

A Multidimensional Model of Healthy Ageing: Proposal and Evaluation of Determinants Based on a Population Survey in Ecuador.

María Fernanda Rivadeneira (✉ mfrivadeneirag@puce.edu.ec)

Pontificia Universidad Católica del Ecuador

María José Mendieta

University of Basel

Jessica Villavicencio

Pontificia Universidad Católica del Ecuador

José Caicedo

Pontificia Universidad Católica del Ecuador

Patricio Buendía

Pontificia Universidad Católica del Ecuador

Research Article

Keywords: Healthy ageing, Quantitative research methods, Multidimensional approach, Cross-sectional study

Posted Date: March 11th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-280664/v1>

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Abstract

Background: Healthy ageing is a complex construct, which involves multiple dimensions. The objective of this study was to design a multidimensional model of healthy ageing and to identify its determinants from national data in Ecuador.

Methods: A cross-sectional analytical study was carried out from the National Survey of Health and Well-being of the Older Adult, 2010. Sample was 1797 adults aged 65 years or more (sample expanded to 898,152). A multidimensional model was designed based on the domains involved in the concept of healthy ageing from the World Organization Health's approach, and the environment dimension. For the analysis, two groups were created per bi-stage cluster: healthy ageing and less healthy ageing. The probability of belonging to the healthiest group was analyzed with bivariate and multivariate logit for complex samples.

Results: The 53.15% of the sample was classified in the healthy ageing group. Women and the poorest older adults are less likely to be in the healthy ageing group (OR 0.58; CI 95% 0.464 - 0.737; OR 0.44; CI 95% 0.343 - 0.564). Older adults with secondary education or higher, who consider their health as excellent and who are satisfied with their life have a greater probability of being in healthy ageing (OR 2.61; 95% CI 1.586 - 4.309; OR 28.49; 95% CI 3.623 - 224.02; OR 0.23; 95% CI 0.165 - 0.341).

Conclusions: The model of healthy ageing addresses multidimensional variables which are summarized in three components: the intrinsic capacity, referring to the physical and mental health, the social and political environment, and the interaction of the elderly with the environment. It was found that the poorest older adults and women are less likely to belong to the healthiest group. Healthy aging plans must focus on socioeconomic conditions and gender equity.

Background

The ageing of the population represents a challenge for the health and social care systems. Globally, the number of people over 60 has increased alarmingly in the last 30 years [1]. It is expected that by 2030, the number of older people will exceed the number of children under the age of ten, while by 2050 they will be more numerous than the adolescent population [1]. Interventions aimed at preventing diseases and disabilities have proven to be cost-effective over time [2], so promoting healthy ageing in the population is appointed as the best strategy. However, at present there is no consensus around its conceptualization, or the indicators that should be considered when evaluating the effectiveness of interventions aimed at promoting healthy ageing [3].

The *healthy ageing* term is not a novel construct. It has been used at academic and political levels to make a distinction between ill and not ill older adults [3, 4]. By using four operational definitions of healthy ageing based on adaptations of the Rowe and Kahn definition of successful ageing, *McLaughling et al.* identified a prevalence of healthy ageing in the United States population ranging from 3.3–35.5%. The authors highlighted that the large variation in the prevalence was the consequence of using rigid criteria, suggesting to give greater importance to the presence of symptomatic disease or the impact that it has on the functional status of the older person [4]. Similar findings were reported by *Rodriguez et. al*, who estimated that the prevalence of healthy aging in the Spanish population varies from 4.5–49.2% depending on the criteria used to define it [3]. In 2015, the World Health Organization (WHO) defined healthy ageing as "the process of promoting and

maintaining functional capacity that allows well-being in old age." [5]. It is based on the interrelation between the intrinsic capacity of a person and their environment, understood as the factors of the outside world. This environment includes factors ranging from an individual level such as the interpersonal relationships, values and attitudes, to a more service and system level that includes the built environment, access to services and social and health policies [5].

The aim of this study was to develop a multidimensional model of healthy ageing and identify the determinants associated with healthy aging, based on data from a national survey from Ecuador.

Design And Methods

Analytical cross-sectional study with a secondary database from the National Survey of Health and Well-being of the Older Adult (SABE, 2010). The SABE survey was carried out with the objective of identifying the health and nutrition conditions of people over 60 years of age in Ecuador. The sampling was random probabilistic and three-stage proportional to the size of the population, with a representativeness at the level of region (Coast and Sierra) and area (urban and rural) [6]. For the analysis of this study, we used the data of people of 65 years and over from the subsample of the SABE. Survey data is available online at: <https://anda.inec.gob.ec/anda/index.php/catalog/292>.

Domains of the Healthy Ageing model

A healthy ageing model was developed based on the WHO concept of healthy ageing [5] and environment characteristics. Three components were considered: intrinsic capacity, environment and older person-environment interaction (Table 1). To determine the intrinsic capacity, we considered six domains: physiological and metabolic health, geriatric syndromes, risk factors, physical capacity, cognitive capacity and psychological well-being were considered. We considered the social well-being and the access of the older person to socio-sanitary policies and services as domains of the environment. In addition, the interaction of the older person with their environment was measured by considering their participation in the community and the transfer and reception of help.

Table 1

Components, domains and concepts of the healthy Ageing model for the older population in Ecuador

Healthy ageing components	Domains	Concept
<i>Intrinsic capacity</i>	<i>Physiological and metabolic health</i>	Absence of the following diagnoses: arterial hypertension, diabetes, cancer, chronic lung disease, cardiovascular disease, cerebrovascular disease, arthritis, rheumatism, osteoporosis and osteoarthritis; or the presence of these diseases, but they are under treatment or they do not limit the functional status of the older person
	<i>Geriatric syndromes</i>	Absence of polypharmacy [7], urinary and fecal incontinence [8–10] and falls [11–12].
	<i>Risk factors</i>	Absence of risk factors for cardiovascular disease such as blood pressure > 150/90, fasting glucose \geq 126, obesity (body mass index, [BMI] \geq 30), alcohol consumption more than 1 day a week, current and past tobacco use, physical activity and hypercholesterolemia according to Adult Treatment Panel III (ATP-III) [13].
	<i>Physical capacity</i>	A score of 6 out of 7 to the following: stand with the feet together keeping eyes open, stand with the heel of one foot in front of the other foot, stand on one foot without leaning or hold onto anything, feel able to get up quickly from the chair five times, get up quickly from the chair five times, feel able to get up from the chair with the arms on the chest five times, and get out of the chair with the arms on the chest five times [3]. In addition, the absence of disability was determined according to the Katz activities of daily living (ADL) test [14].
	<i>Cognitive ability</i>	Absence of dementia and cognitive deficit. Cognitive ability was obtained from the modified mini-mental assessment. A score \geq 14 was used as a cut-off point for the absence of cognitive deficit [15].
	<i>Psychological well-being</i>	Absence of physical, sexual or psychological abuse was obtained by directly asking the older person. For assessing depression, the Yesavage geriatric depression scale in its short version was used, with a cut-off point \leq 4 [16–18].
<i>Environment</i>	<i>Social welfare</i>	Absence of negligence, and economic violence. Social risk was determined by using the Gijón Scale, where a score of \leq 9 was defined as a good / acceptable social situation [19].
	<i>Political environment</i>	An older person beneficiary of social security, or receiving a non-contributory pension, and have access to health services, as well as recipients of support from different institutions
<i>Older person-environment Interaction</i>	<i>Participation in the community</i>	An older person participating in recreational activities, and acting as volunteer in an institution or organization in the community at least once a month [20].
	<i>Recipient or provider of support</i>	An older person receiving or providing support from children, siblings and other family or friends.

We selected a number of variables from the SABE Survey for each domain (Additional file 1). The selection of variables was done using the experience of previous studies focused on determining the prevalence of healthy ageing, as well as the expertise of the researchers [3, 4].

Statistical analysis

For the analysis, two theoretical *groups* were defined *a priori*: healthy ageing and less healthy ageing (Additional file 1). We used a bi-stage cluster descriptive analysis methodology to group older people by similar characteristics, with the assumption that the variables of each domain presented a multinomial distribution.

At first, the domains were divided into intra-domain categories according to compliance with the theoretical model, where the highest number reflects a better health status with respect to each domain (Additional file 2). Next, people were grouped into two clusters according to the similarity of their inter-domain categories. In addition, the characteristics of each group were compared, standardizing to the maximum score of ten to all domains. With the means of the domains for each cluster, a radar graph was made that shows better scores for cluster 1 than for cluster 2 (p value < 0.05), except in the domain of risk factors where the groups converge, the only single domain with a non-significant mean difference (Fig. 1). Finally, from the categories of the two groups, a bivariate logit model was performed for complex samples with an expansion factor available in the national database of SABE. Belonging to one or another cluster was used as a binary dependent variable. Then, with the significant variables ($p < 0.05$), a multivariate logit was performed for complex samples. Explanatory variables were: age, sex, area of residence, level of education, perceived health status, perceived life satisfaction, and poverty by income level. Statistical programs STATA ® version 15.1, and SPSS ® from IBM ® version 25 were used for the statistical analysis.

Results

The sample was delimited to 1797 observations, corresponding to 898,152 adults aged 65 or over, after applying the expansion factor. The 56.65% were women and 43.35% men. More than half of the individuals in the sample were in the range of 65 and 74 years (58.47%). Complete information on the demographic characteristics of the older population of Ecuador is detailed in Table 2.

Table 2
Demographic and socio-economic characteristics, older adults included in the study. National SABE-Ecuador survey, 2010–2011.

Variable	Frecuency (n°)	Percentage (%)
Gender		
Woman	508876	56.66
Man	387285	43.12
Missing values	1991	0.22
Age		
65–74 years	475053	52.89
75–84 years	261416	29.11
85 years or more	76046	8.47
Missing values	85637	9.53
Area		
Urban	584700	65.1
Rural	313452	34.9
Missing values	0	0
Ethnic self-identification		
Mestizo	575297	64.05
White	118342	13.18
Indigenous	93643	10.43
Mulatto	30569	3.4
Afro ecuadorian	30171	3.36
Other	12600	1.4
Missing values	37529	4.18
Level of education		
None	15181	1.69
Literacy center	19632	2.19
Kinder Garden	2745	0.31
Primary	503793	56.09
High school	82704	9.21
College		

Post graduate Variable	Frecuency (n°)	Percentage (%)
Missing values	23778	2.65
	2254	0.25
	248065	27.62

The bi-stage cluster analysis determined two clusters with similar internal characteristics, cluster 1: healthy ageing and cluster 2: less healthy ageing; cluster 1, grouped 53.15% of the sample, and cluster 2, 46.85%. Table 3 describes the characteristics of these groups. The healthy ageing group showed a higher proportion of men than women (60.74% vs 47.54%, respectively), younger older adults (57.41% between 65 to 74 years vs 31.18% of 85 years and older), older adults living in urban areas (55.74%) rather than in rural areas (47.47%), mestizos (56% vs 35% of indigenous) and older adults with higher education (89.62% with college vs 41.07% without formal education). Regarding to their perceived health status, the 91.46% of older people who consider their health as excellent were in the healthy ageing group, and the 58.62% who were satisfied with their life. In the healthy ageing group, 61.7% of the older adults weren't poor.

Table 3

Socio-demographic characteristics for healthy and less healthy ageing. National Base SABE-Ecuador, 2010–2011.

Variable	Clúster 1 – Healthy ageing (n)	Percentage	Clúster 2 Less healthy ageing (n)	Percentage
Gender				
Man	200574	60.74	129623	39.26
Woman	205012	47.54	226230	52.46
Age				
65–74 years	239846	57.41	177899	42.59
75–84 years	117437	51.29	111549	48.71
85 years or more	16204	31.18	35773	68.82
Area				
Urban	292002	55.74	231828	44.26
Rural	113750	47.47	125850	52.53
Ethnicity				
Mestizo	280883	56.00	220681	44.00
White	53999	51.47	50923	48.53
Indigenous	23955	35.02	44451	64.98
Afro ecuadorian	15452	64.69	8436	35.31
Mulatto	14900	56.64	11408	43.36
Other	4367	38.50	6977	61.50
Level of education				
None	4903	41.07	7036	58.93
Literacy	4522	26.01	12862	73.99
Kinder garden	1212	44.15	1533	55.85
Primary	240836	54.82	198513	45.18
High school	58032	76.03	18293	23.97
Bachelor	1717	100.00	0	0.00
College	18143	89.62	2102	10.38
Post Graduate	2254	100.00	0	0.00
¹ Income poverty = income less than USD 1.90 per day.				

Variable	Clúster 1 – Healthy ageing (n)	Percentage	Clúster 2 Less healthy ageing (n)	Percentage
Gender				
How do you consider your health				
Excellent	7180	91.46	670	8.54
Very good	14484	76.54	4440	23.46
Good	117367	73.79	41697	26.21
Regular	224147	53.24	196861	46.76
Bad	42574	27.33	113200	72.67
Are you satisfied with your life				
Yes	373827	58.62	263883	41.38
No	30986	25.18	92084	74.82
Income poverty ¹				
No	272076	61.67	169120	38.33
yes	133676	41.48	188558	58.52
¹ Income poverty = income less than USD 1.90 per day.				

Table 4 shows the results of the bivariate and multivariate analysis for healthy ageing. A woman was less likely to belong to the healthy ageing group, compared to men (OR 0.58; 95% CI 0.46–0.74), this association remained significant in the multivariate analysis (OR 0.69; 95% CI 0.48–0.93). With regard to age, the group over 85 years of age was less likely to be in the healthy ageing group compared to people between 65 and 74 years of age (OR 0.33; 95% CI 0.21–0.55); this association remained significant in the multivariate analysis (OR 0.24; 95% CI 0.14–0.41). An older adult living in rural areas was less likely to be in the healthy ageing group (OR 0.71; C.I. 95% 0.54–0.95); this association lost significance in the multivariate analysis. An older adult with secondary education or higher had 2.61 times the probability of being in the healthy ageing group (95% CI 1.59–4.31), compared with primary education, and this association remained significant in the multivariate analysis (OR 2.22; 95% CI 1.16–4.23). An older adult who considered their health as excellent had a greater probability of being in the healthy ageing group, compared to those who considered their health as poor (OR

28.49; CI 95 % 3.62–224.02). Those who were not satisfied with their lives were less likely to be in the healthy ageing group (OR 0.23; I.C. 95% 0.17–0.34). Older adults within the limits of poverty were less likely to be in the healthy ageing group (OR 0.44; CI 95% 0.343–0.564). These variables maintained their significant association in the multivariate analysis (OR 14.39 I.C. 95% 2.92–70.82; OR 0.30 I.C. 95% 0.19–0.49; OR 0.61 I.C. 95% 0.42–0.89) (Table 4).

Table 4

Association between healthy ageing with sociodemographic variables. SABE-Ecuador national base, 2010–2011.

Variable	Bivariate analysis			Multivariate analysis		
	Odds Ratio	IC 95%	Value p	Odds Ratio	IC 95%	Value p
Gender						
Man	Reference			Reference		
Woman	0.58	0.46–0.78	0.00**	0.69	0.48–0.93	0.01*
Age						
65–74 years	Reference			Reference		
75–84 years	0.78	0.58–1.05	0.09	0.88	0.59–1.30	0.53
85 years or more	0.33	0.21–0.55	0.00**	0.24	0.14–0.42	0.00**
Area						
Urban	Reference			Reference		
Rural	0.71	0.54–0.95	0.02*	0.98	0.67–1.47	0.92
Ethnicity						
Mestizo	Reference			Reference		
Indigenous	1.43	0.72–2.86	0.29	1.06	0.41–2.77	0.91
Afro ecuadorian	1.02	0.48–2.16	0.95	1.28	0.47–3.51	0.63
Mulatto	0.83	0.55–1.13	0.39	0.63	0.39–1.01	0.06
White	0.42	0.27–0.67	0.00**	0.69	0.34–1.39	0.29
Other	0.49	0.19–1.27	0.14	0.29	0.08–1.04	0.06
Level of education						
Primary	Reference			Reference		
None	0.57	0.19–1.72	0.32	0.49	0.14–1.65	0.25
Literacy	0.28	0.11–0.76	0.01	0.28	0.10–0.78	0.02
Kinder gander/ primary	0.65	0.06–7.10	0.72	0.66	0.06–6.71	0.73
High school	2.61	1.57–4.31	0.00**	2.22	1.16–4.23	0.02*

¹ Income poverty = income less than USD 1.90 per day

*Value p significant < 0.05

**Value p significant < 0.01

	Bivariate analysis			Multivariate analysis		
College / post graduate	7.11	2.16–23.39	0.00**	2.85	0.79–10.19	0.11
How do you consider your health						
Bad	Reference			Reference		
Excellent	28.49	3.62–224.03	0.00**	14.39	2.92–70.83	0.00**
Very good	8.67	3.43–21.93	0.00**	7.62	1.64–35.44	0.01*
Good	7.48	5.01–11.17	0.00**	6.61	3.76–11.63	0.00**
Regular	3.02	2.18–4.19	0.00**	3.76	2.50–5.67	0.00**
Are you satisfied with your life						
Yes	Reference			Reference		
No	0.23	0.17–0.34	0.00**	0.3	0.18–0.49	0.00**
Income poverty ¹						
No	Reference			Reference		
Si	0.44	0.34–0.56	0.00**	0.61	0.42–0.89	0.01*
¹ Income poverty = income less than USD 1.90 per day						
*Value p significant < 0.05						
**Value p significantt < 0.01						

Discussion

The efforts for associating a positive concept to the ageing process is not a recent endeavor. In the 44th century BC, Cicero described ageing as a time of opportunities for positive change and productive functioning, while in the 1940s the use of the *successful ageing* concept was linked to the first attempts to develop indicators to determine the degree of satisfaction with life by the American Social Science Research Council [20]. Later, in 1961, Havighurst adopted it, describing the *successful ageing* as an adaptive theory and a testable experience [21]. This term was popularized by Rowe and Kahn, which concentrated on differentiate "usual or normal" ageing from "successful" ageing. These authors developed the *successful ageing* concept to encompass older adults who have a low probability of disease and disability, high physical and cognitive capacity and an active commitment to life [22]. However, this conceptualization has been widely criticized for its restrictive nature [23]. In addition, this conceptualization of successful ageing neglects the effect of the sociocultural context and the older population's opinion of their own ageing experience and overestimates the role of individual behavior [3–4, 20, 22].

Other attempts to describe the ageing process from a positive perspective have been done in the European Region. In 2002, the concept of *active ageing* was introduced with the aim of influencing the determinants of ageing related to socio-health systems and the environment [24]. "Active" was defined as a continuous participation in social, economic, cultural, spiritual and civic aspects and not only the ability to stay physically active or participate in the workforce [24]. But this model has not been validated either. Paúl et al., demonstrated that most of the determinants of this model were not independent [25]; while Bélanger et al. concluded that the active ageing concept could be considered as a human rights policy orientation rather than an empirical measurement tool [26]. Likewise, other authors have pointed out the risk of discrimination that exists when idealizing the concept of active ageing, as a status that all the older population should reach [24].

The interest in demonstrating that the ageing process isn't homogeneous is not a novel concern. By using different conceptualizations, many researchers have tried to describe the differences among those who age in better conditions and those who don't. The huge differences found by McLaughling *et al.* and Rodriguez-Laso *et al.* in the prevalence of healthy ageing in the United States and Spanish population, respectively, highlighted the need to use a more comprehensive criteria to identify the older population who is ageing in a better condition [3–4]. The present study contributes with a novel multidimensional model to assess the healthy ageing at population level, using a less rigorous definition, based on the WHO concept of healthy ageing [5] and environment components.

The domains considered for the multidimensional model offer a more comprehensive view of healthy aging; includes the following components: a) intrinsic capacity, which integrates elements of the physical and mental health, such as geriatric syndromes, risk factors, physiological and metabolic health, cognitive function, physical capacity, and psychological well-being, b) social and political environment, and c) the interaction of the older adult with their environment. These components, in turn, determine the functional capacity of the older adult (Fig. 2). This comprehensive model breaks the paradigm that healthy is equal to the absence of physical illness.

According to this model, in Ecuador, slightly more than half of the older population is ageing healthily (53.15%). This result is above the data reported in the United States and Spain [3–4]. This can be explained partly due to the sociodemographic differences of the older adults included in the different studies, but particularly by the healthy ageing model applied in the present investigation. In our model, the intrinsic capacity of an older person was not limited to the absence of a disease or risk factors. As previous studies have shown that, despite physical limitations and structural obstacles, older people can be considered successful or active, given the compensation process they go through as they age [25, 27].

An interesting finding after the bi-stage cluster analysis is the similarity of the two groups, healthy and less healthy, in the domain of risk factors. This behavior could show that, there are other elements that influence in the healthy ageing. Previous research has demonstrated that certain risk factors such as: obesity, sedentary lifestyle, smoking, alcohol consumption, have a great impact on the ageing process; but other elements, including demographic, epidemiological geographical, or economic situation, could affect how each person ages [28].

When analyzing the characteristics of the healthy ageing and less healthy ageing groups, the differences by sex stand out. This could be explained by the association described between high levels of multimorbidity

and female sex, where older women show a worse health status when compared to men of the same age [29]. Yet, other authors have pointed out that this association is more linked to age than sex, since it has been seen that after the age of 80 the differences in health status by sex are reduced [30–31]. In our study, the association between less healthy and female sex was maintained after adjusting for age and other variables, which points to gender inequalities in the way of aging.

Other variables that were associated with healthy aging were age, educational and economic level. A positive association between age and the presence multimorbidity and disability has been widely recognized [30, 32]. Several studies have shown that the level of education of an older person is associated with the level of understanding of health issues, access to health services and adherence to medical treatments. [33–37].

According to our data, older adults in the worst economic situation are less likely to be in the healthy ageing group, making them a highly vulnerable group. There is vast evidence of the association between a low socioeconomic level and poorer physical and mental health in older adults, as a consequence of exposure to a greater number of risk factors, anxiety, and less access to health services in younger ages [38–40]

In the present study, no significant difference was found between living in an urban or rural area. The combination of an unfavorable external environment for the older population, as well as personal poverty increase their risk of having a poor physical, psychological and mental health status, social isolation, and higher risk of death [5, 41–42]. For this reason, the limitations of the environment, and not simply the place of residence, could be a more important factor to consider when defining whether an older person is ageing in a healthy way or not.

In addition, the self-perception that older adults have about their health, life and mood is important. In our study, the majority of older adults who had a positive perception of their health were categorized in the healthy ageing group. This may be because the healthy ageing group includes people with the best intrinsic ability and a suitable environment that responds to their needs. This is what is known as the “disability paradox” [43]. The well-being and satisfaction for a person, even in physiological conditions or severe disability, is explained by their ability to adapt to their condition, and the balance achieved between their intrinsic capacity and the environment [43–44].

We have some limitations in this study. The use of secondary source data restricted the model to existing variables to determine the domains. The absence of a unified and operational definition of healthy ageing makes a direct comparison between studies impossible. It would be important replicated this study in different populations, to obtain a better understanding of the proposed healthy ageing model. This study have some strengthens. It contributes to the methodological discussion on healthy aging and proposes a multidimensional model for its measurement and comparison between countries. To the knowledge of the authors, the use of a definition of healthy ageing based on ten domains, which consider not only the intrinsic capacity of the person, but also their environment and their interactions with it, has not been described in previous studies. Some studies have reported the ability of the older adult population to adapt to their new conditions, so qualify a person based on the presence or absence of a disease, without taking into account whether or not it affects their functionality in life daily, it is inappropriate. The model applied in this study contributes not only to understanding the heterogeneity of ageing, but also to identifying the group of older adults who need to be prioritized in public policies. This evidence suggests the importance of healthy aging

policies focused on improving socioeconomic conditions and reducing gender inequalities. On the other hand, it would be important that this study can be replicated in countries with different characteristics, to corroborate the proposed multidimensional healthy ageing model.

Conclusion

The model of healthy ageing addresses multidimensional variables in nine domains, which are summarized in three components: the intrinsic capacity, referring to the physical and mental health, the social and political environment, and the interaction of the elderly with the environment. This model conceptualizes healthy aging in a comprehensive way and can be replicated in other contexts. The model also discriminates between a healthier and less healthy group. It was found that the poorest older adults and women are less likely to belong to the healthiest group, so healthy aging plans must focus on socioeconomic conditions and gender equity.

Abbreviations

ADL = activities of daily living

ATP-III = Adult Treatment Panel III

BMI = body mass index

OR = Odds ratio

95% CI = Confidence interval 95%

Declarations

Ethics approval and consent to participate

Secondary database study, does not require approval.

Consent for publication

Not applicable.

Availability of data and materials

The database for this study is publicly available at <https://anda.inec.gob.ec/anda/index.php/catalog/292>

Competing interests

The authors declare that they have no competing interests.

Funding

This research was funded by the Pontificia Universidad Católica del Ecuador, project code 082-UIO-2019.

Author's contributions

MR proposed the study and initial design. MM contributed to the theoretical conceptualization of the model. JC performed the statistical analysis. JV and PB contributed to the definition of variables and geriatric concepts. All the authors participated in the final design of the proposed ageing model. MM and MR wrote the main manuscript text, JC, JV and PB reviewed the manuscript and made important contributions.

Acknowledgements

Not applicable.

References

1. United Nations, Department of Economic and Social Affairs, Population Division. World Population Ageing 2017—Highlights. 2017.
https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf. Accessed 5 Jan 2021.
2. National Center for Chronic Disease Prevention and Health Promotion. The Power of Prevention: Chronic Disease. The Public Health Challenge of the 21st Century [Data set]. American Psychological Association. 2009. <https://doi.org/10.1037/e581002012-001>. Accessed 8 Jan 2021.
3. Rodriguez-Laso A, McLaughlin SJ, Urdaneta E, Yanguas J. Defining and Estimating Healthy Aging in Spain: A Cross-sectional Study. *The Gerontologist*. 2018;58(2):388–98.
4. McLaughlin SJ, Jette AM, Connell CM. An Examination of Healthy Aging Across a Conceptual Continuum: Prevalence Estimates, Demographic Patterns, and Validity. *The Journals of Gerontology Series A*. 2012;67(7):783–9.
5. World Health Organization (WHO). Informe mundial sobre el envejecimiento y la salud. WHO Press. 2015 http://apps.who.int/iris/bitstream/handle/10665/186466/9789240694873_spa.pdf?sequence=1. Accessed 5 Jan 2021.
6. Freire W, Rojas E, Pazmiño L, Fornasini M, Tito S, Buendía P, Waters W, Salinas J, Álvarez P. Encuesta Nacional de Salud, Bienestar y Envejecimiento. SABE I, Ecuador, 2009–2010. Quito: Ministerio de Inclusión Económica y Social - Programa Aliméntate Ecuador; 2010.
7. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. *BMC Geriatrics*, 2017;17(1):1-10.
8. Chong EC, Khan AA, Anger JT. The Financial Burden of Stress Urinary Incontinence Among Women in the United States. *Current Urology Reports*, 2011;12(5):358–62.
9. Ekelund P, Grimby A, Milsom I. Urinary incontinence. Social and financial costs high. *BMJ*, 1993;306(6888):1344.
10. Kessler M, Facchini LA, Soares MU, Nunes BP, França SM, Thumé E. Prevalence of urinary incontinence among the elderly and relationship with physical and mental health indicators. *Revista Brasileira de Geriatria e Gerontologia*, 2018;21(4):397–407.
11. Burns ER, Stevens JA, Lee R. The direct costs of fatal and non-fatal falls among older adults—United States. *Journal of Safety Research*, 2016;58:99–103.

12. Gazibara T, Kurtagic I, Kusic-Tepavcevic D, Nurkovic S, Kovacevic N., Gazibara T, Pekmezovic T. Falls, risk factors and fear of falling among persons older than 65 years of age. *Psychogeriatrics*, 2017;17(4):215–23.
13. Cleeman J. ATP III Guidelines At-A-Glance Quick Desk Reference. 2001.
14. Katz S, Downs TD, Cash HR, Grotz RC. Progress in Development of the Index of ADL. *The Gerontologist*, 1970;10:20–30.
15. Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 1975;12(3):189–98.
16. Anderson DN. Treating depression in old age: The reasons to be positive. *Age and Ageing*, 2001;30(1):13–17.
17. Yesavage JA, Sheikh JI. Geriatric Depression Scale (GDS): Recent Evidence and Development of a Shorter Version. *Clinical Gerontologist*, 1986;5(1–2):165–73.
18. Zis P, Daskalaki A, Bountouni I, Sykioti P, Varrassi G, Paladini, A. Depression and chronic pain in the elderly: Links and management challenges. *Clinical Interventions in Aging*, 2017;12:709–20.
19. Alarcón-Alarcón T, González-Montalvo JI. La Escala Socio-Familiar de Gijón, instrumento útil en el hospital general. *Revista Española de Geriatria y Gerontología*. 1998;33(3):175–79.
20. Bowling A. The Concepts of Successful and Positive Ageing. *Family Practice*, 1993;10(4):449–53.
21. Pruchno, R. Successful Aging: Contentious Past, Productive Future. *The Gerontologist*, 2015;55(1):1–4.
22. Rowe JW, Kahn RL. Successful aging. *The gerontologist*, 1997;37(4): 433-40.
23. Martinson M, Berridge C. Successful Aging and Its Discontents: A Systematic Review of the Social Gerontology Literature. *The Gerontologist*, 2015;55(1):58–69.
24. Foster L, Walker A. Active and Successful Aging: A European Policy Perspective. *The Gerontologist*, 2015;55(1):83–90.
25. Paúl C, Ribeiro O, Teixeira L. Active Ageing: An Empirical Approach to the WHO Model. *Current Gerontology and Geriatrics Research*, 2012.
26. Bélanger E, Ahmed T, Filiatrault J, Yu HT, Zunzunegui MV. An Empirical Comparison of Different Models of Active Aging in Canada: The International Mobility in Aging Study. *The Gerontologist*, 2017;57(2): 197–205.
27. Pruchno R, Carr D. Successful Aging 2.0: Resilience and Beyond. *The Journals of Gerontology: Series B*, 2017;72(2):201–203.
28. Wong R, Ofstedal MB, Yount K, Agree EM. Unhealthy lifestyles among older adults: Exploring transitions in Mexico and the US. *European Journal of Ageing*, 2008;5(4):311.
29. Violan C, Foguet-Boreu Q, Flores-Mateo G, Salisbury C, Blom J, Freitag M, Glynn L, Muth C, Valderas JM. Prevalence, Determinants and Patterns of Multimorbidity in Primary Care: A Systematic Review of Observational Studies. *PLoS ONE*, 2014;9(7):e102149.
30. Hu RH, Hsiao FY., Chen LJ, Huang, PT, Hsu WWY. Increasing age- and gender-specific burden and complexity of multimorbidity in Taiwan, 2003–2013: A cross-sectional study based on nationwide claims data. *BMJ Open*, 2019;9(6):e028333

31. Roberts KC, Rao DP, Bennett TL, Loukine L, Jayaraman GC. Prevalence and patterns of chronic disease multimorbidity and associated determinants in Canada. *Health Promotion and Chronic Disease Prevention in Canada: Research, Policy and Practice*, 2015;35(6):87–94.
32. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: A cross-sectional study. *The Lancet*, 2012;380(9836):37–43.
33. Baker DW, Wolf MS, Feinglass J, Thompson JA, Gazmararian JA, Huang J. Health Literacy and Mortality Among Elderly Persons. *Archives of Internal Medicine*, 2007;167(14):1503–9.
34. Bennett IM, Chen J, Soroui JS, White S. The Contribution of Health Literacy to Disparities in Self-Rated Health Status and Preventive Health Behaviors in Older Adults. *Annals of Family Medicine*, 2009;7(3):204–11.
35. Cho YI, Lee SYD, Arozullah AM, Crittenden KS. Effects of health literacy on health status and health service utilization amongst the elderly. *Social Science & Medicine*, 2008;66(8):1809–16.
36. Sudore RL, Mehta KM, Simonsick EM, Harris TB, Newman AB, Satterfield S, Rosano C, Rooks RN, Rubin SM, Ayonayon HN, Yaffe K. Limited Literacy in Older People and Disparities in Health and Healthcare Access. *Journal of the American Geriatrics Society*, 2006;54(5):770–6.
37. Toci E, Burazeri G, Jerliu N, Sørensen K, Ramadani N, Hysa B, Brand H. Health literacy, self-perceived health and self-reported chronic morbidity among older people in Kosovo. *Health Promotion International*, 2015;30(3):667–674.
38. Brinda EM, Rajkumar AP, Attermann J, Gerdtham UG, Enemark U, Jacob KS. Health, Social, and Economic Variables Associated with Depression Among Older People in Low and Middle Income Countries: World Health Organization Study on Global AGEing and Adult Health. *The American Journal of Geriatric Psychiatry*, 2016;24(12):1196–1208.
39. Gama D, Colombo D. Closing the gap in a generation: Health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health. *Revista de Direito Sanitário*, 2010;10(3):253-66.
40. Vaalavuo M. Deterioration in health: What is the role of unemployment and poverty? *Scandinavian Journal of Public Health*, 2016;44(4):347–53.
41. Mahmood A, Chaudhury H, Michael YL, Campo M, Hay K, Sarte A. A photovoice documentation of the role of neighborhood physical and social environments in older adults' physical activity in two metropolitan areas in North America. *Social Science & Medicine*, 2012;74(8):1180–192.
42. Zhang X, Dupre ME, Qiu L, Zhou W, Zhao Y, Gu D. Urban-rural differences in the association between access to healthcare and health outcomes among older adults in China. *BMC Geriatrics*, 2017;17(1):1-11.
43. Albrecht GL, Devlieger PJ. The disability paradox: High quality of life against all odds. *Social Science & Medicine*. 1999; 48(8): 977–88.
44. Kusumastuti S, Derks MGM, Tellier S, Di Nucci E, Lund R, Mortensen EL, Westendorp RGJ. Successful ageing: A study of the literature using citation network analysis. *Maturitas*, 2016;93:4–12.

Figures

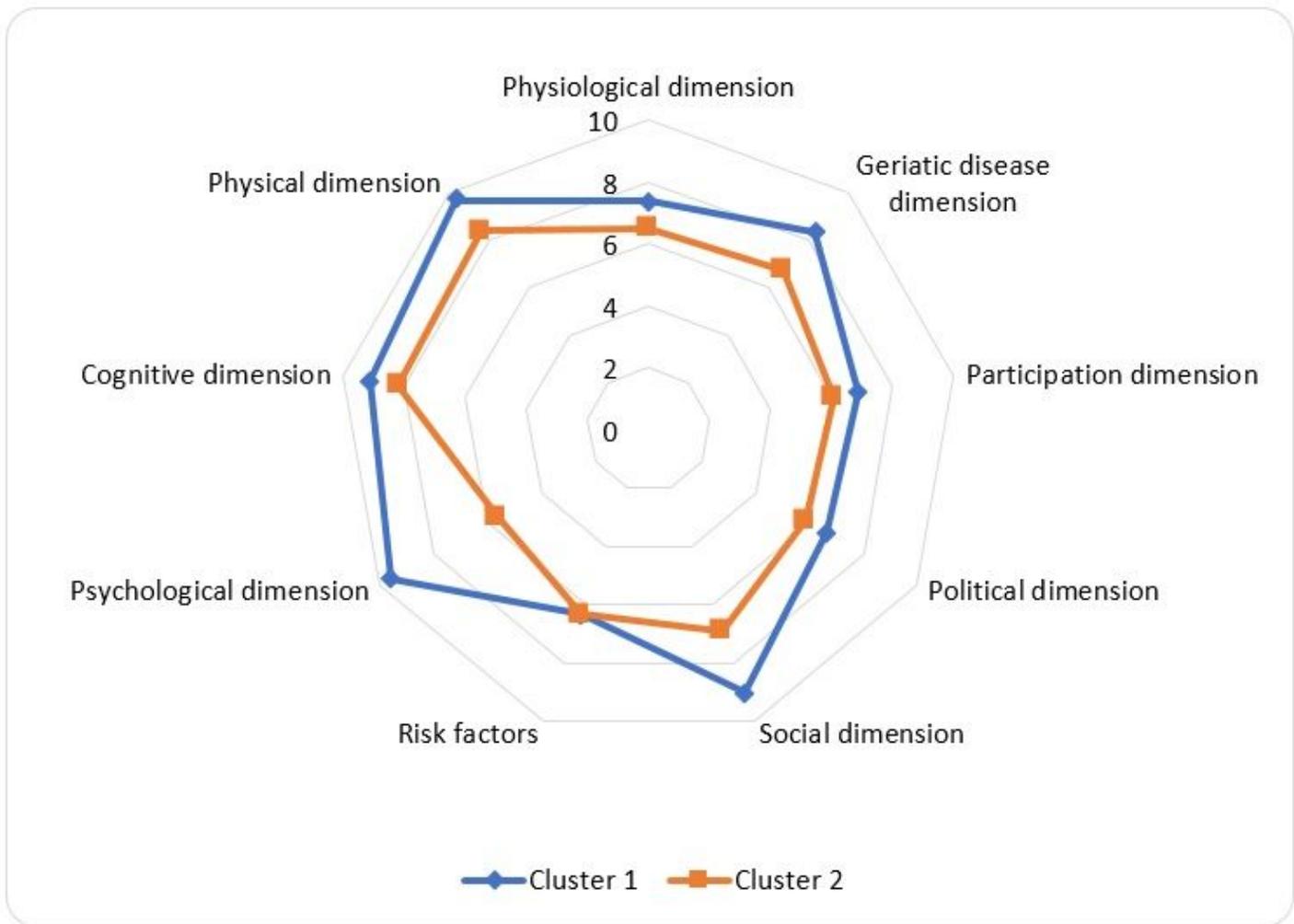


Figure 1

Radar chart showing two clusters with dimensions of the healthy ageing model. The graph presents two clusters: cluster 1 –in blue- “healthy”, cluster 2 –in red color-, “less healthy”. The number represents the health status of each dimension, the closer it is to 10, the better health status according to each dimension.

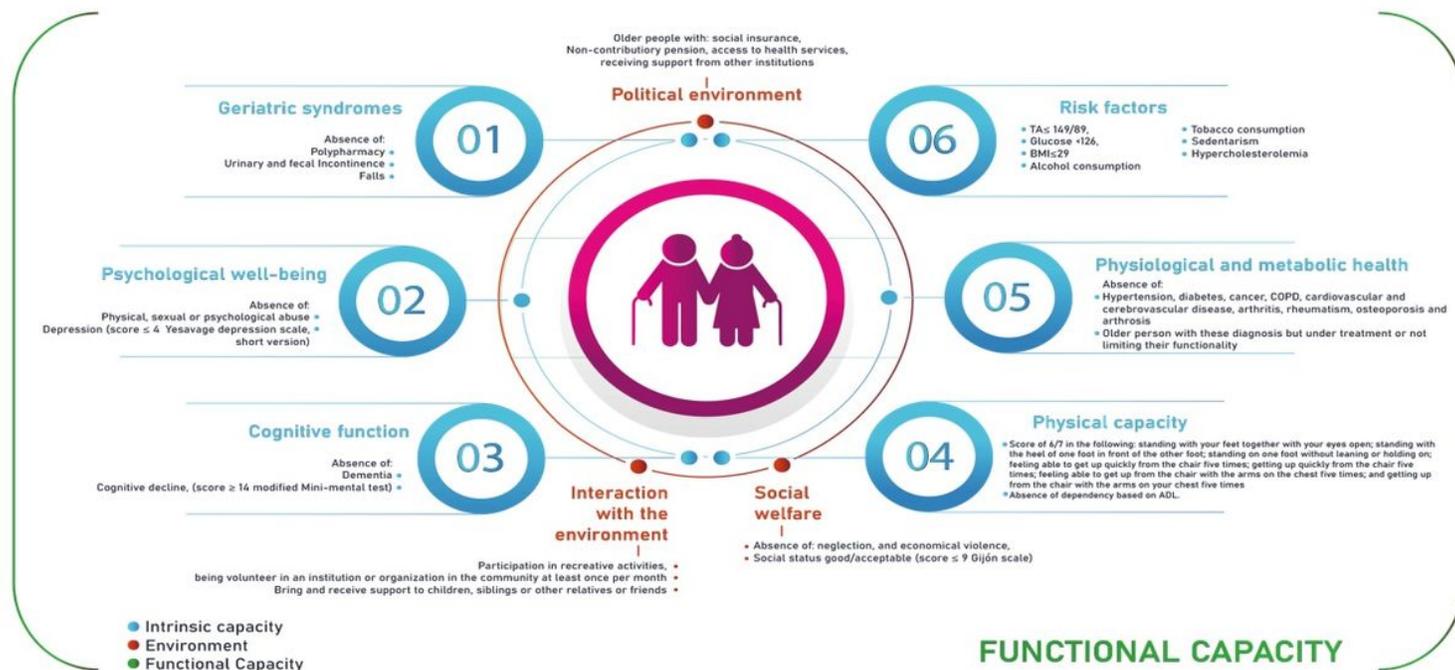


Figure 2

Multidimensional model of healthy ageing The graph summarizes the components of the proposed multidimensional model: a) intrinsic capacity [in blue] and b) environment [in red] and, c) interaction of the older adult with the environment [in red], which determine the functional capacity of the elderly [in green].

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