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EXERCISE PRESCRIPTION FOR HEALTHY ACTIVE AGEING

LIFEAGE GUIDE

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LIFE AGE

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The whole LifeAge consortium with the researchers from the Universities listed below contributed directly to this guide.

For further information on LifeAge please visit:

https://life-age.eu/

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Prologue

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Prologue

1.1. LifeAge project and its philosophy of active ageing

LifeAge project aims to underline the importance of a healthy lifestyle, which includes proper nutrition and physical exercise, in order to achieve a better quality of life in older age. There is no doubt that population ageing is a global phenomenon that affects the whole of Western society. It is determined by profound demographic changes happened in the last decades: the reduction of mortality due to improved health conditions and medical progress, on the one hand, and the contraction of births on the other.
The ageing of the population represents a "triumph" but also a "challenge" for society. Actually, it increases the burden of chronic degenerative diseases linked to ageing, with the consequent increase in welfare expenses and the difficulties of sustainability of the entire social and health system.
Since the early 2000s, the WHO has outlined a strategy for promoting health and improving adults' lives over 64 years of age. The strategy was called "Active Ageing". The strategy and related policies aim at promoting a different concept of ageing by fostering the maintenance of physical, intellectual, occupational and social skills of older adults. These persons are no longer considered "bulky" bearers of care needs, but as a resource for our society.
Stereotypes of ageing are very pervasive in the European mindset. The media, language, and culture tend to facilitate negative images of ageing and depict older adults as elderly with illness or need for care. These images may have profound consequences on the lives of older adults.
Promoting healthy ageing, creating favourable environments and adapting health care systems to the needs of an increasingly older population are the objectives that WHO Europe seeks to achieve within the framework offered by the Strategy and Action Plan for Healthy Aging in Europe 2012-2020 through the implementation of five priority interventions:
1) prevention of falls
2) promotion of physical and sports activities
3) promotion of home care and self-care services
4) Support for participatory development strategies among medical and geriatric care staff
5) vaccines administration and disease prevention programs in medical centres.

Looking at these strategies, no doubt that physical and sports activities are crucial in achieving the healthy and active ageing strategy's objectives. We know from scientific evidence that this kind of activities can preserve functional independence in old adults and maintain a good quality of life.
Physical exercise helps to age better, both physically and psychologically. It helps in controlling high blood pressure and lipid profile, particularly cholesterol levels. It prevents or delays the onset of chronic diseases related to ageing and reduces the risk of the consequences of osteoporosis and fall traumas.
LifeAge aimed to provide more scientific evidence to confirm the importance of regular physical activity for adults aged between 50 and 65 because of its positive effects on various psychological factors and the quality of life of persons.

1.2. Ageing as an opportunities and resources optimization process

According to the definition of the World Health Organization, ageing is a natural and inevitable process. When we say "active process", we want to emphasize that it deals with a

sequence of processes made up with specific external and internal actions whose scope is the optimization of opportunities related to health, participation, and care to improve older people's quality of life.
Active ageing is indeed an optimization process, but not only for older adults. We are facing the most significant demographic change in history. The ageing of the world's population continues to generate social and economic demands that will have to be well managed in the decades to come. Therefore, the active maintenance of a population is a necessity, not a luxury.
Faced with the population's ageing, the WHO has developed a real strategic plan to create active ageing conditions before reaching old age. "health", "participation" and "care" of the elderly are the three primary pillars of active ageing. The objective is to replace the old policies that consider older people passive subjects, with policies that recognize all citizens' right and responsibility to have an active and participatory role in the community's life at all life stages, including the old age.
In practice, what more matters is to develop in the collective imagination a more positive vision of ageing, abandoning the idea of the elderly as sick, lonely and depressed women and men in favour of a proactive older adult who actively participates in social life. The promotion of active ageing is not a recent concept. The United Nations agreed with the International Action on Ageing in Vienna in 1982. The year 2012 was declared the European Year of Active Ageing and Intergenerational Solidarity. In the same year, the active ageing index was developed.
This index measures the capacity of the elderly to realize themselves in terms of autonomy, employment and participation in social and cultural life. The indicators used are the level of employment, participation in volunteering, political participation, physical exercise, access to health services and, finally, personal safety. Other indicators evaluated are closely related to the external environment and therefore: life expectancy, psychological well-being, and being familiar with technologies.

1.3. Physical activity and lifelong learning as key factors to success for active ageing

This is the general framework within which the concept of active ageing is located. This framework has suggested us the variables of LifeAge project. The scope of the project, whose matrix is, in fact, educational, is to help people develop lifelong education skills by using physical activity as a means for active ageing.
An educational program for active ageing needs, first, awareness of health's importance since the youngest age. When they are children, people ought to be educated to choose life regimes that consider the importance of physical activity, the value of a balanced diet, the danger of certain toxic substances and voluptuous use, the usefulness of continuous mental and physical exercise, and medical check-ups.
This was the philosophy of LifeAge project. Its other primary goal is preventing and stopping hypokinesia and the tendency to a sedentary life, typical conditions of old age that can lead to severe problems. This goal goes hand in hand with training specialized figures like trainers, Physical Education teachers and sports educators.
Pedagogy has always emphasized physical activity's relevance as the most appropriate means to achieve a correct way of living one's own life against inactivity and passive leisure and against the intellectualization and bureaucratization of everyday life and all the possible modes of alienation it may imply. For both medicine and pedagogy, sport is the recipe for longevity. For this reason, we need a new philosophy of ageing in our culture. It is essential

to invent a new philosophy of life and ageing. A philosophy by which being continually inspired to establish new social institutions.

The human sciences and medicine have not been until now of great help to deepen in the ageing phenomenon in terms of meaning and significance for human life. This is because until now, a holistic view of ageing has been missed. LifeAge project has tried to fix this problem by proposing a scientific vision but at the same time based on a holistic and interdisciplinary approach to the issues of ageing in human life.

There is a tendency to circumscribe the phenomenon of ageing in the field of medicine. It is a reductionism, because ageing is not a disease, although diseases and illnesses usually accompany it. Ageing raises questions about the great questions of human life's essence: the meaning of life, personal and social identity, relationship with others, social justice and autonomy of the person. Questions that must abandon abstraction and be contrasted by concrete action strategies.

Physical activity can support the new philosophy of active ageing and longevity we are talking about. Of course, physical activity does not lead directly to well-being but provides opportunities to help people enrich their daily life by making them more satisfying.

Physical and sports activity provides human beings with the chance to achieve well-being not through a strictly cognitive and intellectual path, but through active experiences that start from the body as an active centre of energy and power. The experience acts as a set of activities that, once become intentional actions allow people to establish permanent perceptions and habits towards seeking and experiencing well-being to make it a permanent goal of their own learning.

In this sense, physical activity always provides people with new and unique experiences and shows the best path to well-being, offering them opportunities to understand healthy lifestyles' value and effect.

This handbook is the result of the new philosophy of active ageing the LifeAge project was inspired by. I am sure that the scientific and educational results summed up in this book will turn it very soon into a fundamental guide for all those interested in the scientific study of active ageing who will contribute to promoting the health of themselves and all European citizens in the years to come.

2

Promoting the Shift Sedentary Lifestyle Towards Active Ageing – Healthy Habits (Nutrition, Physical Activity, Exercise)

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Keywords: active ageing, nutrition, physical activity, exercise, healthy lifestyle

Promoting the Shift Sedentary Lifestyle Towards Active Ageing – Healthy Habits (Nutrition, Physical Activity, Exercise)

2.1. Introduction

This chapter contains the background of the project, its implementation and benefits of healthy nutrition, physical activity and exercise. As the background of the project tells, this subject of "Promoting the shift sedentary Lifestyle towards Active Ageing – Healthy habits" is a current matter to deal with. Rapidly ageing European population poses its own challenges now and in the near future. This has given us a great matter of motivation towards this subject and the project itself.

2.2. About the project and its implementation

UCAM, Limerick, Latvia, Cadiz and Lapland implement together the LifeAge project, a collaborative European project on the theme of active aging in the Finnish and European context. LifeAge stands for "Promoting the shift sedentary lifestyle toward active aging - LifeAge". Erasmus + SPORT programme kindly co-finances the project.
The research of the project has in key role in order to maintain the functional and well-being of the aging European population. The project aims to assess the health impact of aging and sedentary work on the European population and to promote exercise and physical activity as a key tool for healthy and active aging.
The LifeAge project is a good example of networking that produces tangible results. The lead partner of the project is the University of Murcia (UCAM) in Spain. Their representative attended the EAS Conference hosted by Lapland in 2016. UCAM has long been pushing the theme of physical activity forward with national funding in Spain and has decided to apply for funding through the Erasmus Sports Program in the 2018 application round. They had the idea of building a multinational consortium for the application, and because of earlier contacts, Lapland and Lapland UAS were natural partner.
The application was prepared in spring 2018 and the action was launched in early 2019. The project measures the physical functioning of different age groups and contributes to the theme of active aging. The project will also bring much-needed international R&D funding to the polytechnic.
The Spanish lead partner has built a close cooperation pattern with the locals on the project. In each of the partner countries (Spain, Finland, Italy, Ireland and Latvia), the implementer is a higher education institution or research institute responsible for data collection. The data collection will target the local population and the output of the project will be evaluated together with the end users. Focus group meetings discuss the materials that the project has produced. In addition, a multiplier event will be organized with the local population.
The project has had three project meetings in year 2019: Kick-off meeting in Murcia, Spain, Follow-up meeting in Rome, Italy, and mid-term meeting in Rovaniemi, Finland. The meetings have also been checkpoints to monitor the project's progress and to see if all partners are implementing their deliverables in time.

2.3. Project background

LifeAge project is based on the real needs that are supported with scientific studies and with European and national statistics. The real need comes from statistics that show European populations are ageing rapidly across the continent. There are increasing proportions of elderly people in Europe "due to low birth rates, ageing "baby-boomers" and rising life expectancy". Statistics show that between 2016 and 2060 the share of people over 65 years old from the total population will rise from 19.3% to 29.0%. At the same time the amount of working population (15-64 years old) will decline 11,6% [1].
European Parliamentary Research Service Blogs table 1 (old-age dependency) shows that this ratio in fractions will be 2: 1 in 2060 compared to 4: 1 ratio in the 2010's. Statistics indicate in table 2 (Public expenditure on healthcare) how healthcare costs will rise by 2060. That will put European Union (EU) Member countries pensions, health care and long-term care systems at risk by becoming economically unsustainable [2, 3].

Table 1. Old–age dependency ratio EU27, 2010–2060.

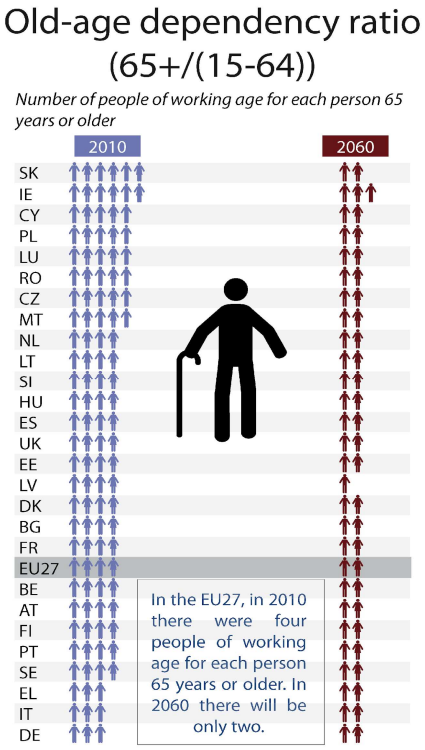
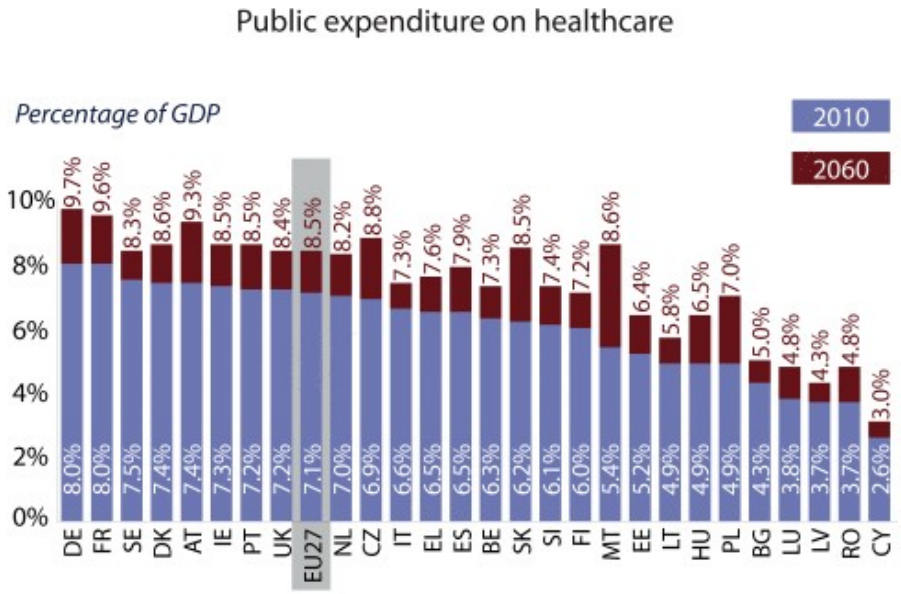


Table 2. Public expenditure on healthcare EU27, 2010–2060.



In addition to old-age dependency ratio, a larger portion of EU citizens do not exercise enough according to the World Health Organization (WHO). In Europe, in general, inactivity and its consequences have begun to become genuine problems. WHO statistics shows that as many as 59% of Europeans are overweight. In addition, the amount of obesity cases has been on the rise. This development is particularly evident in young people and young adults [4]. In the future, the activation of children and adults seems to be one of the major developmental goals of society, not to mention its impact on the overall well-being of the individual.

Challenges of an ageing population haven't developed suddenly, but for many years. WHO launched the theme of 'active ageing' back in 2002. The definition of active aging is: Active aging is a continuous process that aims to provide the best conditions for good health and a sense of security. According to the WHO definition, the word active refers to the continuous involvement of a person in physical, mental and social activities within society [5].

There are clear economic reasons for pursuing active aging by reducing expenditure on health services for the healthy and functional elderly. Healthy people work harder and have longer careers. In Europe, there has been a trend towards early retirement as a result of public policy that even encourages early retirement. As the age bracket ages, retirement policies need to be changed. Active aging would, by acting, be a direct compensation for rising pension and sickness costs [6].

2.4. Introduction to healthy lifestyle

The current state of the weight problems in the EU is alarming. Statistics show that in the EU Member States 59,1 % of male and 44,7 % of female citizens are overweight (18 years and over) in 2014. Weight problems and obesity are increasing rapidly [7]. Table 3 shows gender differences of the weight situation in the Member countries and the EU average.

Table 3. The share of the population that was overweight generally increased with age EU28.

	Males	Females	Total						
	18 years or over		18 years or over	18 to 24	25 to 34	35 to 44	45 to 64	65 to 74	75 years or over
EU-28	59.1	44.7	51.6	22.8	37.8	48.6	59.6	66.0	58.8
Belgium	56.3	42.9	49.3	20.2	38.9	44.8	56.0	62.1	56.6
Bulgaria	62.2	46.8	54.0	20.8	36.7	49.0	64.5	69.1	56.8
Czech Republic	65.0	49.2	56.8	19.9	35.7	53.2	69.8	76.9	63.6
Denmark	55.1	40.6	47.7	25.4	37.5	49.0	55.5	56.8	48.2
Germany	60.3	44.2	52.1	24.5	37.5	49.3	58.7	66.0	61.0
Estonia	57.1	51.1	53.9	24.8	36.3	50.4	64.5	70.4	64.0
Ireland (')	63.1	48.5	55.7	36.9	49.7	55.7	62.4	63.0	53.8
Greece	66.3	48.1	56.7	23.9	41.7	53.0	65.4	71.2	65.6
Spain	60.6	44.4	52.4	24.1	38.2	47.3	59.6	71.0	67.4
France	53.8	41.3	47.2	21.7	35.3	42.9	53.5	62.5	56.7
Croatia	67.5	48.3	57.4	22.3	38.1	53.7	69.2	73.1	65.7
Italy	54.6	36.1	44.9	17.9	29.1	38.7	50.1	59.6	55.2
Cyprus	59.8	37.9	48.3	21.4	31.9	43.0	61.6	69.4	65.4
Latvia	58.9	54.6	56.5	22.0	37.4	51.1	67.5	76.0	70.4
Lithuania	58.3	53.4	55.6	19.7	34.7	51.0	68.5	76.5	66.0
Luxembourg	56.4	39.8	48.0	25.2	36.1	47.3	56.1	59.5	60.4
Hungary	62.3	48.9	55.2	19.0	40.0	51.5	67.9	76.1	55.8
Malta (²)	66.8	55.2	61.0	36.0	52.5	62.7	69.0	74.1	65.3
Netherlands	53.6	45.2	49.4	20.6	35.9	49.5	58.1	61.7	54.9
Austria	56.5	39.9	48.0	23.1	36.2	43.6	55.5	65.1	56.0
Poland	64.1	46.7	54.7	19.3	38.7	52.8	66.0	73.2	65.5
Portugal	57.6	50.0	53.6	23.6	35.1	49.9	63.5	69.3	60.2
Romania	63.2	49.0	55.8	21.8	38.6	54.4	69.3	71.2	58.1
Slovenia	65.0	48.5	56.6	28.1	38.5	56.4	66.3	68.5	64.2
Slovakia	63.0	46.1	54.2	19.3	36.4	50.9	68.1	78.7	69.8
Finland	62.4	47.8	54.7	26.1	42.8	52.0	64.0	65.7	57.0
Sweden	55.8	44.1	49.9	25.6	35.0	52.2	59.5	59.5	50.0
United Kingdom	60.2	51.8	55.7	29.0	47.3	56.0	64.0	62.8	52.6
Iceland	66.1	48.9	57.6	33.7	52.9	59.4	65.2	66.8	59.1
Norway	57.8	40.5	49.3	30.6	39.1	51.7	57.6	56.6	48.0
Turkey	56.4	56.7	56.5	22.4	44.2	64.9	75.4	66.2	56.5

Overweight and obesity are a problem for citizens' health in the EU, as their prevalence in Europe has increased in recent years [8]. The health effects of overweight and obesity are significant, as they increase the risks of chronic diseases such as hypertension, coronary heart diseases, certain cancers, type-2 diabetes and cardiovascular disease. Weight problems can be link to a various psychological problems for specific individuals [9].

The number of people with weight or obesity problems has been increasing. Many people are finding it harder to maintain their 'normal' weight in today's largely obesogenic environment [10]. This can be partly explained by individuals' financial access to healthy and nutritious food, lack of cooking-skills, the abundance and marketing of poor nutritious food, to urban planning choices and lifestyle pressures that reduce the opportunity to do physical activity especially in urban areas, where people are more prone and have more of a sedentary lifestyle. This situation has a substantial direct and indirect economical cost that puts a considerable strain on EU Members healthcare and social resources [11].

The WHO's research on 'active aging' supports the claim for physical, mental and social well-being. According to the study, the following can be affected by active aging:

- Significantly reduces the number of deaths of able-bodied people
- Reduces premature incapacity for work due to chronic diseases
- More older people can maintain a high quality of life and enjoy life

- People are more likely to become an active part of social, cultural and economic society
- Reduced treatment costs and treatment services. [12]

2.4.1 Benefits of a healthy diet

Healthy eating habits are a natural protection against malnutrition and as well diet-related noncommunicable diseases such as heart diseases, strokes, cancer and diabetes. Good eating habits are best learned when they are adopted at a young age. They might have significant health benefits like reducing the risk of developing noncommunicable diseases and becoming overweight or obese at later stages in life. Individuals should have a balanced diet. To this end, you should take the following things into account. [13], [14]
With the balanced diet in mind healthy nutrition helps protect against various nutritional hazards that are listed above. Individuals should keep these facts in mind to adopt a healthy diet according to Dr Ayoub Al Jawaldeh from WHO in 2019:

"BALANCE CALORIES
Energy intake (calories) should be in balance with energy expenditure.

LIMIT FAT INTAKE
Evidence indicates that total fat should not exceed 30% of total energy intake to avoid unhealthy weight gain (1,2,3), with a shift in fat consumption away from saturated fats to unsaturated fats (3), and towards the elimination of industrially-produced trans fats (4).

LIMIT SUGAR INTAKE
Limiting intake of free sugars to less than 10% of total energy intake (2,5) is part of a healthy diet. A further reduction to less than 5% of total energy intake is suggested for additional health benefits (5).

LIMIT SALT INTAKE
Keeping salt intake to less than 5 g per day helps prevent hypertension and reduces the risk of heart disease and stroke in the adult population (6)" [15]

2.4.2 Benefits of physical activity and exercise

The current level of physical activity in the EU among children and adults is low. Physical inactivity is identified as the forth risk factor for global mortality. There are growing evidence that engaging in regular physical activity is associated with better overall health and well-being and a reduced risk of developing non-communicable diseases [16,17].
The World Health Organization has made recommendations for physical activity. The following statistic is made for adults 18-64 years old.

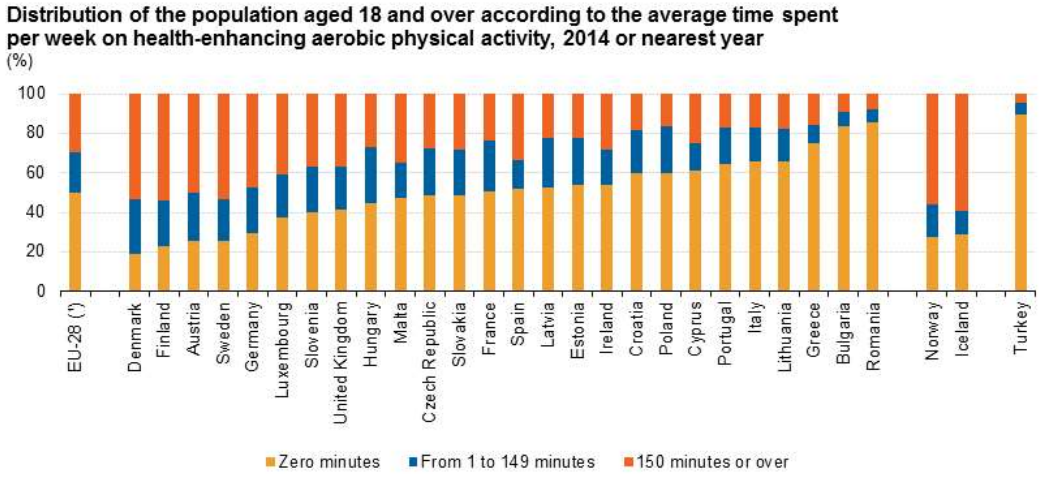
1. "Adults aged 18–64 should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity.
2. Aerobic activity should be performed in bouts of at least 10 minutes duration.
3. For additional health benefits, adults should increase their moderate-intensity aerobic physical activity to 300 minutes per week or engage in 150 minutes of vigorous-intensity

aerobic physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity.

4. Muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week" [18].

These physical activity recommendations should be adopted to the grassroot level of the EU, because inactivity in Europe increasing, as the following statistics (table 4) show over 18-years old participation in physical activity in 2014 [19]. Approximately 50% of the EU citizens spent zero minutes on health-enhancing aerobic physical activity.

Table 4. Distribution of the population aged 18 and over according to the average time spent per week on health-enhancing aerobic physical activity, 2014 or nearest year.



(*) Estimates.

Note: no available data for Belgium and the Netherlands; ranked on the total share of persons not performing at all aerobic physical activity.

Source: Eurostat (online data code: hlth_ehis_pe2e)

eurostat

Recommendations for physical activity and exercise have good scientific evidence of their benefits behind them. WHO has stated that regular exercise such as walking and cycling has significant health benefits: "For instance, it can reduce the risk of cardiovascular disease, diabetes and osteoporosis, help control weight, and promote mental well-being" [19].

Benefits of physical activity and exercise do not only limit to individuals' health. Taking part in sports also increases opportunities for socialization and it has a positive impact on the community and society by promoting social interaction and cohesion. According to WHO study on physical health, engaging in physical activity helps to maintain good mental health, "by reducing individuals' stress reactions, anxiety and depression and by possibly delaying the effects of Alzheimer disease and other forms of dementia" [20].

Promoting physical activity also has a positive environmental impact when individuals do more walking or use bicycles over motored vehicles [21]. By Promoting the benefits of physical activity to EU citizens may have a significant financial impact. Statistics reveal that in 2017 low physical activity rates accounted for almost 152,000 deaths and more than 2.1

million Disability-Adjusted Life Years. This physical inactivity costs the EU 80.4 billion euro per year, through four major non-communicable diseases [22].

2.5 Summary

Statistics by European Commission show that between 2016 and 2060 the share of people over 65 years old from the total population will rise from 19.3% to 29.0%. This will add severe financial problems to members of the European Union not only because of the rising numbers of elderly people, but also beacause the amount of the working population (15-64 years old) will decline 11.6% at the same time.
That is one of the key reasons for keeping citizens of the EU healthy and functional. By doing that some of the citizens' working careers may last longer and this could contribute to EU member economies. In addition to ageing population of the EU members, its citizens are being less active in physical activity and exercise according to WHO. This will also add to the concern of financial stability in the EU because healthcare costs will rise. At this rate EU Member countries pensions, healthcare and long-term care systems are at risk by becoming economically unsustainable.
Less active individuals tend to have more weight issues. Statistics show that 51.6 % of the EU population in 2018 is overweight (18–64 years old) [17]. The health effects of overweight and obesity are significant, as they increase the risks of chronic diseases such as hypertension, coronary heart diseases, certain cancers, type-2 diabetes and cardiovascular disease. Weight problems can be linked to various psychological problems for specific individuals. This situation has a substantial direct and indirect economical cost that puts a considerable strain on EU Members healthcare and social resources.
Promoting benefits of physical activity and healthy nutrition could have a significant impact on the issue of inactivity and weight problems. There is growing evidence that engaging in regular physical activity is associated with better overall health and well-being and a reduced risk of developing non-communicable diseases.
In addition, healthy nutrition might have significant health benefits like reducing the risk of developing noncommunicable diseases and becoming overweight or obese. WHO's 'active ageing' would be a direct compensation for rising pension and sickness costs. The theme of 'active aging' supports the claim for physical, mental and social well-being. According to the study, the following can be affected by active aging:

- significantly reduces the number of deaths of able-bodied people.
- reduce premature incapacity for work due to chronic diseases.
- more older people can maintain a high quality of life and enjoy life.
- people are more likely to become an active part of social, cultural and economic society.
- reduced treatment costs and treatment services [23].

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3

Mental Health and Quality of Life assessment of Adults and Older People

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Mental Health and Quality of Life Assessment of Adults and Older People

3.1. Introduction

This chapter is devoted to mental health issues. Mental health and well-being are as important in older age as at any other time of life. Mental and neurological disorders among older adults account for 6.6% of the total disability for this age group. Approximately 15% of adults aged 60 and over suffer from a mental disorder. (WHO, 2017). The content of the chapter shows the mental health characteristics of the elderly people, mental health and quality of life assessment methods in older people and it develops recommendations for maintaining mental health in the elderly. In the chapter "Mental health and quality of life assessment of adults and elderly people" mental health problems are described from different points of view. The chapter is divided into 8 subsections. In the first subsection the concept of mental health is analysed. In the second subsection the main physiological characteristics of elderly people are discussed. The physiological peculiarities of an organism are closely connected with a person's mental health. In the third subsection psychological and mental health characteristics of elderly people are discussed. In the fourth subsection the most typical mental health disorders of elderly people are analysed. The fifth subsection gives an insight into mental health and quality of life assessment methods of elderly people. In the sixth subsection, the influence of lifestyle and physical activities on the mental health of elderly people is revealed. The seventh subsection shows the relationship between physical activity and cognitive function in the elderly. Eighth subsection is devoted to recommendations to keep mental health of adults and elderly people.

3.2. The concept of mental health

Mental health includes our emotional, psychological, and social well-being. It affects how we think, feel, and act. It also helps determine how we handle stress, relate to others, and make choices. Mental health is an integral and essential component of health. The World Health Organization constitution states: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (Mental health: strengthening our response, 2018). An important implication of this definition is that mental health is more than just the absence of mental disorders or disabilities. Mental health can affect daily life, relationships, and even physical health. Mental health also includes a person's ability to enjoy life – to attain a balance between life activities and efforts to achieve psychological resilience (Newman, 2017).

According to Medilexicon's medical dictionary, mental health is: "Emotional, behavioral, and social maturity or normality; the absence of a mental or behavioral disorder; a state of psychological well-being in which one has achieved a satisfactory integration of one's instinctual drives acceptable to both oneself and one's social milieu; an appropriate balance of love, work, and leisure pursuits" (MediLexicon: Medical Abbreviations, 2020). According to the World Health Organization "Mental health is a state of well-being in which an individual realizes his or her 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" (Mental health: strengthening our response, 2018).

Promoting mental health should be part of promoting healthy ageing. A change in perspective to focus on an upstream approach is needed in mental health. Including mental health in elderly policies is an essential first step to ensure better health and quality of life of any elderly population (Ganga, 2016).
In older adulthood a variety of losses (for example, changes in roles, living arrangements, ability to perform certain activities, deaths of loved ones), chronic illnesses, cognitive, functional and sensory impairments as well as physiological changes of normal aging directly influence the risk of developing a mental health condition as well as the course of that condition. While these circumstances can occur at any time during a person's life, they are more likely both to occur and to be a consistent presence in the life of an older adult. If the older adult is not able to cope effectively with the cumulative effects of these stressors, mental health concerns may be triggered or perpetuated (Krajci et al, 2019).

3.3. Aging and physiological characteristics of older people

Ageing is associated with changes in dynamic biological, physiological, environmental, psychological, behavioral, and social processes. Some age-related changes are benign, such as gray hair. Others result in declines in the function of the senses and activities of daily life and increased susceptibility to and frequency of disease, frailty, or disability. In fact, advancing age is the major risk factor for a number of chronic diseases in humans (Understanding the Dynamics of the Aging Process, 2020).
The aging process has an individual character. The dominance of degradation changes in a particular physiological system determines the type of aging – cardiovascular, endocrine, nervous or metabolic. Typically, the aging profile is determined by the parameters of the cardiovascular, respiratory, muscular system, nervous and mental performance, the state of analyzers system (Pavlova et al, 2014).
Aging affects living organisms and produces a continuous degenerative change in most physiological functions, specifically in body composition. The research was carried out to compare the differences of body composition and physiologic characteristics according to physical activity levels and population of different geographical locations between active elderly participants of a Pilates-Aerobic interventional program and inactive elderly participants. The results of research showed that elderly people have different physiological and body composition characteristics by a level of physical activity and the population in which they live. Active female participants who live in small areas where the number of inhabitants is limited how the best physiological state to cope with aging (Ruiz-Montero & Castillo-Rodríguez, 2018).
Aging causes changes in sensory systems that affect the balance and can lead to falls and severe injuries (Sturnieks et al, 2008). Balance is a fundamental skill that is often compromised with advancing age (Shkuratova et al, 2004). Postural control represents a complex interplay between the sensory and motor systems. Structural and functional declines of the somatosensory system occur with aging and potentially contribute to postural instability in older adults. Clinical evidence suggests that aging results in: 1) diverse and non-uniform declines in the morphology and physiological function of the various sensory structures, 2) preferential loss of distal large myelinated sensory nerve fibres and receptors, and 3) impaired distal lower-extremity proprioception, vibration and discriminative touch, and balance (Shaffer & Harrison, 2007). The studies demonstrate that older men are characterized by poorer balance parameters in the area of anteroposterior displacement of the centre of foot pressure (Wišniowska-Szurlej et al, 2019).

It is recognized that the body temperature of older men and women is lower than that of younger people and that their tolerance of thermal extremes is more limited. The regulation of body temperature does not depend on a single organ, but rather involves almost all the systems of the body, i.e. systems not exclusively dedicated to thermoregulatory functions such as the cardiovascular and respiratory systems. Since these deteriorate naturally with advancing age, the decrement in their functions resonates throughout all the bodily processes, including those that control body temperature. To the extent that the age-related changes in some of these, e.g. in the musculoskeletal system, can be slowed, or even prevented, by certain measures, e.g. fitness training, so can the decrements in thermoregulatory functions. Some deficits, however, are unavoidable, e.g. structural skin changes and metabolic alterations (Blatteis, 2012).

Hypertension, diabetes, and obesity, especially abdominal, and at least some other risk factors appear to be shared between frailty and cardiovascular disease (Piotrowicz & Gąsowski, 2020). Diabetes is one of the major public health problems in the world and one of the leading causes of morbidity and mortality from cardiovascular and chronic kidney disease. Aging of the population is expected to further increase the prevalence of type 2 diabetes, particularly in the age group over 65 (Vrdoljak & Pavlov, 2014). Appropriate management of diabetes includes following a healthy lifestyle, in which reaching physical activity recommendations is an important factor (Pizzol et al, 2019).

Age-related changes in the central nervous system include neuronal loss, demyelination, and deficits in cognitive function (Sims-Robinson et al, 2013). The important structural modifications occurring in brain aging are myelinated fibers damage in nerve fibers and iron accumulation in gray matter nuclei (Guerreri et al, 2019). Ageing is associated with specific impairments of learning and memory. These impairments can be caused, at least partly, by altered synaptic plasticity mechanisms, including deficits in the induction and maintenance of long-term potentiation (Foster, 2012). Synaptic plasticity in the adult brain is believed to represent the cellular mechanisms of learning and memory. Mitochondria are involved in the regulation of the complex processes of synaptic plasticity. Mitochondria are essential components of synaptic activity, mainly because of their functions as energy producer and calcium buffering organelles (Todorova & Blokland, 2017). The relation between mitochondrial dysfunctions and impaired synaptic plasticity in the old brain suggests a key role for mitochondria in the process of memory decline with aging. The oxidative stress or free radical theory of aging suggests that free radicals cause oxidative damage to proteins, DNA, and lipids, and that this damage accumulates over time (Van Remmen et al, 2003).

There are two ageing processes, one physiological, also known as normal ageing, and that of pathological ageing, which depends on the occurrence of chronic diseases. The essence of the former is a gradual, progressive, and a very individual restriction of the organs' functional reserve with age. The changes occur in all cells, tissues and systems and do not affect each organ at the same time, and the rate of change can vary between organs (Kenig, 2019).

3.4. Psychological and mental health characteristics of older people

Old age is a worldwide phenomenon, generally accompanied by a number of problems that the aged have to face and get attuned to. There is a great body of evidence of a rise in morbidity, mortality, hospitalisation and loss of functional status related to common mental disorders in the elderly patients. Overlap of depression and anxiety is very common in older adults, with up to almost half of the elderly patients reporting significant depressive and anxiety symptoms (Parker, 2015). Older adults face a variety of mental health concerns, including depression, anxiety, substance use, trauma, serious mental illness, and personality

disorders. Hoarding is also a significant concern garnering increasing attention. When considering the mental health needs of older adults, it is important to acknowledge that mental health conditions often occur with each other (Krajci et al, 2019).

There may be multiple risk factors for mental health problems at any point in life. Older people may experience life stressors common to all people, but also stressors that are more common in later life, like a significant ongoing loss in capacities and a decline in functional ability. For example, older adults may experience reduced mobility, chronic pain, frailty or other health problems, for which they require some form of long-term care. In addition, older people are more likely to experience events such as bereavement, or a drop in socioeconomic status with retirement. All of these stressors can result in isolation, loneliness or psychological distress in older people, for which they may require long-term care (Mental health of older adults, 2017). Older people with common mental health conditions are more likely to be on drug therapies and less likely to be in receipt of talking therapies compared to other age groups. Older people themselves may be reluctant to seek help – with fewer than one in six older people with depression ever discussing it with their physicians (Mueller et al, 2017). In primary care, anxiety disorders are very common in older people (most often coupled with a life-long history of anxiety which the factors associated with ageing may not have helped, or, in consort with depression). However, it is much less common to see a disorder as a new presentation with anxiety as the primary diagnosis. Anxiety can be a presenting feature of dementia, depression, and physical illness, and should always prompt investigations to exclude any underlying medical cause (especially new onset anxiety and panic disorder). Common causes are myocardial infarction, arrhythmia, thyroid disorders and vitamin deficiencies (Mueller et al, 2017).

There is a mild decline in overall accuracy, beginning in the 60s, that progresses slowly, but sustained attention is very good in healthy older adults. Older adults are more easily distracted, especially if irrelevant information is presented concurrent with important material (Besdine, 2008). Memory changes occur during ageing. Sensory memory is the earliest stage (visual, auditory, tactile); it is inherently unstable and decays rapidly. Primary (short-term) memory is the stage after transfer of sensory memory. There is no loss with age. Secondary (long-term) memory persists for hours, days and years. There is a decline with age, mostly in free recall; recognition is well preserved. The universal temporary decline in the ability to retrieve names generally begins early in middle age, and worsens over time. Distraction interferes with learning more in older persons than in young people(Besdine, 2008). Syntactic skills -the ability to combine words in meaningful sequences show no decline with pure aging. Crystallized intelligence (learning and experience) remains stable or improves with age until the late 70s or beyond, especially in those who remain healthy and engaged in cognitively demanding activities. Fluid intelligence (problem-solving with novel material requiring complex relations) declines after adolescence. Perceptual motor skills (timed tasks) decline with age (Besdine, 2008).

A large deficit at the level of daytime activities is associated with the progressive worsening of cognitive and functional deterioration in older people, resulting in the loss of levels of autonomy and the capability to satisfy their own needs. The high overall number of needs of the elderly with dementia and the high level of psychological distress of their carers highlight the importance of taking into account the suffering of carers and the need to provide supportive interventions to maintain their emotional well-being and enable them to provide high quality care (Passos et al, 2012).

The research recommended that education provide for lifelong learning and the opportunity for flexible participation and account for prior nonacademic learning experiences (Borthwick, 1983). Recommendations for the learning environment included compensations

for vision and hearing loss, learning aids, and teaching in the affective domain. The literature suggested that as the older segment of the population grows and increasing numbers of them participate in all forms of educational programs, the negativism about older persons and ageing must be eliminated and opportunities must be created to make older learners' participate in higher education (Borthwick, 1983). Spirituality and mental health are the most significant predictors of death anxiety.

It is likely that people who are more spiritual may be open-minded, where the role of mindfulness and meditational approaches to life may enable people to cope with the prospect of or when faced with death (Jo, & Song, 2012). Death anxiety refers to "the state in which an individual experiences apprehension, worry, or fear related to death and dying" (Carpenito-Moyet, 2008). With respect to gender, the present findings suggest that elderly women have shown higher levels of death anxiety in comparison to men (Sharma et al, 2019). There are various factors that could influence the extent to which a person experiences death anxiety such as age, gender, religious and spiritual beliefs, living arrangements, locus of control, health and social support (Jo, & Song, 2012). The results of research demonstrate a close correlation between quality of life and depressive mood in the elderly. The early detection and effective management of affective and cognitive symptoms in the elderly can not only restore mental health but may also improve their quality of life (Voros et al, 2019).

3.5. Mental health disorders of older people

Older people are seen as people who are more susceptible to mental health problems and are therefore recognized as a vulnerable group (World health statistics, 2013). Older adults are more likely to experience certain life stressors (eg. chronic illness, death of a loved one) that may increase their risk of developing a mental health disorder. The most prevalent mental health disorders among older adults include anxiety, depression, and dementia (Sorocco &, McCallum, 2006). The prevalence of dementia increases with age. In adults over age 65 the prevalence of dementia is 5% to 7% and the rate increases to 30% in adults over age 85 (What Practitioners Should Know About Working with Older Adults, 1998). Alzheimer's disease and vascular dementia are the most common types of dementias. Other conditions associated with psychological distress that may be observed in adult patients include: adjustment disorders, chronic pain, delirium, sexual dysfunction, sleep disorders, hypochondriasis, substance use/abuse disorders, personality disorders, bereavement, elder abuse, and age-related cognitive decline (What Practitioners Should Know About Working with Older Adults, 1998). Older adults with a mental health disorder, particularly depression, are most likely to be identified, diagnosed, and receive treatment from their primary care physician (Kaplan et al, 1999). So primary care physicians need to be equipped with the appropriate tools and interventions to assess and treat mental health disorders of elderly people. The following are validated assessment measures to screen for the most prevalent mental health disorders in older adults: anxiety screening, depression screening, brief cognitive screenings. Some of these screening tools can be completed by patients as part of the routine paperwork. If the screen is positive for a mental health disorder, refer the patient to a specialist, such as a geropsychologist or geriatric psychiatrist, for further evaluation and treatment (Sorocco &, McCallum, 2006).

General practitioners play a pivotal role in dementia recognition, yet research suggests that dementia often remains undetected in primary care. Lack of knowledge might be a major contributing factor to low recognition rates. Alzheimer's disease is the most common dementia form, and it is followed by vascular dementia (Imre et al, 2019). Alzheimer Disease is a chronic, progressive, and a degenerative type of dementia. More than 50% of dementia

cases are Alzheimer type. Besides this degeneration, lack of acetylcholine in the limbic system is affecting higher cortical functions, memory and learning capabilities. Alzheimer Disease lasts more than 8-10 years, beginning with mild cognitive impairment to terminal stage. This process is classified as "early", "mid" and "late" stage of the disease. The beginning of the degeneration is estimated to be 15-20 years before onset of the clinical manifestations. Therefore preventive measures have higher priorities than the treatment of this condition. A differential diagnosis of dementia needs to be done after onset of the manifestations and symptoms to begin appropriate management with pharmacotherapy (Tanelı, et al, 2010). With the enlarging proportion of ageing population, the incidence of Alzheimer's disease (AD) has been increasing. Nearly 1 million new cases will be found every year and the number of new cases is increasing year by year. Increased risk of AD may be associated with higher age among senior citizens in urban communities. Lower education level and monthly family income, family history of dementia and physical inactivity may all lead to the development of AD (Wang et al, 2019). Lifestyle modification using aerobic exercise and dietary modification represents one of the primary treatment modalities used to mitigate Alzheimer's disease risk, with an increasing number of trials demonstrating that exercise and dietary change, individually and together, improve neurocognitive performance among middle-aged and older adults (Smith, 2019).

Anxiety disorders are a group of mental illnesses, characterized by significant feelings of anxiety and fear. Anxiety disorders cause instability that results in increased use of healthcare services and diminished quality of life for patients and their caregivers. Among older persons the most common are generalized anxiety disorder and panic disorder (Dugue et al, 2002). Effective treatment of anxiety disorders involves a combination of cognitive-behavioural therapy and pharmacotherapy.

Studies suggest that deficits in auditory processing predict cognitive decline and dementia. Older adults with cognitive impairment not only have difficulty with competing acoustic signals but may also show poor temporal processing. The profile of auditory processing deficits among older adults with cognitive impairment may include multiple domains (Edwards et al, 2017).

Epilepsy is one of the most common neurological problems affecting approximately 1% of the world's population with higher incidence among elderly individuals. Some antiepileptic drugs (lamotrigine and valproate) as monotherapy, or in combination, in addition to their anticonvulsant effects, improve mental disorders, especially symptoms of depression and anxiety, social interaction and general well-being of patients. A multidisciplinary approach turned out to be vital in treating the patients affected by epilepsy and comorbid mental disorders in order to improve their quality of life (Grahovac et al, 2011).

The negative impact of depression on patient life quality is well known since it causes various psychosocial problems. A broad range of effective treatments like medication and social-psychological treatments were used used for depression. Therefore, based on age, the degree of using these treatments may vary. The results of the research have shown that group therapy - counseling based on although approach greatly influences the reducing of elderly people's depression (Selehi, 2013). Participating in group sessions of although therapy can work as a social activity. Generally speaking, through participation in group sessions, seniors exchange their ideas, find meaning in life and take the responsibility of past experiences, and these activities are influential in reducing depression.

Positive effect of physical activity on mental health has been proven by scientific research, whereas the quality of life scale is an important instrument for the assessment of the overall functioning of people with mental disorders (Leleikienė et al, 2018). Quality of life of patients with depression partially depends on physical activity at home, activities of daily living and

activities at work. Any kind of physical activity is an important part of personal behaviour that improves the quality of life. Statistically significant relationships between quality of life domains show that general health perception and social functioning improve with higher vitality (Leleikienė et al, 2018). Studies show benefits of music therapy in improving emotional well-being in older adults with chronic diseases. Listening to music, playing an instrument, singing, or a combination of these is useful in relieving depression and improving overall mood (Quach & Lee, 2017).
Physical and mental activity, personal autonomy, a wide range of activities, and avoiding isolation and solitude allow people to experience quality ageing; all these factors can be substantially influenced by the status acquired at a younger age. It is extremely important for the society to develop guarantees for active old age, which would ensure the optimal balance between the possibilities of physical and mental health, social participation and safety (Czibere et al, 2017).

3.6. Mental health and quality of life assessment methods of older people

An assessment is a comprehensive review of a person's mental, physical, environmental and financial condition. This helps to establish his or her ability to remain safely independent and identifies risks and ways to reduce them. Families can conduct assessments on their own but may want to hire an experienced professional to lead them through this process. Professional assessments can take a few hours to several days and vary depending on the level of care needed. All assessments should include a thorough review of a person's physical and mental health; medication use; daily routine; home and community safety; support system; appearance and hygiene; finances and personal interests (How to Assess Your Loved One's Situation, 2010).

Assessment checklist includes physical health, mental health, medication use, daily living, home and community safety, support system, appearance and hygiene, finances and interests (see Figure 1).

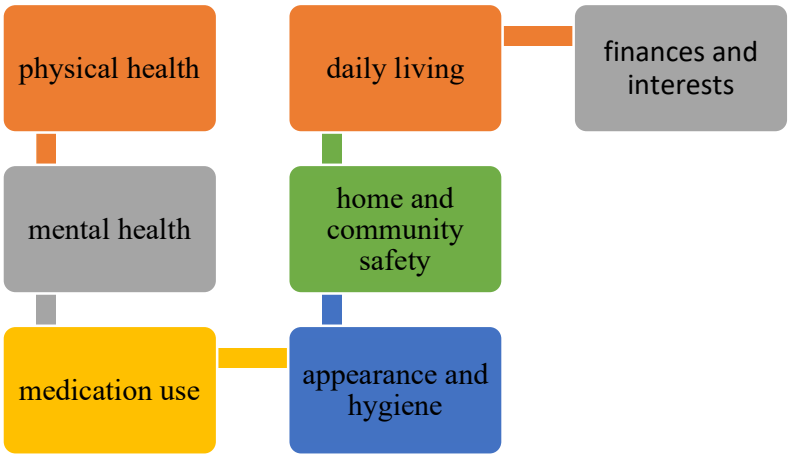

Figure 1. Assessment checklist of senior mental health.

Physical health. Take note of these factors; you may need the help of the elderly person's doctor. Diagnosis of any chronic disease such as diabetes, high blood pressure, arthritis, emphysema, or stroke. Unusual weight loss or gain in a short amount of time. Incontinence. Balance problems: How steady is the person while walking? Persistent fatigue or

sleeplessness. Swollen feet or legs, or limping. Vision problems such as cataracts or use of vision aids. Hearing problems: Is there a need for a hearing aid? If there is one, is it being worn? Dental problems including gum disease, halitosis and ill-fitting dentures. Complaints of pain. List of health professionals being seen.

Mental health. Take note of these factors; a primary care doctor can help, but a geriatric psychiatrist or neurologist might be more helpful. Diagnosis of any psychiatric disorder such as depression, anxiety disorder or psychosis. Diagnosis of Alzheimer's or other forms of dementia. Recent hospitalizations for any of these problems. Mood swings, including rage or hostility. Forgetfulness or wandering off. Sadness or loneliness. Decreased interest in reading, writing and communicating. Difficulty in maintaining friends. Decreased interest in life.

Medication use. List all medicines taken, prescription or over-the-counter, with frequency and dosage. List all herbal remedies, supplements, traditional home remedies or vitamins being used. Is the person able to take medications as directed and avoid interactions? Are there any barriers to proper medicine use, such as forgetfulness, expense, poor understanding of purpose and results of use?

Daily living. List special dietary needs and favorite foods. Describe ability to dress, bathe, get up from a chair, use the toilet, use the phone, climb stairs, get help in an emergency, shop, prepare meals, do housework and yard work, and drive safely.

Home and community safety. Consider neighborhood safety. Consider home safety: Are there throw rugs? A need for handrails in the bathroom? Does the residence have working smoke alarms? Is the person able to avoid telephone and door-to-door fraud? What level of maintenance do the yard and house require?

Support system. Know contact information for key family members, friends, neighbors and clergy. Does the person have visitors or is he or she able to visit friends and family? Is he able to visit a senior center? List membership in organizations and groups.

Appearance and hygiene. Factors to assess: Personal hygiene. Overall appearance. Oral care. Trimmed nails. Well showered and shaved Combed hair. Clean clothes. Appropriately dressed for weather and occasion.

Finances. Factors to assess: Insurance coverage. Long-term care coverage. Total assets. Legal documents including trusts, living wills and durable powers of attorney. Is there an attorney who knows this person?

Interests/lifestyles. Hobbies. Reading preferences: Are glasses or larger-print books needed? Would books on tape be enjoyable? Favorite TV and radio programs. Exercise — gardening and walking count! Musical instruments played. Languages spoken, and is there a preferred language? Favorite conversation topics. Travel experience. Important life events. Religious/spiritual background. Accomplishments. Social activities (How to Assess Your Loved One's Situation, 2010).

Life satisfaction is a broad concept and has been measured by using different instruments. One of the instruments that measure life satisfaction specifically in older adults, considering the entire domain of this concept, is the Life Satisfaction Scale (LSS). The LSS is a revised version of Life Satisfaction in the Elderly Scale developed by Salamon and Conte in 1984. This is a longstanding measure of life satisfaction with optimum psychometric properties (Salamon & Conte, 2003). The LSS has been proved to be convenient and user-friendly to administer. The Persian version of the LSS was worked out and psychometric properties of the LSS were evaluated. It was concluded that the Persian version of the Life Satisfaction Scale is a reliable and valid instrument for measuring life satisfaction in the Iranian older adults (Manije et al, 2018).

Mental health is closely connected with quality of life. Measuring the quality of life of older persons can assist health professionals in achieving a number of important objectives. These

include assessing the effects of illness and treatment, identifying the need for support services, and developing health enhancing environments (Raphael et al, 1995).
Comfort care provides some relief of symptoms if a person has a disease that cannot be cured. When a patient is in the early stages of a life-threatening illness, the goal is to cure the disease. When a cure is not possible, the focus is on quality of life and managing symptoms. Comfort care helps manage symptoms such as tiredness, shortness of breath, nausea, and vomiting. It also helps with pain control. It may include treatments such as chemotherapy, radiation, and surgery to give some relief from symptoms and improve the quality of life. Comfort care programs also try to help with mental health and spiritual needs (RelayHealth, 2013).

3.7. Influence of lifestyle and physical activities on mental health of adults and older people

Lifestyle is one of the most important factors that influence a person's quality of life (Huk-Wieliczuk et al, 2005). Nowadays with highly developed information and communication technologies, people of all ages, and even adults' physical activities are dramatically decreasing. In many countries of the world obesity and overweight are rapidly growing (Saavedra, Ferre, 2008). Depending on the length of hyperkinesis, effects of inactivity can be different, ranging from minor disorders of certain systems of the body and ending with the forming of pathological conditions. A sedentary lifestyle increases the risk of a variety of diseases: cardiovascular disease, type II diabetes and certain types of cancers (Jorgensen, 2001). Low physical activities increase fat tissue, wich results in metabolic disorders and atherosclerotic changes (Saavedra, Ferre, 2008). People who regularly go into sports improve cardiovascular and skeletal fitness, metabolism, change behaviour and reduce the likelihood of depression (Malina, 2005). Various morphological, functional and adaptive changes occur in the human's body during the training process.
Generally, older adults are considered the most physically inactive segment of the population. The main reasons for the physical inactivity among older people are the presence of diseases, fear of injury and falls, lack of energy and weakness, low level of motivation, lack of partners or friends for joint activities, etc. The studies have shown that regular practice of Nordic walking improves the quality of life for both elderly and old people (Bashkireva et al, 2018). The benefits of physical activity in preventing premature mortality have been established by a large set of epidemiological studies. Furthermore, the reduction of acute events such as myocardial infarction observed with higher levels of physical activity together with the increase in disease-free life expectancy among the most active individuals supports physical activity's anti-aging effect (Charansonney, 2011). It is proposed to choose physical exercises according to the biological age of elderly people, their aging profile, the presence of disease and physical activity level. Optimal intensity and character of exercise are established for the old adults with and without chronic pathological diseases. The feeling of well-being or heart rate indexes can be used for control by physical training (Pavlova et al, 2014). The results of the research have shown that older active females had better achievements in motor and psychological tests, which could be translated into better physical overall fitness and preparedness for doing everyday activities in comparison to the non-active female group (Prosoli et al, 2015). The research on elderly people in a southwestern region of the United States revealed that elderly people in the poorest health were older than 75 years, had less than a high school education, were retired or unemployed, and had low household income (Borders et al, 2004).

Lifestyle may be one of the factors largely responsible for compromising the health of elderly people. It has been suggested that sleep disorders increase along with increases in the incidence of various physical disorders in elderly people. Lifestyle, such as exercise, walking and taking short naps related to the maintenance of a good quality of wakefulness (Uezo et al, 2000). The results of the research indicate that the protective factors for good mental health and cognitive functioning in older Croatian workers are being employed, having more education, living with a partner in the household, and being healthier (Bjelajac et al, 2019). The findings of the research revealed that four factors significantly predicted the quality of life of older Malaysian people, which include self-rated health, gender, employment status, and level of education. Self-rated health and level of education had significant positive effects on perceived quality of life; elderly women and employed older persons were more likely to fall in the poor perceived quality of life group. The findings of the research posited that self-rated health and level of education have significant positive effects on the perceived quality of life; being female and employed is related to lower quality of life of an older person living alone (Yahayaet al, 2010).

Although physical activity is a key factor for healthy ageing, many older people lead a sedentary lifestyle. Traditional physical activity interventions do not consider the specific needs and views of older adults. A 'views-on-ageing'-component within a physical activity intervention affects change in physical activity via change in views on ageing (Wolff et al, 2014). The role of social capital in health promotion stresses empowerment, intergenerational support, the building of social trust, and the need to tackle loneliness among older adults. The community/social participation is a key contributor to the maintenance and promotion of a healthier ageing population. Supporting long-term social capital building within communities can lead to improved public health and well-being for an ageing population (Koutsogeorgou et al, 2014). Kinesiologists and other health professionals have an important role in the implementation of active aging strategies and policies (Chodzko-Zajko, Schwingel, 2009).

Physiological function and capabilities deteriorate with aging, and all body systems show decline. Research indicates that physical activity throughout the life span can buffer, to a great degree, the detrimental effects of the aging process, and health educators and practitioners should promote the benefits that properly designed physical activity can provide to this special population (Hyman et al, 2010). The lifestyle Interventions and Independence for Elders trial showed that older adults who follow a structured physical activity program can reduce mobility disability by up to 28 percent, with topics mentioned such as gerontology, group-based community interventions, and quality of life (Friedman & Friedman, 2019). The research has shown that physical activity among the older population of Bulgaria is a matter related to health prevention, improving the quality of life and recovery after illness. Medium intensity workout or a daily walk outdoors would help not only to improve their fitness level but also to maintain the necessary mental health and social activity (Tumanova, 2019). The research in Spain revealed that physical exercise, whether it be the strength program or the multi-calisthenics program, is an effective method for improving and maintaining health, cognitive state, functional independence and stability in frail-aged institutionalized people (Mollinedo Cardalda et al, 2019).

3.8. Physical activities and cognitive functions of older people

Different researches suggest that physical activity is closely connected with mental health and cognitive processes. There is evidence that close connection between physical activity and cognitive functions of humans exists in different age periods especially for old age people.

Due to the growing the ageing populations in many countries throughout the world, there is an increasing interest in lifestyle factors and interventions that will enhance the cognitive vitality of older adults and reduce the risk for age-related neurological disorders, such as Alzheimer's disease. A.F. Kramer and , K.I. Erickson (2007) have found that physical activity enhances cognitive and brain function, and protects against the development of neurodegenerative diseases. Authors (Kramer, Erickson, 2007) discuss future directions to address currently unresolved questions, such as interactions between multiple lifestyle factors on offsetting or protecting against cognitive and neural decline. They conclude that physical activity is an inexpensive treatment that could have substantial preventative and restorative properties for cognitive and brain function.

Physical activity has been shown to benefit brain and cognition in late adulthood. Research using multiscale entropy analysis (MSE) of electroencephalography (EEG) suggests that physically active elderly adults had better accuracy on both visuo-spatial attention and working memory conditions relative to their sedentary counterparts. Additionally, these physically active elderly adults displayed greater MSE values at larger time scales at the frontal (Fz) electrode in both attention and memory conditions (Wang et al, 2014).

D. G. Miranda and joint authors carried out investigations on 1241 respondents in the age of 62-85 years. The questionnaire about physical activity in the age of 15-25 was carried out for these people (Miranda et al, 2003). The authors found a correlation between physical activities in previous years and cognitive functions. The results of the investigation showed positive correlation between physical activity in previous years and speed of information processing for men.

Working memory is considered as the main aspect of cognitive control because individuals need to hold and manipulate information in their mind to coordinate goal-directed behaviours in a variety of cognitive contexts (Diamond, 2006). Combined physical and mental exertion results in significant changes in EEG theta power and network organization in healthy adults. Analysis of EEG data showed that there was an increase in theta power associated with the graded working memory task (anti-saccade and serial addition task) combined with graded exercise task (cycling on a stationary bicycle task) and increase in functional connectivity in the frontal regions of the brain compared with anti-saccade and serial addition task only (Porter et al, 2018).

Although many investigations have showed a connection between physical activities and improvement of cognitive functions, the biological mechanisms which provide it are not completely clear. It is ascertained that physical activities promote synaptogenesis (development of new synapses between nerve cells) and angiogenesis (development of blood vessels in the brain) (Lista, Sorrentino, 2010). Electrophysiological investigations have shown that high levels of physical activity correlates with improvement of functional connections between different structures of the brain.

3.9 Recommendations to keep mental health of adults and elderly people

The mental health of older adults can be improved through promoting active and healthy ageing. Mental health-specific health promotion for older adults involves creating living conditions and environments that support wellbeing and allow people to lead a healthy life. Promoting mental health depends largely on strategies to ensure that older people have the necessary resources to meet their needs, such as: providing security and freedom; adequate housing through supportive housing policy; social support for older people and their caregivers; health and social programmes targeted at vulnerable groups such as those who live alone and rural populations or who suffer from a chronic or relapsing mental or physical

illness; programmes to prevent and deal with elder abuse; and community development programmes (Mental health of older adults, 2017).

Good general health and social care is important for promoting older people's health, preventing diseases and managing chronic illnesses. Training all health providers in working with issues and disorders related to ageing is therefore important. Effective, community-level primary mental health care for older people is crucial. It is equally important to focus on the long-term care of older adults suffering from mental disorders, as well as to provide caregivers with education, training and support. It is important to prepare health providers and societies to meet the specific needs of older populations, including: training for health professionals in providing care for older people; preventing and managing age-associated chronic diseases including mental, neurological and substance use disorders; designing sustainable policies on long-term and palliative care and developing age-friendly services and settings (Mental health of older adults, 2017).

There are different factors that influence a person's mental health – biological, psychological, social, family and environment (see Table 1). Each group of factors plays an important role in maintaining mental health. It is very important to ensure that all of these factors have a positive impact on mental health.

Table 1. Factors that contribute to mental health

Biological factors	Psychological factors	Social factors	Family	Environment
Physical health. Physical activities. Proper nutrition. Cognitive activities.	The joy of life. Ability to cope with stress. Self-awareness. Flexibility.	Social support. Important social role. Stability.	Family support. Good family relationships. Unity in family.	Safety. Access to help. Possibility to have fun.

Extension professionals may be uniquely positioned to provide programming to help older adults age in place. Aging in place programming may help improve quality of life for older adults and their family members and caregivers (Peek & Bishop, 2016).

Exercise is a well-established treatment for depression, and its use in clinical care must be supported by consumers and clinicians. The high level of support for accredited exercise physiologists is evidence of the effectiveness of health promotion campaigns from peak exercise professional agencies (Stanton et al, 2019).

Mental Health Europe is the largest independent network organisation representing mental health users, professionals and service providers across Europe. Mental Health Europe has worked out recommendations to the European Union member states on how to solve mental health problems of elderly people. They are the following: to support early and effective diagnosis schemes when relevant, treatment, support and prevention, with adequate funding at all levels; to increase the use of individual therapy for the bereaved and interventions using for example cognitive behaviour techniques and psychotherapy as these are potentially cost-effective and show decreases in depressive symptoms; to put a focus on ensuring that national and local prevention strategies and initiatives identify older people as a priority group. They should amend presently running prevention strategies and they should develop new programmes that include the elderly; to offer mental health education and outreach in locations frequented by older adults and their families, including rural areas; to work on the training of practitioners in mental health services to recognise and respond to older people's mental health needs; to ensure that mental health issues of elderly people and the way to

prevent them are better known. Fortified awareness-raising activities (also at local level) are necessary and should be supported financially (Ageing and mental health – a forgotten matter, 2014).

It is important to explain practical ways to help seniors to stay mentally well (How to look after your mental health in later life, n.d.):

- Be prepared for changes.

Both getting older and retirement both involve a change in lifestyle for most people. Be ready to retire. Being retired doesn't mean you aren't still busy. Find a sense of purpose, if your work or career is a major part of your life, consider how to deal with the changes.

- Talk about problems and concerns.

Social interaction is important for maintaining your wellbeing. Talk to friends, family, someone with special knowledge, counsellor. Talk about feelings, emotions and everyday events. It is also very good to listen and learn as well – if you don't want to talk about yourself, ask others how they feel.

- Ask for help.

Support from family and friends is invaluable. However, they may lack the special knowledge seniors need despite their best intentions. Asking for help can be harder. Ask for practical help and ask for emotional help. Counselling offers the opportunity to talk about issues in confidence. As well as advice from official sources, there are also networking sites, Internet forums and chatrooms where seniors can share their experience with others facing the same issues.

- Think ahead and have a plan.

Allowing an issue to become a constant worry can be bad for our mental wellbeing. Having a plan to deal with it puts us back in charge and can help improve how we feel. A plan can help you think through all the aspects of a problem or situation. By preparing a plan, you are likely to expose and deal with many of your worries in advance. Your plan should have a clear aim. Don't forget to use your plan and be flexible because not everything can be planned for.

- Care for others.

As we get older, we may find ourselves looking after grandchildren, elderly parents, partners, friends, or neighbours. Caring for others can keep relationships strong and people close. Helping others makes us feel needed and valued, and it boosts our self-esteem. Try not to overburden yourself with care responsibilities. Hard though it seems, it is alright to say 'no'.

- Keep in touch.

Friends can keep you on track when life is difficult. Friendship takes time, and sometimes effort, but having friends is a positive way to maintain good emotional health. Don't lose touch with the people who are important to you – it's never too late to get back in touch with old friends. Technology has had a big impact on the way we communicate. Explore keeping in touch by phone, email, webcam, Skype, Facebook, or letter. Keeping in touch with friends is also about considering what is good for them.

- Be active and sleep well.

Staying active and sleeping well are proven ways to look after our wellbeing. Physical acitivities have to be regular. Being active doesn't have to cost much money. In the longer term, trouble sleeping can lead to mental health problems such as anxiety, stress and depression. Good sleep doesn't just mean lots of sleep, as the amount of sleep that each person needs is different. Keeping your mind active is important, too - tackling puzzles, like crosswords, playing games, like chess, bridge or bingo, reading a book, magazine or newspaper and going on a course or learning a new skill is very important.

- Eat and drink sensibly.

What we eat and drink affects how we feel. The human body and mind need a mix of nutrients to work properly. Sharing food or a drink is an enjoyable social event.

- Do things that you enjoy.

Doing things that we enjoy makes us feel good about ourselves and about life. Whatever we call them, interests, hobbies and pastimes can provide a chance to socialise, or to find time for ourselves. If work has taken up most of your life, it may be time to look around for a new interest to immerse yourself in. Meaningful activity is vital for good emotional health. You may have skills to share with others. Look at local volunteering options.

- Relax and have a break.

Creating a routine for your day or week can give life a structure or rhythm. However, a break from this refreshes the mental batteries. A break needn't be long: just time for what you enjoy and for letting your mind recharge. Relaxing doesn't have to be about sitting down or physically relaxing. It's about doing something you enjoy.

3.10. Summary

Mental health includes our emotional, psychological, and social well-being. Aging is associated with changes in dynamic biological, physiological, environmental, psychological, behavioral, and social processes. The aging process has an individual character. Older adults face a variety of mental health concerns, including depression, anxiety, substance use, trauma, serious mental illnesses, and personality disorders. Older people have been seen as people who are more susceptible to mental health problems and are therefore recognized as a vulnerable group. So primary care physicians need to be equipped with the appropriate tools and interventions to assess and treat mental health disorders of elderly people. All assessments should include a thorough review of a person's physical and mental health; medication use; daily routine; home and community safety; support system; appearance and hygiene; finances and personal interests. Lifestyle may be one of the factors largely responsible for compromising the health of elderly people. There are different factors that influence a plerson's mental health – biological, psychological, social, family and environment. Each group of factors plays an important role in maintaining mental health. It is very important to ensure that all of these factors have a positive impact on mental health and it is very important to follow up practical recommendations which seniors can include in daily routine.

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4

Nutritional Assessment of Adults and Older Persons

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Keywords: nutritional assessment, dietary intakes, anthropometry, older population

Nutritional Assessment of Adults and Older Persons

4.1. Introduction

Demographics of the world's population show that the number of individuals aged 60 years and older will increase from 600 million in the year 2000 to more than 2 billion by 2050 (1). Good health is essential for older persons to remain independent and to continue active participation in family and community life.
Ageing is not only influenced by factors intrinsic to the individual, but also by extrinsic factors such as environmental and lifestyle variables. Of the twenty leading risk factors for disability, chronic disease, and death, a number are nutrition-related and may lead to cardiovascular disease, type 2 diabetes, Alzheimer's disease and certain types of cancer (2). This global epidemiological data has motivated the WHO to update their dietary guidelines (3). This will be discussed further in Chapter 5; however, the aim of this chapter is to outline best practice guidelines for the nutritional assessment of adults and older populations. This is not limited to evaluating dietary adequacy, but includes assessment of medical history, clinical considerations, biochemical markers as well as weight and body composition. It is important to appreciate changes that occur with progressing age in order to understand both the appropriate assessment tools and the changing nutrient requirements of adults and older people.

4.2. Changes in body mass, composition

Among the key determining factors in the ability to maintain a healthy active lifestyle in old age are the preservation of optimal body mass and composition (4). However, after the fourth decade of life, a progressive loss of lean tissue mass, and concomitant increase in fat mass (Figure 1) is observed with increasing age (5). Because of its safety and ease of application, nutrition is well placed to play a key role in the challenge of "keeping healthy people healthy" (6). However, enhancing nutrition for the preservation of health in old age, rather than the solely as a treatment for ill health, has largely been overlooked.

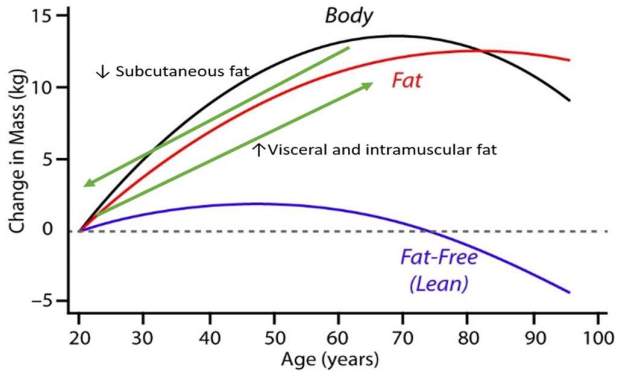

Figure 1 Age-related changes in body composition

(adapted from Jackson et al. (7) Lines represent the longitudinal changes in body weight (black line), fat mass (red line) and fat-free mass (blue line) components from age 20 years.)

4.3. Eating habits of adults and older people

The concept of a physiological decrease in food intake with ageing is certainly not a new one; dietary habits change with age. It is reported that food intakes fall by 25% between 40 and 70 years of age (8). This condition has been referred to as 'anorexia of aging' (9). Protein-energy malnutrition is a frequent condition in the elderly, the pathogenesis of which is likely to be multifactorial. A low-calorie intake represents one of the main risk factors for compromised nutrition due to an increased risk of inadequate intake of essential nutrients (9, 10). Many factors can influence food intakes in ageing; loneliness, poor dentition, illness or decreased appetite (11). Reduced nutrient intake affects both cognitive and physiological functions. Singly or concomitantly (Figure 2), these changes can lead to physical dysfunction and disability.

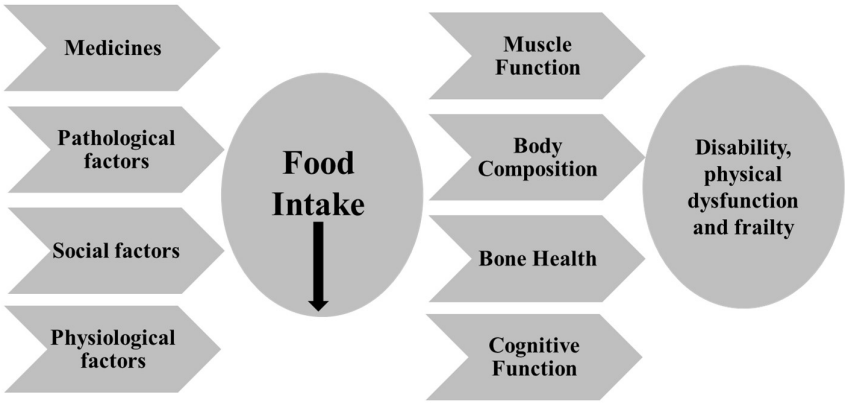

Figure 2 Possible pathways linking nutrition and diet with frailty and disability syndromes

Considering our ageing population, comprehensive investigation of the complex relationships between nutrition, ageing and non-communicable diseases (NCD) must become a priority for policy makers aiming to support expanding healthy ageing populations (12). As the accuracy of methods to assess associations between nutrition and health improves, the transfer of this evidence-based knowledge to clinicians and the public is a vital step in the promotion of healthy lifestyle choices, encouragement of self-management and improvement of health outcomes. Nutrition assessment is an important aspect of this process.

4.4. Nutritional Assessment

Nutritional assessment (dietary assessment and analysis of nutritional status) is one of the specialised interests of nutritionists and dietitians, used in surveillance of populations' nutritional epidemiology, clinical assessment and research (13-16). In clinical nutrition and dietetics, nutritional assessment – data collection, analysis and prescription- is a systematic process to promote health and wellbeing, prevent ill-health, and inform decisions about the nature and cause of nutritional related health issues that affect an individual (17). The same process is used in the management of clinical conditions with medical nutrition therapy (MNT). The elements of nutritional assessment can be summarised as

A. Anthropometric methods

B. Biochemical, laboratory methods
C. Clinical assessment
D. Dietary evaluations

Each of these elements will be discussed.

4.4.1. Anthropometric methods

Basic anthropometric measurements are simple, straight forward, inexpensive and safe (18). They can also be assessed by any individual with appropriate training (19).

Weight, height and girth

Weight may be simply, and with due care, accurately measured. Fewest errors are generally incurred when using a calibrated digital scales (20). Height is best measured using a precisely positioned wall mounted stadiometer. Various indices of obesity have been devised based on weight and height measurements. The most commonly used is the Quetelet Index (21) or Body mass Index (BMI) which is calculated as

Weight (kg) / Height^2 (m)

This assumes that all excess weight (increased BMI) indicates an increase in adiposity, but the correlation is not always the case. BMI may not be the most accurate assessment for those with a broad frame, high muscle mass, or of certain ethnicity (South Asians, Indonesians, Polynesians) (21) . Classification for BMI and associated risk of co-morbidities are in Figure 3.

Classification	BMI (kg/m^2)	Risk of comorbidities
Underweight	<18.5	Low (but risk of other clinical problems increased)
Normal range	18.5–24.9	Average
Overweight (preobese)	25.0–29.9	Mildly increased
Obese	≥30.0	
Class 1	30.0–34.9	Moderate
Class 11	35.0–39.9	Severe
Class 111	≥40.0	Very severe

Figure 3 BMI classification and risk of comorbidities

Abdominal circumference and waist-hip ratio (WHR). Obesity is commonly associated with increased amounts of intra-abdominal fat. Centralised fat deposition is associated with increased risk for morbidity and mortality (22, 23). The ratio of abdominal circumference (often referred to as waist circumference) to hip circumference is an index used to describe adipose tissue distribution or fat patterning (23). A waist-to-hip ratio greater than 0.85 represents a centralised distribution of fat. Most men with a result greater than 1.0 and women greater than 0.85 have increased risk of NCDs (3, 22).

4.4.2. Estimating body composition

Information on composition, as well as total body mass, is important in nutritional assessment. Best practice guidelines (19) and the advantages and disadvantages of different body composition methods (24-26) as well as recent advances in the field (27) are comprehensively addressed elsewhere. We will briefly outline the use and application of

skinfold measurement in body composition assessment in adult populations, as was completed in the Life Age programme of work. Detailed descriptions of measurement methods are available (28) with clear guidance accessible on an associated site https://www.isak.global/.

Skinfold measurements (anthropometry) are among the most common assessments used to characterise subcutaneous fat thickness at various regions of the body. Anthropometry can be prone to overestimation but does provide an affordable and practical assessment tool (29). Practical equations based on skinfold-corrected girth measurements, height, weight, gender, race, and age have been purposed and assessed for reliability elsewhere (30) and have demonstrated high predictive ability for skeletal muscle for male and female adults.

In the current work, body mass was recorded with participants wearing minimal clothing and without shoes to the nearest 0.1kg. Using a stadiometer, height was measured to the nearest 0.1cm with the participant's head positioned in the Frankfurt Plane. Estimation of percentage skeletal muscle mass (SM) was assessed by measuring skinfold thickness at the triceps, medial calf and medial thigh using Harpenden callipers (Assist creative resources Ltd., Wrexham, UK). A Physiomed tape measure (Physiomed, Nottinghamshire, UK) was used to collect corresponding girth measures, which were taken at upper arm, medial calf and medial thigh. These sites were identified in accordance with the International Society for the Advancement of Kinanthropometry (ISAK) standards (31) and chosen to represent all body segments. Trained investigators obtained all measures. Girth was corrected for skinfold measures. Skeletal mass (%) was predicted using the following validated equation from Lee and colleagues (32):

$$\square\square\square = ((\square\square\square\square\square(0.00744 * \square\square\square\square\square\square\square 2\square + 0.00088 * \square\square\square\square\square\square\square 2\square + 0.00441 * \square\square\square\square\square\square\square 2\square) + (2.4 * \square\square\square\square\square -$$
$$0.048 * \square\square\square\square\square\square + race + 7.8)) * 100)/BM$$

Where Ht= stature in meters, CAG = corrected arm girth, CTG = corrected thigh girth, CCG = corrected calf girth, sex= 1 for males, 0 for females and race = 0 for Caucasian, -2.0 for Asian, 1.1 for African American, BM= body mass in kg.

This measurement process and predictive equation use has been previously validated in adult populations (33). It provides a method for body composition assessment that is minimally invasive, not cost prohibitive, which does not require inaccessible equipment and can be completed by assessors with minimal training.

4.4.3. Biochemistry

While anthropometry mostly reflects under or over-nutrition, biochemical tests are needed to demonstrate micronutrient (vitamin, mineral) and hydration, lipid and protein status (34). There are more costs (human and financial resource) associated with biochemical tests due to the requirement for collection, analysis and interpretation of serum and urinary markers. Such biochemical tests have several purposes including diagnosis of a deficiency disease or acute malnutrition; monitoring nutritional management; assessment of the validity of food intake measurements; or simply for reliability and convenience (35). Consultation with an appropriately qualified health practitioner is recommended when undertaking nutritional assessment associated with biochemical markers and in the interpretation of the results.

4.4.5. Clinical assessment

Clinical assessment is an important aspect in the overall nutritional assessment but has been criticised due to the inherent subjectivity of the clinical examination. It is recommended that individual clinical measures of nutrition should not be considered in isolation, but rather used as a component in a screening tool. Many screening tools have been developed and validated, which combine several individual measures to provide a more accurate assessment of nutritional status. Among the practitioner-administered screening tools, the Subjective Global Assessment (SGA) is easy to use, practical, and thus widely used in many institutions (36). The SGA, developed by Detsky et al.,(37) is a tool that formalizes clinical impression interpreted from measurements of functional capacity and from observation of physical signs of malnutrition-inducing conditions (38). Assessment includes checking for visible signs of nutritional deficiencies such as bilateral pitting oedema, emaciation, hair loss, and changes in hair or skin colour. It also includes taking a complete medical history to identify comorbidities with nutritional implications, opportunistic infections, other medical complications, usage of medications with nutrition related side effects, food and drug interactions, and risk factors for disease (e.g., smoking, alcohol use, overweight) that affect or are affected by diet and nutritional status (www.fantaproject.org). The importance of having a tool such as the SGA for use in adult and older populations is that, when validated, it obviates the dependence on individual objective measures of nutritional status (38).

4.4.6. Dietary evaluation

Dietary assessment, encompassing data collection and analysis, supports planning of appropriate dietary intakes. Both retrospective and prospective methods of dietary assessment are commonly used in data collection among general and clinical populations.
Assessing food and fluid intake is an essential part of nutrition assessment. It provides information on dietary quantity and quality, change in appetite, food allergies and intolerance, and reasons for inadequate food intake. The results are subsequently compared with recommended dietary intakes to allow practitioners to identify sub-optimal nutrient intakes and appropriately provide advice on how to improve dietary intakes to prevent malnutrition or treat conditions affected by food intake and nutritional status. Several frequently used methods to assess dietary intake are described.

24-hour recall
This method was designed to quantify the average dietary intake of populations, although it can be used to assess individual nutrition intake. Individuals are asked to recall details of meals, snacks and fluids consumed during the previous 24-hour period. The process can be repeated on several occasions to account for day to-day variation in intake. Practitioners may use prompts to aid recollections by punctuating eating occasions with either time periods or daily activities (e.g., just after waking up, before you were in the garden, after you visited with friends, before going to bed) or to estimate portion sizes by comparison with household utensils and measures, food models, photographic food atlases, or actual food.

Food frequency questionnaire
A food frequency questionnaire (FFQ) is designed to obtain information on overall dietary quality rather than nutrient composition and intake. It is quick and easy to administer and can be done in person or remotely (using online technologies), by individuals with minimal training. The FFQ examines the frequency with which an individual consumes particular

foods or beverages, and often includes an estimate of the size of the portion by comparison with photographic food atlas. While this method is quick and inexpensive. under-reporting on nutrient intakes is common.

Food group questionnaire
Another easy method of dietary assessment is to show clients pictures of different food groups (often available from national nutrition authorities) and ask whether they ate or drank any of those foods the previous day.
Once dietary intake data has been collected the actual food intake reported needs to be converted to estimated nutrient intakes. This process is completed using food databases, which are often devised by government agencies and specific to foods consumed indigenous to a particular jurisdiction. Examples of food databases are the United States Food and Nutrient Database for Dietary Studies (FNDDS) available here https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/fndds/

Dietary Reference Values
Dietary assessment involves assessing the adequacy of daily nutrient intakes against Dietary Reference Values (DRV) for the relevant population. These reference intakes have demographic specificity but European guidelines for adults and older populations are available here: http://www.efsa.europa.eu/en/interactive-pages/drvs.

Recent advances
Dietary quality indices have been used more recently, to assess overall dietary quality. One such index, Predimed, assesses adherence to a Mediterranean Diet. Healthy dietary patterns such as the Mediterranean diet or similar are beneficial against NCDs but, potentially, also against infections due to their effects on immune health (39, 40). Further information on the recommendation for adherence to Mediterranean type diet are presented in the subsequent chapter.
Technological advancements, such as web-based assessment, voice recording, applications, photographic records or scales attached to software aim to increase the usability and accuracy of dietary assessment and to be less burdensome for participants and practitioners.

4.5. Exercise and Activity Assessment

Sedentary behaviours as well as patterns of physical activity (occupational and recreational) are further important considerations in assessing nutritional status. The methods to assess and the current recommendations are covered in subsequent chapters, and should certainly inform a comprehensive nutritional assessment and prescription.

4.6. Summary

Nutritional assessment is the interpretation of anthropometric, biochemical (laboratory), clinical and dietary data to determine the nutritional status of a person or population. Today, most communities are facing a geriatric challenge (13), with an increasing proportion of older people in the population (14). There is a need for effective, personalized, and evidenced-based models for the assessment and evaluation of nutritional status in older people. Methods of assessment are briefly described in this chapter, with reference provided for further reading and support. Nutritional assessments require knowledge, qualified personnel,

and evidenced-based methods to evaluate and meet the nutritional needs of people at old age.

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5

Nutritional Strategies in Support of Healthy Ageing

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Nutritional Strategies in Support of Healthy Ageing

5.1. Introduction

Ageing has both societal and economic challenges. Supporting active and healthy ageing is a priority to ensure individuals maintain or improve a good quality of life, to prevent the development and progression of ill health and to continue to engage and contribute to society.

As stated in previous chapters, life expectancy is at its highest with projected data highlighting a 10% increase in the next 30 years in those aged greater than 65 years (1). Unfortunately, the gains in life expectancy have not been coupled with an increase in years lived without disease and disability, or healthy life years. Age is a significant risk factor for the development of non-communicable chronic diseases such as chronic obstructive pulmonary disease (COPD), cardiovascular disease (CVD), Type 2 diabetes (T2D), cognitive decline, dementia and cancer (2). Whilst some factors that contribute to ill health are non-modifiable and beyond individual control, focussing on modifiable factors such as diet and physical activity levels are integral first steps in strategies to support healthy ageing. The increase in life expectancy that is being experienced globally has focussed attention on the need to improve the morbidity status of the ageing population whereby lifestyle and health behaviours including nutrition are included in healthy ageing strategies.

The aim of this chapter is to consider the importance of optimal nutrition and diet in healthy ageing and to present evidence –based recommendations where diet can support older adults to improve their overall health and wellbeing.

5.2. Age-related changes in food and nutrition

As exercise and activity levels decrease with aging, a decrease in food consumption is also expected. This is coupled with age-related physiological changes which include dental and chewing problems, reports of feeling fuller for longer and impairments in taste and smell which impact on dietary intakes (3). The term 'anorexia of ageing' has been used for the phenomenon of loss of appetite and decreased food consumption. Older adults also eat slower, tend to consume smaller meals and snack less, which leads to lower dietary intakes and in some cases weight loss (4). Medications and co-morbidity status are factors that also affect appetite and food intakes. A difference in energy intake of approximately 16-20% was observed between younger adults and healthy older adults resulting in a reduction of 0.5% body mass per year (4). This is common in older adults and is an independent predictor of adverse health outcomes (5).

5.2.1 Malnutrition Risk

The use of screening tools, which combine several individual measures to provide a more accurate assessment of nutritional status was discussed in Chapter 4. The use of these screening tools has led to greater recognition of risk and diagnosis of malnutrition in older populations and how it accelerates a decline in overall health status, evidenced by increased risk of hospitalisation, longer length of stay in hospital and increased mortality (6). Nutritional 'frailty' is used to describe sudden and significant weight loss and loss of muscle mass and strength (sarcopenia) or an essential loss of physiologic reserves which increases the risk of disability (7). However, sarcopenic states can also be observed in persons who are also either overweight or obese (8). Whilst a lot of the focus of these screening and diagnosis

tools is body composition changes, individuals categorised as being at greater risk of malnutrition are more likely to have poorer diets in terms of overall macro- and micronutrient status (9).

5.3. Nutrient requirements for healthy ageing

Whilst physiological changes associated with increasing age impact on nutritional status, nutritional deficiencies are also commonplace particularly in vulnerable older groups residing in hospital, institutional and care settings. The definition of healthy ageing itself includes diet quality and eating habits as essential components (10) with immediate consequences on outcomes such as overall and disease specific mortality (11). The World Health Organisation (WHO) estimate that eliminating major risk factors for chronic disease such as smoking, lack of exercise and poor diet would reduce the risk of CVD, stroke and T2D by 80% (12). A better-quality diet in older adults is associated with significantly higher physical and emotional quality of life (13) and better functional status (14). It is important to note, however, that although energy requirements are lower, the requirements for many other macro and micronutrients remain stable throughout adulthood into older age.

5.3.1 Fluid

Dehydration is common, is a frequent cause of morbidity and mortality in older people (15) and should not be overlooked in the nutritional assessment process. Older people tend to be less sensitive to thirst and have reduced intakes of foods that normally would contribute to daily fluid intake (e.g. fruits). The WHO indicate that an adult of acceptable weight (assessed by BMI) requires an intake of 30ml of water per kilogram body weight per day (16) and ideally consumed in small quantities across the day (17).

5.3.2 Energy

With aging, a reduced energy expenditure or basal metabolic rate (BMR) is a result of declines in lean tissues and increases in body fat mass. Concurrently, physical activity levels decrease with increasing age. Older adults should aim to meet energy requirements (18) to prevent malnutrition, prevent related conditions and to support optimal immune function. For adults with comorbidities energy needs may require adjustment to reflect metabolic changes due to disease associated mechanisms.

5.3.3 Protein

Protein is considered a key nutrient in older age. Muscle protein synthesis (MPS) occurs in response to a complex interplay among stimuli such as physical activity and hormonal signalling. However, in all circumstances the prerequisite for muscle synthesis is dietary protein. Dietary intake of protein is vital to support MPS, as proteins act not only as a substrate for synthesis, by also as regulators (19). Sufficient protein intake is needed to maintain lean tissues and to prevent or decelerate muscoskeletal conditions such as sarcopenia (20). In a Cochrane review the effects of protein and energy supplementation in those at risk of malnutrition showed that supplementation produced a small (2.2%) weight gain in older people. In a small sample of older people who were already malnourished, mortality rate was reduced when they were supplemented with protein and energy (21).

The nuances of protein feeding (type, timing, apportioning) are often overlooked in the context of protein intakes recommendations. Summary points are presented in subsequent sections.

5.3.3.1 Protein quantity

Current estimates of the nutritional requirements for protein as reported by the WHO/FAO/UNU (22) are defined as "the lowest level of dietary protein intake that will balance the losses of nitrogen from the body, and thus maintains the body protein mass (assumed to be at a desirable level), in persons at energy balance with modest levels of physical activity and any special needs for growth, reproduction and lactation". This definition, however, does not address the optimal intake for health. Instances where individual benefits may be derived from protein intakes in excess of the currently recommended 0.8 $g.kg^{-1}.d^{-1}$ may include older individuals who may gain advantage in terms of muscle mass, strength and functionality. These benefits may in turn be reflected in improved health outcomes (23).
Currently there is a lack of consensus on whether ageing requires an increase in protein dietary requirements. The current recommendation of 0.8 $g.kg^{-1}.d^{-1}$, established by the Institute of Medicine (IOM), was derived from short term nitrogen balance studies in young adults (24) rather than on the maintenance of lean tissue mass in the elderly. While some studies support retaining the current recommended daily allowance (RDA) (19) among the authors suggesting a moderate increase in protein intake to 1.0 – 1.3 $g.kg^{-1}.d^{-1}$ are Campbell *et al.*, Evans *et al.*, Breen and Phillips, and Paddon-Jones *et al.*, (25-29). This increase is thought to be necessary to offset the lower total energy intake observed in ageing (30) and decreased protein synthetic efficiency (31, 32).

5.3.3.2 Protein apportioning

The distribution of protein intake throughout the day may influence MPS. The ingested daily allowance of protein should be spread equally across breakfast, lunch and dinner to optimally stimulate muscle protein synthesis (25). Symons *et al* (33) indicate that it is more important to ingest a sufficient amount of high-quality protein (25–30 g) with each meal rather than 1 large bolus, because greater than 30 g in a single meal may not further stimulate muscle protein synthesis ('muscle–full' hypothesis) and Pennings *et al* (34) support this opinion. Tieland *et al.* (35), report a typical feeding regimen in which the elderly typically ingest smaller amounts of protein with breakfast (~8 g) and lunch (~12 g) and the majority of dietary protein with dinner (~40 g). Lanham-New (36) estimate typical protein feeding patterns at breakfast, lunch and dinner to be 10g, 16g and 49g respectively. Research in Irish cohorts corroborate these findings (37). These reports suggest that few achieve the optimal protein apportioning to attenuate age-related loss of muscle mass, strength and function.

5.3.3.3 Protein quality

In addition to the quantity and apportioning of protein ingested, there appears to be subtle differences in the ability of different protein sources to promote muscle protein synthesis. The differences in the muscle protein synthetic response to the ingestion of various protein sources can be attributed to 1) differences in protein digestion and absorption kinetics (38, 39) as well as 2) amino acid composition (34, 40).

In the context of MPS, many researchers have conducted studies on amino acids to determine which may have the more potent effects. Volpi *et al* have conducted experiments investigating muscle anabolism and catabolism, and amino acids in both young and elderly subjects (41, 42). In 2003, they assessed whether nonessential amino acids are required in a nutritional supplement to stimulate muscle protein anabolism in the elderly and reported that it is the essential amino acids (EAA) that are primarily responsible for the amino acid stimulation of muscle protein anabolism in healthy elderly adults. Other research supports the theory that the EAA are primarily responsible for stimulating MPS (43) whereas non-essential amino acids appear ineffective in this regard (44).
In summary, consideration must be given to the nuances of protein intake other than an emphasis placed on absolute amounts alone. The patterning, source and timing of dietary protein can significantly impact risks of morbidity, particularly in older populations.

5.3.4 Fat

Fat is an important energy source and facilitates the absorption of fat-soluble vitamins A, D, E and K. Fat has important structural and regulatory functions in the body. Fat is the most energy dense nutrient and so intakes above recommended levels can lead to excess total energy intakes, which can lead to the development of overweight and obese states. Whilst trans fatty acids are associated with adverse effects on cardiovascular health (45), monounsaturated and polyunsaturated fatty acids are shown to have beneficial effects in improving cardiovascular risk (46, 47). Long chain omega three fatty acids are proposed to have protective effects on eye and brain health through amelioration of inflammatory processes (48) with potential benefits in the ageing population around cognitive function (49).

5.3.5 Carbohydrates

There is no specific guidance for older adults for carbohydrate intakes. EFSA propose a reference intake range of 45-60% of total energy requirements from carbohydrate (50).

5.3.6 Micronutrients

Although the recommended dietary allowances for older people indicate that their energy needs are lower than their younger counterparts, micronutrient requirements are approximately the same (51). Micronutrient deficiencies are common in older people due to many different factors, for example chronic health conditions, frequent hospitalisation, eating less and choosing low nutrient density foods. Data from Europe (52) suggest that there is an insufficient intake of most micronutrients in older people, apart from Vitamin B12, iron and copper. In particular, intakes were low for vitamin D in females and vitamin E and folate in males and females.
With an overall reduced intake of quantity of food and shifts in diet quality patterns, older adults are at risk of deficiencies in micronutrients with the prevalence of deficiencies and undernutrition highest amongst the very old, women and those residing in care homes and institutions (53, 54). Micronutrients are important for maintaining normal physical and cognitive functions in the ageing body with inadequate intakes leading to deterioration of health and development of certain diseases. Of particular importance for aging population are Vitamins B6, B12 and folic acid, Vitamin D and calcium, antioxidant vitamins and minerals A, C and E, selenium and zinc (55).

See Table 1 for the European Food Safety Authority Dietary Reference Values for the EU for key macro and micronutrients for adults including those aged over 65 years.
Of note, there is a need to be aware of the limitations of devising dietary plans based on recommended dietary intakes as the intake level may not always provide optimal intake for older populations as they were inherently determined on the basis of studies conducted in younger, healthy populations.

5.3.7 Supplementation

Although nutritional supplements may be helpful in the case of nutrient deficiencies or where metabolic conditions or conditions affecting the absorptive capacity effect nutrient utilisation, trials of specific nutrient supplements have been inconclusive with whole of diet approaches generally advised and promoted (56). Exceptions to this include the use of B12 supplements in conditions that warrant supplementation and Vitamin D supplementation for populations that receive inadequate sun exposure and during the winter months in northern latitudes (57).

5.4 Nutritional Strategies to support healthy ageing

Nutritional strategies to promote optimal intakes to meet macro- and micronutrient requirements and ensure diet quality particularly in independent and community dwelling older adults should be a priority. Identifying risk factors that are associated with a decline in nutritional status in this population is a first step in the development of these strategies. For example, in a study of four European countries, living alone was consistently associated with poorer diet (58).
Shlisky *et al* devised a model that looks at the diverse influences that have both positive and negative effects on the nutritional health of older adults (59). The negative effects of age-related physiological factors such as loss of appetite and cognitive function decline and the positive role of social factors such as social support and social interaction should be considered in any public health or community programme to enhance nutritional health (Figure 1).

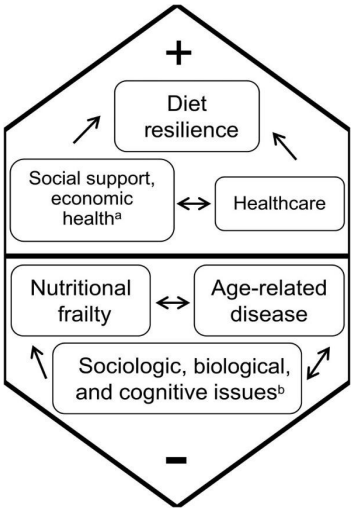

Figure 1 From Shilsky et al (59) – factors with positive and negative influences on nutritional health.

Poor diets in contemporary older adults are common with factors such as age, education status, gender and ethnic background determining diet quality and food variability (3). Older adults tend to report inadequate intakes of fruit, vegetables, legumes, whole grains, nuts or seeds, fish, lean meat, poultry and low fat fluid dairy products but excess intakes of refined grain products, processed and fatty meats, fried foods, solid fats and added sugars (60). The LifeAge project will add valuable information to this data in analysing and reporting the most recent habitual intakes of older adults across Europe. Delving into European datasets where lifestyle behaviours are being tracked will inform health promotion efforts to be employed at younger ages and in particular the promotion of healthier diets and dietary patterns at crucial life stages i.e. middle age to older adulthood.
Effective preventative strategies to enhance nutrition provision to community dwelling older adults, in particular, is important and needs to be in place before the age related decline in food consumption and the onset of malnutrition or other non-communicable diseases occur.

5.4.1 Diet Quality

Increasing diet quality is important at the life stage where food consumption decreases in older populations. Nutrient dense foods are integral to ensuring older adults meet their nutritional needs. Various life transitions can impact upon diet quality and in some studies a notable decrease in diet quality for subgroup populations of older adults were observed (61). In an analysis from four European countries (Finland, Sweden, Italy and the UK) overall diet quality as measured using a diet quality index tool was found to be relatively poor, with few participants reaching optimal levels (62). Anecdotally, diets among older adults can be repetitive and lack variability, can be nutrient deplete with the focus being on ease of acquiring the foods, preparation and cooking methods and dependent on financial status also. These factors increase nutritional risk and may lead to development and progression of chronic diseases (63). Nutrient supplementation is also a cost effective way to meet nutrient targets and improve diet quality in cases where optimal intakes of various foods that are sources of key nutrients cannot be achieved.

5.4.2 Mediterranean diet

The traditional Mediterranean Diet (MedDiet) is predominantly a plant based diet, characterised by a high consumption of vegetables, fruits and nuts, legumes and unprocessed cereals with a low consumption of red meat, meat products and sweets, moderate consumption of fermented dairy (cheese and yogurt), poultry and fish, with red wine consumed in moderation and with meals (64). Whilst the Med Diet differs in its definition across the literature and regions, findings are consistent with respect to its many health benefits. The beneficial health effects are primarily owing to the low intakes of saturated fat, increased intakes of fibre, functional fatty acids and lipids, antioxidants and bioactive compounds.
A number of cohort studies have suggested that adherence to a MedDiet increases longevity in several European populations, in Mediterranean populations (65-67) and in non-Mediterranean populations (68, 69) when the main principles of the MedDiet were applied.
Adherence to the MedDiet is measured with the use of tools or scores, with higher scores reflective of better adherence profiles. The EPIC-elderly (European Prospective Investigation into Cancer and Nutrition) prospective cohort study followed over 74,000 adults aged 60y and older in nine European countries and found that those who adhered to the MedDiet had lower mortality rates (70) and for every two-point increase in the MedDiet

scores, overall mortality was reduced by 8%. The HALE project (the Healthy Ageing: a longitudinal study in Europe) which followed over 2300 healthy older men and women aged 70-90 years for 10 years in 11 European countries found that those adhering to the MedDiet had a lower risk of all-cause mortality (71). Of note, combining MedDiet adherence with moderate alcohol consumption, physical activity and not smoking the rate of all-cause and cause-specific mortality was reduced by more than 50% (71).
Evidence also suggests that cognitive health may be better with adherence to a MedDiet. In a meta-analysis assessing the association between the MedDiet and cognitive decline from five prospective cohort studies, participants in the high adherence group had a 33% reduced risk of both mild cognitive impairment and Alzheimers Disease compared to those in the low adherence group (72). In a pooled meta-analysis study high adherence to a MedDiet was strongly associated with reduced risk for stroke, depression and cognitive impairment (73).

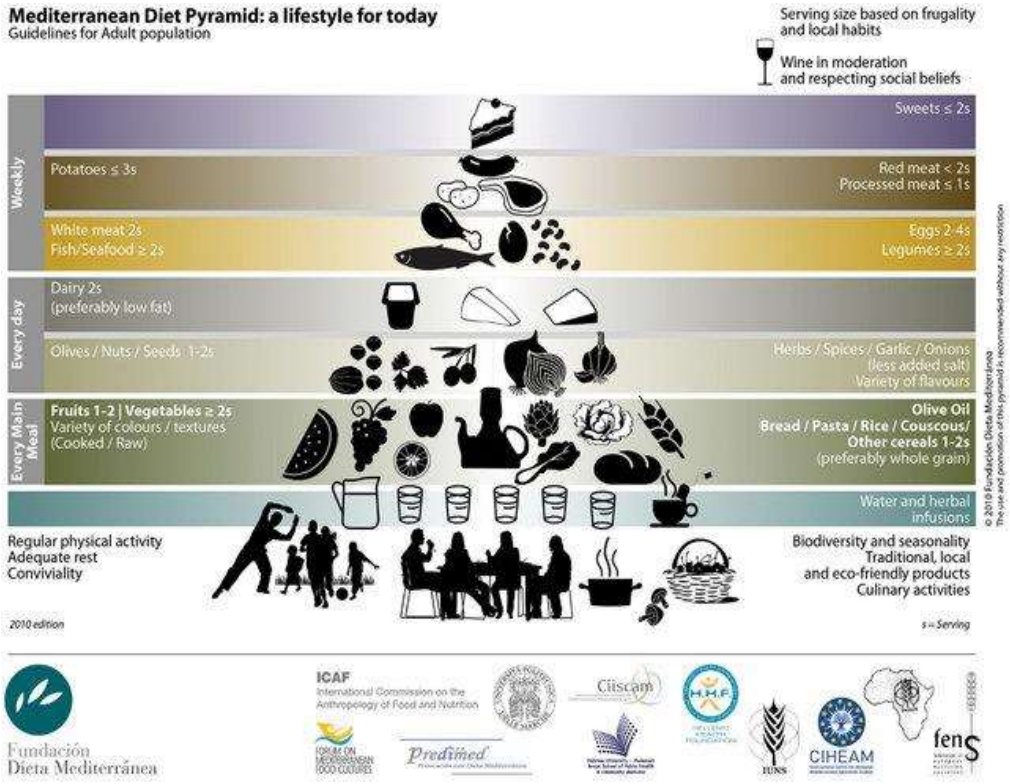

Figure 2 Mediterranean Diet Pyramid depicting recommended food serves and promoting a lifestyle conducive to the Mediterranean ways (64)

5.4.3 Adhering to healthy eating guidelines

Most national dietary guidelines follow similar principals to the Mediterranean diet by promoting the intake of fruit and vegetables, etc., in large quantities and advise that people limit their intake of processed foods. For older adults living in the community, adequate intakes of nutrient-dense foods are the primary mechanism to prevent undernutrition and malnutrition. In parallel, consuming a healthy diet with limited intakes of foods rich in

saturated fats from fatty and processed meats, trans fats from margarines and processed baked products, extrinsic sugars and increased sodium intakes from canned and processed foods (74) will contribute to healthy ageing.

5.5. A word about Nutrition and COVID-19

The spread of the novel coronavirus disease termed COVID-19 caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2A) is a major public health crisis that has dominated every countries public health agenda since late 2019 with. The highly contagious COVID-19 infection has affected millions of people to date and has led to hundreds of thousands of deaths worldwide. COVID-19 infection can manifest as an asymptomatic infection, or patients can present with a mild upper respiratory tract illness that may include cough, fever, fatigue, and shortness of breath (75). In severe cases, the most common complications are sepsis, acute respiratory distress syndrome (ARDS), heart failure, septic shock and death (76). The aging population are identified as a particularly vulnerable group during this time as they are not only predisposed to or living with other non-communicable diseases (NCDs) but are at increased risk of undernutrition and developing infections. A healthy, balanced diet can offer the necessary nutrients for the elderly that can restore and maintain immune cell function, thus increasing protection against chronic inflammation-related NCDs, and potential infections and related inflammatory manifestations (76). Micronutrients in particular have vital roles throughout the immune system that are independent of life stage and it has been determined that those most needed to sustain immunocompetence include vitamins A, C, D, E, B2, B6, B12, folic acid, beta carotene, iron, selenium and zinc (78). Of the evidence, however, it was concluded that the largest body of evidence related to immune function existed for vitamin C, D and zinc (79).

A review published in 2017concluded that three controlled trials found that vitamin C prevented pneumonia and two controlled trials observed a treatment benefit of vitamin C for patients with pneumonia (80). An earlier Cochrane review, (81) undertaken in 2013, collated evidence from three prophylactic trials finding a statistically significant (80% or greater) reduction in pneumonia incidence in the vitamin C groups. It was subsequently concluded that therapeutic use of vitamin C supplementation could be reasonable for patients with pneumonia and low plasma vitamin C levels given its low cost and health risks. A systematic review and meta-analysis (82) has collated evidence from 25 separate randomised controlled trials (n=11 321 participants) studying the effects of vitamin D supplementation on acute respiratory infections among those aged 0–95 years. Protective effects were seen among all participants, but particularly among those with baseline 25-hydroxyvitamin D levels <25 nmol/L, indicative of deficiency. Among the elderly it is recognised that inadequate zinc status impairs immune function, reduces pathogenic resistance, and is linked to an increased incidence and duration of pneumonia, along with overall mortality (83). Rigorous trials, however, are yet to determine the efficacy of zinc supplementation.

Rather than individual supplementation of nutrients healthy dietary patterns such as the Mediterranean diet or similar are beneficial against NCDs but, potentially, also against infections such as COVID-19 due to their effects on immune health (84). Promoting the Mediterranean diet alongside other diets that advocate for high intake of fruits and vegetables and healthy quantities of other food groups to provide all the essential nutrients for health will provide adequacy of recommended dietary intakes which will support immune function. However, there is concern that people who are deficient in some micronutrients such as vitamin C, vitamin D, or zinc may warrant supplementation or may need to modify their

dietary patterns to maintain optimal nutritional status and support healthy immune function. This is particularly important for our vulnerable populations, including the elderly who have been advised to limit their social contacts and keep travel to only essential trips.

5.6. Social engagement as a strategy to enhance diet quality

In informing our strategies, older people are particularly vulnerable in the challenges they face in accessing food and the decreased opportunities for social interactions. In a number of studies in older adults, levels of social engagement, the size of social networks and supports, marital status and if living alone were all linked to differences in diet (85) whereby greater number and quality of social relationship and contacts are associated with improved diet quality. Positive psychological states that encourage healthier behaviour (61) and the positive effects of supportive social environments on health offer many opportunities to promote better diet quality. Interventions and supports that are based around social engagements should be used and have the potential to support better nutritional health. Alongside the social aspects, a positive impact on the psychological wellbeing leads to greater self-efficacy which has been shown to predict adherence to healthier dietary patterns and to positively impact dietary habits (86).

5.7. Summary

The importance of nutrition in increasing healthy life years is paramount given the evidence of the association of suboptimal nutrition with morbidity and mortality. A move away from individual macro and micronutrient supplementation and looking at whole of diet approaches for promoting health and increasing longevity is paramount. Applying country specific dietary guidelines to the older population to achieve is difficult with issues such as access to high quality nutrient dense food, and the physiological changes associated with aging impacting on overall dietary intakes.

National policies and community initiatives or programs that focus on accessing good-tasting and easy to prepare food that are energy and nutrient dense should be a target and desired outcome. Integral to this is to have older adults involved in the development and roll out of these community programs to ensure wide reach and uptake.

Taking into consideration the individual medical history, physical activity levels and comprehensive nutritional and dietary assessment criteria in chapter 4 in informing the most effective dietary management plan there is a need to personalise the diet to an individual's health, social circumstances, activity, preferences and supports to enable uptake and ultimately leading to better outcomes that meet the dietary goals.

Table 1 European Food Safety Authority Dietary Reference Values for the EU for key macro and micronutrients for adults including those aged over 65 years.

Nutrient	**Age**	**Gender**	**AI**	**AR**	**PRIs**	**RI**	**UL**
Energy	60–69 years PAL=1.4	Male	NA	8.4 MJ/day	NA	NA	NA
Energy	60–69 years PAL=1.6	Male	NA	9.6 MJ/day	NA	NA	NA
Energy	60–69 years PAL=1.8	Male	NA	10.9 MJ/day	NA	NA	NA
Energy	60–69 years PAL=2.0	Male	NA	12.1 MJ/day	NA	NA	NA
Energy	60–69 years PAL=1.4	Female	NA	6.8 MJ/day	NA	NA	NA
Energy	60–69 years PAL=1.6	Female	NA	7.8 MJ/day	NA	NA	NA
Energy	60–69 years PAL=1.8	Female	NA	8.8 MJ/day	NA	NA	NA

Energy	60–69 years PAL=2.0	Female	NA	9.7 MJ/day	NA	NA	NA
Dietary fibre	≥ 18 years	Male	25 g/day	NA	NA	NA	NA
Dietary fibre	≥ 18 years	Female	25 g/day	NA	NA	NA	NA
Total carbohydrates	≥ 18 years	Male	NA	NA	NA	45–60 E%	ND
Total carbohydrates	≥ 18 years	Female	NA	NA	NA	45–60 E%	ND
Alpha-linolenic acid (ALA)	≥ 18 years	Both genders	0.5 E%	NA	NA	NA	ND
EPA, DHA	≥ 18 years	Both genders	250 mg/day DHA +EPA	NA	NA	NA	ND
Linoleic acid (LA)	≥ 18 years	Both genders	4 E%	NA	NA	NA	ND
Saturated fatty acids (SFA)	≥ 18 years	Both genders	ALAP	NA	NA	NA	ND
Total fat	≥ 18 years	Both genders	NA	NA	NA	20–35 E%	ND

Trans-fatty acids (TFA)	≥ 18 years	Both genders	ALAP	NA	NA	NA	ND
Protein	≥ 18 years	Male	NA	0.66 g/kg bw per day	0.83 g/kg bw per day	NA	NA
Protein	≥ 18 years	Female	NA	0.66 g/kg bw per day	0.83 g/kg bw per day	NA	NA
Water	≥ 18 years	Male	2.5 L/day	NA	NA	NA	NA
Water	≥ 18 years	Female	2 L/day	NA	NA	NA	NA
Calcium	≥ 25 years	Both genders	NA	750 mg/day	950 mg/day	NA	2500 mg/day
Iron	≥ 40 years	Female (postmenopausal)	NA	6 mg/day	11 mg/day	NA	ND
Iron	≥ 18 years	Male	NA	6 mg/day	11 mg/day	NA	ND
Sodium	≥ 18 years	Both genders	safe and adequate level of 2g/day				
Zinc	≥ 18 years	Male (LPI 300 mg/day)	NA	7.5 mg/day	9.4 mg/day	NA	25 mg/day
Zinc	≥ 18 years	Male (LPI 600 mg/day)	NA	9.3 mg/day	11.7 mg/day	NA	25 mg/day

Zinc	≥ 18 years	Male (LPI 900 mg/day)	NA	11 mg/day	14 mg/day	NA	25 mg/day
Zinc	≥ 18 years	Male (LPI 1200 mg/day)	NA	12.7 mg/day	16.3 mg/day	NA	25 mg/day
Zinc	≥ 18 years	Female (LPI 300 mg/day)	NA	6.2 mg/day	7.5 mg/day	NA	25 mg/day
Zinc	≥ 18 years	Female (LPI 600 mg/day)	NA	7.6 mg/day	9.3 mg/day	NA	25 mg/day
Zinc	≥ 18 years	Female (LPI 900 mg/day)	NA	8.9 mg/day	11 mg/day	NA	25 mg/day
Zinc	≥ 18 years	Female (LPI 1200 mg/day)	NA	10.2 mg/day	12.7 mg/day	NA	25 mg/day
Cobalamin (vitamin B12)	≥ 18 years	Both genders	4 µg/day	NA	NA	NA	ND
Folate	≥ 18 years	Both genders	NA	250 µg DFE/day	330 µg DFE/day	NA	1000 µg/day
Vitamin A	≥ 18 years	Male	NA	570 µg RE/day	750 µg RE/day	NA	3000 µg RE/day

Vitamin A	≥ 40 years	Female (postmenopausal)	NA	490 µg RE/day	650 µg RE/day	NA	ND
Vitamin B6	≥ 18 years	Male	NA	1.5 mg/day	1.7 mg/day	NA	25 mg/day
Vitamin B6	≥ 18 years	Female	NA	1.3 mg/day	1.6 mg/day	NA	25 mg/day
Vitamin C	≥ 18 years	Male	NA	90 mg/day	110 mg/day	NA	ND
Vitamin C	≥ 18 years	Female	NA	80 mg/day	95 mg/day	NA	ND
Vitamin D	≥ 18 years	Both genders	15 µg/day	NA	NA	NA	100 µg/day
Vitamin E as α-tocopherol	≥ 18 years	Male	13 mg/day	NA	NA	NA	300 mg/day
Vitamin E as α-tocopherol	≥ 18 years	Female	11 mg/day	NA	NA	NA	300 mg/day

AI Adequate Intake; AR Average Requirement; PRI Population Reference Intake; RI Reference Intake; UL Upper Limit; EPA Eicosapentaenoic acid DHA Docosahexaenoic acid; PAL Physical Activity Level; LPI levels of phytate intake; NA not applicable; E% percentage of energy intake; bw body weight; RE retinol equivalent

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6

Reducing Sedentary Behaviours by Increasing Activities of Daily Living

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Reducing Sedentary Behaviours by Increasing Activities of Daily Living

6.1. Introduction

This chapter will be focused on defining the most common sedentary behaviours among the general population to provide a clear understanding of how they can be avoided. Health outcomes of sedentary behaviours reduction will be presented to acknowledge the positive effects of the interventions on the population's health. Then, the available intervention methodologies on reducing sedentary behaviours and their effectiveness will be discussed, thereby providing tools for the reader to manage the issue within the most common environments.

6.2. Defining sedentary behaviours for better and effective interventions

Sedentary behaviours (SB) are a complex and multifactorial system which has to be distinguished from the mere absence of physical activity (PA) practice, especially the one that is performed at moderate-to-vigorous intensity (MVPA). In their literature review, Pate *et al.* (1) referred to SBs as "activities that do not increase energy expenditure substantially above the resting level and include activities such as sleeping, sitting, lying down, and watching television, and other forms of screen-based entertainment". According to this definition, sedentary activities do not exceed the threshold for energy expenditure of 1.0-1.5 metabolic equivalent unit (MET), with 1 MET being the energy cost at resting state. Therefore, SBs exclude light PAs (1.6-2.9 METs), such as slow walking and housework, still including a rather complex ensemble of activities that can be performed in different domains (2). The precise description of these domains appears mandatory to define the framework within which the interventions that aim at reducing SBs are designed. The main two domains include occupational and non-occupational sedentary time, respectively referring to leisure-time and work-related settings, within which different sedentary activities can apply (3–5). For instance, the time spent sitting may differ according to the external setting (i.e. in front of a computer at work or a TV at home) or be related to essential daily actions, such as passive transport in a car or bus. Therefore, it is clear that distinct strategies of intervention are required and should target domain- and type-specific activities to produce a long-lasting change in SBs.

From a psychological point of view, SB is a construct that involves psycho-socio-economic features and, hence, the design of behaviour change interventions requires the analysis of each component (2). Michie and colleagues (6) suggested that determining the broad approach and then working on the specific features should be the correct process of designing behavioural change interventions. Therefore, it is important to define the framework within which specific habits take place and to understand their nature. For instance, one should comprehend whether the behaviour to be changed occurs at a population or individual level (e.g. shared with colleagues in the working environment or being an independent personal behaviour) and to which specific domain it belongs (e.g., occupational *vs* non-occupational time). Once the framework is defined, the necessary conditions that should be satisfied for a long-lasting behavioural change are capability, motivation and opportunity. Firstly, the person should have both the psychological and physical capacity to engage the new behaviour in terms of having the necessary knowledge and skills. Secondly, the person's motivation in changing habits should be internally and

externally boosted, thereby energizing those brain processes that are involved in emotional responding as well as analytical decision-making. Thirdly, the external environment should provide the opportunity for making the behavioural change possible or encouraging it. As claimed by the authors of this behavioural change model, these three components can be potentially influenced by each other as well as being affected by the behaviour itself. Hence, it is suggested that interventions aiming at reducing SBs should focus on one of these three conditions after having defined the framework within which the behaviour occurs (i.e. personality traits, internal and external capacity, environmental setting, etc.).

6.3. Health outcomes of reducing sedentary behaviours

It has been demonstrated by several papers in literature that sedentary time is an important modifiable determinant of health (7), and it is an important predictor of healthy ageing (8). Sedentary behaviours have been defined as any waking behaviour characterized by an energy expenditure ≤1.5 metabolic equivalents of task (METs), while in a seated, reclined or lying posture (9). Unfortunately, the amount of sedentary time that older adults accumulate is greater than any other age group, with a trend that increases with age (10,11). Many longitudinal studies underlined an association between sedentary time and mortality (12). As for specific chronic conditions, sedentary time has been related to cardiovascular (CV) disease (13,14). The American Heart Association recently released a Science Advisory that highlighted the deleterious association between SB and CV morbidity and mortality (15). Although the relation between sedentary behaviours and cardiovascular health has been strongly demonstrated, the modulatory effects of physical inactivity on cardiovascular health are complex and not completely clarified yet. Factors related to CV disease, such as arterial stiffness and reduced flow-mediated dilation, have been well documented in physically inactive persons (16). In a recent review, Fossati *et al.* (17) investigated the effect of PA on distinct biomarkers in the elderly. The authors evidenced that PA can improve parameters related to heart function and CV risk like atherogenic lipid profile (17). Prospective observational studies confirm that high–moderate levels of leisure time PA are able to decrease the risk of CV disease and CV mortality, showing a dose–effect relationship (18).
Research studies have evidenced that the association between higher levels of PA and lower CV disease rates can be explained in large part by the reduction of known risk factors, with inflammatory/haemostatic biomarkers making the largest contribution to lowered risk, followed by a positive effect on blood pressure, lipids, and body mass index (17).
Greater time spent in SB has also been evidenced to be associated with increased risk for obesity (19,20); as a matter of fact, these associations remain even after further adjustment for PA. Moreover, it has been demonstrated that SB during childhood and adolescence is a strong predictor of obesity during adulthood (21,22).
Time spent in SB has also been linked to increased risk for site-specific (ovarian, endometrial and colon) cancer and diabetes. However, some literature reviews showed that these associations may be a consequence of overweight/obesity, as further adjustment for BMI generally attenuates several of the reported relationships, particularly in relation to cancer incidence (23). A recent systematic review showed moderate evidence for raised incidence rates of ovarian (sitting time), colon (TV viewing) and endometrial cancers (sitting outside of work and overall sitting) and type 2 diabetes (sitting time) (24).
In adults, time spent in sedentary behaviour has been associated with metabolic syndrome, regardless of the level of PA (25).
In conclusion, sedentary behaviours have been demonstrated to be detrimental for health. Therefore, people should become aware of this effect and try to reduce as much as possible sedentary time in everyday life.

6.4. Interventions to reduce sedentary behaviours

As stated early in this chapter, time spent in pursuing sedentary behaviours is not the mere absence of PA and, as a consequence, interventions including solely the PA implementation may not have a clinically meaningful impact, especially if they do not directly act on SBs. That is because time spent being sedentary is not necessarily reallocated to structured PA practice or, in certain cases, people who are engaged in MVPA might potentially become more sedentary feeling satisfied of having met the minimal PA levels suggested by international PA guidelines. Indeed, there is moderate-to-strong evidence that large and clinically meaningful reductions in sedentary time can be expected from interventions that involve changes in SBs and lifestyle, whereas less consistent and smaller effects have been observed in interventions including PA or a combination of PA and SB (26,27). Furthermore, increasing the time spent in PA alone is sometimes not enough to meaningfully reduce the unhealthy outcomes coming from the time spent being sedentary (28). Therefore, it is paramount that effective interventions not only involve leisure-time physical activity but also propose ways to reduce the amount of time spent performing these behaviours during both occupational and non-occupational time.

The work setting offers both place and conditions within which intervention intended to reduce SB can be implemented. One important key factor that should be taken into consideration when aiming at reducing sedentary time in a workplace-based intervention is the specific occupational activity performed by the worker. Indeed, while some workers perform high levels of occupational physical activity (e.g., factory workers), desk-based workers spend the majority of their working hours sitting, thereby devoting PA practice to leisure-time only. Therefore, it is evident the need for targeted interventions that are based on the specific type of sedentary behaviour, such as workplace-based interventions for desk-based workers and interventions on leisure-time activity for factory workers. In their review, Smith and colleagues (4) suggested that for improving PA in desk-based workers, interventions should be implemented at both inter-personal and physical environment levels to provide social support to the individual as well as to change his/her perception of the workplace environment. Indeed, the more the employees perceive that their managers and workplace environment support PA at work, the more likely they are to be active during the working hours. Practical examples of interventions that are based on these principles can be encouraging managers to promote PA practice by leading walking groups during lunch breaks or manipulating the working environment to generate aesthetically pleasing and positive perceptions. Accordingly, the reorganization of both working environment and practice, for instance by implementing floor-standing printers or trash cans far from the working desk or holding work meetings in areas different than the own workstation, can be viable options to increase movement practice at the workplace. Interestingly, in a review by Mulchandani *et al.* (3) on the effects of workplace PA intervention on cardio-metabolic health markers, the adherence of participants and the long-term participation were highlighted as the main challenges for effective interventions. Although participants in medical and clinical interventions aimed at reducing the incidence of non-communicable and cardiovascular diseases are more easily and constantly monitored, workplace-based interventions lack indeed in the sufficient amount of control to be effective and produce valuable outcomes. Therefore, the motivation has to be constantly reinforced by innovative and practical tools, especially at the beginning of the process. An effective tool is the adoption of prompting software on personal computers at work which provides a reminder to engage in short-bouts

of PA every 30-45 minutes (29,30). It was observed that the effect of such motivational tool is a reduction of approximately 40 min/day in sedentary time in desk-based workers, thereby representing a very promising approach for reducing occupational sedentary time (31).
The opportunities for people to be sedentary outside the workplace are many and mostly involve the computer, television or electronic devices, screen viewing, and the time spent sitting in transport. The interventions for reducing the SB of screen viewing during non-occupational time is effective in the short to medium term, although higher-quality research with larger samples is still warranted by the scientific community (5,31,32). The most common strategy in these interventions is the adoption of special television control devices to restrict access and reduce television viewing time (33,34). Other strategies that can be implemented to reduce screen viewing time include educational interventions that provide knowledge to the person about the health risks deriving from pursuing SBs, such as online coaching, although they showed smaller effect than interventions using television control devices.
Up to date, there is little scientific evidence on the effectiveness of interventions aimed at reducing transport sitting time through active transport (5,35). However, this does not mean that active travel should be restricted to the short walks that are typical of a daily routine (i.e. from the front door to the car). Indeed, although the difficulty of providing evidence-based practical suggestions, the positive impact of walking over long periods and distances on health is consistent and well-known (35). In addition, the use of bicycles for transport can be considered a valuable alternative to the car which allows a translation from a passive type of transport to an active type of transport. Therefore, the transition from passive to active forms of transport, such as walking or cycling, is a shift from a SB to an active lifestyle that is worth maintaining.

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7

Physical Activity and Physical Fitness Assessment Tests in Middle-Aged and Older Adults

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Physical Activity and Physical Fitness Assessment Tests in Middle-Aged and Older Adults

7.1. Introduction

Physical activity is considered as any bodily movement that increases energy expenditure above resting expenditure. There are different ways of measuring physical activity in all populations such as questionnaires or accelerometery. Linked to physical activity, physical fitness is considered as the state of being fit. The assessment of physical fitness is relevant from a public health point of view. Indeed, assessing physical fitness allows you to detect or prevent any future health-related problems.
In this chapter, we are going to learn about different methods (i.e., subjective and objective) for physical activity measurements as well as propose a set of tests for measuring different physical fitness components.

7.2. Physical activity

7.2.1 Self-reported physical activity: Questionnaire

The *Global Physical Activity Questionnaire,* version 2 (GPAQ) is a valid measure used as a self-reported questionnaire to assess the physical activity and sedentary levels (1,2). The GPAQ questionnaire assesses physical activity behaviour in three different domains: at work (which includes paid and unpaid work, inside and outside the home), for transport (to get to and from places), and during leisure time. Some people will be physically active in all three domains, others may not be active in any of the settings. In any case, questions from all three domains should be asked. Another domain related with physical activity is sedentary time. In the GPAQ, there is a unique question about the time spent sitting or reclining on a typical day. The time expected for performing the GPAQ is about 10 minutes.
The *Physical Activity Scale for the Elderly (PASE)* is a reliable, brief and easily scored survey designed specifically to assess physical activity in epidemiological studies in people aged 65 and older (3,4). The PASE includes information on occupational, household and leisure activities over a one-week period. PASE asks people to report frequency and duration for sitting time, walking, flight of stairs, light intensity physical activity, moderate intensity physical activity and strenuous or vigorous physical activity. It also has separate questions on domestic tasks and home and yard care, and a section on job-related or occupational physical activity. The time estimated for measuring physical activity by PASES is 5 minutes.

7.2.2 Objective physical activity: accelerometry

One of the objective methods for assessing physical activity and sedentary behaviour is accelerometry. Accelerometers are wearable devices that measure accelerations of the body segment to which the monitor is attached (5). The signal could be filtered and pre-processed by the monitor to obtain a measure (e.g., counts) or given in raw data (e.g. mg), that is, accelerations recorded due to body movement.
The most used accelerometer is the GT3X+ commercialized by ActiGraph (5,6). Depending on the study sample and aims of the study, the accelerometer could be placed on the wrist or hip (or both). The total physical activity and the accumulated time in the different intensities (light, moderate, vigorous and moderate-vigorous) and sedentary time are calculated. It is recommended to wear the accelerometer for seven consecutive days with a minimum of 4 days (1 day from weekend) with at least 8 valid hours/day of registration (5). The higher the number of hours recorded, the better. Therefore, 24h recording the activity time would be ideal. More information about data collection and processing criteria can be found elsewhere (5). With regard to processing criteria, particularly decisions about cut-points selection for determining different intensities of physical activity and sedentary time, we recommend to check for the latest studies published.

7.3. Physical fitness

7.3.1 Functional Autonomy Test (GDLAM protocol)

For the realization of the functional autonomy test battery it is necessary to have the following considerations: Warm up with joint mobility, perform 3 sets of 10-15 repetitions of the movements of the main joints that will be used during the tests (ankles, knees, hips and shoulders). After the previous joint mobility, walk for at least 5 minutes at intermediate intensity. The next warm up exercise must be performed in 2 sets of 5 repetitions of arm push-ups on the wall and 2 sets of 5 repetitions of a quarter squat. Finally, it is recommended an active stretch with a performance of 2 series of 2-3 repetitions of 10 seconds duration of dynamic stretches of the main muscle groups involved (7).

7.3.1.1 Test 1: Walking 10m (10mW)

The purpose of this test is to record the time that the individual takes to cover a distance of 10 meters without running. The speed of displacement is a key factor to know the autonomy of the adult, as well as its effectiveness in carrying out daily life activities. In the test, the time spent on completing the task is taken in seconds and decimals. The materials needed are a chronometer and tape measure (7).

7.3.1.2 Test 2: Standing up from seated position (SSP)

The test aims to assess the functional capacity of the lower limbs. This test consists of the individual rising and sitting five consecutive times, starting from a sitting position on a chair, without arm support and the seat at 50 cm from the floor. Muscle strength is a key variable for the successful development of activities of daily life. The manifestation of explosive force correlates with the risk of falling in the elderly. Registered value: time spent on completing the task taken in seconds and hundredths. The materials needed are a chair 50 cm high and a chronometer (7).

7.3.1.3 Test 3: Standing up from a prone position (SPP)

This test assesses the individual's ability to stand up from the floor. Having the ability and strength necessary to be able to get up from the ground is a variable that indicates the capacity of independence and autonomy of the older adult. The registered value must be the time spent on completing the task taken in seconds and hundredths. The material needed is a stopwatch. This test involves rising to a standing position as fast as possible at the command "now", starting from the initial ventral decubitus position, with arms alongside the body. *Note:* It is advised that the assessor be placed in front of the participant to help him in case of accident (7).

7.3.1.4 Test 4: Standing up from a chair and moving around the room (SCMA)

The aim is to assess the elderly individual's agility and balance in daily situations. The displacement, as well as sitting and getting up from a chair, are everyday actions that the older adults perform daily in their home. In the test, the time spent on completing the task was taken in seconds and hundredths. The material needed is a stopwatch and a chair of 50 cm high. With a chair fixed to the floor, two cones are placed diagonally to the chair, four meters behind and three meters to the right and left. The participant is sitting on a chair, feet off the floor, and at the command "now", must stand up, move to the right, circle the cone, return to the chair, sit down and lift both feet off the floor. The same procedure is then performed to the left without hesitation. Immediately after they follow a new course, to the right and to the left, and thus circle each cone twice, in the shortest time possible (7).

7.3.1.5 Test 5: Putting on and taking off a shirt (PTS)

This test aims to assess upper limb agility and coordination. The capacity of an adult to dress helps to identify the level of independence to perform the tasks of daily life. Registered value: time invested in completing the task in seconds and hundredths. Materials: chronometer and

T-shirt size "L" (Europe). At the command "now", they should put on the t-shirt and immediately take it off, returning to the original position (7).

7.3.1.6 Test evaluation and interpretation

To calculate the autonomy index of the adult and the older people, the following equation is used. All the tests should be performed twice consecutively (average), with a minimum interval of five minutes between attempts. Using these data and the formula below, the GDLAM autonomy index (GI) could be calculated, in which the lower the GI, the better the result (7).

$$GI = \frac{\left[\left[(10mW + SSP + SPP + PTS)\ x2\right] + SCMA\right]}{4}$$

Table 1. Classification test

Classification/Test	10m W (s)	SSP (s)	SPP (s)	PTS (s)	SCMA (s)	GI (s)
Weak	>7.09	>11.19	>4.40	>13.14	>43.00	>27.42
Regular	7.08- 6.34	11.18-9.55	4.39-3.30	13.13-11.62	43.00-38.69	27.42-24.98
Good	6.33-5.71	9.54-7.89	3.28-2.63	11.60-10.14	38.67-34.78	24.97-22.66
Very good	<5.71	<7.89	<2.63	<10.14	<34.78	<22.66

A recent study has published the reference values in the Spanish context (8).

7.3.2 Static and Dynamic Balance Test
7.3.2.1 Static Balance

To ensure that testing conditions are the same for all participants, the balance test is preferably performed on a smooth, hard floor with the participants barefooted. The static balance could be evaluated with side-by-side stand, semi tandem stand, and tandem stand.

Side-by-side Stand

With their eyes open, the participants must be instructed to start the test in a position with their feet together side-by-side. The participants are instructed to keep the balance without using any assistive device and keeping their arms by their sides. The test will be timed in seconds as soon as the participant reports being stable, and the examiner removes her hand from helping the participant gain a stable position. The test is over after ten seconds have elapsed, when the foot shifts, or when the participant loses the stable position, or raises her arms. Participants are given two trials unless they are able to complete ten seconds on the first. The examiner records the best of the two trial times (9,10).

Semi tandem Stand

With their eyes open, the participants are instructed to start in a semi-tandem stand, in which the heel of one foot will be placed to the side of the first toe of the other foot, with the participant choosing which foot to place forward. The participants are instructed to keep the balance without using any assistive device and keeping their arms by their sides. The Semi tandem Stand test follows the same protocol as the Side-by-Side Stand test. The tests are over after ten seconds have elapsed, when the foot shifts, or when you lose your position, or raise your arms. Participants are given two trials unless they are able to complete ten seconds on the first. The examiner records the best of the two trial times. ***Note*****:** those participants able to maintain the semi-tandem position for 10 seconds will be further evaluated with the feet in full tandem position, with the heel of one foot directly in front of the toes of the other foot (9,10).

Tandem Stand

With their eyes open, the participants must be instructed to start the test in a tandem stand position. The Tandem Stand test follows the same protocol as the Side-by-Side Stand and Semi Tandem test. The participants are instructed to keep the balance without using any assistive device and keeping their arms by their sides. The test will be timed in seconds as soon as the participant reports being stable, and the examiner removes her hand from helping the participant gain a stable position. The tests are over after ten seconds have elapsed, when the foot shifts, or when the participant loses the stable position or raises her arms. Participants are given two trials unless they are able to complete ten seconds on the first. The examiner records the best of the two trial times (9,10).

One leg stand test

The examiner first asks the participants to decide on which leg they would like to stand; it has to be the dominant leg. The participants are then asked to stand initially in a relaxed stance with their weight evenly distributed between both legs. With their eyes open, the participants are instructed to stand on the leg they have selected, without using any assistive device, and keeping their arms by their sides. The One-Leg Stand test will be timed in seconds from the time one foot is lifted from the floor and the test is over after sixty seconds have elapsed, when the stance foot shifts, or when the lifted foot is replaced on the floor, whichever occurs first. The examiner records the better of the two trial times (11).

7.3.2.2 Dynamic Balance - Time Up and Go Test

The timed "Up & Go" measures, in seconds, the time taken by an individual to stand up from a standard armchair, walk a distance of 3 meters, turn, walk back to the chair, and sit down again. The participant wears his regular footwear and uses his customary walking aid (none, cane, or walker). No assistance is given. The participant starts with his back against the chair, his arms resting on the chair's arms, and his walking aid at hand. The participant is instructed that, on the word "go", he is to get up and walk at a comfortable and safe pace to a line on the floor 3 meters away, turn, return to the chair, and sit down again. A stopwatch can be used to time the performance (12).

7.3.3 Maximum Isometric Strength Test

7.3.3.1 Biceps Flexion Strength test

In this test, two maximum voluntary contractions are performed for five seconds, selecting the attempt with the highest peak force signal generated in Newton. The participant starts in a standing position with the trunk upright, elbows attached to the trunk and semiflexion (10º-15º) of the joint of the knees, located on the platform where the chain is attached. From the start position, the steel bar is grasped with the hands, joined to the force sensor held by a steel chain to the platform, whose chain links will allow to vary the angle of the joint, and the maximum contraction will be carried out (13).

7.3.3.2 Leg Extension Strength Test

In this test, two maximum voluntary contractions are performed for 5 seconds, selecting the attempt with the highest peak force signal generated in Newton. The participants start with the trunk upright and their arms across their chest, they will be placed on the chair or measuring surface. Once the knee joint is at 90 degrees, we will place the ankle, attached to

the same force sensor that holds this with a steel chain to a stable and rigid surface, the links of the chain will vary the angle of the joint (14).

7.3.4 Cardiorespiratory fitness Test

7.3.4.1 "6-Minute" Walking Test

The purpose of this test is to assess cardiorespiratory fitness. The main data obtained is the total number of meters walked in 6 minutes. The materials needed are a stopwatch, four cones, long measure tape, popsicle sticks, chalk, masking tape (or some other type of marker) and two chairs (placed along the walkway). The test is performed only once, and preferably at the end of the session. The participant has to walk around for about a minute to cool down and have to walk around the walkway of 46 meters for 6 minutes as fast as possible (*not run*). The participant has to walk outside the cones. The participant can stop and/or sit on a chair if they need it, and then return to walk. Each time that the participant completes a lap a popsicle stick (or something similar) can be given to the participant in order to account for the round around the walk place. Testers have to inform when 3, 2 and 1 min are left; and have to encourage with phrases such as "you are doing well" and "keep up the good work" every 30 second intervals. When the participant finishes, he has to inform the examiner of their score. Less than 320 meters for men and women has been defined as a risk zone (15).

7.3.5 Flexibility Test

7.3.5.1 Chair Sit & Reach

The main objective of this test is to assess lower body flexibility. The value data and register are the centimetres between extended fingers and tip of toe of right leg. The materials needed are a chair or straight-back and 45 cm ruler. The score registered will be the best of 2 trials. The participants sit on the front edge of the chair. The participants sit down with isquion bones at the end of the chair and the evaluated leg totally extended. One leg will be bent and the foot flat on the floor; and the other leg will be extended straight in front of the hip, with the heel on the floor and foot flexed (90º approximately). Hands will be one on the other with the tip of the middle fingers even. In this position, the participants bend forwards at the hip joint (spine should remain as straight as possible, with head in line with spine, not trucked). The participants will try to touch the toe. Less than 10.6 cm for men and 5.08 cm woman has been defined as a risk zone (16).

7.3.5.2 Back Scratch

In this test you place one hand behind the head and back over the shoulder and reach as far as possible down the middle of your back, your palm touching your body and the fingers

pointing downwards. Place the other arm behind your back, palm facing outward and fingers pointing upward and reach up as far as possible, attempting to touch or overlap the middle fingers of both hands. An assistant is required to direct you so that the fingers are aligned, and to measure the distance between the tips of the middle fingers. If the fingertips touch, then the score is zero. If they do not touch, the assistant should measure the distance between the fingers (*negative score*), if they overlap, then it must be measure by how much (*positive score*) (16).

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8

Middle-age adults Exercise Prescription Recommendations: Physical Fitness (resistance, cardiovascular and Flexibility Training)

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Middle-age Adults Exercise Prescription Recommendations: Physical Fitness (Resistance, Cardiovascular and Flexibility Training)

8.1. Introduction: the ageing of the population

The world's population has been aging considerably since the mid-20th century. Based on the European Union's statistics department, Eurostat, the average fertility rate for European Union countries was 1.46 in 2001, rising to 1.58 in 2015, and is expected to little rise further in the future. In spite of these trends, the population of European countries continues to age as a consequence of the increase in life expectancy (1). This process has produced an increase in the proportion of older people in the total population. It is estimated that in 2025 there will be 1.2 billion people over 60, rising to 2 billion by 2050, with an increase in both developed and developing countries (2). In addition, the official retirement age is gradually being raised in most countries. This means that in the future, one in three working adults will be over 50.

Consequently, it will become increasingly important in the coming decades to maintain the population's adequate health status, as well as its ability to work and earn a living, its independence and its self-sufficiency in daily life and leisure.

8.2. Aging, sedentary behaviour and declining physical fitness

Physiological and psychological changes occur at different rates with intra and inter-differences during aging. Hence, it is essential to regard not only the chronological age but also the biological age of middle-aged adult. Chronological age refers to the actual amount of time a person is alive. Thus, chronological age is not affected by health or lifestyle. On the other hand, biological age is a physiological age because it refers to a process in which different molecular changes converge that occur with aging and the decline in physiological function in various systems and organs. The nature of biological age is largely determined by the genetic profile of each individual, which will determine much of the changes at the molecular and functional level of organ systems throughout the aging process. However, the scientific community has shown that these changes are not only determined by genetics, but that other dimensions such as epigenetics, lifestyle behaviors, diseases and the environment can influence the evolution of the biological age (3). In this sense, aging should be seen as a process that can evolve at different speeds, where chronological and biological age interact, and which can favour a healthier and later aging or a premature and less healthy aging.

Due to the importance of the physiological changes associated with aging for people's health and quality of life, it is necessary to highlight the two most relevant systems from a clinical and functional point of view, i.e. cardiovascular and musculoskeletal systems.

Cardiovascular system is composed of by the heart and the blood vessels: arteries, veins and capillaries. It is a transport system used by most living organisms in which the heart pumps blood through a circuit formed by blood vessels in order to move nutrients, metabolites, oxygen, carbon dioxide, hormones, and other substances within the body.

Aging decreases elasticity of blood vessels, so the level of arterial stiffness is increased. As a result, changes occur in the morphology and function of the vessels, increasing blood pressure, as well as the mass and thickness of the heart wall and final diastolic volume of the left ventricle. In the same way, aging produces a reduction of cells in the atrial pacemaker (50-75% at age 50) and a fibrosis-calcification of the His bundle, so intrinsic heart rate decreases with age (3,4). These changes increase the vulnerability of the heart, the risk of

developing age-related cardiovascular diseases such as congestive heart failure, hypertension, aortic stenosis, atherosclerosis and atrioventricular block (3,4).
On the other hand, the musculoskeletal system is formed by the connection of bones, joints, muscles, tendons, ligaments and other structures. As a whole, it constitutes the element that performs the function of support, stability, form, protection and movement of the human body.
From the age of 30, sarcopenia, a decline in muscle mass, can begin to develop. This leads to a reduction in total cross-sectional area of fibres, which is associated with a loss of muscle strength. This loss of muscle mass is associated with an increased risk of falls and fractures, especially in women after menopause (3,4). Furthermore, older people also suffer dynapenia, which specifically refers to the functional loss of the ability to generate strength in older people, not only as a result of morphological changes (sarcopenia) but also neuronal changes (5,6). This decline in muscle mass and strength is associated with a worse physical condition, reduced functionality and increased mortality (7).

8.3. Exercise, ageing and health

WHO reports that not even one third of European adults declare themselves to be sufficiently physically active (8–10). A sedentary lifestyle leads to the premature onset of unhealthy, ill and fragile conditions.
Conversely, evidence shows that regular physical activity is beneficial to improve health in older people; decreasing the risk of developing cardiovascular and metabolic diseases, cognitive deficits or osteoporosis (11). Health benefits of physical activity in relation to cardiovascular disease (12), cancer (13), type 2 diabetes (14) or other conditions have been widely studied. In addition, physical exercise and an active lifestyle delays the process of decline in functional reserve of various systems of the organism. It promotes a biological age lower than that which corresponds chronologically (4).
Therefore, active ageing and a better physical condition should be considered as main tools to prevent the decline associated with aging. It is an active and healthy process that focuses both on adding years to life and adding quality to the years gained (15). These advantages are not just limited to light or moderate aerobic physical activity. In the last years, several studies have also found evidence of beneficial health effects of vigorous sports activities, including strength training.

8.4. Health benefits of exercise on cardiovascular fitness, resistance and flexibility

The existing body of research on exercise and active lifestyle suggests that it has effects on health as a whole, i.e., at physical, psychological and social levels. For example, physical exercise and active lifestyle can reduce the mortality risk; prevent the development of age-related diseases such as obesity, type 2 diabetes, heart disease, stroke, cancer, hypertension, osteoporosis, sarcopenia, etc.; improve sugar and cholesterol blood levels; reduce high blood pressure; improve cardiovascular function; encourage bone remodelling; can improve functional capacity; reduce fall risk; reduce stress, anxiety and depression levels; improve or maintain memory and cognitive functions; and promote social relations and friendship.

8.5. Exercise recommendations

8.5.1. General guidelines

Several associations, institutions and research networks including the World Health Organization (WHO) (9), the American College of Sports Medicine (ACSM) (16), the American Heart Association (AHA) or the Healthy-Age Network on Active Aging, Exercise

and Health among others (17), have prescribed physical exercise recommendations for adults and seniors with the aim of achieving optimal aging.
It is suggested, as general recommendations:

- Be physically active: taking the stairs instead of the elevator, walking or cycling, etc.
- Follow the guidelines for length, frequency and intensity and look for an exercise program that fits your preferences, characteristics and needs.
- Have a medical sports examination before beginning regular physical exercise.
- Choose an exercise program headed by a qualified professional, in this case a Bachelor/Graduate in Sports Science (physical educator).
- Use clothing and footwear suitable and comfortable for the practice being performed.
- Maintain a balanced and healthy diet. Drink water before, during and after exercise.
- Perform a specific warm-up before starting the main part of any exercise session.
- End the session with a cool down period where the exercise intensity is lower than the main part.
- Include strength, aerobic activities (endurance) and flexibility in sport trainings.

8.5.2. Resistance training guidelines

Resistance training can combat weakness, frailty and debilitating consequences in health. Doing strength-training exercises regularly and with an intensity moderate to high improves muscle strength, muscle mass, preserves bone density, independence, and vitality (18). Some specific recommendations about strength training are:

- Do strength training at least 2-3 days per week, not consecutive.
- The session time should not exceed 60 minutes.
- Include in each session 8 to 10 polyarticular exercises that involve large muscle groups (arms, shoulders, chest, abdomen, lower back, hips and legs), with self-loads or done with specific material, for example, elastic bands.
- One set of 8 to 12 repetitions of each exercise is effective, although two or three sets may be more effective. Muscle-strengthening exercises should be performed to the point at which it would be difficult to do another repetition without help but avoiding failure.
- Maintain an intensity from moderate (5 or 6 out of 10 in the Borg scale; 60-75% of 1RM) to vigorous (7 or 8 points out of 10 in the Borg scale; 75-80% of 1RM).
- For sedentary or middle-aged adults with risk of frail cardiovascular disease or osteoporosis, low intensity is recommended. In these cases, it is advisable to start at 20-30% of the 1RM, prioritizing the exercises in a sedentary position.
- Do a recovery between sets and exercises of at least 10-30 seconds.
- Development of muscle strength and endurance is progressive over time. This means that gradual increases in the amount of weight or the days per week of exercise will result in stronger muscles.

8.5.3. Endurance training guidelines

Aerobic activities, also called endurance, make a person's heartbeat more rapidly to meet the demands of the body's movement. Over time, regular aerobic activity makes the heart and cardiovascular system stronger and fitter. Some specific recommendations about endurance training are:

- Activity should move large muscles, during a long time in a low-impact rhythmic manner for a sustained period, such as brisk walking, bicycling, step cardio class, rowing, dancing, swimming, elliptical or yoga, among others.
- Achieve 150 to 300 minutes a week of moderate physical activity (> 30 min, 5 days) or 75-150 minutes a week of vigorous physical activity (> 20-25 min, 3 days); or an equivalent combination of moderate and vigorous physical activity.
- Greater benefits will be achieved by increasing the duration to 300 minutes per week of moderate intensity aerobic work or 150 minutes per week of vigorous intensity aerobic work; or with an equivalent combination of moderate and vigorous physical activity.
- The relative intensity of aerobic activity is related to a person's level of cardiorespiratory fitness. Moderate-intensity activity requires a medium level of effort (5 or 6 out of 10 in the Borg scale; 64-76% HR max; 40-59% HR reserve) to produce noticeable increases in breathing rate and heart rate. For middle-aged adults training, vigorous-intensity activity (7 or 8 points out of 10 in the Borg scale; 77-95% HR max; 60-89% HR reserve) produces large increases in a person's breathing and heart rate.
- Do a progression by increasing session time and weekly frequency. For sedentary people, it is recommended to start with 15-20 minutes per session, 3 days per week, increasing the duration and frequency every 4-6 weeks until they archive recommendations.

8.5.4. Flexibility training guidelines

Joint flexibility may decrease across the age span, which has the potential to affect normal daily functioning. Upper body flexibility is known to be important for activities such as getting dressed and reaching for objects, while lower body flexibility is important for maintaining normal walking patterns and for activities involving bending and reaching (19). Some specific recommendations about flexibility training are:

- To stretch two or three days per week, based on static and dynamic stretching.
- To include all main muscles, i.e., anterior and posterior lower extremities, shoulder girdle, etc., doing two to four series of 10-30 s per muscle, with a rest of 15 s between series.

8.6. Main sections and recommendations of a training session to improve physical fitness in adults

Training sessions must be structured. The elements that they should include are warm-up, training activity and cool down.

A warm-up is essential to get the whole body ready for work. The duration should be 10-15 min and the intensity has to increase gradually. The warm-up should include aerobic exercises with progressive increase in HR, for example, walking increasing speed; joint mobility; dynamic and active static stretching of the main muscles. These exercises can be sometimes combined with cognitive work strategies, such as associations, sequences of movements, etc.

Training activity, as the main part of the session, has a duration of 30-45 min. It usually includes strength and/or balance in the first part and endurance training in the second part. As it has been mentioned above, specific recommendations for each component have to be considered. However, the distribution of time among these capacities depends on the individual aims for each adult depending on their characteristics.

Cognitive capacity can be improved together with strength training using, for example, calculation strategy, problem solving or associations; or with endurance training using, for

example, sequences of movements, repetitions, spatio-temporal perception, etc. It is not recommended to combine it with balance training because this quality already involves the nervous system, especially in the case of including dual tasks such as maintaining a balance position and reading a phrase or counting back to the time.
It is recommended to include a cool-down of 5-10 min to finish the training. The objective of cool-down is to return the adult to basal parameters. The most frequent content included in cool-down is flexibility, specially doing static stretching. It is also possible to include cognitive activities but with light activities as body representations, relaxation or visualizations.

8.7. Conclusions

This chapter has shown the importance of physical exercise practice during middle-adulthood to prevent illness and improve health status. It include the principal aspects and recommendations for practice.

8.8. References

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9

Older Adult Exercise Prescription Recommendations

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Older Adult Exercise Prescription Recommendations

9.1. Introduction

Physical exercise as part of an active lifestyle has been shown to be essential for healthy aging and positive mental health. Being physically active makes it easier to perform activities of daily living, including eating, bathing, toileting, dressing, getting into or out of a bed or chair, and moving around the house or neighborhood. Physically active older adults are less likely to experience falls, and if they do fall, they are less likely to be seriously injured. Physical activity can also preserve physical function and mobility, even premature mortality. Moreover, not performing regular physical activity means a high cost for public institutions and home themselves (1,2). Performing physical activity at these ages may help maintain independence longer and delay the onset of major disability.

9.2. Physical activity guidelines for older adults

Promoting physical activity and reducing sedentary behavior for older adults is one of the main tools to prevent and make face aging. Moreover, it is especially important because this population is the least physically active of any age group, and most older adults spend a significant proportion of their day being sedentary (3). Institutions such as *American College of Sports Medicine (ACSM)*, *American Heart Association (AHA)* or *World Health Association* (WHO) have prescribed physical activity guidelines for older adults with the purpose of maintaining and/or improving their health. In general, the guidelines focus mainly on aerobic, muscle-strengthening, flexibility and balance. Furthermore, it is appropriate and recommended that all older adults do multicomponent physical activities to reduce the risk of injury from falls and improve physical function. *Multicomponent* refers to an exercise program that includes more than one type of exercise, such as aerobic, muscle strengthening, and balance training; it may include gait, coordination, and physical function training.

It is also recommended by the ACSM (4) that older adults should perform physical activity in the manner recommended for prevention as described herein. For older adults who are not active at recommended levels, plans should include a gradual (or stepwise) approach to increase physical activity over time using multiple bouts of physical activity (for example, 10 min). It is important to take into account that it may take a considerable period of time to achieve the physical activity recommendation (5). Those with chronic conditions for which activity is therapeutic should have a single plan that integrates prevention and treatment according to their abilities and conditions so as to avoid sedentary behavior. Integration is facilitated by the fact that preventive recommendations are similar to therapeutic recommendations for many common diseases, including coronary artery disease, hypertension, type 2 diabetes, stroke, high cholesterol, osteoporosis, and/or osteoarthritis (4) and that it is only necessary to make small adaptations of the life style.

The following is a summary with the recommendations for physical activity prescribed by the different institutions for older adults.

9.2.1 Aerobic activities recommendations in older adults

The guidelines for aerobic activities are summarized in Table 1. Daily life activities of light to moderate intensity, i.e., personal care activities, housework, walking or shopping, are beneficial for the older adult and therefore should be carried out in addition to the activities proposed in Table 1(4), even if these are performed with a duration of less than 10 minutes.

Table 1. Aerobic activities recommendations in older adults

Aerobic activities recommendations in older adults	
Frequency	At least 3 days a week to produce health benefits, reduce the risk of injury and prevent excessive fatigue (2)
Duration	At least 150 minutes (2 hours and 30 minutes) to 300 minutes (5 hours) a week of moderate-intensity (2) Or 75 minutes (1 hour and 15 minutes) to 150 minutes (2 hours and 30 minutes) a week of vigorous-intensity aerobic physical activity (2) Or an equivalent combination of moderate- and vigorous-intensity aerobic activity spread throughout the week (2)
Intensity	Moderate: physical activity between 5 and 6 on subjective 10-point effort scale (3) or between 3 and 5.9 times the amount of energy expended at rest (1.6 to 2.9) (2,6) Vigorous: between 7 and 8 on subjective 10-point effort scale (4) or 6 or more times the energy expended at rest (2,6)
Type	Any modality that activates most muscle groups (5) and that does not imply high osteoarticular impact (7), such as walking or hiking; dancing; water aerobics; jogging or running; aerobic exercise classes; some forms of yoga; bicycle; riding

Older adults should aim to do at least 150 to 300 minutes of moderate-intensity physical activity a week, or an equivalent amount (75 to 150 minutes) of vigorous-intensity activity. They can also do an equivalent amount of activity by doing both moderate- and vigorous-intensity activity. As is true for people of all other ages, greater amounts of physical activity provide additional and more extensive health benefits. Older adults who do more aerobic physical activity have a reduced risk of age-related loss of function and reduced risk of physical function limitations compared to the general aging population (2–4,7).
On the other hand, those older people who cannot perform the recommended physical activity due to their health state should remain as physically active as possible, carrying out activities of light to moderate intensity and avoiding sedentary behaviors (3,4). It is important to consider that those individuals who are inactive or insufficiently active and join physical activity programs should avoid starting with vigorous intensity activity or at least not accumulating large volumes. If they do that at the beginning it will reduce the risk of contraindications such as injuries, non-adherence, or acute overloads. Likewise, they should

gradually increase the volume by the number of days per week and the duration of moderate intensity activity. They could even start with periods of physical activity of less than 10 minutes and progressively increase those minutes with activities of light intensity (eg, walking) (5).

As a rule of thumb, a person doing moderate-intensity aerobic activity can talk, but not sing, during the activity. A person doing vigorous-intensity activity cannot say more than a few words without pausing for a breath. Furthermore, 2 minutes of moderate-intensity activity count the same as 1 minute of vigorous-intensity activity. For example, 30 minutes of moderate-intensity activity is roughly the same as 15 minutes of vigorous-intensity activity.

9.2.2 Muscle strengthening activities recommendations in older adults

The institutions also emphasize the need to work on muscle strengthening following guidelines in Table 2. In general, no specific amount of time is recommended for muscle strengthening, but muscle-strengthening exercises should be performed to the point at which it would be difficult to do another repetition (2,5). In this way, the development of muscle strength and endurance has to be progressive over time. That means that gradual increases in the amount of weight, number of sets or repetitions, or the number of days a week of exercise will result in stronger muscles (2,5).

Table 2. Muscle-strengthening activities recommendations in older adults

Muscle-strengthening activities recommendations in older adults	
Frequency	At least 2 non-consecutive (4) days a week (2,3,7,8)
Volume	8-10 exercises (7) 8-12 repetitions of each exercise (7) 1 set to enhance muscle strength and 2-3 sets to improve resistant strength (2,5)
Intensity	40%-50% of 1 RM for recreational older adults (6) 60%-70% of 1 RM for older adults with some experience (6) >=80% for experienced older adults (6) Moderate: physical activity between 5 and 6 on subjective 10-point effort scale (2,4) Vigorous: between 7 and 8 on subjective 10-point effort scale (2,4)
Type	Muscle-strengthening activities that involve all the major muscle groups (legs, hips, chest, back, abdomen, shoulders, and arms) (2,4). Examples of muscle-strengthening activities include strengthening exercise using exercise bands, weight machines, or hand-held weights; body-weight exercise (push-ups, pull-ups, planks, squats, lunges); digging, lifting, and carrying as part of gardening; carrying groceries; some yoga postures; some forms of tai chi) (2,5)

9.2.3 Flexibility activities recommendations in older adults

Flexibility activities are recommended in order to maintain the range of motion that is necessary to carry out activities of daily living (4). Flexibility guidelines are in Table 3.

Table 3. Flexibility activities recommendations in older adults

Flexibility activities recommendations in older adults	
Frequency	At least 2 days per week (4,7), and preferably always on days when aerobic or muscle strengthening activities are carried out (4)
Duration	At least 10 minutes (4)
Intensity	Moderate: 5 or 6 on subjective 10-point effort scale (2,4,7)
Type	Stretching exercises that maintain or increase flexibility by sustained stretching for each muscle group, and static rather than ballistic movements (2,7)

There are several recommendations that have not been included in Table 3 to work flexibility in older adults, for example, keep stretching for 30-60 seconds and / or repeat the flexibility exercise from 2 to 4 times (6). Scientific literature is not conclusive regarding those recommendations, since they have been carried out in observational studies and non-randomized clinical trials. However, it is important to mention them for a well-designed flexibility program.

9.2.4 Balance activities recommendations in older adults

Balance activities can improve the ability to resist forces within or outside the body that cause falls. Therefore, fall prevention programs that include balance training can also significantly reduce the risk of injury, such as bone fractures, if a fall does occur (2). Balance activity guidelines can be found in Table 4.

Table 4. Balance activities recommendations in older adults

Balance activities recommendations in older adults	
Frequency	2 - 3 or more days per week (3,5,9)
Duration	No evidence
Intensity	No evidence
Type	Activities that progressively hinder posture by decreasing the support base (progressing from bipodal support to semi-tandem position, tandem position and mono-foot support) (7). Balance training examples include walking heel-to-toe, practicing standing from a sitting position, and using a wobble board. Strengthening muscles of the back, abdomen, and legs also improves balance (2)

9.3. Cognitive training

The trend of population aging increases the incidence of health-related problems (cardiovascular diseases, metabolic disorders, etc.) and physiological declines (e.g. fragility and physical functionality (10)) generating, thus, dependency. Particularly, one of the most common neurodegenerative problems is dementia, Alzheimer or, in its earliest stage, mild cognitive impairment (11). Moreover, the cognitive frailty phenotype, namely the coexistence of both physical frailty and cognitive impairment, was associated with increased mortality, especially relevant in the inactive older adults (12). However, physical activity may attenuate 36% of the increased risk of mortality among cognitively frail individuals (12). In this line, high-quality evidence supports the use of exercise for the promotion of brain health in older adults (13).

Combined exercise and cognitive training interventions can improve cognitive function in healthy and cognitively impaired older adults (14). Moreover, a recent review suggests that combined cognitive and physical interventions have the potential role to improve more both cognitive (e.g., global cognition, executive function, memory abilities, mood, emotion, motivation, brain cortex, and orientation) and physical functioning (e.g., gait, mobility and balance) in older people with mild cognitive impairment, than those groups that received isolated cognitive and physical exercise (15). Additionally, considering the problems that people have to find time for exercising, combined training can be an effective way to address the improvement of body and mind. However, this positive influence on cognition only occurs when the combined physical and cognitive training meets specific criteria: 1) The intervention has to include at least cardiovascular and strength training combined with cognitive training of attention and/or executive function/working memory (14); and 2) in relation to the structure of the intervention, a frequency of 1 to 3 hours weekly for 12 to 16 weeks (or more) is recommended in order to detect changes in cognitive performance(14).

Combined exercise and cognitive training interventions can be applied in two different structures, sequential or simultaneous exercise-cognitive training (i.e. doing exercise while the individuals are solving problems cognitively), with evidence suggesting that simultaneous training may be more effective than sequential training and exercise alone(14).

Different strategies can be used to integrate cognitive work with physical exercise simultaneously (16). These strategies are not exclusive, and several strategies can be developed at the same time in the same exercise (16). Please, see below the following strategies that we highlight in this book chapter:

Association: proposals based on the association strategy are all those exercises and activities where it is necessary to associate one or more movements to a resource (i.e. object, sound, music, image, or any signal that can be used). This strategy implies to associate movements, with and without displacement, with different themes, such as days of the week, seasons, fruits etc., or themes that are of interest for older people and are familiar to them (16).

Sequences: Sequence of movements implies that each new movement must have a relationship with the previous movement. Examples: sequence of steps of a popular dance, choreography (16).

Sensory-motor activities: Proposals based on enhancing the use of the senses to identify a resource that can be an odour, shape, texture, colour, taste etc., and then reproduce a movement, by means of associations (16). Some examples of activities that use the senses to affect memory are:

a) Writing a letter of the alphabet with the hand on the back of a partner who has to guess what letter it is.

b) Participants walk to the rhythm of the music, when the music stops, they must take one of the cards that are placed upside down on the floor and put it back in place. The objective is to make pairs of identical cards, so the person must remember where the cards are located.

Repetitions: Proposals where one or several movements have to be repeated. The repetition can be suggested immediately after the proposal or can wait some time. Depending on the amount of time we wait, we will be influencing different types of memory. Example: repeat an aerobic choreography immediately (i.e. short-term memory), or repeat it a week later (i.e. long-term memory) (16).

Body representations and descriptions: To corporally reproduce a previously remembered story, a relaxation that has been worked on in previous sessions, a poem/story that they have read previously, or to reproduce what they did one day last week, in the morning, among others. (16)

Attention and observation capacity: In pairs, to repeat the movements performed by the pair. To do exercises that the partner forgot to perform in a prescribed sequence (16).

Verbal activities, language and sounds: In a circle, each participant will say a word and an associated movement, it must be remembered and repeated by all members of the group. Each person says a number from 1 to 100. Every time a 5 or a multiple of 5 is said, an associated action will be performed, for example a clap. (16)

Relaxation and visualizations: With the aim of raising awareness of different parts of the body and lowering the muscle tone of the subject. Visualizations of a landscape can be used by trying to mentally place a series of objects or visualize a story told to the group. (16)

Space-time perception: Go through a proposed space in a drawing. Walk around the room for 1 minute and try to stop when the participant considers that the minute has passed. Move around the room at a specific pace proposed by clapping your hands. Carry out segmental movements at a rate proposed by the person in charge. (16)

Calculation and problem solving: This strategy implies a calculation or problem that must be solved in order to carry out the exercise. As an example: proposing a mathematical operation (sum, subtraction, multiplication...), being its solution the number of repetitions they have to do of a strength exercise; or gymkhanas where they have to solve puzzles (16).

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10

Motivational Strategies to Increase Adherence to Exercise Programs with Age

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Keywords: adherence; motivation; self-determination theory; strategies

Motivational Strategies to Increase Adherence to Exercise Programs with Age

10.1. Introduction

The level of physical activity in the older population decreases with age (1,2). This not only affects the intensity of the exercise, but also its duration, which ultimately results in difficulties in performing daily tasks and overall decreased quality of life (3,4). This state of physical inactivity is considered to be one of the major causes of obesity, mortality and functional disability in the aging population (5,6). Therefore, a proper strategy to increase life expectancy and maintain the individual's wellbeing is to exercise regularly, even at advanced age (7,8). Even though aging should not be regarded as a terminal state, it does cause structural and functional changes, which progressively affect individual's capabilities, and consequently, their health and quality of life (3,9–11).

A growing body of research considers self-determined motivation to be a variable predictor of positive psychological, social and emotional consequences in older adults who engage in physical exercise (12). Following the recommendations of Krech (13), active aging is related to being socially and mentally active through recreational, voluntary, or paid activities, cultural, social, and educational activities (14). Likewise, reduced physical functioning in this population is associated with negative outcomes in later life, including increased risk of dementia and mortality (15).

10.2. Promoting exercise adherence

The adoption of an active lifestyle not only depends on individual behaviors and choices, but also on the interaction between individuals, environment, and public policies (16). Age, sex, health status, self-efficacy, motivation, and genetics are associated with physical activity (17). Genetic and epigenetic factors also influence the propensity for physical activity (18). Twin and family studies provide further evidence that genetic factors contribute to variations in daily physical activity levels (19). Exercise might lead to more exercise, whereas inactivity might have the opposite effect. An absence of evidence suggests the role of the human genome in adherence to exercise programs.

Abundant evidence shows that physical activity and exercise are among the most important factors influencing health status in the older adults (1,20). Exercise programs are also associated with improved psychological health and functional status, and reduced health care expenditures (20). Physical activity is an elixir vita that promotes health and longevity better than any other lifestyle practice, but it is only effective if people do it.

Health services administrators and providers should know that low adherence rates will limit the benefits of the exercise program at their facilities. For example, poor attendance and nonadherence are risk factors leading to health service complications in long-term care programs. Administrators of long-term care programs should consider adherence predictors in the projection of expected outcomes, future program needs, and evaluations (21).

10.3. Motivation

10.3.1 Exercise and Self-Determination Theory (SDT)

Current theories and studies regarding the psychological predictors of success in exercise suggest that the Self-Determination Theory (SDT) (22,23) seems to be the best method to explain the types and levels of motivation that are associated with initiation and maintenance of behavioural changes that reflect attitudinal responses. SDT considers that the origin of

the motivation may be internal or external (more or less self-determination) as individual are more or less involved in the performance of their activities (24). To this end, the theory establishes that motivation is represented by a continuum that discerns 3 types of self-determination, ordered from more to less self-determination: autonomous motivation, controlled motivation and amotivation (25). Autonomous motivation comprises (in descending order regarding level of self-determination) intrinsic motivation, integrated regulation and identified regulation. These types of motivation are evident when the activities are performed for pleasure and leisure, since they are highly interesting activities for individuals (intrinsic regulation) or because they form part of their lifestyle (integrated regulation), or have a high personal value when the individual is conscious of the importance and benefits of physical exercise (identified regulation). Controlled motivation is composed of less self-determining regulations (in descending order): introjected regulation, referring to situations when behaviour is due to internal pressures (i.e. search for self-esteem and avoidance of sense of guilt); and external regulation, which manifests when the behaviour is performed as a consequence of external pressures, such as threats of punishment, rewards or recognition by other individuals (26). Lastly, amotivation represents the lowest level of self-determination (22) and refers to the lack of interest of the individual to perform a task, resulting in disorganization and a sense of frustration, depression or fear (27).

The SDT identifies three basic psychological necessities: the necessity for competence, referring to the feeling that an individual may perceive when he/she is efficient in a certain activity; autonomy, refers to the individual following his/her own initiative and having the sensation of choice; and social relations, defined as the feeling of being part of a group and highly regarded by other individuals. These three basic psychological needs (BPN) are essential for an optimal functioning of the natural progress towards growth and integration, as well as social/constructive development and personal wellbeing (22,27).

The SDT establishes that satisfying the BPN of autonomy, competence and social relations gives rise to the development of more self-determining motivations (28–31). The Hierarchical Model of Motivation (HMM) (32) was developed in order to improve and associate these BPN with SDT motivational constructs (33). According to the HMM, sports instructors, through their intervention in the sessions (i.e. providing information and interacting with the participants) greatly contribute to satisfying basic psychological needs, and consequently, support the level of autonomous motivation. This level of self-determined motivation can predict positive or negative cognitive, affective and behavioural outcomes (i.e., intention to be physically active).

In this sense, it is important to note that for the older population to integrate regular physical exercise into their routines, they must not only know the benefits of this practice, but also the sessions must be designed based on their specific needs, as well as the tasks must be adjusted to their level of competence. Also, they must be performed in a way that social relations are encouraged, so that the motivational component may act as a determining factor in the performance and continuance of the sports practice, with the goal of becoming more physically active (34).

Despite the importance that motivational variables exert on adherence to physical exercise routines, experimental studies have generally focused on determining the effect training programs may have on biological variables, such as VO2 max (35–37), potency (11,38,39), or body composition (40,41), etc.

10.4. Strategies to increase adherence to exercise programs

10.4.1 Strategies for exercise training programs

Motivation is considered important for successful changes in physical activity behavior. The strategies used were based on the principles of the Self-Determination Theory (SDT)

(22,25,33). SDT includes a meta-theory for framing motivational studies, a formal theory that defines intrinsic and varied extrinsic sources of motivation, their role in cognitive and social development, as well as in individual differences (22,24,25,42). SDT is a theory of motivation and personality that addresses three universal, innate and basic psychological needs: autonomy, competence and relatedness. In this sense, and in order to increase the intrinsic motivation in the sessions, it is necessary that instructors propose tasks in which the elderly feel competent, relate to others and have the possibility to make decisions and act on their own initiative (29). Based on previous studies (21,43–46) which have proven the beneficial effect on BPN satisfaction and autonomous motivation, the strategies designed for the exercise programs are these (47):

Strategies based on autonomy

1. *Educate older adults practitioners about the benefit of an exercise programme*. The first step is to inform of the benefits of exercise and the need to increase the level of physical activity for long-term weight control. For example, resistance-training may help preserve fat-free mass during weight loss; resistance-training increases energy expenditure. The amount of energy expenditure depends on the intensity, duration of the activity, and on the muscle group involvement. The increase in energy consumption associated with activity occurs primarily during the activity itself, but there is also a short-lived post exercise increase in metabolic rate. In addition, weight maintenance can be achieved with either programmed or lifestyle activity. Increasing daily lifestyle activities is as effective as a structured exercise programme in maintaining long-term weight loss.
2. *Explain the purpose of the exercise program*. In this manner, the positive perception of the activity is increased, as well as the participant's commitment and sense of autonomy. The goals of the resistance-training session and specific objectives are explained (for example, what muscle groups are involved in each exercise).

Strategies based on competence

3. *Encourage the perception of competence by the participant*. Have the participants focus on improving their own task, avoiding external pressures that may cause stress (e.g. the instructor orients the participants to only focus on improving their own tasks, while providing positive feedback such as "good job, you're doing fine").
4. *Establish moderately difficult objectives*. Emphasize the importance of progression and setting realistic goals. This strategy can help extend the practice time, and serve as a stimulus to initiate and/or maintain the intentions of being physically active (e.g. teach the participants to progress towards the perception of effort and increased loads; it is necessary to explain to the participants that their body will need a number of adjustments before the effects of hypertrophy may be visible. To this end, it is necessary to perform muscle-strengthening exercise and progressively increase the load and repetitions).
5. *Take into account the information provided by the elderly practitioner during the exercise programme*. This information will be obtained during and after the sessions, as participants share their views with the instructor who takes them into account for future interactions (e.g. the instructor must monitor the feelings of the practitioners and know their evolution with training loads, to properly perform the tasks and avoid injury).
6. *Convey an adequate task environment*. Effort and personal improvement should be prioritized, avoiding social comparison. In this manner, it is more likely for the participants to continue to attend the sessions by emphasizing the positive results (for example, explaining to the participant how he/she has improved in the execution of an exercise with free weights, and how with practice he/she will perform the technique more efficiently and increase the load). Also, it is recommended to comment on the values of the task being performed, by applying psychological training techniques such as self-instruction, mental performance of the task,

and relaxation. These aspects correlate with a positive task environment, making the participant aware of the benefits of physical activity for physical, psychological and social health.

7. *Encourage the participants by emphasizing that the activity can be improved through practice*. This consists in redirecting negative emotions (i.e. I cannot do this; I have no resistance; I cannot increase the load) towards positive ones (If you practise long enough you will improve; everyone has their own pace, no hurry; if you practise you will see that it is not that difficult; if you do not try you will not know what you are capable of, etc.).

8. *Offer clear feedback*. The instructors should inform the participants of the exercises they have performed properly, as well as of the mistakes they made. The instructors must always have a positive attitude of encouragement, focusing on how the participant can improve through practice (e.g. recognize the individual's progress and improvement, ensure equal opportunities to all the participants, focus on self-development, congratulate them when improving).

Strategies based on social relations and enjoyment

9. *Encourage the relationship between participants*. One of the most feared aspects of aging is loneliness. To this end, the training sessions are focused on the encouragement of social relations, which are separated into two phases in order to enhance group cohesion and involvement in the activities. The first phase involves the activity itself (task cohesion), where the instructors may encourage a participant who is resting to motivate a partner, or have the participants make joint decisions. The second phase occurs after the session (social cohesion) by encouraging other activities (e.g. proposing mini-events, going together for a healthy breakfast after the training session, attending sports events, etc.).

10. *Have the participants enjoy the activities*. The participants will be more motivated if they really enjoy what they are doing. The instructors must have previous knowledge of the group members, their concerns and requirements, in order to achieve the objectives while enjoying the activities (for example, use music to motivate the participants and perform enjoyable resistance-training activities).

In summary, these 10 strategies, based on previously published studies, increase adherence and enjoyment of the resistance-training programme. In this manner, the participants are less likely to abandon the training programme due to lack of motivation, boredom, or lack of knowledge of the benefits resistance exercise has on their health.

10.5. Conclusions

It is very important for physical sports educators to know the importance of valuing the attitude of practitioners and to know the importance of using motivational strategies that guarantee the satisfaction of basic psychological needs. The need for physical activity and exercise as a preservative for well-being across the life span needs to be reinforced across social strata. Promoting in older adults more self-determined reasons for practicing sports and positive consequences for their general health such as adherence to practice. Sustaining a physically active lifestyle and participating in exercise programs improve the current and future level of health and a state of well-being. Those benefits come across as less disease and sickness are experienced.

Older people have a number of reasons for engaging in physical sports, which are to maintain or improve their health, their concern for social issues and social relationships and the value they give to having fun. Therefore, we must use motivational strategies to help meet these needs in the exercise programs designed for this group.

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11

Multidomain LifeAge Program

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11.1. Healthy Lifestyle general recommendations

To be involved in an exercise program for improving or maintaining physical condition related to health (i.e., cardiorespiratory fitness, strength, muscular endurance, flexibility, balance, coordination and body composition), functionality, autonomy and cognitive function is essential in elderly (1–7).
However, some general recommendations have to be considered in order to do it in the most appropriate and healthy possible way (1–7):

- Try to have a daily physically active lifestyle: taking the stairs instead of taking the elevator, walking or cycling, etc.
- Considerer the recommendations for duration, frequency and intensity recommended, look for an exercise program that suits your preferences, characteristics and needs. Any place can be good for exercising (sports centers, parks, green areas, etc.).
- Get a physical-sports medical examination before starting to do physical exercise.
- Make sure that the physical exercise program is directed by a qualified professional, in this case a graduate in Sports Sciences (physical educator).
- Wear suitable clothing, look for garments that perspire. Avoid the use of elements to promote sweating such as plastics.
- Wear suitable footwear for sports, that is, sneakers.
- You need to drink water before, during and after exercise. Thirst is the first sign of dehydration.
- Follow a healthy diet. This is essential, together with the practice of physical exercise, to achieve changes in body composition.
- Do a specific warm-up before doing the main part of any physical exercise session.
- End the session with a cool down in which the intensity of the exercise is lower than in the main part.
- Avoid the hottest hours in summer.
- Put on sunscreen if you exercise outdoors.

11.2. Multidomain cognitive training and exercise training program

Multidomain healthy lifestyle programs in older people have to focus on these aims, including physical, psychological and social aspects (1–11):
Physical aims:

- To reduce the probability of mortality.
- To prevent the incidence of pathologies, such as overweight and obesity, type 2 diabetes, coronary heart disease, stroke, cancer, hypertension, osteoporosis, sarcopenia, etc.
- To increase HDL and decrease LDL.
- To normalize blood glucose level.
- To reduce high blood pressure.
- To improve cardiovascular function.
- To promote the absorption of calcium from the bones.
- To promote rest during sleep.
- To maintain or improve general dynamic coordination capacity.
- To help maintain weight and body composition in normal values.

- To improve physical condition (cardiorespiratory fitness, strength, muscular endurance, flexibility, balance, and coordination).
- To improve functional capacity.
- To reduce the risk of falling.

Psychological aims:

- To increase the feeling of well-being and self-esteem.
- To encourage the feeling of relaxation and have a good mood.
- To reduce stress, anxiety and depression levels.
- To improve memory and intellectual performance.
- To maintain or improve psychic, spatial and temporal perceptual abilities.
- To maintain or improve cognitive functions (observation, attention, memory, concentration, abstraction and learning).

Social aims:

- To maintain and improve the ability to communicate with others and with oneself.
- To promote social relations and friendship.

In order to achieve these objectives, a multicomponent exercise program focused on adults and the elderly is proposed. It must be directed by a Physical-Sports Educator. Its primary aim is to achieve the global physical activity recommendations of 150 minutes moderate-to-vigorous physical activity per week as the minimum to start reaping health benefits. This minimum can be achieved through different combinations that include supervised physical exercise, along with personalized advice on physical activity and / or physical exercise performed independently (4).
Ideally, the program could be delivered for 5 days a week through supervised physical exercise being enough to achieve the minimum recommended. However, it is recommended that the Physical-Sports Educator provides advice for the additional and complementary performance of physical exercise / unsupervised physical activity and promotes it, given the existing scientific evidence that supports the consequence of greater benefits for comprehensive health (physical, psychological and social) with greater amount of physical activity.
In the event that the program is taught in a sports facility, however, in most of the sport facilities, it is common to find an offer of exercise programs with a frequency of 3 days a week, estimating that ⅔ of the minimum suggested by the weekly international recommendations would be reached. In this case, it would be necessary that the Physical-Sports Educator provides specific advice that would allow the participants to reach or exceed the minimum established by performing physical exercise / physical activity in an unsupervised manner.
In this chapter, we include an example of what could be the content structure of a week with 5 days of supervised physical exercise (Table 1). The exercise program includes sessions in which various contents are worked on, bearing in mind that the recommended order is the one established in the example. A range of time has been provided to work on each quality, but it should be considered only as a recommendation since it should be adapted to the characteristics of the person / group and at the time of planning.
In the case that only 3 days of supervised physical exercise are developed, a recommendation of the content structure for these sessions can be also found in Table 2, as well as the recommendations that the sports physical educator should give for the other 2 days of unsupervised exercise in order to meet weekly recommendations. In this circumstance, priority is given to developing the content of strength and balance in a supervised way, to ensure that the technical execution of the exercises is correct and due to the necessary use of material in some exercises, while cardiorespiratory fitness is easier to develop in an unsupervised way in the daily routine.

Some aspects have to be considered before presenting the model of sessions:

- *Warm-up (10-15 min).* It will include cardiorespiratory fitness exercises with a progressive increase in heart rate (walking increasing speed, etc.), plus a joint mobility work, followed by dynamic and static active stretching of the main muscle groups. Sometimes these exercises can be combined with any of the cognitive training strategies proposed in the recommendations, such as associations, sequences of movements, etc.
- *Main part (30-45 min).* In this part, at least two qualities should be worked on if possible, considering that cardiorespiratory fitness would be worked on last. Previously the work of strength and/or balance would be included. Each component will be worked on taking into consideration the indications previously provided for each of them. Cognitive training can be done in combination with both strength (using, for example, the calculation and problem-solving strategy, association, etc.) and cardiorespiratory fitness (sequences of movements, repetitions, space-time perception, etc.). Although it can also be combined with balance work, it must be considered that this quality intrinsically implies an important work of the nervous system, and even greater if dual tasks are included, for example, maintaining a balanced position and reading a sentence or counting backwards. A range of time for each component has been included as a guideline and its realization will depend on the objectives finally established for each person and/or group. For example, given that it may be faced with a person with a very low level of resistance, the resistance work would have priority over other components. On the other hand, it is possible that in other participants cardiovascular fitness may need to be the priority, combining with other capacities.
- *Cool down (5-10 min).* This part aims to restore basal parameters. It should focus primarily on flexibility work, through static stretching. Moreover, it is also possible to include cognitive training, but with softer activities that use strategies such as body representations, relaxation and visualizations, etc.

Table 1. Supervised 5-day multidomain LifeAge program.

Part of the session	**Duration (60 min)**	**Contents**				
		Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Warm-up	10-15 min	Articular movements and mobility	Articular movements, mobility and cognitive training	Articular movements and mobility	Articular movements and mobility	Articular movements and mobility
Main part	30-45 min	Resistance 25-30 min	Balance 10-15 min	Resistance and functional autonomy 25-35 min	Balance 10-15 min	Resistance and functional autonomy 25-30 min
		Cardiorespiratory 15-20 min Coordination 5 min	Cardiorespiratory 20-35 min	Cardiorespiratory and cognitive training 15-20 min	Cardiorespiratory and cognitive training 20-35 min	Cardiorespiratory 15 min Coordination 10 min
Cool-down	5-10 min	Flexibility and cognitive training	Flexibility	Flexibility	Flexibility	Flexibility and cognitive training

NOTE: To achieve adherence to sports practice, it is very important that physical-sports educators value the motivation of the participants and know the importance of using motivational strategies that guarantee the satisfaction of basic psychological needs. (Chapter 10).

Table 2. Supervised 3-day and non-supervised 2-day multidomain LifeAge program.

Part of the session	**Duration (60 min)**	**Contents**				
		Day 1 (supervised day)	**Day 2 (non-supervised day)**	**Day 3 (supervised day)**	**Day 4 (non-supervised day)**	**Day 5 (supervised day)**
Warm-up	10-15 min	Articular movements and mobility	Articular movements, mobility and cognitive training	Articular movements and mobility	Articular movements and mobility	Articular movements and mobility
Main part	30-45 min	Resistance, balance and functional autonomy 25-35 min Cardiorespiratory fitness and cognitive training 15-20 min	Walking (or other cardiorespiratory fitness) at moderate intensity 20-60 min	Resistance and balance 25-30 min Cardiorespiratory fitness and cognitive training 15 min Coordination 10 min	Walking (or other cardiorespiratory fitness) at moderate intensity 20-60 min	Resistance, balance and functional autonomy 25-30 min Cardiorespiratory fitness 15 min Coordination 10 min
Cool-down	5-10 min	Flexibility	Flexibility	Flexibility	Flexibility	Flexibility and cognitive training

NOTE: To achieve adherence to sports practice, it is very important that physical-sports educators value the motivation of the participants and know the importance of using motivational strategies that guarantee the satisfaction of basic psychological needs. (Chapter 10).

11.3. Conclusions

This chapter has presented an example of an exercise program from a multidomain focus to middle-aged and older people to prevent illness and improve health status with supervision or mixed supervision/non-supervision.

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Glossary of Terms

Glossary of Terms

Adult: An adult is a person who is fully grown or developed. Biologically, an adult is an organism that has reached sexual maturity. In human context, the term adult additionally has meanings associated with social and legal concepts. Human adulthood also encompasses psychological adult development.

Aerobic physical activity: Activity in which the body's large muscles move in a rhythmic manner for a sustained period of time. Aerobic activity – also called endurance activity – improves cardiorespiratory fitness. Examples include walking, running, swimming, and bicycling.

Aging (ageing): Aging (ageing) is the process of becoming older. Aging is associated with changes in dynamic biological, physiological, environmental, psychological, behavioural, and social processes.

Anorexia of aging: The concept of a physiological decrease in food intake with ageing

Anthropometry: Anthropometric measurements are a series of quantitative measurements of the muscle, bone, and adipose tissue used to assess the composition of the body. The core elements of anthropometry are height, weight, body mass index (BMI), body circumferences (waist, hip, and limbs), and skinfold thickness.

Antioxidant: Antioxidants are substances that can prevent or slow damage to cells caused by free radicals, unstable molecules that the body produces as a reaction to environmental and other pressures. They are sometimes called "free-radical scavengers." The sources of antioxidants can be natural or artificial.

Anxiety: Anxiety is a feeling of fear or apprehension about what's to come. Anxiety is the body's natural response to stress.

Anxiety disorders: Anxiety disorders are a group of mental illnesses, characterized by significant feelings of anxiety and fear.

Balance training: Static and dynamic exercises that are designed to improve an individual's ability to withstand challenges from postural sway or destabilizing stimuli caused by self-motion, the environment, or other objects.

Basal metabolic rate (BMR): Basal metabolic rate is the amount of energy per unit of time that a person needs to keep the body functioning at rest.

Bioactive compound: A type of chemical found in small amounts in plants and certain foods (such as fruits, vegetables, nuts, oils, and whole grains). Bioactive compounds have actions in the body that may promote good health. They are being studied in the prevention of cancer, heart disease, and other diseases.

Biochemical markers: In the context of nutritional assessment, biochemical tests are needed to demonstrate micronutrient (vitamin, mineral) and hydration, lipid and protein status.

Body composition: Body composition describes the proportion of fat and non-fat mass in your body. A healthy body composition is one that includes a lower percentage of body fat and a higher percentage of non-fat mass, which includes muscles, bones, and organs.

Body Mass Index (BMI): Body Mass Index is a simple calculation using a person's height and weight. The formula is BMI = kg/m2 where kg is a person's weight in kilograms and m2 is their height in square metres. A BMI of 25.0 or more is overweight, while the healthy range is 18.5 to 24.9. BMI applies to most adults aged 18-65.

Carbohydrates: Carbohydrates are the sugars, starches and fibers found in fruits, grains, vegetables and milk products.

Cardiorespiratory fitness (endurance): A health-related component of physical fitness. The ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity. Usually expressed as measured or estimated maximal oxygen uptake (VO_2max).

Cognitive functions: Cognitive functions refer to multiple mental abilities, including learning, thinking, reasoning, remembering, problem-solving, decision making, and attention.

Cognitive training: It is defined as an intervention consisting of repeated practice on standardised exercises, targeting a specific cognitive domain or domains, for the purpose of benefiting cognitive function.

Comorbidity: the simultaneous presence of two or more diseases or medical conditions in a patient.

Dementia: Dementia is a syndrome in which there is deterioration in memory, thinking, behaviour and the ability to perform everyday activities.

Depression: Depression is a state of low mood and aversion to activity that can affect a person's thoughts, behaviour, feelings and sense of well-being.

Diet quality indices: Diet quality indices are mathematical algorithms used for nutritional epidemiology, aimed at quantifying the degree of adequacy between actual intakes of nutrients or food groups within a population and the reference intakes, which are established based on scientific facts assuring an optimal state of health.

Dietary assessment: Dietary assessment, encompassing data collection and analysis, supports planning of appropriate dietary intakes. Both retrospective and prospective methods of dietary assessment are commonly used in data collection among general and clinical populations. Assessing food and fluid intake is an essential part of nutrition assessment. It provides information on dietary quantity and quality, change in appetite, food allergies and intolerance, and reasons for inadequate food intake. The results are subsequently compared with recommended dietary intakes to allow practitioners to identify sub-optimal nutrient intakes and appropriately provide advice

Dietary fats: Dietary fat refers to the fats and oils found naturally in animal and plant foods, and those used in cooking, at the table, and added to processed foods. Dietary fat is made up of fatty acids. There are two types of fatty acids: saturated and unsaturated.

Dietary reference values (DRV): Dietary reference values (DRVs) is an umbrella term for a set of nutrient reference values that includes the average requirement (AR), the population reference intake (PRI), the adequate intake (AI) and the reference intake range for macronutrients (RI).

Dietary supplements: Dietary supplements are defined in part as products taken by mouth that contain a "dietary ingredient." Dietary ingredients include vitamins, minerals, amino acids, and herbs or botanicals, as well as other substances that can be used to supplement the diet.

Dynamic Balance: the ability to stay upright or stay in control of body movement, and coordination is the ability to move two or more body parts under control, smoothly and efficiently.

Exercise: A subcategory of physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective.

Flexibility: A health and performance-related component of physical fitness that is the range of motion possible at a joint. Flexibility is specific to each joint and depends on a number of specific variables including, but not limited to, the tightness of specific ligaments and tendons. Flexibility exercises enhance the ability of a joint to move through its full range of motion.

Flexibility training: It is the planned process by which stretching exercises are practised and progressed to restore or maintain the optimal range of movement available to a joint or joints.

Functional autonomy: the ability of a person to perform independently the various tasks required in daily life, a core concept in rehabilitation.

Healthy ageing: Healthy ageing is the process of optimising opportunities for physical, social and mental health to enable older people to take an active part in society without discrimination and to enjoy an independent, good quality of life.

Isometric Strength: Exercise involving muscular contractions without movement of the involved parts of the body.

Isotonic Strength: Exercise involving a contraction with muscle shortens or lengthens against a constant load, as when lifting a weight.

Lifestyle: Lifestyle is the interests, opinions, behaviours, and behavioural orientations of an individual, group, or culture. A lifestyle typically reflects an individual's attitudes, way of life, values, or world view.

Macronutrients: Macronutrients are those nutrients that the body needs in large amounts. These provide the body with energy (calories) and are categorised as carbohydrates, proteins or fats.

Malnutrition: Malnutrition is a condition that results from following a diet that does not supply a healthy amount of one or more nutrients. This includes diets that have too little nutrients or so many that the diet causes health problems. The nutrients involved can include calories, protein, carbohydrates, fat, vitamins or minerals.

Mediterranean diet: The traditional Mediterranean Diet (Med Diet) is predominantly a plant based diet, characterised by a high consumption of vegetables, fruits and nuts, legumes and unprocessed cereals with a low consumption of red meat, meat products and sweets, moderate consumption of fermented dairy (cheese and yogurt), poultry and fish, with red wine consumed in moderation and accompanying meals.

Mental activity: Mental activity can be described as anything that stimulates, activates or enriches the mind. Mental activity takes place whenever one is awake, ranging from merely daydreaming to reading a book or learning a new language.

Mental health: Mental health refers to cognitive, behavioural, and emotional well-being. It is all about how people think, feel, and behave. It also helps determine how we handle stress, relate to others, and make choices.

Mental health disorders: Mental health disorders are an abnormal state of mental health. There are many different mental health disorders, with different presentations. They are generally characterized by a combination of abnormal thoughts, perceptions, emotions, behaviour and relationships with others.

Micronutrients: Micronutrients, often referred to as vitamins and minerals or trace elements, are vital to healthy development, disease prevention, and wellbeing. Although only required in small amounts, micronutrients are not produced in the body and must be derived from the diet.

Moderate-intensity physical activity: On an absolute scale, moderate-intensity refers to the physical activity that is performed at 3.0–5.9 times the intensity of rest. On a scale related to an individual's personal capacity, moderate-intensity physical activity is usually a 5 or 6 on a scale of 0–10.

Multicomponent physical activity: For older adults, multicomponent physical activity is important to improve physical function and decrease the risk of falls or injury from a fall. These activities can be done at home or in a structured group setting. Many studied interventions

combine all types of exercise (aerobic, muscle strengthening, and balance) into one session, and this has been shown to be effective. An example of a multicomponent physical activity programme could include walking (aerobic activity), lifting weights (muscle strengthening), and could incorporate balance by walking backwards or sideways or by standing on one foot while doing an upper body muscle-strengthening activity, such as bicep curls.

Multidomain intervention: Multi-domain interventions include multi-component training with resistance training modalities, cardiorespiratory endurance training, balance/stability training, flexibility and mobility training, as well as other essential domains such as cognitive, healthy eating or motivation.

Muscle-strengthening activity: Physical activity and exercise that increase skeletal muscle strength, power, endurance, and mass (e.g. strength training, resistance training, or muscular strength and endurance exercises).

Muscle protein synthesis (MPS): Muscle protein synthesis is a naturally occurring process in which protein is produced to repair muscle damage caused by intense exercise. It is an opposing force to muscle protein breakdown (MPB) in which protein is lost as a result of exercise.

Non-communicable disease: A non-communicable disease (NCD) is a disease that is not transmissible directly from one person to another. NCDs include Parkinson's disease, autoimmune diseases, strokes, most heart diseases, most cancers, diabetes, chronic kidney disease, osteoarthritis, osteoporosis, Alzheimer's disease, cataracts, and others.

Nutrition screening tools: Screening of patients using a validated method or tool is the first step in identifying people that are at risk of being or becoming malnourished, and who are likely to require nutrition intervention / support. There are many nutrition-screening tools in use across the world. However, the most commonly used screening tool in all care settings is the 'Malnutrition Universal Screening Tool' ('MUST').

Nutritional assessment: Nutritional assessment (dietary assessment and analysis of nutritional status) is one of the specialised interests of nutritionists and dietitians, used in surveillance of populations' nutritional epidemiology, clinical assessment and research. In clinical nutrition and dietetics, nutritional assessment – data collection, analysis and prescription- is a systematic process to promote health and wellbeing, prevent ill health, and inform decisions about the nature and cause of nutritional related health issues that affect an individual. The elements of nutritional assessment can be summarised as A. Anthropometric methods; B. Biochemical, laboratory methods; C. Clinical assessment; D. Dietary evaluations.

Nutritional frailty: a term used to describe sudden and significant weight loss and loss of muscle mass and strength (sarcopenia) or an essential loss of physiologic reserves, which increases the risk of disability.

Older people: Older people has been defined as a chronological age of 65 years or more.

Physical activity: Physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure – including activities undertaken while working, playing, carrying out household chores, travelling, and engaging in recreational pursuits.

Physiological characteristics: Physiological characteristics refer to the physical functions of a human. Physiological characteristics derive from the structural information of the human body.

Protein-energy malnutrition: Protein–energy malnutrition (PEM), sometimes called protein-energy undernutrition (PEU), is a form of malnutrition that is defined as a range of pathological conditions arising from coincident lack of dietary protein and/or energy (calories) in varying proportions. The condition has mild, moderate, and severe degrees.

Proteins: Protein is a macronutrient that is essential to build muscle mass. It is commonly found in animal products, though it is also present in other sources, such as nuts and legumes. Chemically, protein is composed of amino acids, which are organic compounds made of carbon, hydrogen, nitrogen, oxygen or sulphur.

Psychological characteristics: Psychological characteristics are characteristics including psychological trait (represented by personality traits) and state (represented by mental health state).

Recommended dietary allowance (RDA): The recommended dietary allowance (RDA) is the average daily dietary intake level that suffices to meet the nutrient requirements of nearly all (97–98%) healthy persons of a specific sex, age, life stage, or physiological condition (such as pregnancy or lactation).

Reference nutrient intake (RNI): The Reference Nutrient Intake is the amount of a nutrient, which is enough for at least 97% of the population.

Sarcopenia: Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength and it is strictly correlated with physical disability, poor quality of life and death. Risk factors for sarcopenia include age, gender and level of physical activity.

Saturated fat: Saturated fat is a type of dietary fat. It is one of the unhealthy fats, along with trans-fat. These fats are most often solid at room temperature. Foods like butter, palm and coconut oils, cheese, and red meat have high amounts of saturated fat.

Social engagement: Social engagement (also social involvement, social participation) refers to one's degree of participation in a community or society.

Static Balance: it is the ability to maintain the body in some fixed posture. The ability to maintain postural stability and orientation with centre of mass over the base of support and body at rest.

Quality of life: Quality of life is the general well-being of individuals and societies, outlining negative and positive features of life. Quality of life is an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns.

Quality of life assessment methods: Quality of life assessment methods are methods to assess the quality of life. Quality of life assessment methods are used for a comprehensive review of a person's mental, physical, environmental and financial condition.

Waist circumference: Waist circumference is a measurement taken around the abdomen at the level of the umbilicus (belly button). Health experts use waist circumference to screen patients for possible weight-related health problems.

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