JAMDA xxx (2017) 1.e1–1.e7

JAMDA

journal homepage: www.jamda.com

Original Study

Development of a Healthy Aging Score in the Population-Based Rotterdam Study: Evaluating Age and Sex Differences

Loes Jaspers MD [a], Josje D. Schoufour PhD [a], Nicole S. Erler Dipl.-Stat [a,b], Sirwan K.L. Darweesh MD [a,c], Marileen L.P. Portegies MD, PhD [a,d], Sanaz Sedaghat PhD [a], Lies Lahousse PhD [a,e], Guy G. Brusselle MD, PhD [a,e,f], Bruno H. Stricker MD, PhD [a], Henning Tiemeier MD, PhD [a,g], M. Arfan Ikram MD, PhD [a], Joop S.E. Laven MD, PhD [h], Oscar H. Franco MD, PhD [a], Maryam Kavousi MD, PhD [a,*]

[a] *Department of Epidemiology, Erasmus University Medical Center, Rotterdam, The Netherlands*
[b] *Department of Biostatistics, Erasmus University Medical Center, Rotterdam, The Netherlands*
[c] *Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, MA*
[d] *Department of Neurology, Erasmus University Medical Center, Rotterdam, The Netherlands*
[e] *Department of Respiratory Medicine, Ghent University Hospital, Ghent, Belgium*
[f] *Department of Respiratory Medicine, Erasmus University Medical Center, Rotterdam, The Netherlands*
[g] *Department of Psychiatry, Erasmus University Medical Center, Rotterdam, The Netherlands*
[h] *Division of Reproductive Medicine, Department of Obstetrics and Gynecology, Erasmus University Medical Center, Rotterdam, The Netherlands*

Keywords:
Healthy aging
age differences
sex differences
mortality
longevity
epidemiology

A B S T R A C T

Objectives: To develop a healthy aging score (HAS), to assess age and sex differences in HAS, and to evaluate the association of the HAS with survival.
Design: Prospective population-based cohort.
Setting: Inhabitants of Ommoord, Rotterdam, The Netherlands.
Participants: A total of 1405 men and 2122 women, mean (standard deviation) age 75.9 (6.4) years.
Main measures: We included 7 domains in the total score of HAS: chronic diseases, mental health, cognitive function, physical function, pain, social support, and quality of life; each scored 0, 1, or 2 in each domain. A total score (range 0–14) was constructed and was assessed continuously and in tertiles (13–14: healthy aging, 11–12: intermediate aging, 0–10: poor aging). Sex-specific change in the mean HAS was computed for the age categories of 65–69, 70–74, 75–79, 80–84, and ≥85 years. The association between HAS and mortality was assessed with Cox proportional hazards models.
Results: Mean follow-up was 8.6 (3.4) years. Men had poorer scores in the chronic disease domain than women. However, women had poorer mental health, worse physical function, more pain, and lower quality of life compared with men. The prevalence of healthy aging was higher in men (n = 396, 28.2%), than in women (n = 526, 24.8%). The mean (standard deviation) HAS was 11.1 (2.2) in men and 10.7 (2.3) in women. Mean HAS was higher in men than in women for all age categories. The β for change in mean HAS across the 5 increasing age categories was −0.55 (−0.65 to −0.45) in men and −0.65 (−0.73 to −0.57) in women. The age-adjusted hazard ratio per unit increase in HAS with mortality was 0.86 (0.83–0.89) in men, and 0.89 (0.87–0.91) in women.

Oscar H. Franco and Maryam Kavousi contributed equally to this work.

The Rotterdam Study is funded by Erasmus MC and Erasmus University, Rotterdam, The Netherlands; The Netherlands Organization for Scientific Research (NWO); The Netherlands Organization for Health Research and Development (ZonMw); the Research Institute for Diseases in the Elderly (RIDE); the Ministry of Education, Culture and Science; the Ministry for Health, Welfare and Sports; the European Commission (DG XII); and the Municipality of Rotterdam. This study was sponsored and funded by Metagenics Inc. S.K.L.D. and M.A.I. received support from Stichting Parkinson-Fonds. L.L. is a Postdoctoral Fellow of the Research Foundation-Flanders (FWO). M.K. was supported by the AXA Research Fund. No funding source was involved in study design; collection, analysis, and interpretation of data; writing of the report; and decision to submit for publication. No funding source had the ability to veto publication of study results.

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: L.J. reports research support, and O.H.F. reports grants from Metagenics Inc, during the conduct of the study. L.L. reports personal fees from Boehringer Ingelheim GmbH, nonfinancial support from Novartis, grants from AstraZeneca, grants and nonfinancial support from European Respiratory Society, grants and nonfinancial support from Belgian Respiratory Society, outside the submitted work. J.S.E.L. reports grants from Ferring, Merck-Serono, MSD, Organon, Shering Plough, and Serono, during the conduct of the study. M.K. is supported by the AXA Research Fund, during the conduct of the study. J.D.S., N.S.E., M.L.P.P., S.S., G.G.B., B.H.S., and H.T. have nothing to disclose.

* Address correspondence to Maryam Kavousi, MD, PhD, Department of Epidemiology, Erasmus University Medical Center, Office NA-2905, Dr. Molewaterplein 50, PO Box 2040, Rotterdam 3000 CA, The Netherlands.
E-mail address: m.kavousi@erasmusmc.nl (M. Kavousi).

http://dx.doi.org/10.1016/j.jamda.2016.11.021

Conclusions: Levels of HAS were lower in women compared with men, in all age categories. The HAS declined with increasing age for both sexes, albeit slightly steeper in women. The HAS was strongly associated with mortality in both sexes. A better understanding of population healthy aging and sex differences in this regard could aid to implement strategies for sustainable healthcare in aging populations.

Our population is aging.[1,2] Between 2008 and 2040, the proportion of people aged 65 years and older is projected to increase from 7% (506 million) to 14% (1.3 billion) of the world's population.[3] In addition, the number of oldest old (aged 80 years and over) is expected to increase by 233% in this time period.[3] This demographic shift can be explained by better living standards and improvements in both preventive and curative healthcare.[4] Simultaneously, the main causes of death have shifted from infectious diseases toward age-related chronic diseases.[5] These observed trends have led to aging, and particularly healthy aging, to become one of the top public health challenges,[6,7] and resulted in the first World Report on Aging and Health from the World Health Organization in 2015.[8]

Focusing on health as a multidimensional state could facilitate prevention and treatment strategies.[9] Theoretical frameworks have been formulated,[10–14] and various operational definitions have been applied to populations.[15,16] For example, Rowe and Kahn introduced a model for successful aging that included avoiding disease and disability, high cognitive and physical function, and engagement with life.[13,14] This model has been critiqued for being too unidimensional, with its strong focus on physiological constructs for successful aging.[17] Therefore, recent applications have comprehensively included psychosocial constructs, such as mental health and self-perceived health.[18–20] In addition, it has been suggested that continuum-based measures for healthy aging might better capture the heterogeneity of the phenotype, as opposed to the more widely adopted dichotomous approaches.[19,21] However, to date, no consensus for the measurement of healthy aging exists.

Worldwide, women outlive men by 6 to 8 years. However, these years are often spent with more disease and disability: "men die quicker, women get sicker."[9,22] Although the operationalization of healthy aging measures is upcoming, no studies have comprehensively assessed age and sex differences. Within the population-based Rotterdam Study, comprehensive and detailed information on subjective and objective measures, which are necessary to construct a healthy aging score, are available. In addition, the vital status of all participants has been precisely adjudicated in this cohort of middle-aged and elderly men and women. Therefore, we aimed to develop a healthy aging score (HAS) within the population-based Rotterdam Study and to assess age and sex differences. Furthermore, for illustrative purposes, we aimed to evaluate the association of the HAS with survival.

Methods

Study Population

This study was embedded within the Rotterdam Study: a prospective, population-based cohort among subjects 55 years and older in the municipality of Rotterdam, The Netherlands. The rationale and study design have been described elsewhere.[23] The baseline examination of the original cohort was completed between 1990 and 1993 (RS-I, visit 1). In the fourth visit of RS-I (2002-2004), assessments of social support and quality of life were introduced. Therefore, the current study included all participants alive at the fourth visit of RS-I. Of the 5.008 participants available for inclusion, 1.481 were excluded due to missing data in more than 5 domains of the HAS. Hence, 1.405 men and 2.122 women were included in the current study. The Rotterdam Study has been approved by the Medical Ethics Review Board of Erasmus Medical Center and by the Ministry of Health, Welfare and Sport of the Netherlands, implementing the Wet Bevolkingsonderzoek: ERGO (Population Studies Act: Rotterdam Study). All participants provided written informed consent to participate in the study and to obtain information from their treating physicians.

Assessment of Healthy Aging Score

In line with previously defined conceptual frameworks and applications,[10–21] we included 7 biopsychosocial domains in the development and construction of the healthy aging score. These domains involved: chronic diseases, mental health, cognitive function, physical function, pain, social support, and quality of life. In each domain, the status was graded as low (0, corresponding to a worse status within the domain), moderate (1), or high (2, corresponding to an optimal status within the domain); Scheme 1. A total score, ranging from 0 to 14 was constructed, by summing up the values of these 7 domains. An extensive description of the HAS construction can be found in Supplemental Methods 1A.

Scheme 1
Definition of Healthy Aging Score

Domain	Low (Score of 0)	Moderate (Score of 1)	High (Score of 2)
Chronic diseases*	>1 disease, "multimorbidity"	1 disease	0 diseases
Mental health CES-D	Score of 23 to 60	Score of 17 to 22	Score of 0 to 16 (no depressive symptoms)
Cognitive functioning MMSE	Score of 0 to 20	Score of 21 to 25	Score of 26 to 30
Physical functioning bADL/iADL	Severe disability on either bADL or iADL	Everything in between	Mild disability on bADL and iADL
Pain	(Very) severe pain in hands, knees, hips or back for at least 1 activity	Everything in between	No or mild pain in hands, knees, hips and back in all activities
Social support	'Agree' in 0–2 statements	'Agree' in 3–4 statements	'Agree' for all 5 statements
QoL	Low QoL on 5–8 items	Low QoL on 1–4 items	High QoL on all 8 items

bADL, basic activities of daily living; CES-D, Center for Epidemiologic Studies Depression Scale; iADL, instrumental activities of daily living; MET, metabolic equivalent; MMSE, Mini-Mental State Examination; QoL, quality of life.

*Chronic diseases included myocardial infarction, revascularization, heart failure, stroke, Parkinson disease, diabetes mellitus, chronic obstructive pulmonary disease, cancer, and chronic kidney disease.