine test but also about the potential results and follow-up recommendations” (p. 12).

To ensure that patients can make informed decisions about which therapy to follow, or which medications to take, suitable advertising should be designed. This should take into consideration that patients come from various social systems, and they might use different medias, or have different health literacy levels (Korngiebel et al., 2016). A challenge for precision medicine is therefore to be an opportunity for all kind of patients.

5. Behavioural medicine

Behavioural medicine refers to a broad field of medicine. To further understand how behavioural medicine could contribute to precision medicine, first there is the need to define what behavioural medicine is. In the following section, the definition postulated from the International Society of Behavioral Medicine (ISBM) will be given, alongside with comments from other authors.

5.1. A definition of behavioural medicine

The International Society of Behavioral Medicine (ISBM) has updated in 2020 the definition of behavioural medicine, adding some specifications to the definition that was given by Schwartz and Weiss during the Yale conference in 1978. Although the original definition realized the unique goal of “bringing together behaviourally oriented biomedical scientists (MDs) with biomedically oriented behavioral scientists (PhDs) for the purpose of forging a productive synergy of the two” (Weiss & Schwartz, 2019, p. 10), the definition was not up to date anymore. Behavioural medicine is therefore nowadays defined as

“A field of research and practice that builds on collaboration among multiple disciplines. These disciplines are concerned with the development and integration of behavioral and biomedical knowledge relevant to health and disease. Behavioral knowledge refers to psychosocial, societal, economic, cultural, existential, and environmental processes of health- and disease-related behavior, and biomedical knowledge refers to physiological, pathological, and medical processes. This knowledge is applied to prevention, health promotion, diagnosis, treatment, rehabilitation, and care. The scope of behavioral medicine is broadly inclusive of behavioral and biomedical science as well as clinical and public health practice”. (p. 3)

In 2017, Johnston and Johnston discussed how behaviour components should be given more attention to in the field of behavioural medicine, because “Since the original definition, there has been an increasing focus on behaviour as a cause and consequence of health status, to complement the earlier emphasis on stress, emotions, beliefs, traits and mental health” (p. 10). In the following years, the health system has recognized that behaviour is determinant for all health issues, both physical and psychological (Johnston & Johnston, 2017).

The comprehensive definition of behavioural medicine can also imply that this definition can be used as an umbrella term for various related fields (Nater, 2017). In some cases, it might be difficult to differentiate between similar fields, like for example for the distinction between behavioural and psychosomatic medicine: “the field that is covered by psychosomatic medicine is almost identical to that of behavioral medicine. Even if the only difference between the two disciplines is behavioral medicine’s reliance on “public health and health promotion”, it seems difficult to clearly differentiate the two disciplines, as findings from psychosomatic medicine research will inform both public health and health promotion efforts” (Nater, 2017, p. 17).

Figure 1 gives an overlook over the various disciplines that encompass behavioural medicine. Behavioural medicine is therefore to be meant as an interdisciplinary field. Depending on the patient, disease or situation, methods and variables from different fields might be more or less relevant.

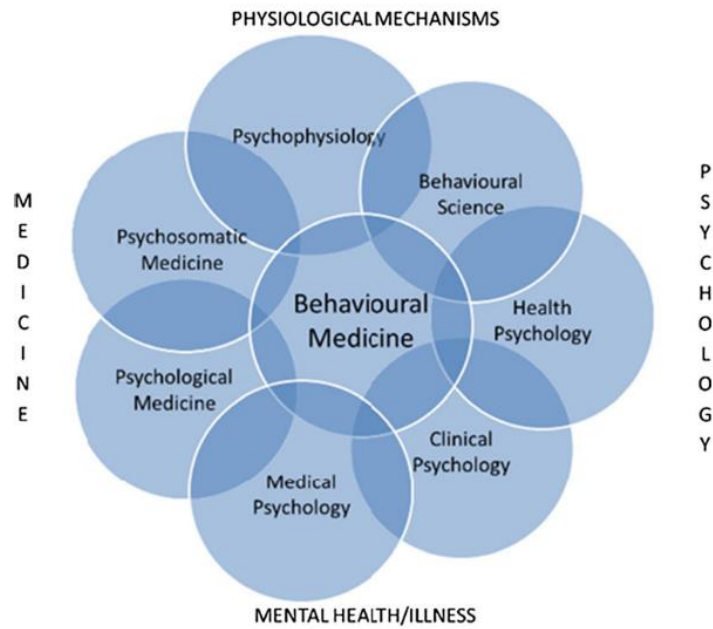


Figure 1: Overlaps between psychological and other disciplines in behavioural medicine. Figure from Johnston & Johnston, 2017, p. 10

6. Interventions in old age

Health in old age is an important goal that needs to be achieved within the next decades, in order to sustain the economic, social and health system. How can this be done? the following subchapters will focus on systematic reviews regarding the state of the art of interventions that specifically target older cohorts of people. Special attention will be given to precision medicine and behavioural approaches, to offer a comparison of the two methods.

A special chapter is about new technologies, as they could be very useful to achieve the health goals set by the WHO, and because they represent a point of connection between behavioural and precision medicine.

Consequently, specific subchapters about the different influencing factors regarding successful ageing will analyse the existing interventions who target them. Such a division can show if the wide range of influencing factors for successful aging are being recognised and addressed by the health system.

6.1. What kind of approaches exist?

Interventions can take many forms. In this thesis, the focus is on precision and behavioural medicine approaches. The sections regarding the state of art about interventions in old age are mainly based on systematic reviews (for example: Ladapo et al., 2018; Liu et al., 2019; Naito et al., 2018; Montana et al., 2020; Jang & Kunde, 2021; and others).

6.1.1. Focus: precision medicine approach

Precision medicine uses personal information, like genomic data, environmental and psychological conditions that are unique for each patient. The goal is to be able to monitor the patients to target a disease before it occurs, or to treat conditions in a personalized manner, rather than using a standardized treatment (Liu et al., 2019). In this sense, precision medicine is to be considered as an “individual and continuous healthcare service” (Liu et al., 2019, p. 49089).

Here is an example of applied precision medicine. Liu et al. (2019) reviewed the method of Digital Twins Healthcare, used in interventions that target the elderly. The authors define this method as “A novel, generalized, and extensible framework in the cloud environment for monitoring, diagnosing and predicting aspects of the health of individuals using, for example, wearable medical devices, toward the goal of personal health management, especially for the elderly” (Liu et al., 2019, p. 49088). Digital twins could be helpful because of the real time monitoring they offer, that could promote targeted interventions to prevent the onset of more severe health problems. For example, based on the health records of a specific patient, different drugs could be used to address a health problem. The following is an example of a situation that could occur in real life:

“Then, after data processing and data analysis according to the patient ID, PHR [Personal Health Records] records, and their gene type, the DTH [Digital Twin Healthcare] model gave a simulation result that one person had symptoms of arrhythmia, and the medication reminder service is activated. [...] The dosage of medicines is based on their personal physical and genetic condition. For example, one volunteer’s gene type belongs to DPYD TA (rs 67376798), so that person was reminded to reduce the dose of the drug named Fluorouracil. Also they had a gene type named CYP2C19*2/*2, which affects the drug named Clopidogrel, so the service suggested that they do not take this medicine. This function reflects that the individualized

medication can be achieved in this platform based on DTH” (Liu et al., 2019, p. 49098, 49099).

A second example comes from a study conducted by Ladapo et al. (2018). The authors wanted to “compare healthcare utilization and clinical outcomes among patients with suspected coronary artery disease (CAD) using a blood-based age/sex/gene expression score (ASGES) versus conventional cardiac functional or anatomical testing” (p. 890). A personalised approach resulted in diminishing the need for invasive procedures, and in general less cardiovascular problems in elderly patients.

6.1.2. Focus: behavioural approach

As analysed in the previous section, behavioural medicine encompasses many fields of medicine. Depending on the specific patient or health situation, different approaches could be given more or less importance. For this reason, depending on the target of the intervention, methods can change.

When considering treatments that target physical changes, like in elderly patients with advanced cancer, interventions will be more focussed on behavioural changes, like for example improving physical activity to enhance life quality (Naito et al., 2018). On the other hand, when cognitive factors are more relevant, like in depression treatment interventions, cognitive therapies are more indicated and more useful in improving old people’s quality of life (Khezri Moghadam, Vahidi & Ashormahani, 2018).

6.2. New Technologies

New technologies like smartphones, social medias, videogames and wearable devices are becoming more and more popular and useful in everyday life activities. Such tools can be useful for doctors to monitor patients without having to physically meet them, and they can help to act promptly when symptoms indicate an anomaly.

Wortley, An and Heshmati (2017) reviewed the use of “Serious Games” in psychological interventions that target the elderly. To define serious games, the authors rely on the definition that can be found on Wikipedia:

“A serious game or applied game is a game designed for a primary purpose other than pure entertainment. The ‘serious’ adjective is generally pre-pended to refer to video games used by industries like defence, education, scientific exploration, health care, emergency management, city planning, engineering, and politics.” (Wikipedia, last accessed on 29.11.2021)

Serious games have gained a lot of attention in the last years, mostly because of they offer a lot of potential benefits, and at the same time considerably little costs and risks (Wortley et al., 2017). Serious games are for example used to improve the cognitive abilities of elderly patients who suffer from dementia, and to also help them to better manage everyday activities (Wortley et al., 2017).

Another important issue where new technologies could aid old people is this of social isolation (Chen & Schulz, 2016). Social isolation is common among the elderly, and it has proved to have negative consequences on both physical and psychological health (Chen & Schulz, 2016). However, new technologies like smartphones or social medias cannot be the only method used to address the problem of social isolation among the elderly. Chen and Schulz (2016) report how the positive effects produced by their use “seemed to be short-term and did not last for more than six months after the intervention” (p. 1). Moreover, old

people often need a training to learn how to use these technologies, otherwise they might not be able or motivated enough to use them in a proficient way (Chen & Schulz, 2016).

However, barriers of different kinds could prevent or make it more difficult for different people to profit from new technologies (Chen & Schulz, 2016). Social barriers like segregation of immigrants or cultural backgrounds can interfere with technologies usage. Also physical barriers, like impediments of hands or poor eyesight could influence the preferences of old people towards other solutions. These factors stress how important it is to consider every patient constellation as a unique one, in order to find the solution that fits better.

The use of new technologies should therefore be seen as a complementary aid. Moreover, they could not be suitable for every person in the same manner (Chen & Schulz, 2016). The situation of every patient should be analysed to discover to which extent could new technologies be a useful aid in the pursuing of the intervention's goals.

6.3. Interventions and successful ageing

As said in chapter 2.2., in the coming years the ageing population will influence the development of several important fields in society. If older adults could live a fulfilling and productive life even in old years, this would result in benefits both for them and the society they live in. It is therefore in the interest of the entire society, that interventions to ensure this goal are developed.

An example of prospective goals to meet the need for a future that is more inclusive of the elderly is given by the WHO. The WHO (2017) declared the years 2020-2030 as "The Decade of Healthy Ageing". During this decade the aim is to achieve many different goals in the context of successful ageing.

The following subchapters describe interventions that target old people. The subchapters are divided into the same sections as the “Successful ageing” chapter, so that a specific focus for each point can be given.

6.3.1. Target: Health and functionality

There are a few steps that can ensure that old people are overall healthy and can maintain their functional ability. First of all, as proposed by the WHO in 2016, the healthcare system should align to the needs, resources and rights of elderly patients (Rudnicka et al., 2020). Moreover, like it was said in chapter three, many old people suffer from chronic impediments. It is therefore important to provide appropriate health systems and infrastructures that can provide long-term cure to old patients (Rudnicka et al., 2020).

Cheng et al. (2018) conducted a systematic review of practical interventions with the aim of improving the health and functionality of old patients by preventing falls in people aged 60 years and over. Results show that the most efficient approach is that of using multifactorial approaches – meaning all studies that encompass three or more interventions –, instead of usual care. Cheng et al. (2018) propose three possibilities of why multifactorial interventions seem to be more effective:

“The fact that MFI was more effective than most single interventions may be due to one of three possibilities: (a) It includes components of single interventions that are effective, and/or (b) the interaction between two or more components of MFI create positive results, and/or (c) different interventions are effective for different individuals based on any number of individual differences, and applying MFI increases the likelihood of a “match” between an effective intervention and particular individuals” (p. 9).

This review could be helpful to practitioners and people who take care of elderly patients. An appropriate selection of interventions could improve the health and functionality of the patients, and at the same time reduce the health costs.

Multifactorial interventions often also consider patients' preferences (Vermunt et al., 2017). Being able to express own preferences and have an active role in the therapy development could improve patients' motivation and adherence to the therapy (Vermunt et al., 2017).

6.3.2. Target: Physical and cognitive fitness

To maintain physical and cognitive fitness at an advanced age, environment plays a crucial role (Rudnicka et al., 2020). Friendly environments who foster facilitated access to infrastructures helps old people to maintain their autonomy, while at the same time promoting health, personal development and social involvement (Rudnicka et al., 2020).

Physical fitness is also ensured by nutrition. Dysfunctional eating habits, like an excess in body fat, can have many negative consequences, like for example "an increased risk of knee osteoarthritis, sarcopenia, physical deterioration, reduced quality of life, and present risk factors that are commonly associated with coronary heart disease, stroke, and other disorders such as dementia (Curilem Gatica, Bahamondes Ávila, Bruneau-Chávez, & Bernal de la Rosa, 2021, p. 6).

To address the overweight problem and maintain functional ability, Curilem Gatica et al. (2021) found that the most effective interventions are the ones who integrate multicomponent exercises and at the same time a caloric restriction on the diet.

6.3.3. Target: Affect and control

Emotion regulation is important at all life stages to give people the confidence of being able to influence the environment and to experience personal growth and autonomy (Montana et al., 2020). Montana et al. (2020) conducted a systematic review to discover to which extent interventions based on virtual reality technologies can improve the emotion regulation skills of older adults. Virtual reality seems promising, because it “allows the user to learn complex emotion regulation strategies in the context of life-like digital environments. Virtual reality interventions can modify the user’s emotion regulation by inspiring new actions, allowing for the modification of the emotional response across a reappraisal of emotional stimuli, and subsequently, memorizing the re-evaluated experience” (Montana et al., 2020, p. 17).

Emotion regulation can also be addressed using more “traditional” methods. Music interventions can positively influence the emotional well-being of older people, and help in reducing symptoms of depression and anxiety (Jang & Junde, 2021).

6.3.4. Target: Social participation and engagement

To effectively address global ageing, it is necessary that all the population takes into consideration this trend (Rudnicka et al., 2020). In fact, the WHO proposed the creation of a national framework for healthy ageing, that should inform society and politics on the measures to address population ageing (Rudnicka et al., 2020).

A difficulty that can prevent social participation at older stages of life are barriers, both physical and ideological (Townsend, Chen & Wuthrich, 2021). In such cases, prevention can be effective in developing and maintaining supportive networks, and to build neighbourhoods that encourage social participation at all life stages (Townsend et al., 2021).

But the most crucial factor that influences social participation is motivation. Old people that are motivated to maintain and / or expand their social network can better profit from social activities and more effectively engage in long-term participation (Townsend et al., 2021). Moreover, old people are increasingly motivated to participate in social life when they perceive their neighbourhood as “cohesive and socially accessible” (Townsend et al., 2020, p. 373).

Townsend et al. (2021) call out for action that encompasses all levels of society:

“It is important to note that although social participation and motivation can be facilitated at the individual level with therapy/intervention programs, it is within the power of small local systems (e.g., local councils) to also meet the needs of their community and foster systemic change” (p. 375).

7. Discussion

The study of longevity and health in old age can take many forms, and be more or less focused on behavioural or precision medicine approaches. Up to now, most studies focused on the search for genetic components (Dato et al., 2017). Research has found some correlation between genes and longevity, but these are not enough to explain the wide variability.

“Approximately one-quarter of the variation in lifespan in developed countries can be attributed to genetic factors. However, even large population based studies investigating genetic influence on human lifespan have been disappointing, identifying only a few genes accounting for genetic susceptibility to longevity” (Dato et al., 2017, p. 147).

At the same time, also the influence of environmental factors has been studied (Dato et al., 2017). But neither of these two fields can give satisfying enough results alone. There is a need to study the interactions that occur between them, in order to deepen the understanding of the influential variables of health in old age (Dato et al., 2017).

Dato et al. (2017) addressed this issue:

“The precise knowledge of the effects of environment and lifestyle on the basic molecular mechanisms of ageing may allow to elaborate preventive measures, in order to increase life expectancy and thus, the chance to attain longevity. Environmental factors may have either additive or multiplicative effects on health and longevity, triggering a series of coordinated changes in the physiological and developmental patterns able to produce alternative phenotypes during the life-course of an individual – a process commonly known as developmental plasticity” (p. 151).

Moreover, environmental effects often have a cumulative effect over time (Dato et al., 2017). And like genes, children “inherit” the social situation in which their parents live, with the advantages and disadvantages it brings (Dato et al., 2017).

When the precision medicine initiative was announced in 2015, it was believed that “recent advances in genome sequencing, cohort study designs, health informatics, and mobile/wireless technologies make now an opportune time for a large precision medicine cohort initiative” (Riley et al., 2015, p. 243). The field of precision medicine promised to bring individualized treatments, that based both on genetic variants and also on behavioural and environmental factors (Riley et al., 2015). Riley et al. (2015) made a statement about how they imagined the precision medicine initiative to be in the years to come

“The Precision Medicine Initiative is much more than just “genes, drugs, and disease”. It is a comprehensive effort to better understand which treatments work for which individuals under which conditions” (p. 245).

But, as it was said in chapter 4.2., precision medicine actually focuses more on individual differences in genes, rather than on environment and lifestyles (Davis & Shanley, 2017).

A possible explanation for this selective application of precision medicine could be found in nomenclature (Davis & Shanley, 2017). Davis and Shanley (2017) argue that in the field of precision medicine, genes and molecular processes monopolise the general attention. This because the terms that refer to environmental and social determinants do not have the corresponding scientific and medical nomenclature.

“For precision medicine, we believe that symmetric -ome nomenclature will help standardize the ways in which scientists and clinicians can describe, define, capture, and analyze the comprehensive set of factors that affect human health — and, in turn, accelerate precision medicine as the revolutionary approach that its proponents envision” (Davis & Shanley, 2017, p. 65).

On the other hand, behavioural medicine has a well-defined range of action and of the many fields that are encompassed under the general term. In this sense, a more detailed definition of precision medicine and what multimodal approaches could be comprehended in it could be helpful in better outlining what can be considered “precision medicine” and what not.

As we have seen in chapter 6., most of the successful interventions focus on a multimodal approach. For this reason, one of the major contributions that behavioural medicine could give to precision medicine is that of adopting a multidisciplinary approach. As already stated, genomic or environmental information alone cannot give satisfying explanations. If, instead, precision medicine would really stick to its definition and take into consideration the individual differences both at a molecular and environmental level, this could bring many advantages to the medical field.

8. Conclusions

Global population ageing is a real and important issue, that needs to be addressed in order to ensure a healthy future to people and societies as a whole. In order to develop successful interventions and strategies, the health system should take into consideration certain steps. First of all, a clear definition of what does health at an old age look like. In this sense, the definition of successful ageing that was given in chapter 3.1. can be used. Consequently, the most effective approach should be used. As it was reported in chapter 6., the most effective interventions are the ones that use a multifactorial approach. This means that many aspects must be considered: environmental, individual, social, biological and psychological factors are all of importance.

The precision medicine initiative seems like an ideal approach, as it proposes to develop interventions that are specifically tailored to every patient and its unique situation. But to really stick to its definition and bring real advantages, precision medicine needs to broaden its focus. Nowadays, most precision medicine studies only focus on genomic data, and this is not enough to bring real progress to the health system.

In this sense, behavioural medicine methods and history could help in determining how should precision medicine develop. The definition of behavioural medicine encompasses many fields of action, that can be more or less relevant depending on the current patient. If also precision medicine could develop a range of action that takes into consideration many different fields and variables, it could then bring the positive results it aims to.

A final personal remark: writing this thesis has been challenging because although precision and behavioural medicine have been researched by many authors that try to connect them, there are very few recent papers that apply these theories, pro and cons to practical examples of interventions with old patients. It has been demanding to bring them together.

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