Determinants of healthy ageing: a systematic review of contemporary literature.

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Systematic Review

Title: Determinants of Healthy Aging: A Systematic Review of Contemporary Literature

Short title: Healthy Aging Determinants: Systematic Review

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Abstract

Background: Healthy ageing frameworks have been highly explored. Our objective was to assess existing frameworks for healthy ageing and to identify commonly described factors that can potentially act as determinants of healthy ageing.

Methods: We carried out a systematic review by searching five electronic databases- EMBASE, MEDLINE, Cochrane, PsychINFO, and CINAHL from January 2010 to 20 November 2020 to capture contemporary evidence. Eligible studies needed to report a clear framework of healthy ageing in humans, within one or more of three domains (physical, mental/cognitive, social), in English. No restriction was placed on geographical location. Retrospective studies, studies that did not report a framework of healthy ageing, and studies with a focus on diagnostic measures were excluded.

Results: Of 3329 identified records, nine studies met eligibility criteria and were included. Most of the studies were qualitative or cross-sectional, and the majority were carried out in Asia, followed by North America, Australia, and Africa. Most studies are Using Critical Appraisal Skills Programme checklist for qualitative studies and the Newcastle-Ottawa Scale for cross-sectional studies, we found majority of studies were of high quality. The ten determinants identified for healthy ageing include physical activity; diet; self-awareness; outlook/attitude; lifelong-learning; faith; social support; financial security; community engagement, and independence.

Conclusions: We identified ten determinants of healthy ageing proposed by the contemporary evidence base. There appears to be increasing acknowledgement the instrumental role social and mental/cognitive well-being as determinants of healthy ageing. The extent to which each determinant contributes to healthy ageing requires further evaluation.

Keywords: healthy ageing, determinants, framework

Introduction

Worldwide, the population aged over 65 is increasing at a faster pace than all other age groups [1]. As a result of this demographic shift, it is important to look at ways to improve the quality of life of older adults and support independent living. The COVID-19 pandemic has disproportionately affected people over 65 years of age, who had previously been in good health [2]. Given the global impact of COVID-19, it is more crucial than ever to identify determinants of healthy ageing that can be applicable across different communities and countries to build their path to better health.

Ageing as a concept has been vastly explored, a particularly important aspect being how to define what it means to age well. Key leaders in the field of ageing such as Rowe and Kahn defined successful ageing as the absence of physical impairment and chronic diseases, as well as optimal social participation and mental well-being [3]. Rowe and Kahn brought the field forward with their inclusion of mental and social wellbeing. The idea that to age healthily one must be free of disease or impairment is something that has carried throughout the years, but in more contemporary times this has been disputed and modified.

Previous reviews in this field have provided valuable information on internal and external factors that promote healthy ageing in older age, as well as better engagement in healthier and active lifestyles [4,5]. In 2013 Lara et al. developed five fundamental domains of healthy ageing: physiological and metabolic health; physical

capability; cognitive function; social well-being and psychological well-being [6]. Comparatively in 2017 Hornby-Turner et al. categorised four domains: personal, social, economic, and environmental [4]. This shows the lack of consensus of what ageing well entails due to the variability between studies.

Lu et al, a review comparing methods used to assess healthy ageing, evaluated the common terms used in ageing studies (e.g., successful ageing, active ageing), and established that the term healthy ageing was most appropriate for their study [7]. The main reason as to why healthy was preferred was because of the World Health Organization's (WHO) definition. The WHO defines health as "a state of complete physical, mental/cognitive, and social well-being, rather than merely the absence of disease or infirmity" [8]. The WHO established their definition of health in their constitution in 1948 and still stand by the initial definition. It highlights that being healthy is not solely determined by the absence of disease, even though may be a contributor. The WHO's definition also highlights the three main domains of health: physical, mental, and social well-being [8]. Separating healthy ageing into these three domains can facilitate the development of a framework to assess and guide an individual towards healthy ageing.

The aim of this systematic review was to synthesise the evidence on healthy ageing frameworks by critically evaluating existing frameworks, identifying the methods used in frameworks to evaluate health ageing, and if appropriate to propose a revised, contemporary framework for healthy ageing. In doing so also identifying factors that can act as determinants of healthy ageing within the domains of physical, mental/cognitive, and social well-being in line with the WHO definition of health [8].

Methods

We carried out a systematic literature review by searching five databases [EMBASE (Ovid), MEDLINE (Ovid), Cochrane Central Register of Controlled Trials (Ovid), PsychINFO (Ovid), CINAHL (EBSCO)] in November 2020, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement.[9] The PRISMA checklist was included in the supplementary material, as table 1. A PRISMA protocol was not registered.

Search Strategy

The following search terms were used in OVID (EMBASE, MEDLINE, Cochrane, PsychINFO): healthy ageing.mh. or (healthy ageing or healthy aging).tx,tw,ab,hw,kw.) and (measurement tool or scale or instrument or questionnaire).mp. and EBSCOhost (CINAHL): MH(healthy ageing) OR TX(healthy ageing OR healthy aging) AND (measurement tool OR scale OR instrument OR questionnaire)

Eligibility

To be eligible for this systematic review, studies were required to meet the following criteria: 1) Studies published in English, 2) Articles published between January 2010 and November 2020 (to capture contemporary evidence) 3) Studies that were conducted in humans. There were no restrictions for inclusion based on geographical location. The following exclusion criteria were applied: 1) Retrospective studies, 2)

Studies that did not report a framework of healthy ageing, 3) Studies with a focus on clinical diagnostic measures (e.g., Magnetic Resonance Imaging (MRI)).

Study Identification

All identified studies were transferred to Covidence (Melbourne, Australia) systematic review software where they were deduplicated [10]. The titles and abstracts were screened by two independent reviewers (GK, TA) with conflicts resolved by discussion or a third reviewer (PKM). Following that, full-text screening was conducted on all retrieved studies by two independent reviewers, with conflicts similarly resolved by discussion or a third reviewer (PKM). Reasons for exclusion at full-text screening stage are reported in the PRISMA flow chart (Figure 1).

Outcomes and Data Extraction

The main outcome was a framework for successful healthy ageing. For this systematic review, outcomes also included identification of determinants that fall within the three domains of physical, mental/cognitive, and social well-being. Data were independently extracted from included studies by two reviewers (TA, GK). Disagreement was resolved by discussion and/or by a senior author (PKM). The following data were extracted: country, study design, age, number of participants, gender, specific population studied, main framework, and healthy ageing domains.

Derived Frameworks and Categorisation into Domains

Following full-text screening and data extraction, due to the nature of studies, meta-analysis was not feasible, therefore we conducted a narrative synthesis. A framework for healthy ageing was identified as a primary outcome in all included studies (Supplementary material).

Quality Assessment

Included studies were critically appraised independently by two researchers (TA, GK), using the Critical Appraisal Skills Programme (CASP) Checklist for qualitative studies and the Newcastle-Ottawa Quality Assessment Scale (NOS) adapted for cross-sectional studies [11,12].

Results

Study Selection

Of 3329 studies initially identified, after removing duplicates, 2970 studies underwent title/abstract screening during which 2818 studies were excluded for the following reasons: did not focus on healthy ageing and/or had a focus on diagnostic measures (e.g., MRI). Thus, a total of 152 studies were retrieved in full and screened against the inclusion and exclusion criteria by two reviewers independently (GK, TA) to determine their eligibility. 143 studies were excluded, as they did not report a framework for

healthy ageing. Nine studies that reported frameworks of healthy ageing were included in the review (Figure 1) [13 - 21].

Quality Assessment

All studies were found to be of high quality according to the CASP Checklist for qualitative studies and the NOS for cross-sectional studies (Supplementary Table 2, Supplementary Table 3). Five qualitative studies did not adequately report the relationship between the researcher and the participants [14 – 21]. Meaning whether the researcher assessed their role and bias and its potential influence on the study [11]. Two cross-sectional studies did not report the comparability between respondents and non-respondents [13,18].

Study Characteristics

The total number of participants in this review was of 2407, ranging from 11 to 683 participants in individual studies (Table 1). Most studies had a sample size greater than 100, and were predominantly conducted in Asia [13 -16]. Eight studies were carried out on both genders and one was solely on females. The majority of participants were above sixty years of age: study mean ages ranged from 64 to 85.2. Most of the studies were qualitative in nature and employed either semi-structured interviews or focus groups. Three studies used cross-sectional design (e.g., surveys) [13,17,18]. There were four studies that were conducted in people with specific conditions or circumstances. Two focused on Multiple Sclerosis (MS) patients [17,19], one on incarcerated women [15] and one on immigrants [20].

Determinants of Healthy Ageing

Overview

Six out of the nine studies included determinants of successful ageing within the three healthy ageing domains of physical, mental/cognitive, and social well-being (Table 2, Figure 2) [14, 15, 16, 17, 20, 21]. Three studies only addressed the mental/cognitive and social domains. Of the nine studies, there were five that had determinants that covered more than a single domain, meaning the determinant could not be solely classified into one domain [14,15,17,18,20]. Ten overall determinants were identified, with independence being present in all three domains. Figure 2 shows the combination of determinants found in each study by the overlapping of the shapes, each of which represents a study.

Physical Well-being

Seven studies included determinants within the physical domain [14-18,20-21]. These studies emphasized the need to maintain a good level of physical capability to enhance successful healthy ageing. Wallack et al. focused on MS participants, therefore physical activity was addressed as a subtype of “lifestyle choices and habits” specifically in the body category [27]. This included exercise but also alternative therapies and medication management due to their potential effects on the body. Conversely, the other studies focused more on the aspect of exercise and keeping active as physical activity. Three studies used diet as a determinant for physical health,

yet the specifics of the kind of diet or nutritional elements were not reported [14,15,17]. Lucas et al. included diet as part of the sustaining phase of healthy ageing due to its role in maintaining and supporting physical health [15].

Mental/Cognitive Well-being

All studies included mental/cognitive determinants of successful healthy ageing. Four main determinants emerged in relation to the mental/cognitive well-being domain, namely: self-awareness, outlook/attitude, life-long learning, and faith.

The determinant of self-awareness included self-esteem, self-achievement [13], resilience [19], body awareness and sense of purpose [17]. Ploughman et al. defined resilience as “the participants ability to adapt to changes” specifically being conscious of the new circumstances they are presented with and choosing to modify their choices to support the new conditions [19]. This definition of resilience closely relates to Wallack et al. definition of body awareness, specifically relating to one’s lifestyle choices [17]. Additionally, body awareness differs in the Wallack et al. study due to the specific circumstance of MS being studied [17].

The determinant of outlook/attitude, found in seven studies, ties into self-awareness [15-21]. Amosun et al. divided their findings into two overarching themes, one focused on participants found to have future-oriented behaviour and the second for participants without a future oriented behaviour [21]. The final themes for successful ageing were specified within those that had a future oriented behaviour, which included the theme

of preparing for the afterlife. It was noted that having a good outlook and attitude towards the future impacted ageing in a positive way, rather than “awaiting death” [21].

Life-long learning (e.g. reading, taking up a new hobby, or learning a new language), found in three studies, is intricately connected with outlook/attitude [14,18,20]. Thanakwang et al. specifies that “engaging in active learning” is very important in successful healthy ageing particularly in the field of technology [14]. Additionally, continuous learning has a good cognitive impact aiding in maintaining one's cognitive function as they age.

Lastly, faith was found in five studies, which included the aspects of beliefs, religion, and spirituality [14,15,17,18,21]. Lucas et al. focused on incarcerated women as participants and created a framework that had the five stages of successful ageing [15]. Within the third phase (“reforming phase”) and the fifth phase (“sustaining phase”), faith was significant [15]. Being in isolation has a large impact on mental health and immersing in faith was shown to support stability as well as increase motivation. Both of which support a good outlook towards life as the participants age and began to develop illnesses. Additionally, Robleda et al. found that participants reported that as you age it becomes more difficult to look forward to the future and immersing oneself in faith gave their life a higher sense of purpose [18].

Social Well-being

All studies included social determinants of successful healthy ageing [13-21]. Three main determinants (Social Support, Financial Security, Community Engagement) were identified for the social domain.

Social support was reported across seven out of the nine studies [13-15,17-20]. Social support was defined as establishing relationships and building rapport not only with family members but also with acquaintances. Additionally, Wallack et al. focused on MS patients, and brought up the factor of effective and accessible healthcare, which was classified as social support because participants' relationships with their care providers were valued [17].

Community engagement (identified in seven studies), ranged from volunteering, to religious gatherings, such as going to church, and feeling acquainted with the community [14-18,20-21]. According to Amosun et al. engaging in community activities gave the participants a sense of purpose [21]. This was particularly explored by Hui Chian Teh et al. who focused on Chinese immigrants living in Australia [20].

The last determinant, which was identified across seven studies, was financial security [14,16-21]. Robleda et al. defined financial security as being able to maintain a good quality of life [18], whereas Hui Chian Teh et al. focused on the aspect of not having to be a financial burden to family [20]. What both studies have in common was the emphasis on being able to maintain a good lifestyle; Hui Chian Teh et al. specified that having access and the ability to afford proper care as you age was highly important [20], which Wallack et al. agreed with for their MS participants [17]. The key aspect found across all studies that included financial security was the ability to continue to live a comfortable life and for many it included not having to rely on others.

Independence as an Overlap Determinant

Independence as a determinant was explored in six studies and is present across all three domains [13-14, 17-20]. It includes aspects such as one's physical or mental/cognitive ability to live without support as well as being financially independent from family or friends. It was clearly shown in different studies that how independence is perceived changes according to the individual's circumstances. For Ploughman et al. and Wallack et al. both of whom focused on participants with MS, physical independence played a significant role in terms of how far their physical capability spanned [17,19]. The studies that did not research participants with MS, also found independence to affect the physical domain as well as the social and mental/cognitive well-being domains. Due to the lack of a chronic disease, when independence was mentioned in these studies it was not solely focused on the individual's physical independence. For Thanakwang et al. being self-reliant was a very important factor in the active ageing scale used [14].

Discussion

On 14th December 2020, the United Nations General Assembly declared 2021-2030 as the Decade of Healthy Ageing [22]. Healthy ageing replaced the WHO previous focus on active ageing. Although the concept of active healthy ageing has been widely researched and discussed in academic, political, and popular media arenas, systematic reviews that assess existing healthy ageing frameworks are lacking. To the best of our knowledge, this review illustrates the first attempt to systematically identify key determinants related to healthy ageing. The novelty of this research lies in the

comparison of contemporary healthy ageing frameworks that have already been proposed. We identified ten determinants for healthy ageing, namely: physical activity; diet; self-awareness; outlook/attitude; lifelong-learning; faith; social support; financial security; community engagement; independence.

The determinants of healthy ageing can vary depending on many factors including culture, age, and gender. Therefore, it is important to consider that the studies were from varied geographical locations. This may have a large effect on what is considered important for achieving healthy ageing due to the difference in culture/customs [23]. Additionally, including a study with the premise of being an immigrant made it clear how integral community immersion and engagement is for an immigrant as they age, further emphasizing cultural differences. However, the geographical diversity arguably provided more depth and spread to this review, because it enabled the identification of commonalities such as social support, independence, and financial security. This in turn will increase opportunities for local and global initiatives to optimise healthy ageing across different communities and countries.

Often, studies investigating healthy ageing focus on the biological factors (e.g., genetics and illnesses) that play a role in ageing [24]. We sought to identify modifiable factors to provide a better insight into healthy ageing. By doing this, non-biological factors, such as social, mental/cognitive, and physical well-being, were shown to play a substantial role [24]. For example, Wallack et al. who studied MS patients, focused on the participants' acceptance and awareness of their body and its capability and how that largely impacted their mental health [17].

346 Our results illustrated that many of the determinants of physical, mental/cognitive, and
347 social well-being are interrelated. For example, in the physical domain both
348 determinants, physical activity and diet, can affect the mental/cognitive determinant of
349 attitude/outlook. Increasing physical activity and eating a balanced diet has been
350 shown to boost the mood and energy levels of individuals which consequently
351 improves their attitude/outlook towards life [25,26]. There was a contrast in terms of
352 physical activity depending on the targeted group of participants, e.g. those with MS
353 differed from those without. The inter-relation of determinants establishes the idea that
354 healthy ageing cannot be segmented into isolated factors but is an inter-dependent
355 measure. An example is how faith is linked to outlook/attitude, as it can be part of goal
356 setting and gives individuals something to work on and improve as they age.
357 Additionally, often, having a strong sense of faith aids an individual to find a greater
358 sense of purpose. These inter-relations could be because different people place a
359 higher value on different determinants, depending on their subjective views or life
360 experiences [27]. Additionally, the inter-dependence between determinants supports
361 the idea that healthy ageing is not a single stable measure, but that it is a balance that
362 is constantly adjusted between all the determinants [28,29]. Therefore, to successfully
363 evaluate healthy ageing there is a need to assess all the identified determinants and
364 understand the value and hierarchy the individual ascribes to each determinant at the
365 individual level. Independence could not be classified in only one domain since it has
366 been found to be “highly significant for life satisfaction” and its loss to be a highly feared
367 occurrence in ageing [30]. Thus, it was more appropriate to categorize it into an
368 overlapping determinant included across all three domains.

369 This review gains its strengths from the combination of rigorous search and extraction
370 methods and the underlying theoretical framework which guided the synthesis.

Another strength of our work is that one of the exclusion criteria was studies that used clinical measurements for their results. This makes our proposed determinants more widely applicable to groups that do not have access to clinical diagnostic measures (e.g., blood tests, MRI). Additionally, by limiting the years of inclusion from 2010 to 2020, it was possible to focus on the most contemporary research available which builds on early established research in healthy ageing [28].

One of the limitations stems from the point of the original studies' definitions and categorisation. Most studies included in this review defined determinants differently, which made direct cross-cultural comparisons challenging. Only studies written in the English language were included, which might affect the ability to generalise results to non-English-speaking countries and may have resulted in us excluding relevant studies. Moreover, the studies included were cross-sectional in nature, and therefore did not allow for investigation of causality between determinants and reports of healthy ageing. There was a larger proportion of female participants in the included studies, which might under-represent what males consider to be healthy ageing. The concept of healthy ageing is likely to be a dynamic process meaning important determinants may even vary within an individual depending on their age, further evaluation of relative contribution these determinants is warranted, albeit this is beyond the scope of the current study.

The application of the results from this review to pre-existing longitudinal cohort data could provide direct comparison of these determinants in their contribution to healthy ageing at population level. Through our review we have created a more specialised understanding of healthy ageing by finding commonalities and differences among the nine identified frameworks. Future research would be to conduct a sense-checking

exercise via focus group work with older adults to propose the new framework and whether this framework fits with their concept of healthy ageing. This is particularly important to evaluate whether all determinants have the same weighting towards defining healthy aging and how it may vary with age, gender, race/ethnicity, and socioeconomic factors. Another alternative would be to cross reference this framework with large self-reported health studies to see how reliable and applicable this data is. Moreover, future studies should have an agreed terminology on how to better define determinants, which will be crucial for cross-cultural comparisons. Our results support the use of the term healthy ageing rather than successful or active ageing, in accordance with Lu et al. as it more holistically encompasses the domains of health as defined by the WHO [7,8]. Additionally, going forward we suggest using the terms determinants rather than factors as it encompasses the direct effect that the determinants have on healthy ageing.

In summary, we have systematically reviewed the contemporary literature on frameworks of healthy ageing and identified ten determinants of successful healthy ageing. These are: social support, financial security, community engagement, independence, self-awareness, outlook/attitude, life-long learning, faith, physical activity, and diet. Healthy ageing appears to be the result of all these determinants being optimised. By creating a clear framework of the factors that influence healthy ageing at an individual level, public service providers and policy makers can be guided to identify and give incentives to work towards improvement in health focusing on specific determinants that are relevant to an individual’s circumstances.

Statement of Ethics: An ethics statement was not required for this study type, no human or animal subjects or materials were used.

Conflict of Interest Statement: Authors declare no competing interests to declare.

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Data Availability Statement: All data generated or analysed during this study are included in this article and its supplementary material files. Further enquiries can be directed to the corresponding author.

Table 1 Characteristics of included studies

Study	Geographical Location	Study Design	Age	Number of Participants	Gender of Participants	Specific Population Studied	Main Outcome (Framework)	Healthy Ageing Domains
Hyun Cha et al. [13]	Asia (South Korea)	Cross- sectional	> 60	*N* = 305	Female: 72.8% Male: 27.2%	N/A	Conceptual Framework for Healthy Ageing	Mental/Cognitive Social
Ploughman et al. [19]	North America (Canada)	Qualitative (Semi-structured interviews)	> 55	*N* = 18	Female: 77.78% Male: 22.22%	Multiple Sclerosis	Conceptual Framework of Healthy Ageing with Multiple Sclerosis	Mental/Cognitive Social
Thanakwang et al. [14]	Asia (Thailand)	Qualitative (Focus groups and interviews)	> 60	*N* = 500	Female: 64% Male: 36%	N/A	The Active Ageing Scale Thai Model	Physical Mental/Cognitive Social
Wallack et al. [17]	North America (Canada)	Cross-sectional (Survey)	> 55	*N* = 683	Female: 78% Male:22%	Multiple Sclerosis	7 Determinants of Healthy Ageing with MS	Mental/Cognitive Social
Robleda et al. [18]	Australia	Cross-sectional	> 50	*N* = 153	Female: 68.9% Male: 31.1%	N/A	Concept map: 9 Quality of Life Domains	Physical Mental/Cognitive Social
Amosun et al. [21]	Africa (South Africa)	Qualitative (Questionnaire)	> 60	*N* = 625	Female: 85.1% Male: 14.9%	N/A	6 Themes of Future-Oriented Behaviour	Physical Mental/Cognitive Social
Lucas et al. [15]	Asia (Philippines)	Qualitative (Interviews)	> 60	*N* = 15	Female: 100% Males: 0%	Incarcerated	The Road to Success Model: 5 Phases of Successful Ageing of Incarcerated Women	Physical Mental/Cognitive Social
Chen et al. [16]	Asia (China)	Qualitative (Semi-structured interviews)	> 80	*N* = 97	Female: 56.7% Male: 43.4%	N/A	Umbrella Model for Self-Reliant Successful Ageing	Physical Mental/Cognitive Social
Hui Chian Teh et al. [20]	Asia (Chinamigrants to Australia)	Qualitative (Semi-structured interviews)	> 60	*N* = 11	Female: 63.6% Male: 36.4%	Chinese immigrants living in Australia	11 Emerging Themes on Successful Ageing	Physical Mental/Cognitive Social

449 **Table 2 Determinants of healthy ageing**

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Studies	Hyun Cha et al. [13]	Ploughman et al. [19]	Thanakwang et al.	Wallack et al. [17]	Robleda et al. [18]	Amosun et al. [21]	Lucas et al. [15]	Chen et al. [16]	Hui Chian Teh et al. [20]
Physical									
Physical activity	N/A	N/A	✓	✓	✓	✓	✓	✓	✓
Diet	N/A	N/A	✓	✓			✓		
Mental/cognitive									
Self-awareness	✓	✓		✓		✓	✓		
Outlook/attitude		✓		✓	✓	✓	✓	✓	✓
Life-long learning			✓		✓				✓
Faith			✓	✓	✓	✓	✓		
Social									
Social support	✓	✓	✓	✓	✓		✓		✓
Financial security		✓	✓	✓	✓	✓		✓	✓
Community engagement			✓	✓	✓	✓	✓	✓	✓
Overlap									
Independence	✓	✓	✓	✓	✓				✓

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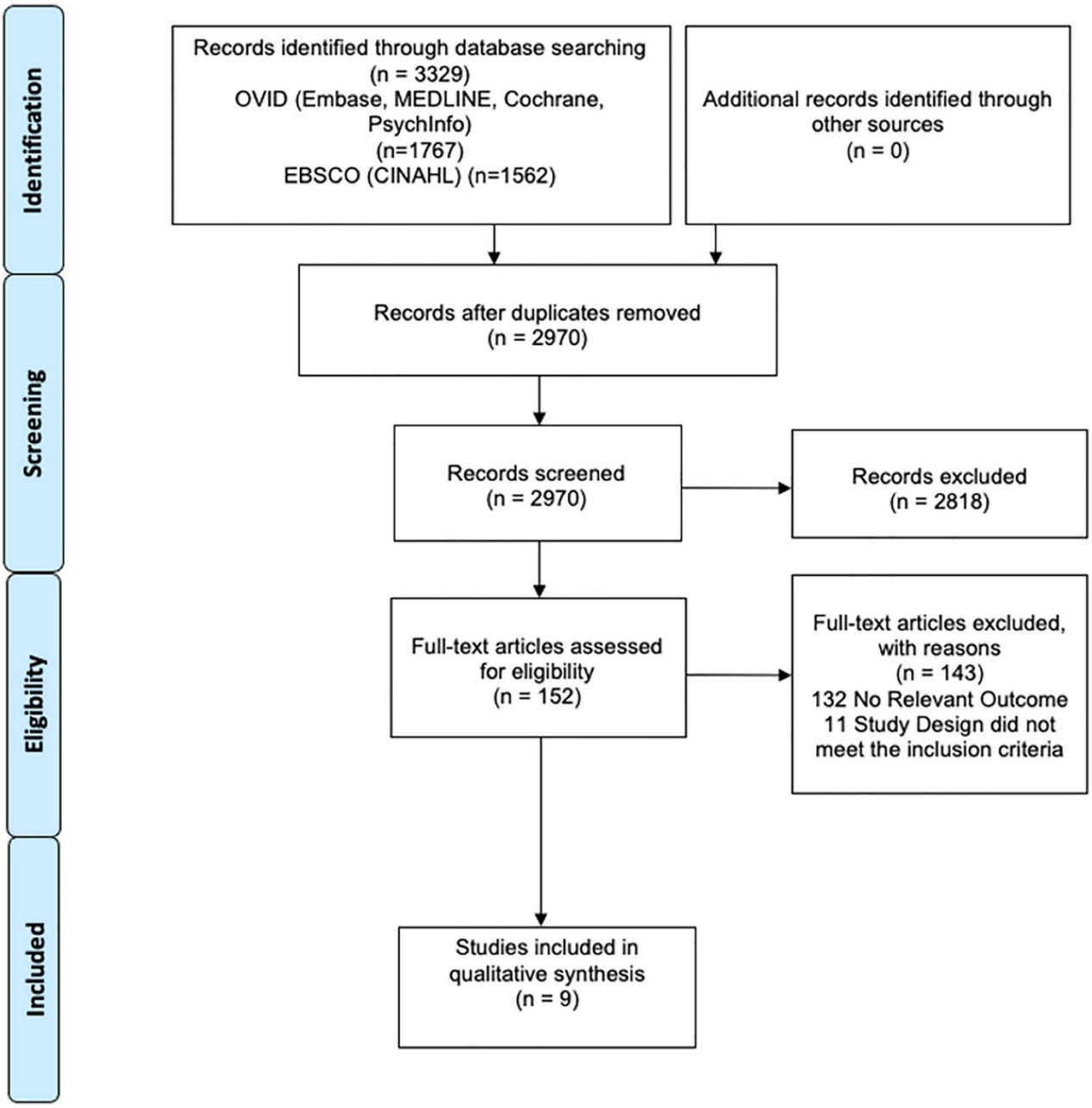
452 **Fig. 1.** PRISMA 2009 Flow Diagram



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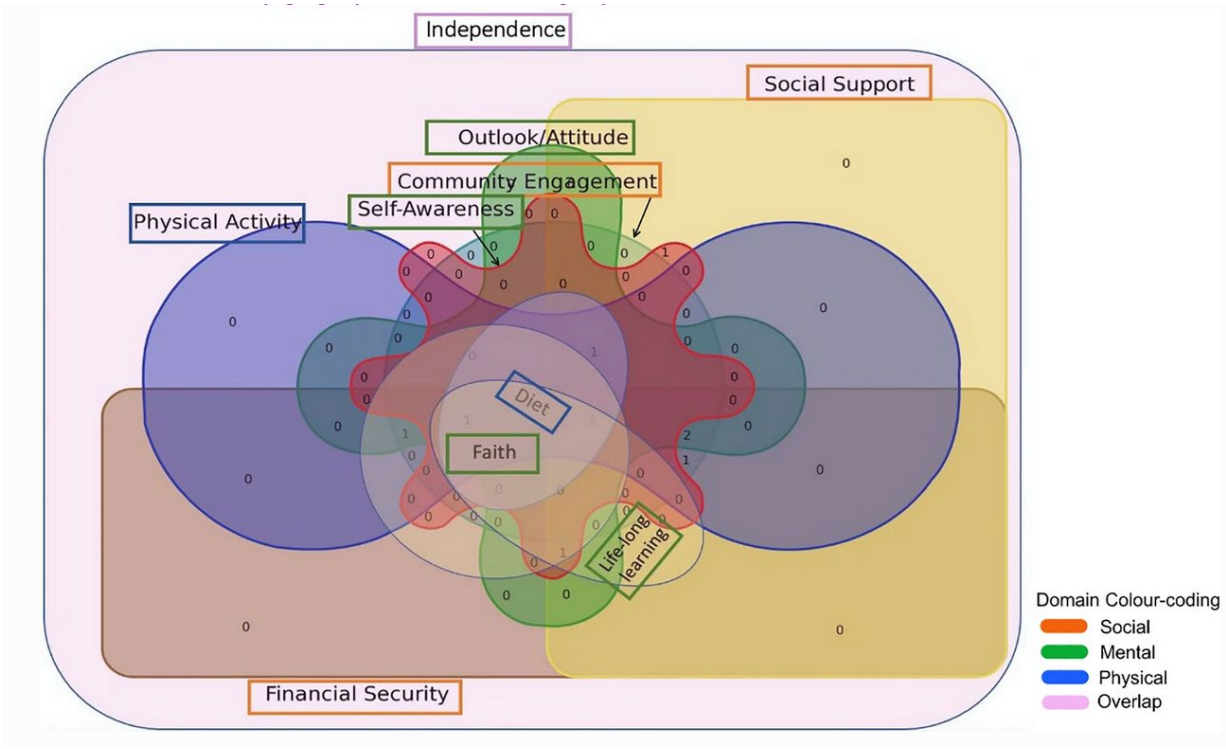

Fig. 2. Pictorial representation of determinants of healthy ageing. 0: no shared studies, 1: one shared study, 2: two shared studies. There are ten shapes, each representing a determinant. The border of the label of each shape is colour-coded according to the domain they correspond to. The numbers within each shape overlap represents how many studies included that combination of determinants. Venn diagram created using Bioinformatics and Evolutionary Genomics (http://bioinformatics.psb.ugent.be/cgi-bin/liste/Venn/calculatevenn.htpl).

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Supplementary Material

Supplementary Table 1. PRISMA 2020 Checklist Outcomes

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 4
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 5
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 5-6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 6
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 6-7
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 6-7
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A

Section and Topic	Item #	Checklist item	Location where item is reported
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Page 7
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Pages 6-7
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Pages 6-7
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 7 Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 7
Study characteristics	17	Cite each included study and present its characteristics.	Page 9 Table 1 Figure 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 7-8
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Table 1
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	N/A
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Page 8
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Page 7-8
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 15
	23b	Discuss any limitations of the evidence included in the review.	Page 17

Section and Topic	Item #	Checklist item	Location where item is reported
	23c	Discuss any limitations of the review processes used.	Page 17
	23d	Discuss implications of the results for practice, policy, and future research.	Page 18
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	N/A
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	N/A
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 19
Competing interests	26	Declare any competing interests of review authors.	Page 19
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	N/A

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Supplementary Table 2 (S1). CASP Checklist

Section A: Are the results valid?	**Ploughman et al. (2012)[19]**	**Thanakwang et al. (2014)[14]**	**Amosun et al. (2018)[21]**	**Lucas et al. (2018)[15]**	**Chen et al. (2019)[16]**	**Hui Chian Teh et al. (2019)[20]**
Was there a clear statement of the aims of the research?	(+)	(+)	(+)	(+)	(+)	(+)
Is a qualitative methodology appropriate?	(+)	(+)	(+)	(+)	(+)	(+)
Was the research design appropriate to address the aims of the research?	(+)	(+)	(+)	(+)	(+)	(+)
Was the recruitment strategy appropriate to the aims of the research?	(+)	(+)	(+)	(+)	(+)	(+)
Was the data collected in a way that addressed the research issue?	(+)	(+)	(+)	(+)	(+)	(+)
Has the relationship between researcher and participants been adequately considered?	?	?	?	?	?	(+)
Section B: What are the results?						
Have ethical issues been taken into consideration?	(+)	(+)	(+)	(+)	(+)	(+)
Was the data analysis sufficiently rigorous?	(+)	(+)	(+)	(+)	(+)	(+)
Is there a clear statement of findings?	(+)	(+)	(+)	(+)	(+)	(+)
Section C: Will the results help locally?						
How valuable is the research?	(+)	(+)	(+)	(+)	(+)	(+)

Supplementary Table 3 (S2).. Critical Appraisal using Newcastle-Ottawa Score (NOS) adapted for cross-sectional studies.

	Selection				Comparability	Outcome		Max of 10
Study	**Representativeness of the sample**	**Sample size**	**Non-respondents**	**Ascertainment of the exposure**		**Assessment of outcome**	**Statistical test**	
Hyun Cha et al. (2012)[13]	*	*		**	**	*	*	8
Wallack et al. (2016)[17]	*	*	*	**	**	*	*	9
Robleda et al. (2017)[18]	*	*		**	**	*	*	8

Derived Frameworks and Categorisation into Domains

We collated all the determinants of each framework into an excel table. We subsequently grouped the determinants into three domains (physical, mental, social) based on the commonalities and how they were described. Due to the variability of terms used in each study to define the healthy ageing determinants, two researchers (TA, GK) independently assessed the studies and agreed on which determinants could be categorised under each of the three domains. The classification was dependent on which domain each determinant best represented. For example, faith was deemed to be a mental well-being determinant because when used in the studies it was predominantly related to how it impacted the individual's mental state, rather than as a method to aid their social interaction. It is worth noting that previous studies have used different terminologies to define determinants (e.g., assets, factors, predictors, themes). For the purpose of this study the term determinants was used consistently. By exploring applicable ways to identify healthy ageing, we mapped existing healthy ageing frameworks and established their determinants.