CHARLES UNIVERSITY
Faculty of Physical Education and Sport

Lifestyle Factors and Successful Ageing: A Systematic Review on the SuperAger Phenomenon

Bachelor's Thesis

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Declaration

I declare that I carried out this thesis independently and that I have cited all used information and literary sources. This work or its substantial part has not been submitted for obtaining any other or the same academic degree.

To date:

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Eliška Thompsonová

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Abstract

Title: Lifestyle Factors and Successful Ageing: A Systematic Review on the SuperAger Phenomenon

Background: As the world's population continues to age, the importance of studying the elders becomes more relevant. Age is one of the most prominent risk factors for diseases and understanding how to overcome or prevent the onset of any of them should be the goal for us as health promoting professionals. One of the straight-forward preventive measures is lifestyle.

Objectives: The aim of this thesis was to assemble lifestyle factors that potentially contribute to the successful ageing of SuperAgers.

Methods: A total of 6 databases were systematically reviewed using keywords established to help answer the review question. 654 studies were identified through the primary search and 10 studies were identified by hand search. After removing the duplicates, another 590 studies were excluded and 20 studies were selected for further eligibility. These studies were assessed using the Newcastle Ottawa Scale.

Results: The number of studies finally retrieved from the systematic search was 20. Physical activity was identified as the most likely lifestyle factor to be positively associated with SuperAgeing. Social engagement, diet and adherence to cognitive activities were also found to be influential, as opposed to alcohol consumption and tobacco smoking that showed a negative impact on cognitive functions.

Keywords:
cognitive functions, episodic memory, physical activity, diet, elderly

Abstrakt

Název: Faktory životního stylu a úspěšné stárnutí: Systematická rešerše fenoménu SuperAgeingu

Teoretická východiska: S narůstajícím věkem světové populace narůstá i zájem o porozumění stárnutí osob v souvislosti s jejich způsobem života. Věk je jedním z nejvýznamnějších rizikových faktorů onemocnění. Odhalit a porozumět, jak překonat a předcházet jejich vzniku, by měl být cíl pro nás jako pro odborníky zabývající se zdravím a zdravým životním stylem. Právě zdravý životní styl je zjevným preventivním opatřením proti vzniku a nástupu onemocnění související s věkem.

Cíle: Cílem systematické rešerše bylo shrnout faktory životního stylu, které podle dostupné literatury přispívají k úspěšnému stárnutí u SuperAgerů.

Metody: Celkem šest literárních databází bylo systematicky prozkoumáno pomocí klíčových slov, která byla vybrána pro efektivní zodpovězení výzkumné otázky. 654 studií bylo identifikováno v základním vyhledávání a 10 studií pomocí ručního hledání. Po vyřazení duplikátů následovalo vyřazení dalších 590 studií. Finální počet vybraných studií byl 20, které se podrobily hodnocení kvality pomocí baterie Newcastle Ottawa Scale.

Výsledky: Celkově bylo vybráno 20 studií. V těchto studiích byla pohybová aktivita identifikována jako nejpravděpodobnější faktor životního stylu, který se zdá pozitivně spojen se SuperAgeingem. Sociální angažovanost, strava a praktikování kognitivních aktivit byly také považovány za vlivné, na rozdíl od konzumace alkoholu a kouření tabáku, které ukázaly negativní vliv na kognitivní funkce.

Klíčová slova:
kognitivní funkce, epizodická paměť, pohybová aktivita, dieta, senioři

List of used abbreviations

AD – Alzheimer's disease

ADL – Activities of daily living

ALSA – Australian Longitudinal Study on Ageing

BMI – Body Mass Index

BP – Blood pressure

DASH – Dietary Approach to Stop Hypertension

DSM 5 – Diagnostical and Statistical Manual of Mental Disorders, Fifth Edition

IADL – Instrumental activities of daily living

LASA – Longitudinal Ageing Study Amsterdam

LAPAQ – LASA physical activity questionnaire

LF – Lifestyle factors

MCI – Mild cognitive impairment

MIND – Mediterranean-DASH Intervention for Neurodegenerative Delay

NCDs – Non-communicable diseases

PA – Physical activity

PD – Parkinson's disease

QOL – Quality of life

SA – SuperAgeing

UI – Urinary incontinence

VLS-ALQ – Victoria Longitudinal Study-Activity Lifestyle Questionnaire

WD – Western diet

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1 INTRODUCTION

This bachelor thesis is a systematic review that focuses on the issues of ageing in today's world. As the world's population continues to grow older, studying the ageing stage of life becomes increasingly relevant. Ageing is an inevitable process that occurs in all living organisms, and humans are no exception. Understanding the perks and drawbacks of the ageing phenomenon may lead to more effective interventions when working with an older cohort.

Modern medicine has gone a long way in extending the human lifespan. In the past two decades life expectancy has augmented by over six years, however, living longer does not necessarily equate to a higher quality of life. This is one of the reasons why it is important to address the topic of ageing and study it thoroughly, not only from the physiological and medical point of view, but also for individuals to understand what to do to maintain a good quality and healthy life for as long as possible.

Healthy ageing should not be taken for granted as age is a substantial factor in developing different types of diseases. Those individuals who manage to maintain good health and experience lower rates of diseases are termed successful agers, often experiencing a higher quality of life compared to those whose lives are burdened by disease-ridden conditions.

Another aspect of ageing is the role of genetics. Many age-related aspects are determined by genetics, and little can be done to change its impacts. Some individuals over the age of 80 maintain notable cognitive functions with little to no apparent decline, even though cognitive deterioration is common for this age group. These individuals are identified as SuperAgers. While a common formula for successful ageing has not been found, modifiable lifestyle factors such as the amount of physical activity, diet, and social engagement seems to have significant effects on the way we age.

The aim of this thesis is to systematically review literature and assemble lifestyle factors that have been identified by research teams that contribute to SuperAgeing.

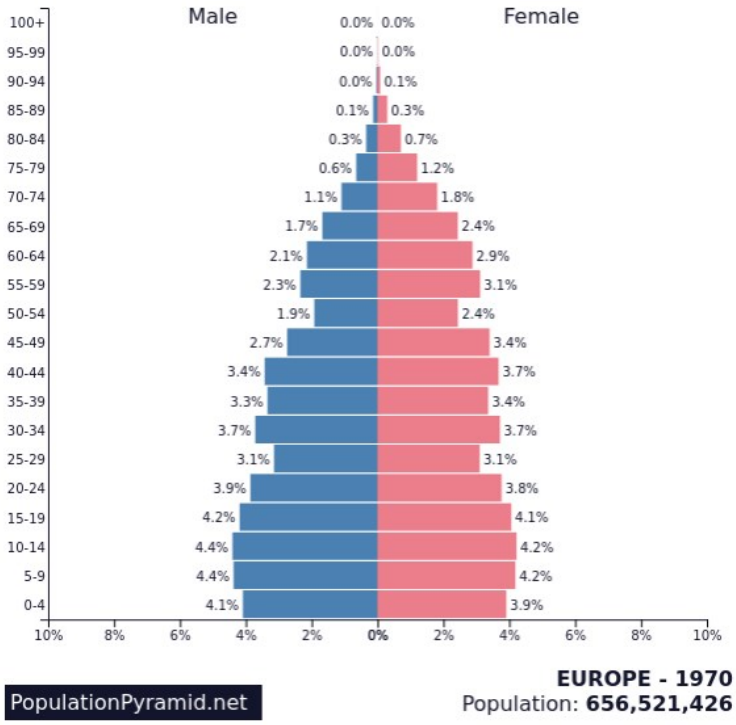
2 THEORETICAL BACKGROUND

2.1 Demographics of Ageing

The population pyramid in Europe has changed over the last 50 years, and it continues to change. The change inclines to an ageing population with birth rates generally decreasing, and life expectancy increasing. The difference in birth rate today compared to the 20th century comes with lower rate of infant deaths, and therefore, survival rate of the kin is high. Moreover, modern medicine has found ways how to tackle a large range of diseases and mortality rate has decreased as the result (Schoeni and Ofsteadl 2010; He et al. 2016).

The following figures (1-3) show a comparison between the years 1970, 2020, and 2050. In 1970, the age groups that had the highest populations were 5–9 and 10–14 years. The structure of the population pyramid during this time showed a broad base that gradually narrowed towards the top of the pyramid.

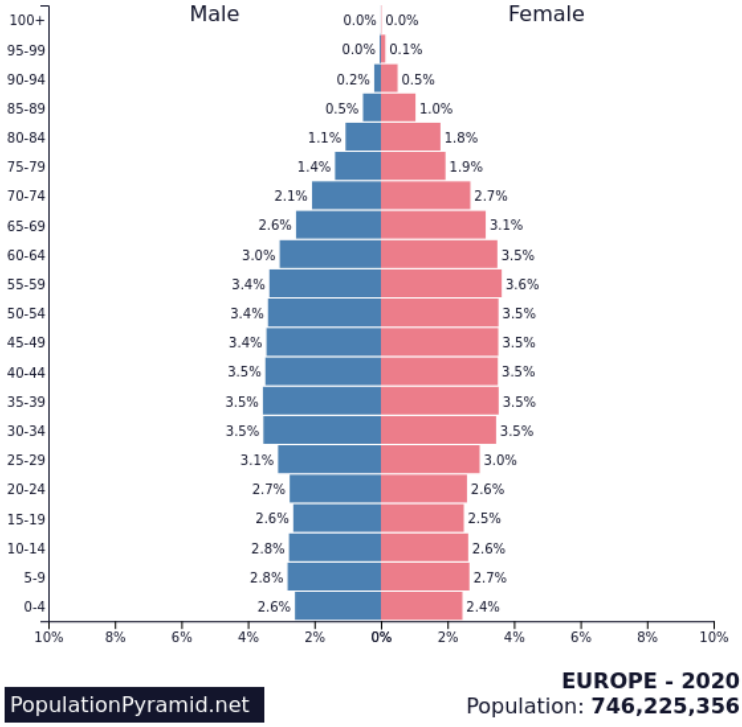
Figure 1 European Population Pyramid – 1970



(*Population Pyramids of the World from 1950 to 2100* [2022]).

50 years later, in 2020, a demographic shift is observed when compared to the 1970 population pyramid. The base of the pyramid has tapered, and the highest populated age group has become the 55–59 bracket. This shift corresponds to the 1970 pyramid, as this group, which now holds the majority, was also the largest, albeit, then they were part of the 5–9 age group.

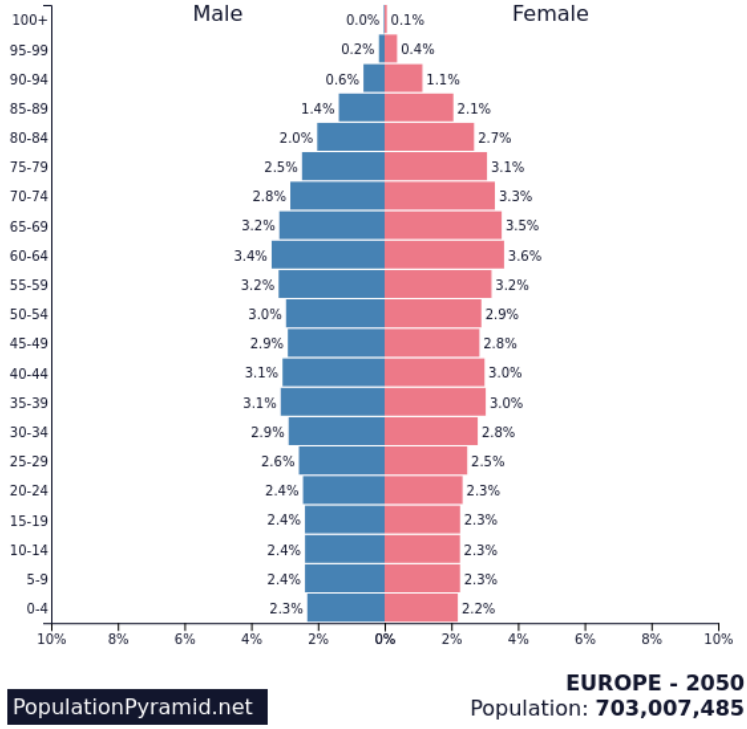
Figure 2 European Population Pyramid – 2020



(*Population Pyramids of the World from 1950 to 2100* [2022]).

The concern starts to be visible, as the pyramid shifts, and by 2050 (Figure 3) it is predicted that the most populated age group will be heading towards retirement. This rearrangement of the European demographic may bring challenges to the economic systems of ageing European countries, because of the increased proportion of elders compared to individuals in their productive years (Schoeni and Ofstedal 2010; Partridge et al. 2018).

Figure 3 European Population Pyramid – 2050



(*Population Pyramids of the World from 1950 to 2100* [2022]).

Japan is now experiencing the demographic situation that is predicted for European countries by 2050. Cognitive impairments and other health issues strain public services as age is the primary risk factor for many age-related diseases (McCurry 2015).

Overall, the demographic pyramids are a dynamic graphical representation of the distribution of the population. World events such as natural disasters or pandemics take their toll on the population number, therefore the future population pyramids are solely a prediction (Muramatsu and Akyama 2011).

2.2 The Ageing Process

Scientists have taken the time to explore the process to observe age-related differences such as memory and reasoning, immune function, forced expiratory volume, number of teeth, muscles strength that manifest when comparing older individuals with the younger (Hofer and Sliwinski 2001). All of these declines lead to other underlying problems, which make ageing and the later stages of life complicated to sustain in health.

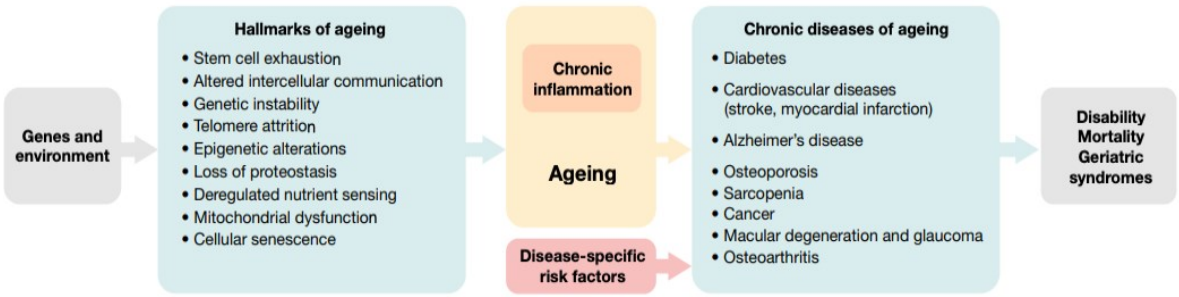
To understand the ageing process and its causes, it is crucial to first learn about the hallmarks of ageing, albeit, not necessarily into extensive depth. In 2013, Carlos

López-Otín, a Spanish biochemist, and his team published a review paper "*The Hallmarks of Aging"*, where they identified and categorised "*the cellular and molecular hallmarks of ageing"* using published literature of the subject area. It may not be visible at first, because bodily processes initiate at the cellular level; the smallest components of what makes us human (apart from DNA structures), however, a study like this is of great significance and contributes to the understanding of ageing, since it brings together a large number of studies and examines the topic in detail. The aim of their research was not only to provide insight into the complexity of ageing, review literature on the topic, but also to "*improve human healthspan"* (López-Otín 2013, p. 1209), a topic that has often been overlooked.

The nine identified hallmarks were divided into three categories, each with a different role in the ageing process. The first category – Primary hallmarks – includes four out of the nine hallmarks that are *"considered to be the primary causes of cellular damage"* (López-Otín 2013, p. 1207). These are genomic instability (or genetic instability), telomere attrition, epigenetic alterations, and loss of proteostasis. The second category – Antagonistic hallmarks – includes three hallmarks that seem to respond to the damage caused by the primary hallmarks and attempt to repair the cellular damage, these being deregulated nutrient sensing, mitochondrial dysfunction, and cellular senescence. Finally, the third category – Integrative hallmarks – is referred to as the culprits of the phenotype; stem cell exhaustion and altered intercellular communication. These are identified as the visible signs and characteristics or "*the functional decline associated with ageing"* as described by the authors themselves (López-Otín 2013, p. 1207). All these features or hallmarks explain the life cycle the mammalian bodies go through and provide clarification on the typical ageing process and its connection with age-related diseases (Ferrucci et al. 2020).

The following flowchart (Figure 4) shows the impact of the hallmarks of ageing on the body and the chronic diseases associated with the ageing process.

Figure 4 The Hallmarks of Ageing and Chronic Diseases of Ageing



(Campisi et al. 2019).

Figure 4 was used in a review paper published by Campisi et al. (2019). The flowchart provides a visual aid of the linkage between the genetic changes and age-related diseases with the key examples. It also makes a reminder that these conditions often lead to disability, mortality, and geriatric syndromes; circumstances that decrease the individual's quality of life. The hallmarks of ageing are processes that contribute to physical, cognitive, and other changes in the body. For example, genetic instability refers to the genetic damage that occurs and accumulates in the body and can lead to different types of abnormalities. This specific hallmark is often utilised to help explain ageing, because it is one of the key processes that leads to chronic inflammation and accelerates the progression (Hakem 2008).

When the genetic information is not transcribed adequately during cell division or telomere attrition, the quality of the chromosomes is affected, and again, the body becomes more susceptible to ageing and diseases such as cancer (Shammas 2011). The overall outcome as demonstrated in Figure 4 may be disability, mortality, or the development of geriatric syndromes (see Chapter 2.3).

Another one of the hallmarks of ageing is proteostasis; a mechanism that takes care of the protein balance in the body. This time, the hallmark affects not only the physical appearance of the body, but the loss of this process can eventually lead to neurodegenerative diseases such as Alzheimer's disease (AD) or Parkinson's disease (PD) (Powers et al. 2009).

Overall, the hallmarks of ageing help us understand the ageing process with a deep explanation at the cellular level. They try to approach the reasons that cause ageing and help the acknowledgement of the fact that ageing should not be considered a disease itself, rather consider it a strong risk factor for a range of conditions (Campisi et al. 2019).

Schumacher et al. (2021) reviewed literature in search for the cause of ageing. They aimed to uncover if DNA damage was utterly behind the ageing process or if there are other known causes of ageing. The results obtained in their study showed that DNA damage is the primary cause of ageing, hence supporting the theory of the hallmarks by López-Otín et al. (2013).

For centuries people have longed for a cure for ageing. Cosmetics have taken over the ageing stage ever since (Cavallo et al. 2007). The society is not used to seeing the ageing body as it is, with all its phases. This is happening especially because the art of hiding imperfections (such as make up, anti-ageing creams, some cosmetic surgeries, and others) is popular, even though ageing is a natural process (Brown 2008) and occurs in all living things.

The ageing stage of life is no doubt complicated. It takes a toll on the physical appearance of the individual, psychological changes that commonly occur, and finally, changes in social aspects of life that also appear. These are challenges that need to be addressed adequately by specialists, because the aged body and mind work differently compared to younger adults (Matud and García 2019).

2.3 Gerontology, Geriatrics, and Geriatric Syndromes

2.3.1 Gerontology and Geroscience

Gerontology is the science that studies ageing, the ageing process, and the problems associated with this specific life experience. The professionals – gerontologists – that take an interest in this topic, research a wide range of problematics related to ageing. The first articles on gerontology were published in the Journal of Gerontology in 1946, and since then, the journal is active and publishes up-to-date articles on this ever-growing topic. Gerontologists study ageing from numerous points of view, starting with the social, economic, and political issues, ending with successful ageing, health issues, and physical and mental changes that occur at this stage of life (Frank 1946; Tornstam 1992; Holstein and Minkler 2003).

In 2005 the term *geroscience* was introduced in the world of gerontology. It is an interdisciplinary science that investigates the thin line between normal ageing and chronic disease (Lithgow 2013).

2.3.2 Geriatrics

Geriatrics and gerontology are two terms that are often misused and interchanged. While gerontology focuses on the study of the individuals and the situations they face as they age, geriatrics is the medical specialization that attends the elders in hospitals and approaches their overall needs (Morley 2004).

2.3.3 Geriatric Syndromes

Flacker (2003) challenges the usage of the term "geriatric syndrome" and suggests that in this context the word "syndrome" may not be entirely fitting. In general, a syndrome refers to a cluster of symptoms that together form the manifesting syndrome (Calvo et al. 2003). However, geriatric syndromes do not necessarily conform to this, as each individual symptom present in a geriatric patient can also be considered a syndrome itself. This implies that the concept of geriatric syndromes differs from the traditional understanding of syndromes.

It is not necessary for everyone to suffer from these syndromes; however, many elders do, and it is of great importance to visit a geriatrician and find the best solution for the patient and the family. Some may experience only one or two of the symptoms, nevertheless, others may show various clinical manifestations. Experts on gerontology and geriatrics do not all agree with the same list of geriatric syndromes (Flacker 2003), nevertheless, the following segment shows an overview of 7 different issues that may be included in the list.

Urinary Incontinence

Urinary incontinence (UI) may not seem particularly threatening at first; however, it is a condition that plays a big role in decreasing one's quality of life (QOL) (Agarwal and Agarwal 2017). The International Continence Society defines UI as *"the complaint of any involuntary leakage of urine"* (Abrams et al. 2003, p. 38). The impact of UI takes a toll on the social life of the individual, as they often experience feelings of shame, depression, and anxiety due to the condition. Furthermore, urinary incontinence frequently correlates with urinary tract infections (Batmani et al. 2021), which also undermines the patient's desire to stay at home and may potentially lead to isolation and the initiation of other geriatric syndromes.

Instability / Risk of Falls

Being unstable on one's legs leads to an increased risk of falls. Instability may have a physiological cause (Horlings et al. 2008) such as muscle weakness, vestibular deficiency, balance control, visual impairments, and others; (see Table 1); nevertheless, it is not uncommon that the cause of the fall is due to obstacles on the floor or unsuitable footwear or a combination of more factors (Hatton and Rome 2019; Ungar et al. 2013).

Table 1 Likely Causes of Falls in the Elderly.

Cause	*Mean percentage (%)*	*Range (%)*
Accident / environment-related	31	1–53
Gait / balance disorders or weakness	17	4–39
Dizziness / vertigo	13	0–30
Drop attack	9	0–52
Confusion	5	0–14
Postural hypotension	3	0–24
Visual disorder	2	0–5
Syncope	0.3	0–3
Other specified causes	15	2–39
Unknown	5	0–21

Adapted from: Rubenstein (2006).

The concern about the elders falling does not necessarily have to be the actual fall, but more so the consequence of the impact. This is why fall prevention is of such importance and different professionals address the issue (Ungar et al. 2013).

Immobility

Another one of the geriatric syndromes is immobility – the difficulty to move around independently. Rosso et al. (2013, p. 618) state that *"mobility is defined as the ability of an individual to purposively move about his/her environment."* When mobility is impaired the quality of one's life decreases, especially when this happens later in life. The onset of other geriatric syndromes becomes more frequent, as they become more frail and often depressed (Webber et al. 2010).

Immobility is a factor that affects self-sufficiency of the elders and their ability to carry out activities of daily living (ADL). This can lead not only to social isolation, but to becoming dependent on someone else (a family member or carer), and unfortunately to more severe disabilities (Manini 2013).

Depression

As social isolation becomes more prominent in the lives of older adults, the feeling of loneliness increases. Research suggests that loneliness is associated with depression in old age (Van As et al. 2022). With increasing age, the prevalence of depression among the elders grows, as well as other problems associated with ageing emerge. Life becomes more challenging as physical and mental changes in the body occur and the adaptability of the individuals decreases (Cosh et al. 2019; Abdoli et al. 2022).

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) suggests that depression may be an early symptom of dementia. However, the intervention is crucial, as addressing the depressive disorder appropriately may be linked to improving the memory decline that is reported by the patient.

Depression in the elders may be due to their overall condition. For instance, elderly patients with cancer are more vulnerable to developing depression and other geriatric syndromes. However, as they age, the death of someone close, multiple deaths in a short period of time, injuries, diseases, and other challenges increase the probability of suffering from depression. This leads to a decrease of QOL of the individual (Magnuson et al. 2019).

Delirium

The DSM-5 (p. 596) describes delirium as *"a disturbance in attention that develops over a short period of time"*. It is an acute neurocognitive disorder that characterises as cognitive decline that has no other possible explanation. It forms part of the geriatric syndromes. The prevalence of delirium increases with age (up to 14% in individuals over the age of 85) and is frequent among hospitalised elders. Hein et al. (2014) conducted a study to establish the prevalence rate of delirium in hospitalised patients. They found that

1 out of 4 hospitalised patients presented symptoms of delirium, out of which 69% were being treated for a number of diseases.

Polypharmacy is common among older adults, and it also increases the probability of experiencing delirious states. It is the condition of suffering from multiple diseases that require numerous medications. The mixture of the drugs is not always adequate and together may increase the risk of developing delirium (Kurisu et al. 2020; Hein et al. 2014).

Dehydration

Staying hydrated is remarkably important for the proper functioning of the body. When not enough water is provided to the organs, they lose their abilities, because water is necessary to maintain balance at cellular level (Chapman et al. 2020). Dehydration is a condition highly common in older adults. They are often diagnosed with dehydration after being admitted to the hospital and is one of the first issues that is addressed by the hospital staff (as well as dealing with the actual reason of admission) (Edmonds et al. 2021).

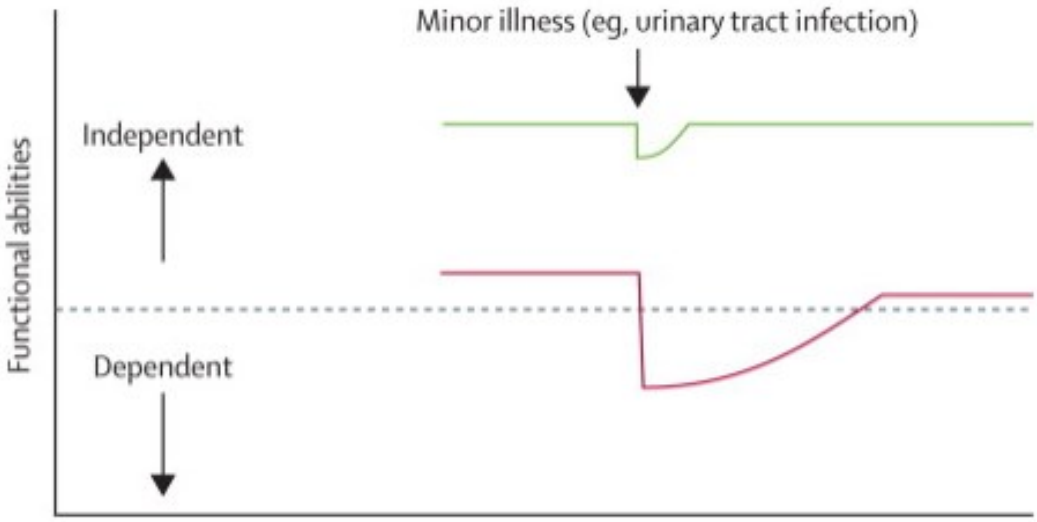
Overall, dehydration is closely linked to other geriatric syndromes, such as delirium, the risk of falls, or urinary incontinence. When the patient presents signs of UI, he or she may likely not want to increase their water intake (or will decrease frequency of drinking water), to prevent uncontrollable leakages (Bhanu et al. 2020). However, this strategy is not adequate, as it increases the risk of urinary tract infections, a condition that is widely prevalent in the elder, especially in women (Silva et al. 2021).

Frailty

Frailty is the outcome of a compilation of at least two age-related symptoms. The symptoms are measurable and the level of frailty of an individual can be scaled. Research identifies these signs as frailty: weakness, slowness, poor endurance, unintentional weight loss, low level of activity, sarcopenia, and weak grip strength (Chen et al. 2014; Morley et al. 2006; Clegg et al. 2013). These criteria represent domains that need to be preserved in order to be strong enough to carry out basic activities of daily living (ADLs), and therefore, remain active and not become frail.

The frailer the elder, the more vulnerable his or her state becomes, especially when unexpected events happen, such as falls or illness. The following figure shows the difference between the impact a minor event can have on a frail individual compared to an elder that does not show signs of frailty (Clegg et al. 2013).

Figure 5 Impact of Minor Illness on a Frail Individual



Clegg et al. 2013

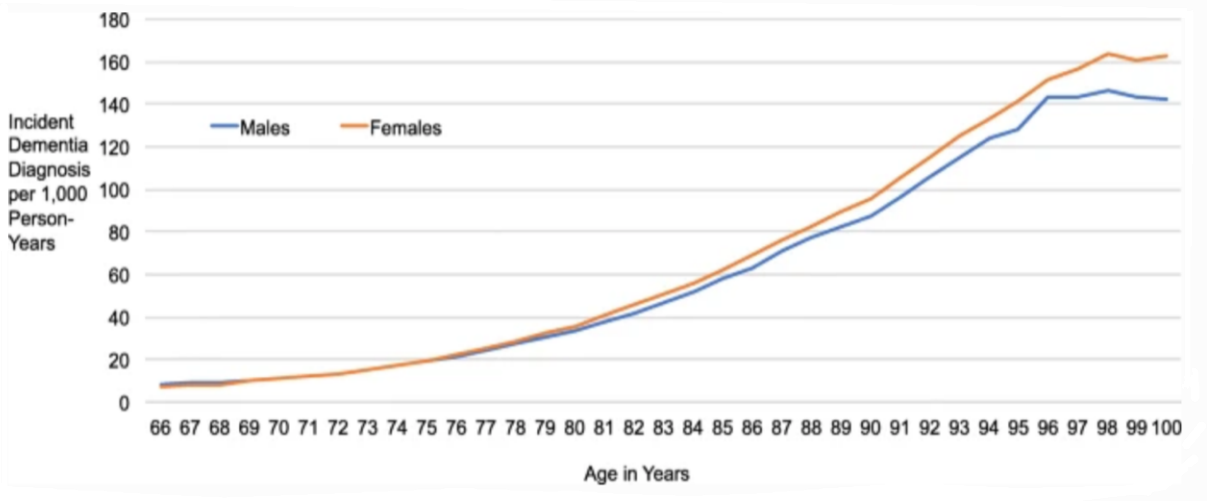
The frail elder is represented by the red line. The starting point of the frail elder is slightly above the point where the individual becomes dependent and is no longer able to independently carry out ADLs. This is shown by impaired functional abilities and the need of assistance in everyday life (Clegg et al. 2013).

As minor stressors (such as urinary tract infection as shown in Figure 5) have such a significant impact on the frail elder, according to Chen et al. (2014) interventions should be designed to prevent frailty, and also manage the comorbidities these patients may be facing. By addressing comorbidity, specialists can work towards diminishing the potential risks and improve the overall quality of life of the patients.

2.4 Alzheimer's Disease and Other Dementias

Dementia is a neurocognitive disorder that primarily affects cognitive functions. Usually, the onset of dementia is around the age of 65 at youngest, nevertheless, it is not uncommon that first symptoms may be present earlier (Lambert et al. 2014). Age is considered as one of the most dominant risk factors for dementia, with the prevalence increasing as the individual ages. In the following figure (Figure 6) we can observe a positive correlation between age and dementia diagnosis.

Figure 6 Incident Dementia Diagnosis



(Olfson et al. 2021)

At the age of 66 there is a minor difference in the prevalence of males and females, with males showing a higher incident rate than females. Around the age of 80, females have an increased incidence of dementia diagnosis. Olfson et al. (2021) suggest that the reason for this difference may be due to the difference in survival rate of women and men, with women tending to live longer lives.

The typical symptoms of dementia include cognitive decline in many of the cognitive domains, such as memory, executive functions, attention, perception, social skills, and language. The symptomatology of dementias, however, extends itself over other domains, affecting a broader area of the individual's life. Behavioural and psychological symptoms (BPSD) are also part of the spectrum of symptoms present in the different types of dementia (Cerejeira et al. 2012).

The overall symptoms of dementia are deeply pervasive since the symptoms are closely linked. As dementia progresses, the decline in all the domains becomes more visible.

2.4.1 Alzheimer's Disease

Alzheimer's disease (AD) is a neurodegenerative disorder that affects the functioning of the brain. It is known to be the most common cause of dementia, with research suggesting it being 50–60% of all the cases (Blennow et al. 2006). According to the DSM-5 progressive memory decline and learning difficulties are the first symptoms of AD followed by a gradual decline in cognitive functions (*American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders* 2013, p. 611).

The cause of AD is not wholly known, with new theories arising (Drachman 2014) and contributing to the understanding of the disease. The major theory is the "amyloid hypothesis" where so-called plaques and tangles are found in the cerebral cortex in the brain of the affected individual. Plaques are amyloid beta (Aß) compounds that pathologically accumulate in the brain, and tangles are tau protein that abnormally hyperphosphorylated (addition of phosphate groups to proteins) and eventually form protein aggregates known as "tangles". This causes synaptic dysfunction followed by neuronal death, and eventually causes dementia (Blennow et al. 2006). Similar structures can be observed in the brains of patients with mild cognitive impairments (MCI) and in the brains of AD patients that have not yet developed AD symptoms (Sperling et al. 2011).

Drachman (2014) offers a different view on the aetiology of Alzheimer's disease. He suggests that the accumulation of plaques and tangles in the brain of the elders may be attributed to the vulnerability of their already ageing brain, when considering ageing as one of the most prominent risk factors of AD (Kawas et al. 2000). His theory points to the not-so-clear cause and effect of Aß compounds accumulating in the brain since the development of AD in younger individuals is unlikely.

Vermunt et al. (2019) divided the progression of Alzheimer's disease into 4 stages. Other researchers use a different number of stages to describe the gradual decline, but the outcome is essentially the same. The initial stage called the preclinical frequently passes unnoticed, as the changes start happening in the brain without clinical manifestation. The length of this stage will vary, depending on the extent of the

individual's cognitive reserve, which is unique in every person. It may vary somewhere approximately between 2 to 15 years (Vermunt et al. 2019).

The cognitive reserve is a coping mechanism of the brain that develops during one's life and creates neuronal linkages and stronger connections through cognitively stimulating activities (Stern 2012). These activities may be anything from learning a new exercise, learning a new language, years of education, or challenging the brain in any other way (van Praag et al. 2000). During the ageing phase of life, the hippocampus slowly atrophies; during the development of AD, amyloid beta plaques accumulate in the brain and contribute to hippocampal atrophy. The cognitive reserve protects the brain from manifesting the symptoms of atrophy (Valenzuela et al. 2008).

In the second stage – prodromal AD – mild symptomology is present with seldom moments of forgetting recent information or denominating objects. The second stage may frequently pass close to unnoticed; however, gradual decline will occur and slowly progress to the third stage. During the third stage the individual starts having difficulties with activities such as remembering appointments, finding the right words when expressing verbally, and slowly social contact becomes harder to maintain. The stage is called the mild AD dementia (Vermut et al. 2019).

The final stage is moderate-to-severe AD dementia. In this stage language problems are prominent; patients tend to be disoriented; they develop swallowing problems (dysphagia), and aspiration pneumonia is frequently developed, as the brain continues to atrophy (Kalia 2003). During this stage, geriatric syndromes are heavily present (e.g., immobility, urinary incontinence, delirium, dehydration, malnutrition, etc.) and taking care of the patients can result challenging.

The reason why AD is such an interesting topic to discuss when studying the SuperAgeing individuals is because the two sets are on the opposite side of the spectrum. Patients with AD have problems with episodic memory from early stages of the disease (Tromp et al. 2015), yet SuperAgers tend to show outstanding results in episodic memory tasks until late stages of their lives (Rogalski et al. 2013).

2.4.2 Other Types of Dementia

Vascular dementia is often presented as the follow-up cause after AD. Its prevalence in 2015 was 18–32 % as presented in Table 2. The table also shows that vascular dementia

is the only type that does not have a strong genetic predisposition linked to it (Ferencz and Gerritsen 2015).

Table 2. Prevalence and Heritability in Different Types of Dementia.

	Prevalence (%)	***Heritability (%)***
Alzheimer's disease	34–54	33
Vascular dementia	18–32	<1
Frontotemporal dementia	10–20	50
Dementia with Lewy bodies	4–7	40

Adapted from: Ferencz and Gerritsen (2015).

The vascular type must be differentiated from aphasia since the cause of the problem originates from a vascular disruption such as a stroke. On the one hand, aphasia is essentially a language disorder with some cognitive domains impaired due to brain injury, stroke, or brain tumour. The extent of damage determines the severity and type of aphasia that affects the individual (Godecke and Armstrong 2021). On the other hand, vascular dementia manifests mainly cognitive impairments with language problems being a common symptom, but not the primary.

It is not unusual that aphasia symptoms after a stroke may merge, and the final diagnosis becomes vascular dementia (Lin et al. 2022). However, since a stroke is such an acute event, early diagnosis of the extent of damage should be determined soon after, for therapists to start working with the individual and achieving the best possible recovery results (Chiu et al. 2021). Vascular dementia is specific to its unknown symptoms because its nature is not the same in each patient as it is caused by cerebrovascular damage (Román et al. 1993).

Frontotemporal dementia (FTD) has a 10–20 % prevalence rate (Ferencz and Gerritsen 2015), suggesting that it is not that common, however its impact is extremely hard not only on the individual, but also on the family and carers that share living spaces with the patient. The DSM-5 divides FTD patients depending on their symptomatology. Either they manifest dominantly behavioural changes such apathy and compulsive stereotypical behaviour – conducts that were not usual for the person before developing FTD (*American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders* 2013, p. 614–615).

Last of the four most common dementias is dementia with Lewy bodies. Its characteristic symptoms are especially impaired attention and alertness spans, hallucinations, and cognitive decline. The onset of this type of dementia is commonly associated with deliria episodes and sleep issues (*American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders* 2013, p. 618).

2.5 Cognition and cognitive functions

The human cognition is a complex network of processes that allow us to learn and understand the world around us. Every piece of information received by the brain is added to the network and a response is created to facilitate the adjustment to the present situation. Every person possesses a unique cognitive profile. The neuronal connections that intertwine in the brain creating the mind of the individual are dependent of infinite factors that influence the person (Bassett and Gazzaniga 2011; Smallwood et al. 2021).

Neuroscientists divide cognition into different cognitive functions that carry out separate, yet closely connected operations in specific areas of the brain. According to Harvey (2019), eight cognitive functions are identified to this day. These include sensation. perception, motor skills and construction, attention and concentration, memory, executive functions, processing speed, and lastly, language and verbal skills.

For the purpose of this thesis 4 types of cognitive functions will be further discussed.

2.5.1 Attention

Attention is a cognitive function that allows the human brain to focus on a specific task or to choose relevant information. Basic neuroscience recognises two types of attention – selective attention and sustained attention. The adequate functioning of attention is crucial for carrying out most types of activities. Throughout our live we learn to control attention and enhance our attention span (Isbell et al. 2018).

Selective attention helps choosing the relevant information that enters the brain for further analysis. Some theories suggest that selective attention works together with inhibitory control, which inhibits distracting and unnecessary information (Van Moorselaar and Slagter 2020). When the inhibitory control or selective attention is

impaired, too much irrelevant input is accessed by the brain that does not have the capacity to use all the information. Individuals with this impairment are easily distracted and are often diagnosed with neurodevelopmental disorders such as ADHD (attention deficit hyperactive disorder) (Mirabella 2021).

Sustained attention is the ability to direct one's attention to a specific activity. The time span that an individual can focus on one task varies from person to person. It is the process that allows us to study, play sports, or even communicate with other people (Esterman and Rothlein 2019; Isbell et al. 2018). The impairment of sustained attention is also linked to the diagnosis of ADHD (Mirabella 2021).

2.5.2 Memory

Memory is yet another cognitive function that utilises information from the outside world. It is the ability to encode, store, and retrieve information, which allows us to learn and build upon past events (Glenberg 1997).

Memory is a widely studied function that is divided in various ways, depending on different theories. The basic division is short-term and long-term memory. Baddley (1986) suggested that memories are stored in buffers and different types of information were stored in separate sections. The current understanding of memory is more complex and divides memory in a more thorough way, exploring the diverse functionalities memory has (Jonides et al. 2008).

Working memory is the process of using obtained information and adjusting the information for specific needs. It allows us to use the information we acquire through different senses (Baddeley and Logie 1999).

Episodic memory works in close relation with working memory. It is the component that stores memories of our daily lives, such as remembering events from near past, for example, yesterday's lunch or other simple, everyday events (Harvey 2019). The impairment of episodic memory is characteristic for age-related diseases such as Alzheimer's disease, dementia, mild cognitive impairments, or amnesia (Tromp et al. 2015).

Another type of memory is the procedural memory. It stores motor actions, movements, skills, sport associated activities, and others. Research suggests that the reason why individuals with cognitive impairments are still able to carry out motor skills

is the theory that procedural memory is not linked directly to episodic memory, which is highly associated with memory impairments (Harvey 2019; Oudman et al. 2015).

Harvey (2019) synthesised two more memory types in his work, these being semantic memory and prospective memory. Semantic memory stores verbally obtained information, decodes language, and stores the meaning of words (Binder and Desai 2011). Prospective memory is the process of remembering future events. Understanding time and remembering events that will take place in the future and helps us remember what we wanted or want to do (Einstein and McDaniel 2005).

2.5.3 Language

Language is a cognitive function that allows us to receive and produce language stimuli to communicate among each other. It works in association with all the other cognitive functions and may be characterised as a skill that is acquired during the first years of life (Plunkett 1997).

The processes that are involved in language are stored in different parts of the brain. This is observable when these brain regions are damaged due to stroke or brain injuries (Kiran and Thompson 2019). Neurodegenerative disorders also have an impact on language, due to the atrophy of the brain, and also due to the close association with memory, which is frequently impaired in neurodegenerative disorders (Harvey 2019).

2.5.4 Executive Functions

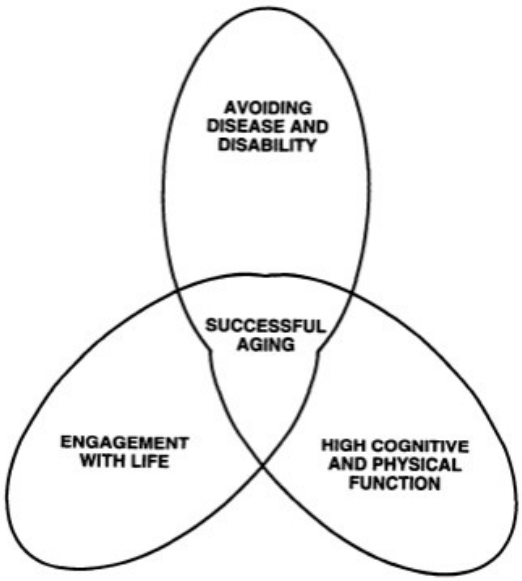
Another complex cognitive function is the ability to find solution and link information together to create a plan for the expected outcome. Any activity that requires more than one step to reach the goal (for example making a cup of coffee) will employ the executive function domain. To carry out a what seems simple action of making a cup of coffee, concentration, self-control, and problem solving are still processes that need to be appropriately functioning, otherwise the action will not be successful (Diamond 2013).

When executive functions are impaired, the individual has difficulties maintain attention, has troubles adhering to the steps that need to be taken to achieve the desired outcome, and overall, everyday life becomes challenging (Guarino et al. 2019).

2.6 Successful Ageing

To age successfully means to age in a manner that allows the individual to continue living their life the way they were used to, without severe diseases or cognitive declines. This approach to the ageing stage of life is crucial when the tendency of the world's population is shifting towards an older demographic. In 1987, Rowe and Kahn compared usual ageing and successful ageing in a number of age-related domains. Ten years later, the same duo aimed to define successful ageing and described three essential factors (see Figure 7).

Figure 7 The Successful Ageing Triad



Rowe and Kahn (1997)

The first factor is to some extent genetical or influenced by previous behaviour. They suggest that low incidence of disease and disability is fundamental for successful ageing together with the remaining factors. These are characterised by preserved cognitive functions and a good physical state as well as an active engagement with life. When all three components are present in the life of the elder, it is most likely considered as successful ageing.

The definition by Rowe and Kahn (1997) seems logical, however, some researchers found the theory overly rigorous, as avoiding disease and disability at old age is not always realistic. Strawbridge et al. (2002) conducted a study to find whether

subjective evaluation of successful ageing matched the theory by Rowe and Kahn. They found that the participants tended to rate themselves as successful agers, even though not all criteria Rowe and Kahn presented were met. This may suggest that self-esteem or self-image may also be a part of the process and the internal state of the individual should be also included in the definition.

Annele et al. (2019) suggest that successful ageing is a more dynamic term that incorporates many angles of the life of the ageing individual compared to when successful ageing was first introduced by Rowe and Kahn in 1997.

2.7 SuperAgeing

Research has used the concept of SuperAgeing in multiple contexts since its initial introduction, and its meaning needs to be clarified. Numerous studies use the term superageing to describe entire societies, communities, or even countries. This would be typical for the Japanese (Muramatsu and Akiyama 2011), and now also the Chinese (Lopreite and Zhu 2020) and German population (Schöllgen et al. 2010). In this context, superageing is used to describe the demographic situation that is currently one of Japan's challenges as their ageing society is reaching extremely high numbers of inhabitants over the age of 64. This is affecting especially their economy and healthcare system, forcing them to pioneer solutions in this domain, with other countries soon experiencing similar difficulties (McCurry 2015).

SuperAging or SuperAgeing (SA) – in the form that is used for this thesis – was first defined in 2012 by researchers at the Alzheimer Centre at the Northwestern University, specifically by Rogalski and her team. They identified individuals over the age of 80 with cognitive performances comparable to those 20-30 years younger, which is not the standard for all 80-year-olds, as SuperAgers (Rogalski et al. 2013).

To clarify, a superageing society is a demographic term that describes the nature of a population, whereas SuperAgeing refers to individuals identified as SuperAgers with specific superior cognitive functions. Some researchers refer to the phenomenon to as Cognitive SuperAgeing, which also helps clarifying the difference between the terms (Cook Maher et al. 2017).

According to Rogalski et al. (2013) SuperAgers are 80-year-olds (or more) characterised by their preserved memory, specifically their episodic memory. The results of episodic memory performance of these individuals are unusually high, not only for their age category, but it is surprisingly comparable to adults in their 60s. To fulfil the SA criteria the individuals must also present good results in other cognitive domains, scoring as well as the average of their age category (80+).

Typically, the testing battery to assess episodic memory is the Rey Auditory Verbal Learning Test (RAVLT). The RAVLT consists of a list of 15 words (list A) that is verbally presented to the participants. Once the list is read out, the participants start recalling as many words from the list as possible. It is further repeated another 4 times. After the final recall of list A, list B is presented as an interference list. The participants recall the words from list B and proceed to recall list A. This is an example of delayed recall, a domain which is characteristic for episodic memory (Rey 1964; Khosravi Fard et al. 2016).

Research teams are currently studying the SA phenomenon, looking for similarities presented by the SuperAgers. Rogalski et al. (2013) used structural magnetic resonance imaging (MRI) to investigate the brain regions of the SuperAgers. They found that SuperAgers have superior cortical thickness compared to typical agers, lower genetical material predicting diseases such as Alzheimer's disease. They also showed differences in the anterior cingulate gyrus, and less age-related atrophy of the brain (Gefen et al. 2014).

Non-genetical approaches have also been taken. Gefen et al. (2014) and Tichá et al. (2023), for instance, examined other cognitive domains such as language, logical memory, processing speed, and others. They found that SuperAgers have minor cognitive declines over time compared to typical agers, matching the results of the MRI studies by Rogalski et al. (2013).

SuperAgeing is a complex phenomenon, that needs more investigation for thorough understanding. Researchers are making great effort to understand its background to help future generations age in an effective and healthy way.

2.8 Lifestyle

Defining lifestyle is not an easy task. It is a term that englobes features of the way we live our lives that depends on a lot of different factors and is remarkably unique to each individual. Not only is it determined by the context of where we grow up, who we grow up with, but it also depends on the activities we do, people we spend time with, and the resources we have. What is also fundamental in choosing the lifestyle that suits us best, are our beliefs and values that are built throughout our lives; however, all can change when the mind is set to change it (Farhud 2015; Yeager and Dweck 2020).

Knowing that lifestyle is the way of life of every individual, not all lifestyle choices are considered healthy. There are several factors that are highly intertwined with health benefits and the lifestyle chosen or lived by an individual.

2.8.1 Physical activity

One of the fundamental factors of staying healthy is physical activity (PA). Rhodes et al. (2017, p. 943) define PA as *"any bodily movement that results in an increase in energy expenditure".* They suggest that any type of exercise that increases heart and respiration rate is beneficial to the human organism.

In 2002 the World Health Organization published a news article on physical inactivity and its possible impact on the increased risk of various diseases. Twenty years later the issue continues to grow. Altavilla (2016) designed a review on how physical inactivity negatively effects the health of individuals, leading to changes in both the physical and psychological well-being. He found that physical inactivity has a positive correlation with the risk of falls due to balance disorders and weakness (see Chapter 2.3; Table 1) due to lack of usage of muscles. However, the risk of falls is not the only reason why physical activity (PA) is sought to be beneficial. Civilization diseases (or non-communicable diseases) such as hypertension, cancer, type 2 diabetes, coronary heart disease, are highly associated with hypokinesia (Lee et al. 2012; Altavilla 2016; Zhang and Chaaban 2013). Zhang and Chaaban (2013) found that up to nearly 20 % of cases of civilization disease in China were linked to the lack of PA. They analysed data on the different types of diseases (mentioned above) and compared them to each other. Stroke and type 2 diabetes were found to have the highest correlation with inactivity. The aim

of their study was to point out the impact physical inactivity has on the economy. The results show significant impact and suggest designing intervention programmes for this issue to settle.

As Zhang and Chaaban (2013) suggested, the WHO and the Organisation for Economic Co-operation and Development (OECD) together created a guide to address the unfavourable situation of the lack of physical activity among the European population. Their goal was to educate and spread awareness of the ongoing problems underlying the inactivity of people and presenting solutions for governments to use and make changes to policies. The policy guidance included interventions in schools, workplace, healthcare, urban designs (such as cycling lanes, parks, and public transport), and programmes for sports clubs to enhance overall participation (OECD/WHO 2023).

Regardless of the evidence that physical activity has significant effects on health, it is not the only key to a healthy lifestyle.

2.8.2 Diet

Nurturing the body with adequate nutrition choices can result in significant benefits. Our eating habits in the western world have evolved and indulging and pleasure eating are large risk factors that have changed the way we provide our body with nutrients (de Ridder and Gillebaart 2022). The primary reason we eat is to supply our body – organs and cells – with all the nutritional elements necessary for everything to work as efficiently as possible. Together with other factors (especially genetical and environmental factors) inadequate food consumption may lead to several non-communicable diseases (NCD), such as cardiovascular problems, cancer, obesity, type 2 diabetes, and others. A healthy diet is one of the modifiable lifestyle factors that can decrease the probability of developing an NCD (Cena and Calder 2020).

In 2013 the WHO presented a so-called *Global action plan for the prevention and control of NCDs*. Their aim was to spread awareness of the preventability of NCDs and present possible steps for countries to take. An unhealthy diet was identified as one of the four risk factors of developing an NCD, together with tobacco use, physical inactivity and excessive alcohol consumption.

A typical Western diet (WD) consists of high-caloric fatty foods, processed foods. refined grains, and excessive amounts of salt and sugar. Instead of focusing on the

nutrients consumed and the feeling of satiety, the western mindset focuses on the pleasure of eating, which leads to overeating and obesity (Christ et al. 2019). There are other diets, for example the Mediterranean diet, which are naturally healthier and contain quality components such as fresh fruit and vegetables, legumes, fish, plant-based oils, and others (see Table 3; Appendix 8.2). This makes the food intake higher in dietary fibre with positive effects on the digestive and cardiovascular system (Cena and Calder 2020).

Table 3 (see Appendix 8.2) shows five different types of diet considered healthy according to research. The Mediterranean, the Healthy Nordic, and the Traditional Asian diet are natural diets that are based on ingredients popularly used in these regions. The other diets shown in Table 3 (DASH and MIND) are special diets developed for clients with specific goals and needs. DASH stands for the Dietary Approach to Stop Hypertension. It is prescribed to patients with high blood pressure (BP) with ambitions to lower the BP and mitigate the probability or severity of cardiovascular diseases (Siervo et al. 2015). The MIND diet (Mediterranean-DASH Intervention for Neurodegenerative Delay) utilizes a Mediterranean approach and was designed for patients with hypertension, similarly as the DASH diet, however, it is also used to prevent and decrease the risk of dementia. Morris et al. (2015) conducted a study to compare the effectiveness of both these diets (DASH and MIND) in reducing the risk of AD. They found that both diets decrease the risk; however, the MIND showed positive results even when moderately followed by the patient. Table 3 provides insight on the recommended servings of dietary components of each of the diet (Cena and Calder 2020).

All the diets presented in Table 3 share a common underlying approach. They suggest daily intake of fruit and vegetables as well as daily consumption of whole grains. Red meat and poultry intake are reduced to a few times a week as opposed to a typical western diet (Christ et al. 2019). The unanimity of the dietary components and recommended servings shows that the importance of quality nutrients and mindful consumption may lead to a healthy lifestyle (Cena and Calder 2020).

Dietary patterns have also been identified as factors affecting the ageing process. The first association was made in the 1930s. Researchers found that when mice and rats consumed less calories, their lifespan was extended. This experiment was further replicated on primates in 2009, seventy years later. Conclusions were made, and Campisi et al. (2019) suggested that healthy diets help improve lifespan and healthspan, whereas overeating is linked with a shorter and disease-ridden life.

2.8.3 Hydration

Staying hydrated is essential for the correct functioning of our organs and other bodily processes such as thermoregulation. The human body obtains water by drinking, eating, and metabolic water production. However, most of the daily water intake is through drinking water directly. The amount of water consumption per day depends on the amount of physical activity, the outside temperature, and generally it will depend on the amount of fluid being secreted (Popkin 2010; Perrier et al. 2021).

Hydration in later stages of life becomes a challenge since the feeling of being thirsty gradually declines. Nevertheless, this does not mean that elders need less water for their bodies to function properly – rather the contrary. Lack of water can impair the kidneys, cognitive functions can be affected, and the onset of delirious states may occur. Overall, dehydration is a geriatric syndrome itself and can lead to many other additional health issues (Popkin 2010).

2.8.4 Social Engagement and Cognitive Stimulation

Being socially active creates cognitive stimulation as social interactions require the usage of various cognitive functions. Social engagement is any activity that is carried out with someone else. A simple conversation can be considered social engagement, as can living with somebody (Walker et al. 2019), or, for example, grandparenting (Burn and Szoeke 2015). Research suggests that social engagement may be a lifestyle factor that reduces the risk of dementia diagnosis, and on the contrary, loneliness may lead to increased probability of health issues and mortality (Hackett et al. 2019; Holt-Lunstad et al. 2015).

2.8.5 Stress

Stress is a two-sided coin. It can serve as a motivator to preform better under certain conditions; or it can be a negative factor that may cause health issues when becoming chronic. O'Connor et al. (2021) conducted a review and found numerous studies showing that chronic stress experienced during childhood and early in life may lead to the development of various diseases. Nevertheless, the duration of stressful situations seems to be an indicator of how the stressor effects the brain. Shorter stressors, in fact, have shown protective elements that strengthen mental health and slow down cognitive decline (Dhabar 2019).

2.8.6 Sleep

Sleep is a lifestyle factor that affects many aspects of the human life. Sleeping forms part of our everyday life and we need to sleep in order to regain the energy that was used up during the day, mitigate accumulated stress, and overall, relax our body and brain. Studies suggest that sleep is a process that is formed into different stages. When the stages are not met, proper regeneration is not happening in the body, and it can result in sleep deprivation called insomnia. This is a sleep disorder that affects the whole organism, as sleep is necessary for optimal functioning (Eugene and Masiak 2015).

3 RESEARCH QUESTION AND OBJECTIVES

3.1 Objectives

The objective of this thesis was to systematically review the literature on SuperAgeing and identify the studies that explore the lifestyle factors that could potentially lead to the phenomenon.

A systematic review aims to answer a research question by reviewing evidence-based literature, looking into the topic through various angles. The idea is to create an overview of scientific literature and to synthesise the information provided by the different researchers in a structured manner. It is also a tool that helps to identify if a topic has a significant number of research conducted, or if it is an area that needs to be studied more (Boland et al. 2017).

3.2 Research Question

What are the known lifestyle factors contributing to SuperAgeing?

3.3 Search Strategy

3.3.1 Databases

After a brief scoping search, a total of 6 databases were selected for the systematic search. This included PubMed, Wiley Online Library, Web of Science, ScienceDirect, Scopus, and ProQuest. Initially, the Human Kinetics Library was also thought to be used, however, the studies retrieved were reviews, hence not applicable to the set of inclusion criteria. The goal of the search was to identify studies concerning SuperAgers and elders with preserved cognitive abilities, and various lifestyle factors.

3.4 Inclusion and Exclusion Criteria

As part of the methodology of this systematic review a PICO (population, intervention/exposure, comparison, and outcome) table was developed to help define the inclusion and exclusion criteria, as well as creating the review question mentioned above (Schardt, et al., 2007). It was designed to create structure and a baseline for the research. This helps identify the key elements of the review and gives support during the screening

process. Table 4 shows the PICO inclusion criteria, nevertheless, more detail was needed to establish the inclusion and exclusion criteria with additional aspects to verify the selection process.

Table 4 PICO Criteria

P *Population*	*I* *Intervention / exposure*	*C* *Comparison*	*O* *Outcome*
80+, preserved cognition, episodic memory intact	Lifestyle factors	Not relevant / not necessary for this SR	Successful ager / SuperAger

3.4.1 Inclusion Criteria and Exclusion Criteria

Establishing inclusion criteria is a fundamental part of the search strategy to retrieve relevant studies and gather data for further analysis. Table 5 presents the inclusion and exclusion criteria chosen to adequately answer the review question.

Table 5 Inclusion and Exclusion Criteria

	Inclusion	*Exclusion*
Participants	– Aged 80 and over – Preserved cognition (without signs of cognitive decline) – Episodic memory data noted in study	– Younger than 80 years old – Signs of cognitive decline or impairment – Diagnosed with any type of dementia – Other health problems (e.g.: back pain, tumour) – No measurements (or decline) of episodic memory

Study Design	– Cohort studies – Randomized clinical trials – Longitudinal studies – Retrospective studies	– Any type of review
Publication Language and Date	– Published in English – Published from 2013 to 2023	– Published in other languages – Published before 2013
Other		– Irrelevant topic – Insufficient data provided

3.5 Screening and Selection

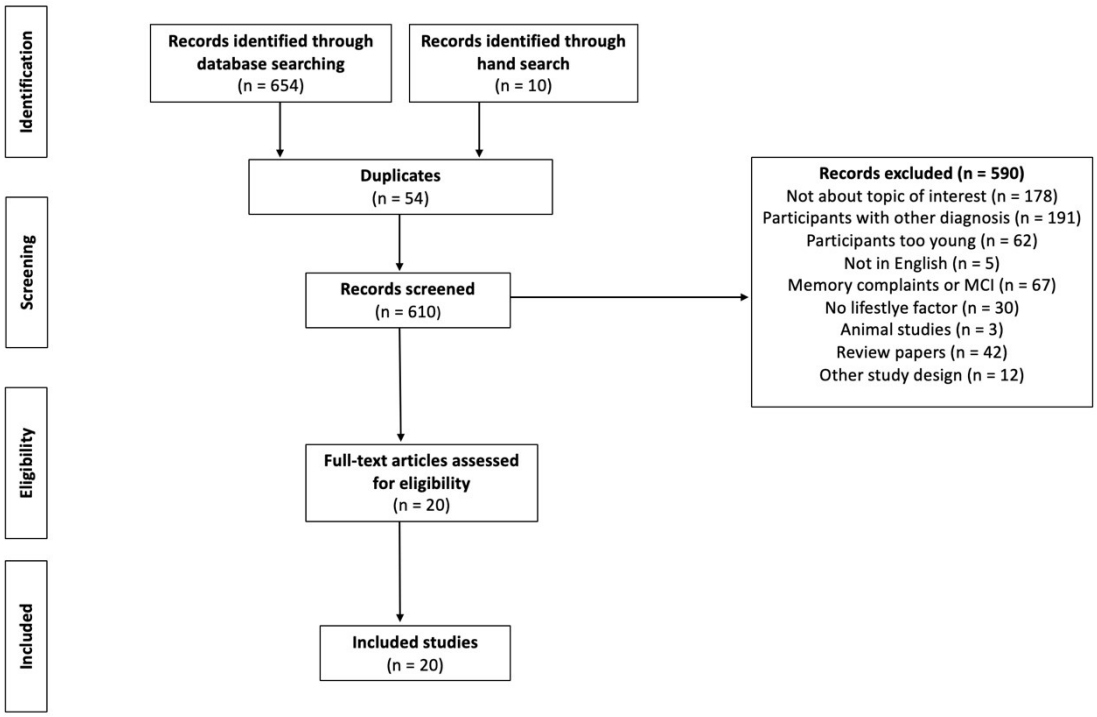
A total of 654 studies were identified based on the keywords selected. Each database required an individualised approach to the search, such as the use of Boolean operators (AND, OR, NOT), hence not all databases profited from its use. The search query consisted of these keywords: superageing, superagers, ageing, episodic memory, lifestyle factors, physical activity.

The same filters were applied to each search to specify the relevance of the query, however, not all databases had the same options. The filters used were the following: studies issued in English, studies published in a 10-year span (2013-2023), and only research articles (to eliminate books, chapters, and other articles from the search). After applying these filters less studies were found but the search was more accurate, and the studies were more relevant.

Figure 8 shows the PRISMA flow diagram. A total of 654 studies were identified through database search and 10 studies were included to the search through hand search. 54 duplicates were further excluded. 610 abstracts were screened by two reviewers, and after comparing the screening results of both reviewers, 590 studies were excluded.

Finally, 20 studies were assessed for full-text eligibility and were included in the analysis of the systematic review.

Figure 8 PRISMA Flow Diagram: Study Selection



3.6 Data Extraction and Critical Appraisal

Data extraction was carried out using a bespoke extraction form (see Appendix 8.3) designed to identify the population enrolled by each study, the design of the study, the outcome, and most importantly – the lifestyle factor they examined. Subsequently the data was synthesised into data extraction tables to give a clear understanding of the nature of the studies included. Both tools were self-designed to match the purpose of the systematic review.

The quality of each of the 20 studies that were identified through the screening process was assessed using the Newcastle Ottawa Scale (NOS). It is a tool that assesses non-randomized studies and was chosen for this review, given that only non-randomized studies were included in the final draft.

The NOC has two forms of assessment: Case-Control Studies or Cohort Studies. In this case the latter was used, consisting of 4 numbered items in the Selection category, 1 item in the Comparability, and 3 numbered items in the Outcome category. Each item provides the possible options to choose from and stars are awarded depending on the option selected. The Selection category can award a maximum of 4 stars to a study, the Comparability category awards a maximum of 2 stars, and the Outcome category can award up to 3 stars. Depending on the distribution of the stars, each study is classified as either good, fair, or poor quality (Stang 2010).

Table 6 – Newcastle Ottawa Scale

	Selection	**Comparability**	**Outcome**	**Quality level**
Bielak	**	**	**	Fair quality
Brown	**	**	**	Fair quality
Calandri	***	**	***	Good quality
Cook Maher	**	**	***	Fair quality
Dawe	***	**	***	Good quality
Ferencz	**	**	**	Fair quality
Festini	***	**	**	Good quality
Griffa	**	**	**	Fair quality
Halaschek	**	**	**	Fair quality
Hardman	**	**	***	Fair quality
Hayes	**	**	**	Fair quality
Kim	***	**	**	Good quality
Klaming	**	**	**	Fair quality
Lee	**	**	**	Fair quality
Reas[1]	**	**	**	Fair quality

Reas[2]	**	**	***	Fair quality
Wagner	**	**	**	Fair quality
Watts	**	**	**	Fair quality
Yang	****	**	***	Good quality
Yu	**	**	**	Fair quality

(*Ottawa Hospital Research Institute*)

All the studies selected before quality assessment passed this elimination process. Good or fair quality was assigned to the studies. Most studies, except Yang, received 2 or 3 stars in the Selection category. The main reason was the item that aimed to assess if the outcome of the study was or was not present at the start of the research. Understanding the nature of the studies selected, this item was not going to be met, since the objective of our finding is the lifestyle factors and the impact it had on the participants being SuperAgers. Both were likely to be present at the beginning of the study (sometimes even essential to meet inclusion criteria as participants), considering that the majority were longitudinal or retrospective studies.

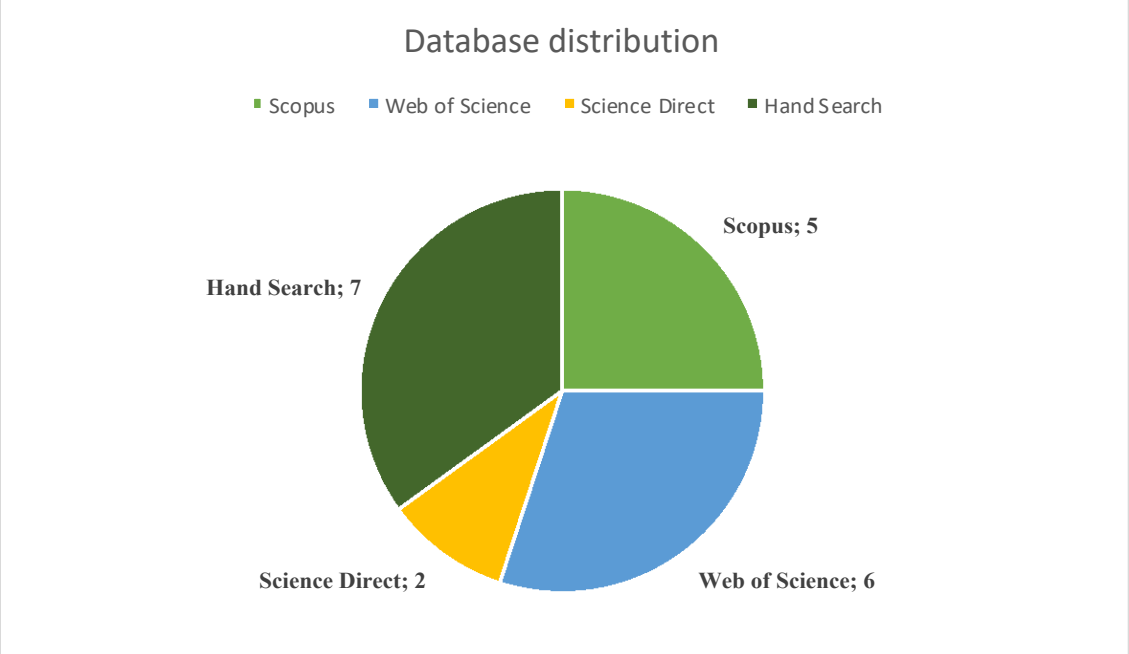
4 RESULTS

The results of the systematic review are presented in several tables and graphs to provide a visual representation of the descriptive data.

4.1 Study Characteristics

Table 7 (see Appendix 8.2) shows an overview of the characteristics of the 20 included studies. The dates of publication range from 2013 to 2023 according to the inclusion criteria. Furthermore, out of the initial 6 databases reviewed, only studies from 3 databases were finally included as well as hand searched studies. Graph 1 shows the distribution of studies identified from each database. Notably, the most effective (yet genuinely time-consuming) method in identifying studies was through hand search, which helped obtain a total of 7 relevant studies.

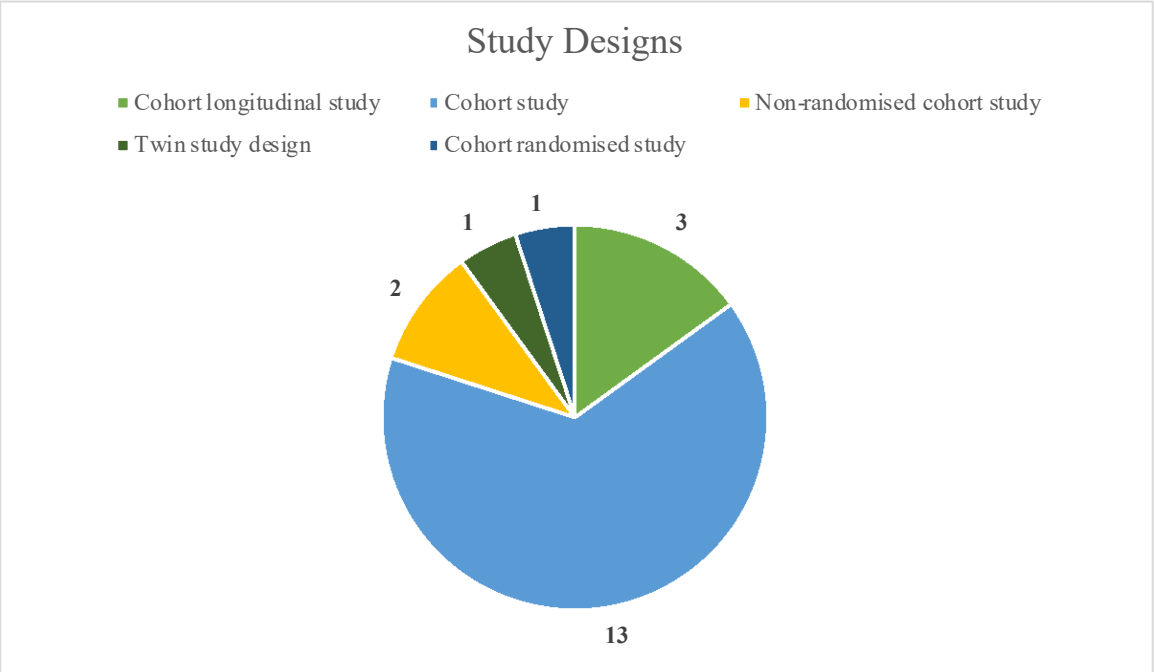
Graph 1 – Number of Studies Retrieved from Each Database



The country of origin was retrieved from each of the studies. It was found that 8 of the studies were conducted in (or in association with) the USA, 4 in Australia, 3 in Canada, and rest were conducted in non-English speaking countries. This is further discussed in the discussion chapter (see Chapter 6).

Graph 2 depicts the different designs used by researchers in the identified studies. Merely cohort studies were dominantly found (13 out of 20) across the spectrum, however, out of the 5 included study designs only one design (Twin study design) was not a cohort study.

Graph 2 – Representation of Study Designs



4.2 Participant Characteristics

The information about the participants of each of the included studies is presented in Table 8. Most of the studies provided information about the number of participants, mean age at baseline, age range (6 studies did not provide this data), and the number of female and male participants.

Table 8 Participant Characteristics

Study	*No. of participants*	*Mean Age (baseline)*	*Age Range*	*Gender (female; male)*
Bielak	1321	77,5	65 – 98	635; 686

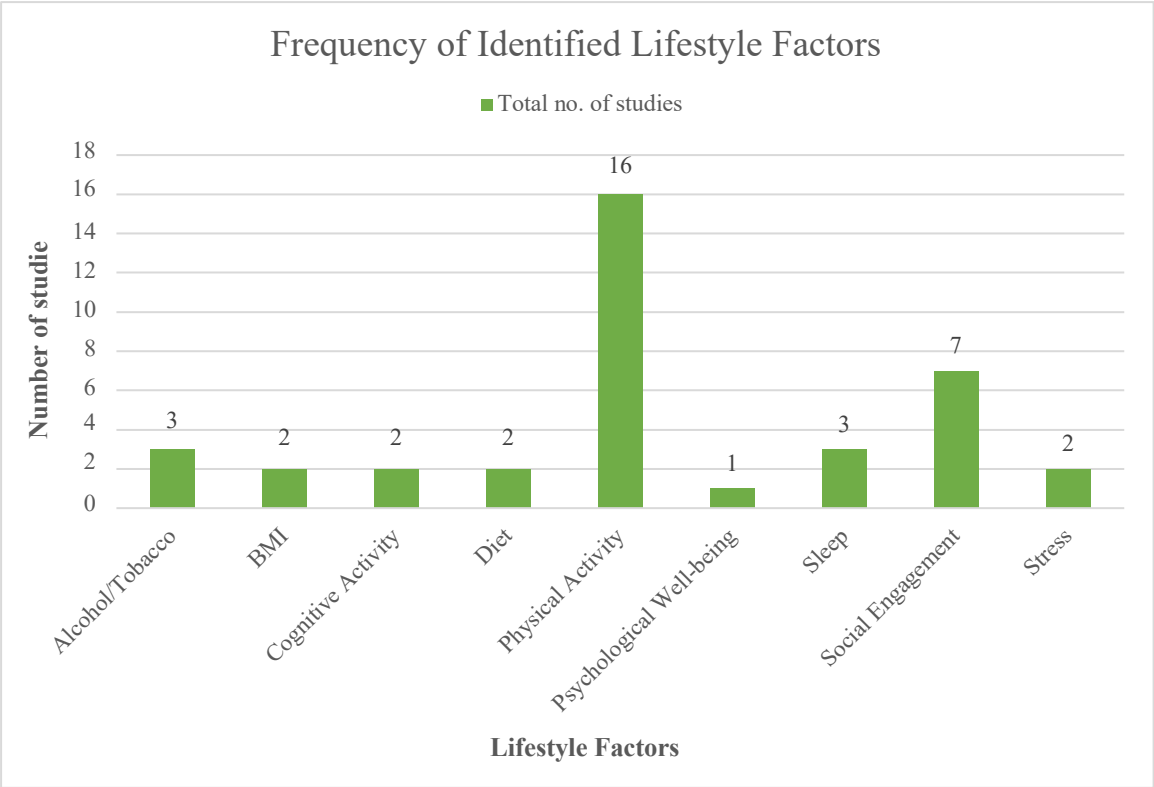
Brown	755	68,3	N/A	490; 265
Calandri	40	82,8	81,7 – 84,1	14; 26
Cook Maher	50	83,8	81,7 – 86,3	35; 15
Dawe	318	91,1	N/A	226; 92
Ferencz	2480	71,69	60 – 100	Both, not specified
Festini	330	68,5	50 – 89	201; 129
Griffa	46	91,6	85 – 90	20; 26
Halaschek	480	88,5	85 – 105	325; 155
Hardman	93	77,8	60 – 90	65; 28
Hayes	31	64,5	55 – 82	18; 13
Kim	90	72,0	N/A	75; 15
Klaming	1966	76,1	N/A	1058; 908
Lee	238	71,0	65 – 90	157; 81
Reas (1)	1826	75,1	60 – 99	1095; 731
Reas (2)	2027	73,5	64 – 85	1216; 811
Wagner	2730	N/A	70 – 81	Only female
Watts	2449	62,5	N/A	1189; 1260
Yang	40	70,8	65 – 87	30; 10
Yu	327	67,4	N/A	355; 133

The data from Table 8 reveals that the mean age of the participants at baseline varied, with the lowest being 62.5 (Watts et al. 2018) and the highest 91.6 (Griffa et al. 2021). Only 3 (Bielak et al. 2014; Calandri et al. 2020; Griffa et al. 2021; Watts et al. 2018) out of the 20 studies had more male participants eligible to take part in the studies. When summed up all the participants, a total of 9934 participants were female, whereas 5384 were male.

4.3 Identified Lifestyle Factors

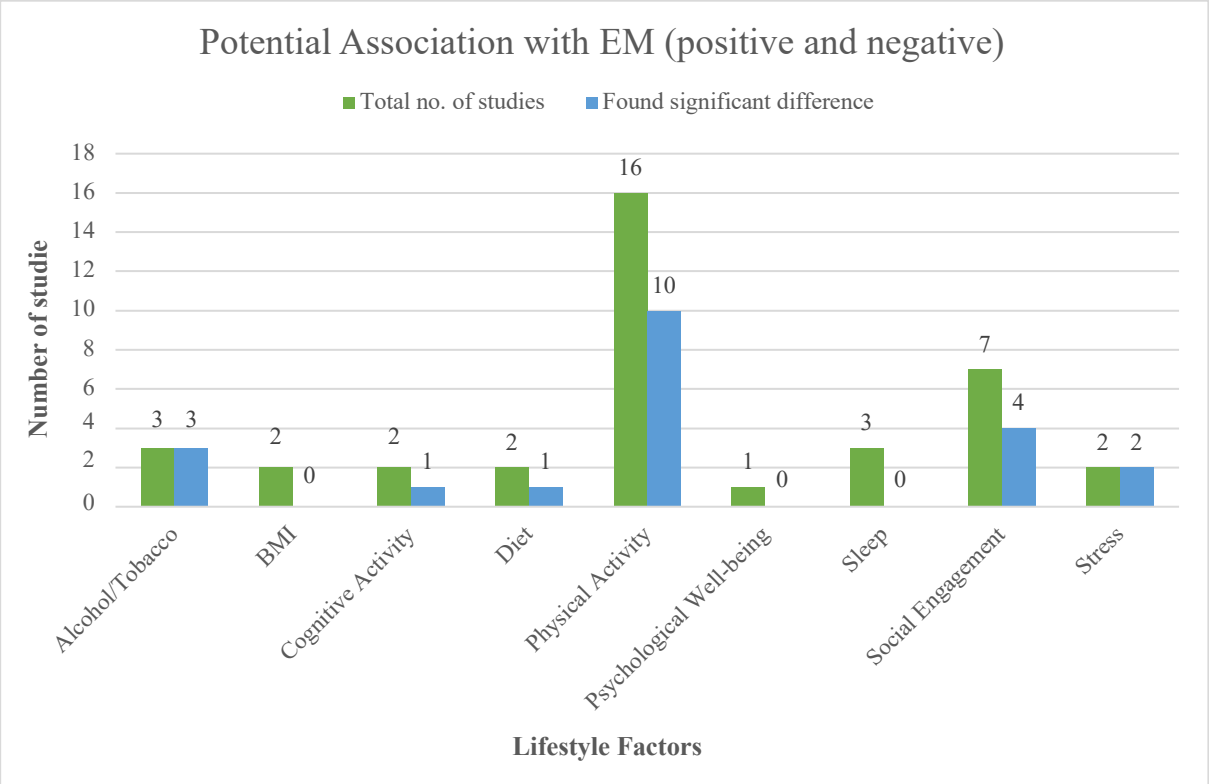
Graph 3 represents the identified lifestyle factors examined by the researchers of the included studies. Numerous studies examined more than one lifestyle factor. Physical activity was identified a total of 16 times, being the most frequent factor examined by research in this field. Social engagement was the second most frequent lifestyle factor, followed closely by the consumption of alcohol and tobacco smoking with 6 and 5 mentions consecutively.

Graph 3 Frequency of Identified Lifestyle Factors



Graph 3 solely shows the number of studies that explored each lifestyle factor, whereas graph 4 (p.46) shows the total number of studies and the number of studies that found a positive impact between the lifestyle factor and episodic memory performance.

Graph 4 Identified Lifestyle Factors and Potential Associations with Episodic Memory



Alcohol consumption and tobacco smoking was identified as a lifestyle factor that showed impact on the performance of episodic memory of individuals. Out of the three studies that provided data on this parameter, all showed the same result (for more detail see Chapter 4.4; Table 11).

Physical activity and social engagement both had over 50 % of positive outcomes and were associated with better episodic memory results. Even though not all the studies had consistent outcomes, these two parameters were highly represented in the identified studies and showed that these lifestyle factors may be critical for preserving one's cognitive functions (for more detail see Chapter 4.4; Table 9-10).

Stress was found to be an interesting variable. Both studies that examined stress as a hypothetical influential lifestyle factor found that stress does fulfil the hypothesis. However, each of the studies found opposite results. Festini et al. (2016) found that stress is associated with better episodic memory results, whereas Yu et al. (2020) found that SuperAgers reported less stress in their lives than typical agers did.

Moreover, cognitive activity and diet were poorly represented. Out of the two studies for each lifestyle factor, one showed significant difference and the other did not.

Finally, BMI, psychological well-being, and sleep were factors that did not show significant differences throughout the research.

4.4 Lifestyle Factor Findings

The aim of this study was to identify the lifestyle factors that contribute to the successful ageing of SuperAgers. In the section above graphical representation of the identified factors was conveyed; hence, following section presents the findings in tables that provide more detail about the particular studies.

Physical Activity

As mentioned before, physical activity was found as a lifestyle factor that potentially contributes to SuperAgeing. Table 9 shows all the 16 studies that examined PA. Most of the studies used surveys to obtain data on the participants quality and quantity of physical activity. Dawe et al. (2021), Hayes et al. (2015), and Kim et al. (2020) all used different devices that monitored PA and the results were assessed for each participant. All three found similar results – physical activity is associated with better cognitive functions (specifically episodic memory) and is a lifestyle factor that could be considered as impactful on successful ageing and SuperAgeing. Nevertheless, other studies that used the questionnaires to assess PA also found similar outcomes with a total of 10 out of 16 leading to a similar conclusion.

The activities identified by the researchers of the studies ranged from everyday activities, such as stair-climbing, gardening, or walking, to sport activities such as jogging.

Table 9 – Physical Activity Results Table

Study	***Lifestyle Factor***	***How was PA measured?***	***Identified activities***	***Results***	***Conclusion***
Bielak	PA	2 question questionnaire	Walking sessions / vigorous exercise	PA showed no associations.	Social interaction was the most effective
Brown	PA	VLS-ALQ questionnaire. Frequency of participation was noted.	Gardening, exercise activities, outdoor activities, recreational sports	Socially active = more PA. PA and social activity showed better memory results	An active lifestyle is beneficial for memory performance and cognition
Calandri	PA	According to the WHO Global recommendations on PA for health.	Not specified	No difference found.	Lifestyle factors did not show any hints in cognition between normal agers and SA.
Dawe	PA	Activity monitor device for 10 days.	Walking and jogging	MRI post-mortem brain images showed a positive correlation between phyhsical activity and cognition.	Being active is associated with better cognitive functions
Halaschek	PA	Activity questionnaire	Walking and exercise	No significant difference between NA and Super-Seniors	PA was not a factor that would show significant difference.
Hayes	PA	ActiGraph accelerometer	Total step count	PA associated with increased results in episodic memory tasks.	PA showed a positive association. PA is a lifestyle factor that may contribute to

					successful ageing.
Kim	PA	Fitbit Alta HR	Not specified	SA burnt more energy during the day that typical agers.	PA was identified as a potential lifestyle factor that contribute to SA
Klaming	PA	LAPAQ (questionnaire)	Outdoor walking, cycling, light household, heavy household, sport activities	PA was associated with better memory, however time showed no difference	Rate of decline in memory was not dependent on PA.
Lee	PA	Questionnaire	No. of activities, intensity, total no./week	PA showed no association with cognitive performance	
Reas[1]	PA	Questionnaire	Retrospective: teenager, 30y.o., 50y.o.	PA showed association with cognitive performance	PA in older age was associated with EM.
Reas[2]	PA	Questionnaire	Retrospective: teenager, 30y.o., current.	PA showed association with cognitive performance	PA in older age was associated with better EM.
Wagner	PA	Questionnaire	Walking, stair-climbing	_____	Higher levels of PA associated with better EM
Watts	PA	Questionnaire	Level of intensity (light, moderate, vigorous)	PA showed association with cognitive performance	PA associated with better cognition only in male participants.
Yang	PA	Self-guided home-based physical aerobic exercise programme	_____	PA group showed positive association with	Long-term delayed improvement in EM after exercise programme.

				memory performance.	
Yu	PA	Questionnaire	Frequency of PA	PA did not show association with cognitive performance.	Busier and more stressful lifestyles were associated with SA.

Social Engagement

Table 10 presents details on the studies that examined social engagement, another lifestyle factor that seems to have an influential impact on memory performance. All of the 7 studies assessed social engagement using subjective questionnaires. Most measured the frequency and the type of activity the participants carried out on a regular basis. The activities that were considered by each research were diverse, ranging from calling a family member or friend, contacting people by email, to social activity memberships or going to church. Interestingly, Yu et al. (2020) found that a socially isolated lifestyle was linked to superior episodic memory results. None of the other studies shared this finding.

Table 10 – Social Engagement Results Table

Study	*Lifestyle Factor*	*How was* social engagement *measured?*	*Identified activities*	*Results*	*Conclusion*
Bielak	Social Engagement	Questionnaire	Frequency of participation: group social and one-on-one	One-on-one social activity was positively associated with less episodic memory decline.	Cognition is linked to frequency and type of activity.
Brown	Social Engagement	Questionnaire	Social activities of everyday life: restaurant, friend visit, church, volunteering	No association was found	No association was found
Calandri	Social Engagement	Questionnaire	N/A	No association was found	Social engagement does not explain SA

Cook Maher	Social Engagement	Questionnaire	Positive relationship with others	SA is associated with greater levels of social engagement.	SA is linked to greater social engagement.
Klaming	Social Engagement	Questionnaire	No. of memberships, no. of social activities. Frequency of participation.	No. of memberships, attending activities, and frequency of attending meetings were positively associated with episodic memory	Social engagement is linked to enhanced memory performance
Lee	Social Engagement	Questionnaire	Contacting family, neighbour, friend. Group activities, church, voluntary work.	Social engagement was positively associated with EM	Socially active individuals had better EM scores.
Yu	Social Engagement	Questionnaire	N/A	Socially isolated lifestyle associated with superior EM	Social isolation is linked to superior EM as opposed to social engagement.

Alcohol and Tobacco

Another recognised lifestyle factor was alcohol consumption and tobacco smoking. Table 11 shows the results of the findings of these factors. All three studies agreed on that smoking tobacco was associated with poorer memory function. Yu et al. (2020) found that SuperAgers were less likely to be smokers and tended to consume less alcohol.

Even though the results for smoking were comparable in all three studies, alcohol consumption was a factor that showed some differences. Halaschek et al. (2018) did not mention alcohol consumption in their conclusion, Klaming et al. (2017) showed that light-to-moderate alcohol consumption was associated with better memory function as

opposed to alcohol abstinence, and finally the SuperAgeing participants from the Yu et al. (2020) study were less likely to consume alcohol compared to typical agers.

Table 11 – Alcohol and Tobacco Results Table

Study	*Lifestyle Factor*	*How was it measured?*	*Results*	*Conclusion*
Halaschek	Alcohol / tobacco	Questionnaire	SA were less likely to smoke. Frequency of alcohol consumption was the same for both.	Less tobacco smoking was associated with better cognition
Klaming	Alcohol / tobacco	Questionnaire	Alcohol abstinence = worse cognition; no association between heavy alcohol consumption and memory function. Smoking was associated with poorer memory function.	Light-to-moderate alcohol consumption was associated with better memory. Smoking tobacco is a negative lifestyle factor associated with memory
Yu	Alcohol / tobacco	Questionnaire	SA were less likely to smoke or consume alcohol	Both smoking and alcohol consumption was less likely in SA individuals

5 DISCUSSION

This systematic review appears to be the first to assemble research papers on lifestyle factors that contribute to successful ageing as a SuperAger, hence, it cannot be compared to previous findings. However, former research has found an interest in lifestyle factors affecting cognitive impairments such as those manifested in Alzheimer's disease (Dhana, et al. 2020). AD has a strong genetical explanation, nevertheless, studies suggest that lifestyle factors may help delay the symptoms of the disease by enhancing the cognitive reserve, brain reserve, and cognitive resilience (Ferencz et al. 2014; Liang et al. 2010). This offers new ground of exploration; if declining cognitive functions can be delayed by modifiable factors, the SuperAger phenomenon, where cognitive functions are preserved, could hypothetically also be influenced by these factors.

Research on lifestyle factors and successful ageing are not uncommon, however, research on lifestyle factors and SuperAgers is a separate matter. Meeting the SuperAger criteria is exceptional and studying this cohort has its pitfalls (Calandri et al. 2020). In this systematic review studies addressing the SuperAger cohort were reinforced with studies that focused on participants nearing the SuperAger criteria. This approach was adopted after recognising the scarcity of existing research on the topic. Four out of the twenty studies examined participants explicitly characterised as SuperAgers or individuals with superior cognition (Calandri et al. 2020, Halaschek et al. 2018, Kim et al. 2020, Yu et al. 2020).

Physical activity and social engagement were the two factors most represented among the 20 included studies in the systematic review. Surprisingly, the 4 studies that focused precisely on SuperAgers did not share the same results as the studies that examined successful agers or elders with better episodic memory results. Overall, physical activity showed the highest impact on memory results from all the identified lifestyle factors, followed by the results of social engagement. However, none of the four SuperAger studies met these results. Calandri et al. (2020) found no association between social engagement and SuperAgeing, Yu et al. (2020) showed unexpected results on social engagement that suggested that socially isolated individuals have better episodic memory results. Results on physical activity were not significant in 3 out of the 4 studies, even though 9 of the remaining studies did show some significant difference in the

participation in physical activities. The factor most consistent throughout the two groups of studies was tobacco smoking; all found a negative impact on memory performance.

Stress was another lifestyle factor revealed by the included studies. Unlike physical activity and social engagement, stress was not as widely examined, with only two studies addressing it. It was found uncertain if stress is a positive or negative factor; hence, more evidence is needed for a clear understanding of stress as a lifestyle factor contributing to SuperAgeing.

Furthermore, diet is a lifestyle factor frequently studied by researchers and together with physical activity has shown implications in improving overall health and in preventing various diseases (Connor et al. 2020). In the present review, diet was surprisingly underrepresented and showed less implication than expected. Even though diet is commonly linked to healthy ageing (e.g., Yeung et al. 2021), only one study suggested a positive association between a healthy diet and cognitive performance (Hardman et al. 2018).

Noteworthy findings were presented by Kim et al. (2020). They compared SuperAgers and typical agers in various domains and found that typical agers were more likely to suffer from type 2 diabetes mellitus, as well as high blood pressure. Their findings showed that SuperAgers moved more throughout the day burning more energy than typical agers. Type 2 diabetes and high blood pressure are two conditions closely linked to lack of physical activity and diet (Sami et al. 2017; Adeva-Andany et al. 2019; Kemps et al. 2019; Feigin et al. 2016). This supports the relevancy of systematically reviewing the lifestyle factors that play a role in ageing as a SuperAger.

All in all, the review question was addressed, and numerous lifestyle factors were identified. It is questionable if these lifestyle factors have an actual impact on SuperAgeing, as it is evident that limited research has examined the impact. The SuperAgeing theory is relatively young, and it is indisputable that this topic will be further explored in near future.

5.1 Strengths and Limitations

The main asset of this systematic review is the total number of databases reviewed, which leads to thorough understanding of the situation in this research area of published literature. However, a limitation that should be considered in contrast was the decision of not including grey literature in the review. Doing so could have brought more evidence and would have created a deeper overall understanding of the topic, not only in the published sphere.

Additional limitations of the review are evident. The included studies lack design heterogeneity with most of them being cohort studies. It would be preferable to include randomised controlled trials studies to reduce bias and obtain a better understanding of the causality of SuperAgeing.

Even though dual screening of abstracts was executed, involving multiple reviewers would reduce risk of assessment and researcher bias, leading to more reliable results. Involving additional reviewers would have also helped in selecting more favourable key words, which could potentially lead to better findings.

Despite the limitations of this work, it set a decent foundation for further research to address the issue.

6 CONCLUSION

The aim of this thesis was to systematically review literature and assemble lifestyle factors that contribute to SuperAgeing. The theoretical background gives a basic overview of the impact ageing has on individuals going through the ageing stage of life, but also summarises the global issues that the world's population is approaching.

Studying the ageing phenomenon is crucial, as the population continues to age. Understanding how to age well and find ways to stay healthy, active, and cognitively astute will bring positive outcomes and could potentially prevent or delay the onset of age-related diseases.

Physical activity and social engagement were found to be the most influential lifestyle factors that are often seen in the individuals that show little or no cognitive decline over time. SuperAgers, in general, tend to be more active and choose healthier options compared to typical agers, leading socially full lives, and find ways to keep their brain unimpaired.

In conclusion, the lifestyle factors that contribute to SuperAgeing and successful ageing should be considered important topics to study, as these factors can be frequently influenced by the individual's choices. Conducting more studies in the field of lifestyle factors could lead to a better understanding of the impact they have on the human brain and body.

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8 APPENDICES

8.1 List of all figures, tables, and graphs

8.1.1 Figures

8.1.2 Tables

8.1.3 Graphs

8.2 Supplementary Tables

Table 3 – Comparison of Different Types of Diets

Dietary Component	*Recommended Servings*				
	Mediterranean (Bach-Faig et al. 2011)	**DASH** (Campbell 2017)	**MIND** (Marcason 2015)	**Healthy Nordic** (Adamsson et al. 2012)	**Traditional Asian** (*Asian Heritage Diet* [no date])
Fruits	1–2/meal	4–5 servings/day	Berries: ≥ 2 servings/week	Fruits, berries, vegetables, and potatoes: ≥ 500 g/day	Daily
Vegetables	≥ 2 servings/meal	4–5 servings/day	Green leafy: ≥ 6 servings/week Other: ≥ 1 serving/day		Daily
Whole grains	1–2 servings/meal	7–8 servings/day	≥ 3 servings/day	Bread: 4–6 slices/day Cereal: 1.5 servings/day Pasta: 3 servings/week ß-glucan-rich foods: 3 g/day	Daily
Diary	Low-fat: 2 servings/day	Low- or non-fat: 2–3 servings/day	Cheese: < 1 serving/week Butter: < 1 Tbsp/day	Low-fat milk: ≤ 5dL/day Cheese: for cooking	Yogurt: daily to weekly
Nuts, seeds, legumes	Olives/nuts/seeds: 1–2 servings/day Legumes: ≥ 2 servings/week	4–5 servings/week	Nuts: ≥ 5 servings/week Beans: > 3 servings/week	Nuts (mostly almonds): 15 g/day	Daily

Beef, pork, ham, lamb, veal, poultry	Red meat: < 2 servings/week Processed meat: ≤ 1 serving/week White meat: 2 servings/week	Lean protein: ≤ 2 servings/day	Red meat: < 4 servings/week Poultry: ≥ 2 servings/week	Meat: ≤ 500 g/week Poultry: ≤ 300 g/week	Red meat: infrequent Poultry: daily to weekly
Fish / seafood	≥ 2 servings/week		≥ 1 serving/week	3–5 servings/week	2 servings/week
Fats, oils, salad dressing	Olive oil: 1–2 servings/meal	2–3 servings/day	Olive oil as primary oil	5 g/bread slice 0.5 dL/day as dressing	Healthy cooking oils: daily to weekly
Sweets	≤2 servings/week	≤ 5 servings/week	Pastries & sweets: < 5 servings/week	On weekends	Infrequent
Other	Eggs: 2–4 servings/week Potatoes: ≤ 3 servings/week	Sodium < 2,300 mg/day	Fried or fast food: < 1 serving/week	Eggs: stay withing daily recommended cholesterol intake Fruit/vegetable juice: 4 dL/week	Eggs: daily to weekly
Alcohol	Wine: in moderation	Women: ≤ 1 drink/day Men: ≤ 2 drinks/day	1 glass/day	Habitual amount	In moderation

Adapted from: (Cena, Calder 2020)

Table 7 Study Characteristics

Study	***Date of publication***	***Database***	***Country***	***Design***	***Recruitment***	***Lifestyle factor***
Bielak	2014	Scopus	Australia	Cohort longitudinal study	Australian Longitudinal Study of Ageing (ALSA)	PA Social Engagement
Brown	2016	Web of Science	Canada	Cohort study	Victoria Longitudinal Study (VLS	PA Social Engagement
Calandri	2020	Hand search	Argentina	Cohort study	Participants volunteered	PA Other
Cook Maher	2017	Hand search	USA	Cohort study	Northwestern University SuperAger programme	Psychologic well-being
Dawe	2021	Scopus	USA	Cohort study	Rush Memory and Ageing Project (MAP)	PA
Ferencz	2014	Scopus	Sweden	Cohort study	Swedish National Study on Ageing and Care in Kungsholmen (SNAC-K)	PA

Festini	2016	Web of Science	USA	Cohort study	Dallas Lifespan Brain Study (DLBS)	Busyness Stress
Griffa	2021	Web of Science	Switzerland/ Netherlands	Cohort study	European Medical Information Framework for AD 90+ Study (EMIF AD	Cognitive activities
Halaschek	2019	Hand search	Canada	Non-randomised cohort study	BC MSP* subscribers; volunteers from press; BC Stats	PA Alcohol/tobacco
Hardman	2018	Science Direct	Australia	Cohort study	Care and retirement villages	Diet Medication
Hayes	2015	Scopus	USA	Non-randomised cohort study	Boston University Memory Disorder Research Centre; flyers; YMCAs; libraries.	PA Other
Kim	2020	Hand search	South Korea	Cohort study	Gangseo Centre for Dementia (Seoul)	PA Sleep
Klaming	2017	Web of Science	Netherlands	Cohort longitudinal study	Longitudinal Ageing Study Amsterdam (LASA)	PA Sleep Social engagement Alcohol/tobacco

*BC MSP – British Colombia Ministry of Health Service Plan

Lee	2014	Web of Science	Australia	Twin study design	Older Australian Twins Study (OATS)	PA Cognitive activity Social engagement
Reas[1]	2019	Web of Science	USA	Cohort study	Rancho Bernardo Study of Healthy Ageing	PA Alcohol/tobacco
Reas[2]	2019	Hand search	USA	Cohort study	Rancho Bernardo Study of Healthy Ageing	PA Alcohol/tobacco BMI
Wagner	2022	Science Direct	France/USA	Cohort study – nested case-control sample	Nurses' Health Study (NHS)	PA Diet/BMI
Watts	2015	Scopus	Australia/USA	Cohort longitudinal study	PATH Through Life Project	PA
Yang	2022	Hand search	Canada	Cohort randomised study	Ryerson Senior Participant Pool (RSPP)	PA
Yu	2020	Hand search	Singapore	Cohort study	Ageing in a Community Environment Study	PA Social engagement Sleep Stress Acohol/tobacco

8.3 Data Extraction Form

1. Study title

2. Authors

3. Method
    a. Participant recruitment
    b. Participant characteristics
        i. Number
        ii. Age
        iii. Inclusion/exclusion details

4. Lifestyle factor/s identified

5. Lifestyle factor measurement

6. Episodic memory assessment

7. Results

8. Discussion

9. Additional info

10. Comments