Predictors of high self-rated health in home-living older adults aged 80 years and above

Master of clinical health sciences, nursing science program, UMC Utrecht, Utrecht University

Name	N. Bijman (Nienke)
Student number	5659604
Status paper	Final
Date	June 28, 2017
Supervisor	Dr. Nienke Bleijenberg
Mentor	Dr. Janneke de Man – Van Ginkel
Internship department	UMC Utrecht, Julius center, department nursing science
Target journal	Journal of American Geriatrics Society
Word count paper	3483
Word count abstract	299
Word count summary	298
Criteria for reporting	TRIPOD: Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis

Abstract

Predictors of high self-rated health in home-living older adults aged 80 years and above

Background. Self-rated health (SRH) is frequently used to measure health and is a predictor of mortality and functional decline in older adults. To maintain their independent living with good health, it is important to determine predictors of high SRH in older adults. However, knowledge regarding these predictors in older adults aged 80 years and above is scarce.
Aim. To determine predictors of a high 12-month SRH in home-living older adults aged 80 and above and to assess dimensions of the positive health (PH) concept in which the predictors are embedded.
Method. Secondary data analysis was performed using longitudinal data, collected in the Netherlands between October 2010 and March 2012. SRH was measured by asking participants "How is your health in general?" and dichotomized into high and low. A logistic regression analysis was used to determine relationships between the candidate predictors and SRH.
Results. In total, 807 participants, with a median age of 84 years (interquartile range 82–87), were included, and 35.5% of them reported high SRH. Having children, increased physical functioning, less morbidities, no pain/discomfort, and increased vitality are significant predictors that are associated with high SRH. These predictors are embedded in the PH domains of bodily functions and quality of life.
Conclusion. The identified predictors and PH domains indicate that health is influenced by not only diseases but also by bodily functions and quality of life.
Recommendations. To maintain health, it is recommended for care providers to signal a decrease in physical functioning, vitality, and pain/discomfort in older adults. Prevention strategies and interventions to increase vitality and physical functioning and to reduce pain/discomfort and morbidities are recommended to maintain good health in this population.

Keywords: *community-dwelling, oldest old, predictors, self-rated health, positive health*

Samenvatting

Voorspellers van goede zelf-ervaren gezondheid bij thuiswonende ouderen van 80 jaar en ouder

Achtergrond. Zelf ervaren gezondheid (SRH) is een veel gebruikte maat om gezondheid te meten én is een voorspeller van mortaliteit en functionele achteruitgang bij ouderen. Om ouderen zelfstandig te laten wonen in goede gezondheid is het belangrijk om de voorspellers van goede SRH te kennen. Echter, kennis van deze voorspellers bij ouderen van 80 jaar en ouder is zeldzaam.

Doel. Vaststellen van de voorspellers van 12-maanden goede SRH bij thuiswonende ouderen van 80 jaar en ouder en te bepalen in welke dimensies van het concept van positieve gezondheid (PH) deze voorspellers passen.

Methode. Secundaire data-analyse is uitgevoerd met gebruik van longitudinale data verzameld tussen oktober 2010 en maart 2012. SRH is gemeten door de vraag “Hoe is uw gezondheid in het algemeen?” en gedichotomiseert in goed en slecht. Logistische regressieanalyse is gebruikt om de relatie tussen SRH en de kandidaat voorspellers te bepalen.

Resultaten. In totaal zijn 807 participanten geïncludeerd met een leeftijdsmediaan van 184 (interkwartielafstand 82-87), 35,5% heeft een goede SRH. Het hebben van kinderen, beter fysiek functioneren, minder morbiditeit, geen pijn/discomfort en meer vitaliteit zijn voorspellers van een goede SRH. Deze voorspellers zijn onder te verdelen in de domeinen van PH lichamelijke functies en kwaliteit van leven.

Conclusie. De gevonden voorspellers laten zien dat gezondheid niet alleen wordt bepaald door ziekten maar ook door lichamelijke functies en kwaliteit van leven.

Aanbevelingen. Om gezondheid te behouden is het aanbevolen voor zorg professionals om achteruitgang in fysiek functioneren, vitaliteit en pijn/discomfort tijdig te herkennen. Preventie strategieën en interventies gericht op het verbeteren van fysiek functioneren en vitaliteit en het verminderen van pijn/discomfort en chronische ziekten zijn aanbevolen om een goede gezondheid bij thuiswonende ouderen te behouden.

Trefwoorden: ouderen, voorspellers, zelf ervaren gezondheid, positieve gezondheid, thuiswonend

Introduction

The worldwide population of older adults is growing. While aging, people often develop multiple, complex problems on the physical, psychological, and social domain.[1] These problems occur more often in older adults aged 80 years and above.[1] Due to these multiple problems, people experience declined health and increased risk of mortality.[1] Maintaining independent living with good health and preventing deterioration in health are important to maintain the quality of life in older adults aged 80 and above.

Health is defined by the World Health Organisation (WHO) as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity".[2] However, another concept of health has recently been introduced by Huber et al.[3] To prevent confusion with the WHO definition, the term "positive health" is used. Positive health (PH) is defined as "health as the ability to adapt and to self-manage in the face of social, physical, and emotional challenges".[4] Positive health focuses on peoples' abilities instead of peoples' limitations and indicates that people with chronic conditions are able to experience good health, in contrast to the WHO definition.[2,4] Positive health consists of six dimensions: bodily functions, mental functions and perception, spiritual/existential dimension, quality of life, social and societal participation, and daily functioning.[4] These six dimensions of PH indicate that PH is a wide and diverse concept.

Self-rated health (SRH) is a frequently used outcome measure of health.[5] SRH basically consists of asking individuals to rate their health status. Jylhä[5] described SRH as an individual and subjective concept influenced by both biological indicators and psychological experiences. In both SRH and PH, health is reflected as a broad concept. However, the exact relationship between SRH and PH is unknown. Interpretations of SRH differ by age and gender.[5] SRH has proved to be a predictor of mortality and functional decline in older adults.[6,7] By contrast, in older adults aged 65 and above, SRH is cross-sectional associated with multi-morbidity, functional limitation, problems with instrumental activities of daily living, poor mental health, and depressive symptoms.[8-10] Though there are the different interpretations of SRH by age, previous findings are not generalizable for people aged 80 and above.[5]

To the best of our knowledge, no research has focused on the longitudinal predictors of SRH in older people or on the cross-sectional determinants of SRH in people aged 80 and above. Knowledge regarding predictors of high SRH in this population might contribute to the development of healthcare interventions tailored toward individual needs and improving quality of life for this population. To get an insight into the relationship of SRH and PH, the predictors of high SRH are categorized according to the dimensions of PH.

Aim

The purpose of the current study was to determine the predictors of a high 12-month SRH in home-living older adults aged 80 and above and to assess dimensions of the PH concept in which the predictors are embedded.

Methods

Design

Secondary data analysis was performed on data collected in the Utrecht Primary care PROactive Frailty Trial (U-PROFIT). Details of this trial are described by Bleijenberg.[11] Data of this trial have a prospective, longitudinal nature with a one-year time frame, which is recommended for prognostic research.[12]

Population and domain

The study population consists of home-living older adults aged 80 years and above in the Netherlands who participated in the U-PROFIT.[13] Recruitment was performed in general practices (GPs) of three primary-care networks in Utrecht from October 2010 to March 2011.[11] Inclusion was based on GP data using a software application to extract data from the electronic medical records (EMRs).[11] Participants were included in the U-PROFIT if they were aged 60 years or above and fulfilled at least one of the following three inclusion criteria[11]: (a) frailty, defined by a frailty index score of ≥ 0.20; and/or (b) polypharmacy, defined as chronic use of five or more different medications; and/or (c) a consultation gap, defined as not having consulted the general practitioner in the past 3 years (except for the yearly influenza vaccination). Participants were excluded if they were living in an elderly or nursing home or were terminally ill.[11] For the current study, only participants aged 80 and above were selected since this was the population of interest.

Data collection

The primary outcome was SRH, measured 12 months after the baseline measurement. SRH was measured using one item from the RAND-36 asking "How is your health in general?" followed by responses on a five-point Likert scale ranging from *excellent* to *poor*.[14] According to Ebrahimi et al.[15], SRH was dichotomized and labeled as (1) (*high*) if the responses were *good*, *very good*, or *excellent* and labeled as (0) (*low*) if the responses were *reasonable* or *poor*. Self-rated health has a homogeneity coefficient (h) = 0.52, meaning that SRH is a strong one-dimensional scale.[16]

The candidate predictors were measured at baseline. Demographic predictors of interest were age, sex, marital status, having children, living arrangement (*alone* or *with others*), country of origin, and socio-economic status (SES). Marital status was categorized into

married or sustainable living together and unmarried, widow(er) or divorced. Socio-economic status was categorized into *low*, *moderate*, or *high*, using status scores provided by Dutch Institute for socials Research, which are based on postal codes.[17] Table 1 presents the candidate predictors and their operationalization categorized into the six dimensions of PH.[4]

Table 1

The candidate predictors "physical functioning", "mental health", "vitality", and "social functioning" were measured using the corresponding subscales of the RAND-36. The RAND-36 is an internationally recognized health-related quality of life survey validated for use in the Netherlands with reliable subscales.[14] Psychometric properties of the subscales are examined for the Dutch population (Table 1).[16] All subscales are derived from a combination of different items transformed into a 0–100 summary score, whose higher score indicates better health.

The EuroQol five-dimensional scale (EQ-5D) was used to measure the "EQ-5D".[18] The EQ-5D has five dimensions and five items: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.[18] The health state of each item is assessed using three response options ranging from *no* to *extreme problems*. To obtain the EQ-5D summary score, the EQ-5D Dutch summary index was used.[19] The EQ-5D is a validated instrument of measuring quality of life in older populations and has the ability to discriminate between groups and has strong levels of responsiveness.[18] "Pain/discomfort" and "anxiety/depression" were measured using the corresponding individual items from the EQ-5D. "Cognitive functioning" was measured using one item derived from the EQ-5D.[20] The response options of pain/discomfort, anxiety/depression, and cognitive functioning were dichotomized into *no problems* and *problems*.

"Frailty" was measured using a validated frailty index based on health deficits (symptoms, signs, diseases, social problems, and functional impairments) that are routinely assessed in the EMRs using the International Classification of Primary Care (ICPC) codes.[11,21]

"Functional limitation" was measured using the modified Katz-15 index for activities of daily living (ADL) and instrumental activities of daily living (IADL) (range 0–15).[22,23] Respondents have to indicate if assistance is required (yes/no) for ADL functions (e.g., bathing and dressing) and/or IADL functions (e.g., meal preparation and household tasks). Higher scores indicate more functional limitations. The Katz-15 is a validated and reliable scale for measuring functional limitation in home-living older people in the Netherlands.[22]

"Number of chronic diseases" was measured based on morbidities experienced in the last 12 months from a list of 17 predefined conditions (e.g., diabetes, asthma, and cancer).

Included conditions are based on a listing widely used in the Netherlands to record multi-morbidity.[24]

Procedures

Frailty, the number of medications, and consultation gap were derived from EMR data prior to inclusion and were used as inclusion parameters. All other candidate predictors, including demographics, were obtained using self-report questionnaires at baseline and after 12 months.

Data analysis

The total percentage of missing data was 3.4%, and the total percentage of complete cases was 53.7%. To increase power and to prevent bias, missing values were replaced by multiple imputation on all candidate-predictor variables and SRH.[25] Ten imputed datasets were obtained using all candidate-predictor variables and SRH to reflect the missing values.

Due to the nature of the data, descriptive statistics were summarized using mean, standard deviation, and range for normally distributed continuous data; median, interquartile range (IQR), and range for skewed continuous data; as well as counts and proportions for categorical data.

Logistic regression analysis was used to determine the predictors of SRH because of the dichotomous outcome measure (SRH) and the continuous and categorical predictors. To prevent incomplete information from the predictors, all categorical predictors were tested for extreme uneven split.[26] If needed, categories were collapsed. Because of proportions <0.1, the binary candidate predictors temporary residence in care or a nursing home, country of origin, and consultation gap were excluded from the prediction analysis. To prevent bias, all data were checked for meeting the assumptions of logistic regression — linearity with the logit and no multicollinearity — no problems occurred.[26]

Univariate logistic regression analysis was used to measure the association between SRH and the candidate predictors using Odds Ratios (*ORs*), 95% confidence interval (CI), and *p*-values. Backward selection, using the Akaike information criterion (AIC) with $p \leq 0.157$, was used to build the final model.[27] The AIC was used to reduce overfitting the data and is recommended for building prediction models.[27] Because trial data were used with significant intervention effect, the intervention was included as a separate predictor by using the enter method.[12] Model performance was measured using different parameters.[27] The Hosmer and Lemeshow test was used to measure the goodness of fit of the final model. Nagelkerke's r^2 was used as a value of the percentage of SRH predicted by the final model. The area under the receiver operation curve (AUC) was used to test discrimination performance between participants with high and low SRH, and specificity and sensitivity were used to measure the

true positive and true negative percentage of SRH predicted by the model. IBM SPSS statistics version 23 (Armonk, New York, USA) was used to conduct all statistical analysis. Since SPSS does not show pooled estimates for the model performance parameters, the mean results of the 10 imputed data sets were used to obtain pooled results.

Ethical issues

The current study was conducted in accordance with the principle of ICH Good Clinical Practice, applicable privacy requirements and the guiding principles of the declaration of Helsinki.[28,29] The U-PROFIT has been approved by the institutional review board of the University Medical Centre Utrecht (UMCU) (protocol ID 10-149/O) and is registered as NTR2288.[11] All participants signed an informed consent.[11] Data are cleaned from any personal data by means of a trusted third-party procedure, and no additional consent from the participants was required. Approval for secondary data analysis was obtained from the principal investigator.

Results

In total, 807 participants, with a median age of 84 years (IQR 82–87), were included in the analysis; 533 (66%) participants were female (Table 2). The majority of the participants were Dutch (96%). The SES was spread as follows: 33.5% of the participants had a low; 36.5%, a moderate; and 30%, a high SES. The median number of chronically used medications was seven (IQR 5–9), the median number of chronic diseases was two (IQR 1–3), and the median Katz-15 score was two (IQR 1–4). Approximately half of the population had homecare assistance. Of the 626 (78%) participants with follow-up data, 222 (35.5%) reported high SRH, and 404 (64.5%) reported low SRH.

Table 2

Table 3

Univariate logistic regression analysis showed that 13 out of 20 candidate predictors had a statistical significant association with SRH ($P \leq 0.05$) (Table 3).

The final model included five predictors representing demographics and the PH domains of bodily functions and quality of life (Table 4). In the final model, the probability of having a high SRH improved by having children (*OR*: 1.74 (95% CI, 0.94–3.24)), increased physical functioning (*OR*: 1.02 (95% CI, 1.01–1.03)), and increased vitality (*OR*: 1.02 (95% CI, 1.01–1.04)). The probability of having a high SRH decreased with having more chronic diseases (*OR*: 0.84 (95% CI, 0.72–0.98)) and pain/discomfort (*OR*: 0.50 (95% CI, 0.33– 0.77)). Performance parameters of the model gave a Nagelkerke r^2 of 0.28, implying 28% of the

variation in SRH is predicted by the model. The Hosmer and Lemeshow goodness of fit test (χ^2 = 12.97, *df* = (8), *p* = .236) indicates no statistical significant difference between predicted and real values. The discrimination performance of the model is fair with an AUC of 0.77 (95% CI, 0.73–0.80), specificity of 51.6%, and sensitivity of 86.7%.

Table 4

Discussion

The current study identified predictors of a high 12-months SRH in home-living older adults aged 80 years and above and categorized the predictors into the domains of PH. Having children, increased physical functioning, less morbidities, no pain/discomfort, and increased vitality are predictors significant associated with high SRH. These predictors are embedded in the PH domains of bodily functions and quality of life.

As known by the researchers, this is the first study that focuses directly on the predictors of SRH in older adults aged 80 and above. However, the findings do exhibit similarities with studies that focused on the cross-sectional associations of SRH in older adults aged 65 and above in other countries. Having less morbidities and increased physical functioning are both found to be cross-sectionally associated with high SRH in various countries.[8-10] In Scandinavia, pain is found to have a cross-sectional significant association with health-related quality of life in elderly people[30] and to be associated with low SRH in the general population[31]. This implies that physical functioning, less morbidities, and no pain/discomfort are all three significant predictors that are also cross-sectionally associated with high SRH. In line with our findings, in Australia, vitality, measured with the RAND-36 vitality subscale, is found to be a predictor of SRH in a broad (45–95 years old) population.[32] The same study indicates that despite the association between mental health and SRH, vitality accounted for most of the mental health effect. This is in line with our results, in which none of the mental health predictor variables were included in our final model. This implies that vitality has a stronger association with SRH than mental health, and might as well have more influence on SRH. The significant association between having children and high SRH in the final model might indicate the importance of having social contacts and a support system while aging. However, social functioning, measured with the RAND-36 social functioning subscale, is not included in our final model.

The current study has not found a significant relationship between age and SRH. This result is in agreement with previous findings regarding SRH being interpreted differently in different age groups.[5] Although SRH is found to be interpreted differently by age, sex, and culture[5], the current study's participants rate their health more negatively than younger cohorts in other western countries. A proportion of 35.5% rated their SRH as high, which is

less than those in Australia (85+, 62%), the USA (65+, 69%), Spain (65+, 56%), and Iceland (65+, 63%).[8-10,33] However, a similar proportion is found in a frail elderly population in Sweden including 75% older adults aged 80 and above (34%).[15] This might imply that Dutch older people aged 80 and above rate their health lower than their peers in other western countries do. Another possible explanation might be that the population of our study is frailer than the general over-80 population. Participants were included in the U-PROFIT if they fulfilled at least one of the three following inclusion criteria: (a) frailty, defined as a frailty index score of ≥0.20; and/or (b) polypharmacy, defined as chronic use of five or more different medications; and/or (c) consultation gap, defined as not having consulted the GP in the past 3 years. We found that 99% of our population chronically used five or more medications, which indicates our population might be frailer compared to the general Dutch over-80 population.

The results of the current study should be interpreted in the light of some limitations. First, generalizability of the results is affected by the fact that 99% of our population chronically used five or more medications. In 2008, the prevalence of polypharmacy in older adults in Sweden ranged from 47% at 80 to 61% at the age of 95.[34] Although it is unknown whether this polypharmacy proportion is appropriate for the Netherlands, it indicates a large group of adults aged 80 and above who are chronically using less than five medications is under-reflected in our population. Second, although the predictors of SRH are assessed longitudinally, these predictors do not imply any causality. As a result, the found association between each predictor and SRH might be influenced by a third factor. Third, data collection took place in 2010, and data were not collected in the face of the positive health concept. We tried to link the candidate predictors to the PH domains using the underlying aspects of PH.[4] However, not all six PH domains and the underlying indicators were reflected in our candidate predictors. This means that no statements can be made about the domains with limited or no candidate predictors. Fourth, the current study tried to identify predictors of high SRH. Although the discrimination performance of the model is fair (AUC: 0.77) the model is good in predicting low SRH (sensitivity: 86.7%) but poor in predicting high SRH (specificity: 51,6%). This means that despite our search for predictors of high SRH, it is advisable to use the identified predictors for predicting low SRH.

A strength of the current study is the measurement of the candidate predictors. For all candidate predictors, international relevant scientific measurement scales were used, making the results of the current study comparable with other studies. Another strength of the current study is the large sample size, which we were able to achieve due to secondary data analysis. Because of this large sample size, we were able to include all candidate predictors in one model instead of grouping the candidate predictors in different models.

By linking the predictors into the domains of PH, a first step is made to uncover the relationship of SRH and PH in home-living older adults aged 80 and above. The identified predictors of SRH are embedded in the PH domains of physical functioning and quality of life. These domains imply that health, measured using SRH, is not only influenced by diseases but also by physical functioning and quality of life. This result is more related to the PH concept than to the WHO definition of health, and under scribes that people with chronic conditions are able to experience good health.[2,4] Further research, in which all PH domains are completely included, is recommended to reveal the relationship of SRH and PH.

The results of the current study contribute to the worldwide knowledge of the oldest old and help in improving their SRH by targeting interventions and prevention strategies towards the found predictors. For most of the found predictors of SRH, relevant scientific interventions are available. First, the fact that vitality is a strong predictor of SRH indicates the relevance of vitality in the lives of people aged 80 and above. It is recommended that population-based interventions be aimed at vitality[35], and that the older adults with decreased vitality be identified and supported with personalized interventions.[36] Second, for physical functioning to be a strong predictor of SRH, indicates that improving physical functioning might improve SRH. Therefore, interventions for improving physical functioning are recommended. Exercising has been found to improve physical functioning in older adults with physical functioning problems.[37] Third, the number of chronic diseases is another strong predictor of SRH. Chronic diseases are mainly influenced by lifestyle factors, which indicate the relevance of health and lifestyle interventions and improving the management of chronic conditions.[38] Finally, having pain/discomfort is found to be a predictor of SRH. Having pain is a major problem in home-living older people.[39] Older people do think that pain is a part of aging; therefore, healthcare professionals are not always consulted about this problem.[40] It is advisable for healthcare professionals to identify and intervene in pain in older people to minimalize pain and maintain SHR.

In conclusion, in home-living adults aged 80 and above, predictors of a high 12-months SRH are having children, increased physical functioning, less morbidities, no pain/discomfort, and increased vitality. The PH domains in which these predictors are embedded are bodily functions and quality of life. The identified predictors and PH domains indicate that health is not only influenced by diseases but also by bodily functions and quality of life. To maintain health in this population, it is recommended for healthcare professionals to signal a decrease in physical functioning, vitality, and pain/discomfort. Prevention strategies and interventions aimed at increasing vitality and physical functioning and reducing pain/discomfort and morbidities are recommended for maintaining health in this population. Knowledge of these predictors of SRH in the oldest old helps in focusing on developing healthcare interventions for maintaining high SRH in aging populations.

References

(1) Baltes PB, Smith J. New frontiers in the future of aging: From successful aging of the young old to the dilemmas of the fourth age. Gerontology 2003 Mar-Apr;49(2):123-135.

(2) World Health Organisation. Constitution of the world health organisation. 2005. Available from: http://apps.who.int/gb/gov/assets/constitution-en.pdf. [Accessed 26th November, 2016].

(3) Huber M, Knottnerus JA, Green L, van der Horst H, Jadad AR, Kromhout D, et al. How should we define health? BMJ 2011 Jul 26;343:d4163.

(4) Huber M, van Vliet M, Giezenberg M, Winkens B, Heerkens Y, Dagnelie PC, et al. Towards a 'patient-centred' operationalisation of the new dynamic concept of health: A mixed methods study. BMJ Open 2016 Jan 12;6(1):e010091-2015-010091.

(5) Jylha M. What is self-rated health and why does it predict mortality? Towards a unified conceptual model. Soc Sci Med 2009 Aug;69(3):307-316.

(6) Lee Y. The predictive value of self assessed general, physical, and mental health on functional decline and mortality in older adults. J Epidemiol Community Health 2000 Feb;54(2):123-129.

(7) Idler EL, Benyamini Y. Self-rated health and mortality: A review of twenty-seven community studies. J Health Soc Behav 1997 Mar;38(1):21-37.

(8) French DJ, Browning C, Kendig H, Luszcz MA, Saito Y, Sargent-Cox K, et al. A simple measure with complex determinants: Investigation of the correlates of self-rated health in older men and women from three continents. BMC Public Health 2012 Aug 13;12:649-2458-12-649.

(9) Millan-Calenti JC, Sanchez A, Lorenzo T, Maseda A. Depressive symptoms and other factors associated with poor self-rated health in the elderly: Gender differences. Geriatr Gerontol Int 2012 Apr;12(2):198-206.

(10) Arnadottir SA, Gunnarsdottir ED, Stenlund H, Lundin-Olsson L. Determinants of self-rated health in old age: A population-based, cross-sectional study using the International Classification of Functioning. BMC Public Health 2011 Aug 25;11:670-2458-11-670.

(11) Bleijenberg N, Drubbel I, Ten Dam VH, Numans ME, Schuurmans MJ, de Wit NJ. Proactive and integrated primary care for frail older people: Design and methodological challenges of the Utrecht primary care PROactive frailty intervention trial (U-PROFIT). BMC Geriatr 2012 Apr 25;12:16-2318-12-16.

(12) Moons KG, Royston P, Vergouwe Y, Grobbee DE, Altman DG. Prognosis and prognostic research: What, why, and how? BMJ 2009 Feb 23;338:b375.

(13) Bleijenberg N, Drubbel I, Schuurmans MJ, Dam HT, Zuithoff NP, Numans ME, et al. Effectiveness of a proactive primary care program on preserving daily functioning of older people: A cluster randomized controlled trial. J Am Geriatr Soc 2016 Sep;64(9):1779-1788.

(14) VanderZee KI, Sanderman R, Heyink JW, de Haes H. Psychometric qualities of the RAND 36-item health survey 1.0: A multidimensional measure of general health status. Int J Behav Med 1996;3(2):104-122.

(15) Ebrahimi Z, Dahlin-Ivanoff S, Eklund K, Jakobsson A, Wilhelmson K. Self-rated health and health-strengthening factors in community-living frail older people. J Adv Nurs 2015 Apr;71(4):825-836.

(16)Moorer P, Suurmeije T, Foets M, Molenaar IW. Psychometric properties of the RAND-36 among three chronic diseases (multiple sclerosis, rheumatic diseases and COPD) in The Netherlands. Qual Life Res 2001;10(7):637-645.
(17)Sociaal Cultureel Planbureau. Statusscores (in Dutch only). 2009. [Internet] Available from: http://www.scp.nl/onderzoek/lopend_onderzoek/a_z_alle_lopende_onderzoeken/statusscores. [Accessed 22th November 2016].
(18)Lutomski JE, Krabbe PF, Bleijenberg N, Blom J, Kempen GI, MacNeil-Vroomen J, et al. Measurement properties of the EQ-5D across four major geriatric conditions: Findings from TOPICS-MDS. Health Qual Life Outcomes 2017 Mar 3;15(1):45-017-0616-x.
(19)Lamers LM, Stalmeier PF, McDonnell J, Krabbe PF, van Busschbach JJ. Measuring the quality of life in economic evaluations: The Dutch EQ-5D tariff. Ned Tijdschr Geneeskd 2005 Jul 9;149(28):1574-1578.
(20)Hoeymans N, van Lindert H, Westert GP. The health status of the Dutch population as assessed by the EQ-6D. Qual Life Res 2005 Apr;14(3):655-663.
(21)Drubbel I, de Wit NJ, Bleijenberg N, Eijkemans RJ, Schuurmans MJ, Numans ME. Prediction of adverse health outcomes in older people using a frailty index based on routine primary care data. J Gerontol A Biol Sci Med Sci 2013 Mar;68(3):301-308.
(22)Laan W, Zuithoff NP, Drubbel I, Bleijenberg N, Numans ME, de Wit NJ, et al. Validity and reliability of the Katz-15 scale to measure unfavorable health outcomes in community-dwelling older people. J Nutr Health Aging 2014 Nov;18(9):848-854.
(23)Weinberger M, Samsa GP, Schmader K, Greenberg SM, Carr DB, Wildman DS. Comparing proxy and patients' perceptions of patients' functional status: Results from an outpatient geriatric clinic. J Am Geriatr Soc 1992 Jun;40(6):585-588.
(24)RIVM. Lokale en nationale monitor gezondheid (in Dutch only). 2005 [Internet] Available from: https://www.monitorgezondheid.nl/gezondheidindicatoren.aspx. [Accessed 24th October 2016].
(25)Vergouw D, Heymans MW, van der Windt DA, Foster NE, Dunn KM, van der Horst HE, et al. Missing data and imputation: A practical illustration in a prognostic study on low back pain. J Manipulative Physiol Ther 2012 Jul;35(6):464-471.
(26)Field A. 19.4 Sources of bias and common problems. In: Carmichael M, editor. Discovering statistics using IBM SPSS statistics. 4th edition ed. London: SAGE; 2014. p. 768-772.
(27)Royston P, Moons KG, Altman DG, Vergouwe Y. Prognosis and prognostic research: Developing a prognostic model. BMJ 2009 Mar 31;338:b604.
(28)Dixon JR,Jr. The International Conference on Harmonization Good Clinical Practice guideline. Qual Assur 1998 Apr-Jun;6(2):65-74.
(29)World Medical Association. World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA 2013 Nov 27;310(20):2191-2194.
(30)Jakobsson U, Hallberg IR, Westergren A. Overall and health related quality of life among the oldest old in pain. Qual Life Res 2004 Feb;13(1):125-136.
(31)Mantyselka PT, Turunen JH, Ahonen RS, Kumpusalo EA. Chronic pain and poor self-rated health. JAMA 2003 Nov 12;290(18):2435-2442.

(32)Burns RA, Sargent-Cox K, Mitchell P, Anstey KJ. An examination of the effects of intra and inter-individual changes in wellbeing and mental health on self-rated health in a population study of middle and older-aged adults. Soc Psychiatry Psychiatr Epidemiol 2014 Nov;49(11):1849-1858.
(33)Sargent-Cox KA, Anstey KJ, Luszcz MA. Determinants of self-rated health items with different points of reference: Implications for health measurement of older adults. J Aging Health 2008 Sep;20(6):739-761.
(34)Wastesson JW, Canudas-Romo V, Lindahl-Jacobsen R, Johnell K. Remaining life expectancy with and without polypharmacy: A register-based study of Swedes aged 65 years and older. J Am Med Dir Assoc 2016 Jan;17(1):31-35.
(35)Beddington J, Cooper CL, Field J, Goswami U, Huppert FA, Jenkins R, et al. The mental wealth of nations. Nature 2008 Oct 23;455(7216):1057-1060.
(36)Bolier L, Haverman M, Westerhof GJ, Riper H, Smit F, Bohlmeijer E. Positive psychology interventions: a meta-analysis of randomized controlled studies. BMC Public Health 2013 Feb 8;13:119-2458-13-119.
(37)de Vries NM, van Ravensberg CD, Hobbelen JS, Olde Rikkert MG, Staal JB, Nijhuis-van der Sanden MW. Effects of physical exercise therapy on mobility, physical functioning, physical activity and quality of life in community-dwelling older adults with impaired mobility, physical disability and/or multi-morbidity: A meta-analysis. Ageing Res Rev 2012 Jan;11(1):136-149.
(38)Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: Elimination of the leading preventable causes of premature death and disability in the USA. Lancet 2014 Jul 5;384(9937):45-52.
(39)Abdulla A, Adams N, Bone M, Elliott AM, Gaffin J, Jones D, et al. Guidance on the management of pain in older people. Age Ageing 2013 Mar;42 Suppl 1:i1-57.
(40)Cornally N, McCarthy G. Chronic pain: The help-seeking behavior, attitudes, and beliefs of older adults living in the community. Pain Manag Nurs 2011 Dec;12(4):206-217.

Tables

Table 1: Candidate predictors used to explain SRH arranged into the six dimensions of PH

Dimension of PH and its underling aspects	Predictors	Operationalisation	Range	Measurement scale	Psychometric properties
Bodily functions • Medical facts • Medical observations • Physical functioning • Complaints and pain • Energy	Number of chronic diseases	Number of chronic diseases[a]	0 – 17	Continuous	
	Physical functioning	Rand-36 physical functioning subscale	0 - 100, higher score = better physical functioning	Continuous	h = 0.75[b], r = 0.9, Cronbach's alfa = 0.92, mean inter-item correlation = 0.54, test-retest correlation = 0.82[c]
	Pain/discomfort	EQ5D pain subscale	0 = no, 1 = yes	Ordinal	
	Frailty	Frailty index	0 - 1	Continuous	
	Number of medications	Number of chronical used medications	0 ≤	Continuous	
	Consultation gap	Time since last GP visit	0 = less than one year, 1 = more than one year	Binary	
	Hospital admission	Hospital admission in last 12 months	0 = no, 1 = yes	Binary	
	Home care assistance	Having home care assistance	0 = no, 1 = yes	Binary	
	Temporary residence in a care home or a nursing home	Care home or nursing home residence in last 12 months	0 = no, 1 = yes	Binary	
Mental functions and perception • Cognitive functioning • Emotional state • Esteem/ self-respect • Experiencing to be in charge/ manageability • Self-management • Resilience, sense of coherence	Mental health	RAND-36 mental health subscale	0 - 100, higher score = better mental health	Continuous	h = 0.60 [b], r = 0.87, Cronbach's alfa = 0.85, mean inter-item correlation = 0.55, test-retest correlation = 0.73[c]
	Cognitive functioning	EQ5D+C cognitive functioning subscale	0 = no problems, 1 = problems	Ordinal	
	Anxiety/depression	EQ5D anxiety/depression subscale	0 = no, 1 = yes	Ordinal	

Table 1 continued

Dimension of PH and its underling aspects	Predictors	Operationalisation	Range	Measurement scale	Psychometric properties
Spiritual/ existential dimension • Meaning/ meaningfulness • Striving for aims/ideals • Future prospects • Acceptance	Not measured in current study				
Quality of life • Quality of life/ well-being • Experiencing happiness • Enjoyment • Perceived health • Flourishing • Zest for life • Balance	EQ-5D	EQ-5D	0.33 - 1, higher score = better health	Continuous	
	Vitality	RAND-36 vitality subscale	0 - 100, higher score = better vitality	Continuous	h = 0.49 [b], r = 0.76, Cronbach's alfa = 0.82, mean inter-item correlation = 0.54, test-retest correlation = 0.76[c]
Social and societal participation • Social and communicative skills • Meaningful relationships • Social contacts • Experiencing to be accepted • Community involvement • Meaningful work	Social functioning	RAND-36 social functioning subscale	0-100, higher score = better social functioning	Continuous	h=0.73 [b], r = 0.80; Cronbach's alfa = 0.7, mean inter-item correlation = 0.55, test-retest correlation = 0.88[c]
Daily functioning • Basic ADL • Instrumental ADL • Ability to work • Health literacy	Functional limitation	Katz 15: Sum of ADL and IADL functions were assistance is needed	0-15, higher score = more assistance needed	Continuous	KR-20 = 0.80[d]

Note. PH = positive health; EQ-5D = EuroQol five-dimensional scale; EQ-5D+C = EQ-5D with an extra cognitive dimension; GP = general practitioner; ADL= activities of daily living; IADL= instrumental activities of daily living; h = homogeneity coefficient, r = reliability coefficient, KR-20 = Kuder-Richardson-20 measure

[a] Experienced in the last twelve months from a list of 17 predefined conditions.

[b] Adapted from: Moorer P, Suurmeije T, Foets M, Molenaar IW. Psychometric properties of the RAND-36 among three chronic diseases (multiple sclerosis, rheumatic diseases and COPD) in The Netherlands. Qual Life Res 2001;10(7):637-645.

[c] Adapted from: VanderZee KI, Sanderman R, Heyink JW, de Haes H. Psychometric qualities of the RAND 36-Item Health Survey 1.0: a multidimensional measure of general health status. Int J Behav Med 1996;3(2):104-122.

[d] Adapted from: Laan W, Zuithoff NP, Drubbel I, Bleijenberg N, Numans ME, de Wit NJ, et al. Validity and reliability of the Katz-15 scale to measure unfavorable health outcomes in community-dwelling older people. J Nutr Health Aging 2014 Nov;18(9):848-854.

Table 2: Baseline characteristics[a]

Characteristics		**Population *N* = 807**
Demographic factors		
Female, *n* (%), no missing		533 (66.0)
Age (years), median (IQR) [range], no missing		84.0 (82-87) [80-98]
Marital status (married or sustainable living together), *n* (%), missing 10 (1.2%)		318 (39.9)
Having children (yes), *n* (%), missing 49 (6.1%)		652 (86.0)
Living arrangement (with others), *n* (%), missing 40 (5.0%)		299 (39.0)
Country of origin (Netherlands), *n* (%), missing 7 (0.9%)		771 (96.4)
Socio-economic status[b], *n* (%), missing 2 (0.2%)	1 = low	270 (33.5)
	2 = moderate	294 (36.5)
	3 = high	241 (29.9)
Bodily functions		
Number of chronic diseases, median (IQR) [range], no missing		2.0 (1-3) [0-8]
Physical functioning (0-100), mean ± *SD* [range], missing 1 (0.1%)		44.9 ± 27.6 [0-100]
Pain/discomfort (yes), *n* (%), missing 9 (1.1%)		608 (76.2)
Frailty (index 0-1), median (IQR) [range], missing 116 (14.0%)		0.08 (0.06-0.12) [0.00-0.26]
Number of medications, median (IQR) [range], missing 116 (14.0%)		7.0 (5-9) [0-17]
Consultation gap (more than one year), *n* (%), missing 116 (14.0%)		17 (2.5)
Hospital admissions (yes), *n* (%), missing 12 (1.5%)		188 (23.6)
Home care assistance (yes), *n* (%), missing 16(2.0%)		399(50.4)
Temporary residence in a care or nursing home (yes), *n* (%), missing 17(2.1%)		36 (4.6)
Mental functions and perception		
Mental health (0-100), mean ± *SD* [range], missing 1 (0.1%)		67.7 ± 17.5 [8-100]
Cognitive functioning (problems), *n* (%), missing 7(0.9%)		299 (37.4)
Anxiety/depression (yes), *n* (%), missing 9 (1.1%)		220 (27.6)
Quality of life		
EQ-5D (-0.33 - 1), median (IQR) [range], no missing		0.775 (0.651-0.811) [-0.2 - 1.0]
Vitality (0-100), mean ± *SD* [range], missing 2 (0.2%)		53.1 ± 19.0 [0-100]
Social and societal participation		
Social functioning (0-100), median (IQR) [range], missing 18 (2.2%)		37.5 (37.5-50.0) [0-75]
Daily functioning		
Functional limitation (0-15), median (IQR) [range], missing 2 (0.2%)		2.00 (1-4) [0-13]

Note. IQR = inter quartile range, EQ-5D = EuroQol five-dimensional scale
[a] Based on original data
[b] Based on ZIP-code

Table 3: Univariate associations with high SRH (N = 807)

Predictors		SRH high *n* = 298 (36.9%)	SRH low *n* = 509 (63.1%)	β	*SE*	*P*	*OR*	95% CI
Demographic factors								
Sex (female), *n* (%)		185 (62.1)	348 (68.4)	-0.28	0.18	.125	0.76	0.53 - 1.08
Age, mean ± *SD*		84.6 ± 3.9	84.7 ± 3.6	-0.01	0.02	.782	0.99	0.95 - 1.04
Marital status (married, sustainable living together), *n* (%)		121 (40.6)	201 (39.5)	0.04	0.16	.789	1.04	0.77 - 1.42
Having children (yes), *n* (%)		266 (89.3)	426 (83.7)	0.47	0.27	.081	1.60	0.94 - 2.72
Living arrangement (with others), *n* (%)		121 (40.6)	192 (23.8)	0.12	0.16	.463	1.12	0.82 - 1.53
Socio-economic status[a], *n* (%)	1 = low	76 (25.5)	195 (38.3)	-	-	-	-	-
	2 = moderate	118 (39.6)	177 (34.8)	0.56	0.20	.006	1.75	1.18 - 2.59
	3 = high	105 (35.2)	137 (26.9)	0.70	0.22	.002	2.01	1.30 - 3.12
Bodily functions								
Number of chronic diseases, mean ± *SD*		1.71 ± 1.33	2.50 ± 1.38	-0.45	0.07	<.001	0.64	0.56 - 0.74
Physical functioning (0-100), mean ± *SD*		58.9 ± 27.4	36.8 ± 24.2	0.03	0.00	<.001	1.03	1.03 - 1.04
Pain/discomfort (yes), *n* (%)		181 (60.7)	434 (85.3)	-1.32	0.19	<.001	0.27	0.18 - 0.39
Frailty, mean ± *SD*		0.10 ± .06	0.10 ± .06	-2.90	1.43	.043	0.06	0.00 - 0.92
Number of medications, mean ± *SD*		7.23 ± 3.27	7.78 ± 3.33	-0.05	0.03	.107	0.95	0.89 - 1.01
Hospital admissions (yes), *n* (%)		51 (17.1)	140 (27.5)	-0.61	0.22	.005	0.55	0.36 - 0.83
Home care assistance (yes), *n* (%)		124 (41.6)	282 (55.4)	-0.56	0.17	.001	0.57	0.41 - 0.80
Mental functions and perception								
Mental health (0-100), mean ± *SD*		73.2 ± 16.8	64.5 ± 17.2	0.03	0.01	<.001	1.03	1.02 - 1.04
Cognitive functioning (having problems), *n* (%)		96 (32.2)	208 (40.9)	-0.39	0.21	.073	0.68	0.44 - 1.04
Anxiety/depression (yes), *n* (%)		52 (17.4)	170 (21.0)	-0.87	0.22	<.001	0.42	0.27 - 0.65
Quality of life								
EQ-5D (-0.33 - 1), mean ± *SD*		0.79 ± 0.19	0.64 ± 0.23	3.71	0.73	<.001	40.7	9.0 - 183.7
Vitality (0-100), mean ± *SD*		61.6 ± 19.1	48.1 ± 17.1	0.04	0.01	<.001	1.04	1.03 - 1.05
Social and societal participation								
Social functioning (0-100), mean ± *SD*		43.7 ± 10.1	40.1 ± 11.6	0.03	0.01	<.001	1.03	1.02 - 1.05
Daily functioning								
Functional limitation (Katz-15), mean ± *SD*		2.0 ± 2.4	3.3 ± 2.5	-1.23	0.05	<.001	0.79	0.73 - 0.87

Note. SRH = self-rated health, CI = confidence interval, EQ-5D = EuroQol five-dimensional scale

[a] Based on ZIP-code

Table 4: Final logistic regression model[a] to predict high SRH (N = 807)

	β	*SE*	*P*	*OR*	95% CI
Intercept	-2.22	0.53	<.001	0.11	0.04 - 0.31
Demographic factors					
Having children (yes)	0.55	0.31	.079	1.74	0.94 - 3.24
Bodily functions					
Number of chronic diseases	-0.18	0.08	.027	0.84	0.72 - 0.98
Physical functioning (0-100)	0.02	0.00	<.001	1.02	1.01 - 1.03
Pain/discomfort (yes)	-0.69	0.22	.002	0.50	0.33 - 0.77
Quality of life					
Vitality (0-100)	0.02	0.01	<.001	1.02	1.01 - 1.04

Nagelkerke r^2 = .283, Cox & Snell r^2 = .207, Hosmer and Lemeshow goodness of fittest: X^2 = 12.97, df = (8), p = 0.236, AUC = 0.77 (*SE* = 0.02, CI 0.73 - 0 .80)

Note. CI = confidence interval, AUC = area under the receiver operating curve

[a] Adjusted for intervention category