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# Health literacy supports active aging

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**Abstract**

From the individual viewpoint, active aging refers to the ability of older persons, depending on their goals, functional capacity and opportunities, to engage in desired activities. This study investigated the role of health literacy in active aging among persons differing in their number of chronic conditions. Data were collected from 948 individuals, 57% women, aged 75, 80 and 85 in 2017-2018 in the city of Jyväskylä in Central Finland. Health literacy was assessed with the 16-question version of the European Health Literacy Survey (HLS-EU-Q16), active aging with the University of Jyväskylä Active Aging Scale (UJACAS) and self-reported physician-diagnosed chronic conditions. Both health literacy (r= 0.40) and number of chronic conditions (r= -0.21) correlated with the active aging score. Linear regression models revealed that health literacy was a stronger predictor than chronic conditions of active aging (β 0.18, $p<0.001$ vs. β -0.06, $p=0.030$) and that its predictive value remained statistically significant after adjustment for cognitive capacity, number of depressive symptoms, physical performance and length of education. Higher health literacy can enable older persons, including those with multiple chronic conditions, to maintain higher levels of active aging. As more people are projected to live with chronic conditions to older ages, health literacy may help them to cope with illnesses and functional limitations and lead a fulfilling life. These cross-sectional findings lay a foundation for future prospective and experimental studies on health literacy and active aging.

## Introduction

"What is a good life in old age and how can it be achieved?" are commonly asked questions in the debate on aging (Ehni et al., 2018). However, much depends on who defines the meaning of a good life and who are to benefit from it. Despite a conceptual shift in emphasis away from the concept of successful or healthy aging towards the notion of active aging, the debate around this theme has largely centered on societal values, norms and benefits related to productivity, with older people regarded as a social and economic resource (Foster & Walker, 2015). In line with this, indicators of active aging have emphasized the importance of employment, increased life expectancy and independence, and measures of active aging have been conducted at the societal level or between countries (Zaidi et al., 2017). Similarly, healthy, successful and/or active aging has been seen as the norm that all individuals can aspire to (Holstein & Minkler, 2003). On this view, physical realities are neglected and older people perceived as a homogeneous group (Stephens et al., 2015). However, as people age, their risk for having several coexisting chronic conditions increases (Chang et al., 2019; WHO, 2016). Despite age-related health issues, individuals' intrinsic motivation to act in meaningful ways is also present in old age (Coleman, 2000; Ryan & Deci, 2000).

The will to perform self-selected meaningful activities has been identified as a key factor in active aging research implemented from the individual perspective (Rantanen et al., 2018; Stephens et al., 2015). Thus, to explore active aging at the individual level, we define it as "the striving for elements of wellbeing through activities relating to a person's goals, functional capacities and opportunities" (Rantanen et al., 2018). As opposed to society-level measures, this novel conceptualization frames the measurement of active aging from the viewpoint of individuals and the resources they need to pursue what is personally important for them. A new measurement of active aging (the University of Jyväskylä Active Aging Scale, UJACAS (Rantanen et al., 2018), based on this conceptualization and drawing on the Activities and Participation chapter of the International Classification of Functioning (ICF) (WHO, 2002), acknowledges individuals' participation in regular every-day activities. A material difference between this and other active aging indices, such as the Active Aging Index 2012 published by the European Commission (Zaidi et al., 2013), is the inclusion of grassroots level activities, such as artistic pursuits, being outdoors in natural environments, and spirituality, and assessments of each activity based on willingness, ability, opportunity and frequency.

This conceptualization reflects individuals' capabilities to perform the functions of daily life they value as the basis for resilient aging (Stephens et al., 2015), that is, for "balancing of the pains and pleasures associated with becoming older" (Gattuso, 2003). Furthermore, it recognizes that health and wellbeing may have different meanings for older people with different levels of physical capacity (Stephens et al., 2015), owing, for example, to different numbers of chronic conditions. This is important, as the prevalence of simultaneous, multiple chronic conditions (i.e., multimorbidity) has been estimated to be over 60 % globally, and higher still among those aged 85 or older (Fabbri et al., 2015). Multimorbidity has been related to several negative outcomes, such as poor quality of life (Koroukian et al., 2016; Marengoni et al., 2011), disability (Wijers et al., 2019) and mortality (DuGoff et al., 2014). However, little is known about its associations with holistic and positive perceptions of active aging, as defined above, or what mechanisms or personal resources (e.g. health literacy) might explain these associations.

Health literacy, meaning the ability to find, understand, use and evaluate health-related information, has been recognized as a critical determinant of health (Sorensen et al., 2012). Health literacy can be viewed as a personal resource and a health asset that, as opposed to a risk factor, can increase empowerment and enhance control over health-related decision making (Nutbeam, 2008). This line of reasoning is based on the health asset model, which emphasizes positive resources for maintaining and sustaining health (Morgan & Ziglio, 2007).

Evidence for the importance of health literacy in old age has been shown in several studies. Higher health literacy is associated with better health outcomes among older persons (Tiller et al., 2015) and with more positive health behavior, such as more frequent engagement in physical activity (Kobayashi et al., 2016). Higher health literacy has also been associated with higher sense of purpose in life (Musich et al., 2018) and higher engagement in social activities (Iwasa & Yoshida, 2018). Conversely, low health literacy is a predictor of less favorable outcomes, such as steeper decline in physical function (Smith et al., 2015), multimorbidity and long-term illnesses (Aaby et al., 2019). Among patients with chronic conditions in the general population, higher health literacy was associated with better self-management and more confidence in acting in medical consultations (Heijmans et al., 2015). However, the role of health literacy in active aging among people with chronic conditions is unknown. Given that WHO Europe has urged its member states to "promote health literacy, enhance governance and create environments favorable for improving health literacy through the life-course"

(WHO Europe, 2019), more information is needed on the correlates of health literacy among older persons.

This study analyzed the association between health literacy and active aging among people with varying numbers of chronic conditions. Drawing from the health asset model, which posits that health assets are protective and enabling factors which can help an individual to maintain or improve their health (Morgan & Ziglio, 2007), we hypothesized that health literacy would be differently associated with active aging among persons differing in their number of chronic conditions. Specifically, we assumed that persons with a higher number of chronic conditions and high health literacy would score higher on the active aging scale (UJACAS) than those with a higher number of chronic conditions and low health literacy.

## Materials and methods

### *Participants*

This study is based on data collected between October 2017 and December 2018 at the University of Jyväskylä, Finland, as part of a cohort study titled "Active aging – resilience and external support as modifiers of the disablement outcome (AGNES)". Details of the AGNES cohort study have been published earlier (Rantanen et al., 2018). Briefly, the AGNES cohort study comprises a population-based sample of men and women aged 75, 80 or 85 residing in the city of Jyväskylä in Central Finland. Those living independently in the study area, able to communicate, and willing to participate were considered for participation in the AGNES study. After an initial invitation and phone interview, eligible participants filled in a postal questionnaire and, typically within one week, were interviewed in their homes face-to-face by a trained interviewer using computer-assisted personal interview technology (Portegijs et al., 2019). The overall participation rate was 36.6% (Portegijs et al., 2019). Of the total of 1 021 participants, those who had provided answers to the health literacy questionnaire and from whom we had received information on chronic conditions (n=948) were included in the present analyses. All of the participants were native Finns. Those excluded (n=73) were older, had less education, lower cognition and poorer physical performance. The ethical committee of the Central Finland Health Care District approved the AGNES study protocol on August 23, 2017. All participants signed a written informed consent before entering the study. The principles of the Declaration of Helsinki were followed throughout the study.

### *Measures*

*Demographics*

Participants' gender and age were drawn from the Finnish National Population Register. Those enrolled for this study were aged 75, 80 or 85. Information on living arrangements (alone or with someone), role as a family caregiver (yes or no) and length of education in years was obtained via the study questionnaire.

*Chronic conditions*

Physician-diagnosed chronic conditions were self-reported during the home interview. Participants were asked to report whether they had any of the conditions listed under ten categories of chronic conditions, and to specify the conditions they had. The ten categories were respiratory conditions (asthma, pulmonary disease, chronic bronchitis, other), cardiac conditions (myocardial infarction, coronary heart disease, heart failure, atrial fibrillation or other arrhythmias, other), vascular conditions (hypertension, thrombosis or intermittent claudication, other), cerebrovascular condition or brain injury (stroke or other cerebral infarction, brain injury, other), musculoskeletal condition (rheumatic arthritis, osteoarthritis, chronic back pain or problems, chronic neck pain or problems, osteoporosis, other), visual or auditory impairment (cataract, not surgically repaired; glaucoma, macular degeneration, hearing disorder, hearing injury or other hearing debilitating condition), diabetes mellitus, malignant cancer, neurological conditions (Parkinson's disease, Alzheimer's disease or dementia, epilepsy, other) and depression. In addition, an open-ended question about any other physician-diagnosed chronic conditions was asked and the responses were later categorized by a nurse. For the present analyses, the number of chronic conditions was calculated by summing all the individual illnesses and conditions reported by the participants (range 0-12). The sum was further recoded into the following groups: 0-1, 2, 3, 4, 5 and 6 or more chronic conditions.

*Health literacy*

Health literacy was measured with the Finnish translation of the short version of the European Health Literacy Survey (HLS-EU-Q16) (Sorensen et al., 2013). The validity and reliability of the original instrument has been tested by the developers (Pelikan et al., 2014; Sorensen et al., 2013) and the feasibility and test-retest repeatability of the instrument has been tested and found to be satisfactory in the current population (Eronen et al., 2019). Participants were asked to rate how easy it is for them to find, understand, use and apply health-related information (e.g., How easy would you say it is to find information on treatments of illnesses that concern you?). The response options were selected from a four-point Likert

scale: 0) very easy, 1) easy, 2) difficult and 3) very difficult. A health literacy score was computed by recoding the response options very easy and easy as 1 and difficult and very difficult as 0 and summing the responses. This yielded a score ranging from 0 to 16, which was recoded into inadequate (0-8), problematic (9-12) and sufficient (13-16) health literacy, according to the guidelines provided by the developers of the instrument (Pelikan et al., 2014).

*Active aging*

Active aging was measured with the validated University of Jyväskylä Active Aging Scale (UJACAS), which has good test-retest repeatability (Rantanen et al., 2018). The active aging assessment comprises 17 items: practicing memory, using a computer, advancing matters in one's own life, exercising, enjoying the outdoors, taking care of one's appearance, crafting or DIY, making one's home cozy and pleasing, helping others, maintaining friendships, getting to know new people, balancing one's personal finances, making one's days interesting, practicing artistic hobbies, participating in events, involvement in societal/communal matters, and doing things according to one's world view. Participants were asked to look back over the previous four weeks and rate their willingness, ability, opportunity and frequency of doing each activity on a scale from zero (lowest) to four (highest). Sub-scale scores for each of the four dimensions (range 0-68) and a total score (range 0-272) were calculated by summing the scores of individual items.

*Indicators of functioning*

Depressive symptoms, cognitive capacity and physical performance as indicators of functioning were considered potential confounders, owing to their expected associations with health literacy and active aging. Depressive symptoms were assessed with the Center for Epidemiological Studies Depression Scale (CES-D, range 0-60) (Radloff, 1977), physical performance with the Short Physical Performance Battery (SPPB, range 0-12) (Guralnik et al., 1994) and cognitive capacity with the Mini-Mental State Examination (MMSE, range 0-30) (Folstein et al., 1975) as part of the at-home interview. Each of these tests has been validated in older people (Beekman et al., 1997; Guralnik et al., 1994; Folstein et al., 1975).

*Statistical analyses*

Characteristics of participants between the three health literacy categories were compared and tested with chi square analyses (categorical variables) and analyses of variance (ANOVA) (continuous variables). Bivariate correlations between the health literacy score, number of

chronic conditions and active aging total score and sub scores were tested with Spearman correlation coefficients for all participants and separately in the three age categories. Linear regression analyses were used to estimate the associations between the health literacy score, number of chronic conditions and UJACAS scores. We constructed four models with the active aging score as the outcome: Model 1 included demographic factors (gender, age, length of education and living alone); chronic conditions were added in Model 2; health literacy was added in Model 3; and, finally, the indicators of functioning (depressive symptoms, cognitive capacity and physical performance) were added in Model 4. We present the standardized betas and the adjusted R-squared.

In addition, using a general linear model, we compared the marginal means (with standard errors) of the active aging score between persons at different health literacy levels by the categories of chronic conditions. The marginal means were adjusted for gender, age, length of education, cognitive capacity, depressive symptoms and physical performance. All analyses were performed with IBM SPSS version 24 and statistical significance was set at 0.05.

**Results**

Characteristics of the 948 participants are presented in Table 1. The 75-year-olds showed the highest proportion of participants with sufficient health literacy (60.5%) and the 85-year-olds the highest proportion of those with inadequate health literacy (18.8%). Those with sufficient health literacy had the longest education, highest cognitive capacity, best physical performance and lowest number of depressive symptoms.

In the bivariate correlations analyses, when all participants were included in the analyses simultaneously, both the health literacy score and number of chronic conditions correlated with the active aging total score and all its four sub-scores; see Table 2.The correlations by age group between the health literacy score, active aging total score, and all four sub-scores were modest but statistically significant, indicating that higher health literacy was associated with higher scores on the active aging scale: the lower the number of chronic conditions, the higher the active aging score. The correlations between number of chronic conditions and the active aging total score and sub-scores were statistically significant for all participants combined. When analyzed by age, the will to act sub-score did not correlate with number of chronic conditions in the 75-year-olds. Among the 80-year-olds, the will to act and level of activity sub-scores did not correlate with number of chronic conditions, and among the 85-year-olds the only statistically significant correlation was between the ability to act sub-score

and number of chronic conditions. Because of the parallel correlations between health literacy and the active aging sub-scores, further analyses were run only for the active aging total score.

The results of the linear regression models are presented in Table 3. The first model included the demographic variables (gender, age, length of education and living alone). In Model 2, the variable number of chronic conditions was added and showed a negative association with the active aging total score (β -0.21, $p<0.001$). Model 3 also included the health literacy score, which was associated with the higher active aging total score (β 0.34, $p<0.001$), while the association with number of chronic conditions, although somewhat attenuated, remained statistically significant (β -0.17, $p<0.001$). In the final model, the further addition of cognitive capacity, depressive symptoms and physical performance attenuated the coefficients of health literacy (β 0.18, $p<0.001$) and chronic conditions (β -0.06, $p=0.021$), although they remained statistically significant. The adjusted R-squared for the final model was 0.44.

The marginal means and standard errors of the active aging score among persons with different health literacy levels by the chronic condition categories are shown in Figure 1. In each chronic condition category, the participants with sufficient health literacy had significantly higher active aging scores than those with problematic or inadequate health literacy. However, the marginal means of participants in any of the health literacy levels did not differ statistically significantly across the chronic condition categories.

**Discussion**

Our findings suggest that higher levels of health literacy may enable older persons to maintain higher levels of active aging, including those with multiple chronic conditions. To our knowledge, this is the first study to address the association between health literacy and active aging. The present results, together with our earlier findings that higher active aging scores coincide with better quality of life (Rantanen, et al., 2018), support the speculation that health literacy is an asset for leading an active and good life in old age, irrespective of the number of chronic conditions.

In line with previous studies (Tiller et al., 2015; Vogt et al., 2017), the mean number of chronic conditions was highest among those with inadequate health literacy and lowest among those with sufficient health literacy. A novel finding was that higher health literacy

was associated with higher active aging scores including also persons with chronic conditions. Potentially, the better resources and self-care skills of individuals with good health literacy may underlie the related outcome of more positive perception of active aging (Osborn et al., 2011). Health literacy may also capture an individual's resources for coping with illnesses, such as dealing with medications and visiting health care services for regular check-ups. Moreover, it is possible that persons with higher health literacy also possess other resources that enable them to find ways to continue engaging in activities meaningful to them irrespective of chronic conditions. (Siltanen et al., 2019; Tourunen et al., 2019). This explanation is in line with our finding that in each of the chronic conditions categories (0-1, 2, 3, 4, 5 or 6 chronic conditions), the highest marginal means of the active aging scores were among those with sufficient health literacy.

While the highest active aging scores were observed among those with sufficient health literacy and no or only one chronic condition, their scores did not differ statistically significantly from those of persons with sufficient health literacy in any of the other chronic conditions categories. Thus, it seems that high health literacy buffers against the negative consequences of chronic conditions, irrespective of their number. Our findings are also in line with results from the large European health literacy project HLS-EU, in which health literacy was associated with less limitations from chronic conditions (Sorensen et al., 2015). There are several possible reasons for this. First, because we simply summed the number of chronic conditions, we were unable to assess the relative importance of different clusters of chronic conditions (Fabbri et al., 2015). Second, we did not have information on the severity of each reported condition. Chronic conditions per se do not render a person unable to live an active life in old age; however, they may necessitate adjustments and adaptations that impair individuals' opportunities to participate in meaningful activities (Hedman et al., 2015). Our results suggest that health literacy plays an important role in this process, even when other factors impose a strain on the capacity of an older person. Moreover, although depressive symptoms and physical performance showed notably high associations with the active aging scores, the association between health literacy and active aging remained statistically significant even after the models were adjusted for these factors.

An older person with chronic conditions is often a client of a health care professional. Persons with low health literacy are more frequent users of medical consultations (Tiller et al., 2015), probably because low health literacy is a barrier to managing multiple chronic condi-

tions independently (McGilton et al., 2018). To respond to the individual needs of older patients requires that health care workers adapt their communication according to the client's level of health literacy. However, health professionals working in different organizations may not always have the competence to identify patients and clients who have health literacy problems. This in turn may lead to further difficulties in communication and non-optimal management of their conditions or life situation (Kaper et al., 2019). For instance, older persons with chronic conditions may receive conflicting advice from different health professionals, such as recommendations for and warnings against physical activity (Hirvensalo et al., 2005). Health literacy should not be seen solely as a characteristic of an individual, but also as a result of the interaction between the individual and health care systems, organizations and professionals. Hence, enhancing health literacy among older persons in a productive way also needs input at the system level (van der Heide et al., 2018).

*Strengths and limitations*

A major strength of this study was the large population-based sample. The participation rate was 36.6%, which was typical for a study involving older persons. Moreover, the novel measure of active aging has been validated (Rantanen et al., 2018). The potential and suitability of the activity items to indicate variance was confirmed in a thorough process involving researchers and older persons (Rantanen et al, 2018). The health literacy questionnaire that we used has been shown to be suitable for assessing older Finns (Eronen et al., 2019). Data were collected in face-to-face interviews, thereby enabling clarification of questions when needed. Conducting the interview in participants' homes made it easier for persons with mobility difficulties to participate.

Some limitations need to be considered. This was a cross-sectional study and therefore we cannot assume any causality between the study variables. Although, as suggested by Koroukian et al. (2016), we included a wide variety of chronic conditions, we did not know the severity of each condition or how strong an impact specific conditions had on people's lives, and therefore the number of chronic conditions alone does not provide a complete picture of the disease burden of our participants. In addition, our participants were predominantly ethnic Finns and therefore the results warrant confirmation in other cultures.

## Conclusions

Finding ways to optimize active aging is important. Health literacy is one asset that can empower older adults to lead an active life – irrespective of their chronic conditions. These results lay a foundation for an entirely new area of study and justify further prospective and experimental research focusing on the possibility to enhance health outcomes by improving health literacy among older adults and developing health literacy interventions.

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**Data availability**

After completion of the study, data will be stored at the Finnish Social Science Data Archive without potential identifiers (open access). Until then, pseudonymized datasets are available to external collaborators upon agreement on the terms of data use and publication of results. To request the data please contact Professor Taina Rantanen (taina.rantanen@jyu.fi).

**Conflict of interest**

The authors declare no conflicts of interest.

**Table 1.** Participant characteristics by health literacy level (n=948); 2017-2018, Finland.

| | **Health literacy level** | | | |
|---|---|---|---|---|
| | Inadequate (n=112) | Problem-atic (n=335) | Sufficient (n=501) | p-value |
| | % | % | % | |
| **Women** | 56.3 | 60.1 | 56.6 | 0.564 |
| **Lives alone** | 45.5 | 43.6 | 37.7 | 0.127 |
| **Family caregiver** | 8.0 | 8.9 | 9.6 | 0.862 |
| **Age group** | | | | **<0.001** |
| **75** | 8.4 | 31.2 | 60.5 | |
| **80** | 12.5 | 38.3 | 49.2 | |
| **85** | 18.8 | 40.6 | 40.6 | |
| N**umber of chronic conditions** | | | | 0.232 |
| **0-1** | 9.4 | 32.9 | 57.6 | |
| **2** | 11.8 | 32.8 | 55.4 | |
| **3** | 8.7 | 31.8 | 59.5 | |
| **4** | 14.4 | 38.1 | 47.5 | |
| **5** | 12.5 | 39.3 | 48.2 | |
| **6 or more** | 15.2 | 39.9 | 44.9 | |
| | mean (SD) | mean (SD) | mean (SD) | |
| **Years of education** | 10.4 (3.6) | 11.0 (4.1) | 12.3 (5.1) | **<0.001** |
| **Cognitive capacity (MMSE)** | 26.7 (2.4) | 26.8 (2.6) | 27.6 (2.1) | **<0.001** |
| **Depressive symptoms (CES-D)** | 12.7 (9.1) | 10.0 (7.6) | 6.8 (5.6) | **<0.001** |

**Table 2.** Bivariate correlations between health literacy score (HL), number of chronic conditions (CC) and active aging total score (UJACAS) and its four sub-scores for all participants (n=948) and by age groups of 75 (n=443), 80 (n=313) and 85 (n=192) years; 2017-2018, Finland.

| | **All participants** | | **75** | | **80** | | **85** | |
|---|---|---|---|---|---|---|---|---|
| | HL | CC | HL | CC | HL | CC | HL | CC |
| **UJACAS total score** | 0.40[b] | -0.21[b] | 0.37[b] | -0.22[b] | 0.43[b] | -0.17[a] | 0.31[b] | -0.13 |
| **Will** | 0.28[b] | -0.08[a] | 0.27[b] | -0.06 | 0.31[b] | -0.08 | 0.17[a] | -0.02 |
| **Ability** | 0.37[b] | -0.27[b] | 0.31[b] | -0.32[b] | 0.38[b] | -0.20[b] | 0.34[b] | -0.20[a] |
| **Possibility** | 0.40[b] | -0.23[b] | 0.37[b] | -0.24[b] | 0.40[b] | -0.19[a] | 0.31[b] | -0.17[a] |
| **Frequency** | 0.31[b] | -0.12[b] | 0.27[b] | -0.12[a] | 0.34[b] | -0.10 | 0.25[b] | -0.05 |

[a] $p<0.05$, [b] $p<0.001$

**Table 3.** Linear regression models of the associations of demographic factors (gender, age, length of education and living alone), chronic conditions, health literacy and indicators of health and functioning (cognitive capacity, depressive symptoms, physical performance) with active aging total score; 2017-2018, Finland.

| | **Model 1** | | **Model 2** | | **Model 3** | | **Model 4** | |
|---|---|---|---|---|---|---|---|---|
| | $R^2$= 0.096 | | $R^2$=0.136 | | $R^2$ =0.241 | | $R^2$=0.438 | |
| | β | p-value | β | p-value | β | p-value | β | p-value |
| **Gender** | 0.04 | 0.240 | 0.06 | 0.091 | 0.05 | 0.095 | **0.060** | **0.022** |
| **Age** | | | | | | | | |
| • **75** | **0.27** | **<0.001** | **0.23** | **<0.001** | **0.18** | **<0.001** | **0.08** | **0.035** |
| • **80** | **0.17** | **<0.001** | **0.15** | **<0.001** | **0.14** | **0.001** | 0.06 | 0.103 |
| **Length of education** | **0.17** | **<0.001** | **0.16** | **<0.001** | **0.11** | **<0.001** | **0.08** | **0.004** |
| **Living alone** | **0.11** | **0.002** | **0.10** | **0.002** | **0.09** | **0.004** | 0.024 | 0.375 |
| **Number of chronic conditions** | | | **-0.21** | **<0.001** | **-0.17** | **<0.001** | **-0.06** | **0.021** |
| **Health literacy score** | | | | | **0.034** | **<0.001** | **0.18** | **<0.001** |
| **Cognitive capacity** | | | | | | | **0.13** | **<0.001** |
| **Depressive symptoms** | | | | | | | **-0.29** | **<0.001** |
| **Physical performance** | | | | | | | **0.29** | **<0.001** |

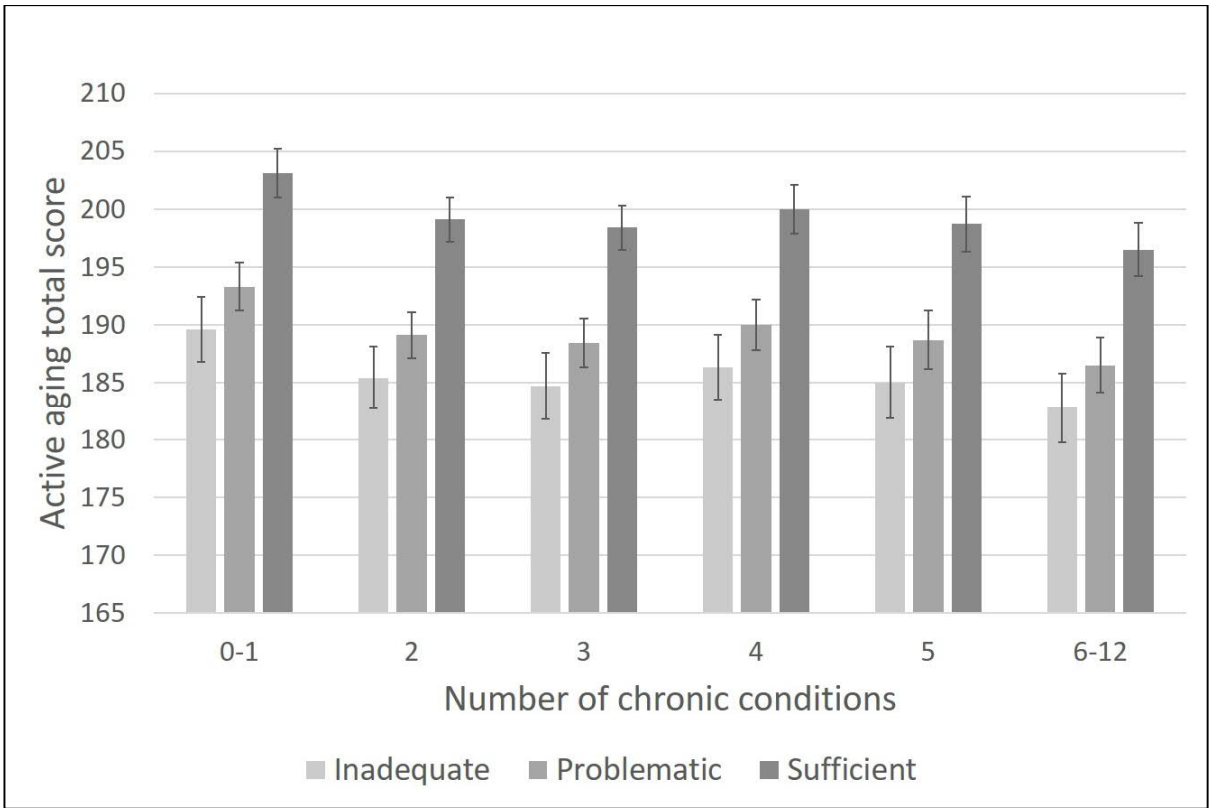


**Figure 1.** Marginal means of the active aging total score with standard errors in the six categories of chronic conditions by level of health literacy; 2017-2018, Finland.

## References


Aaby A, Beauchamp A, O'Hara J, Maindal HT. Large diversity in Danish health literacy profiles: perspectives of long-term illness and multimorbidity. Eur J Public Health 2020; 30(1): 75-80. doi: 10.1093/eurpub/ckz134

Beekman AT, Deeg DJ, Van Limbeek J, Braam AW, De Wries MZ, Van Tilburg W. Criterion validity of the Center for the Epidemiologic Studies Depression Scale (CES-D): Results from a community-based sample of older subjects in the Netherlands. Psychol Med 1997; 27:231-5. doi: 10.1017/s0033291796003510

Chang AY, Skirbekk VF, Tyrovolas S, Kassebaum NJ, Dieleman JL. Measuring population ageing: an analysis of the Global Burden of Disease Study 2017. Lancet Public Health 2019; 4(3): e159-e167. doi: 10.1016/S2468-2667(19)30019-2

Coleman PG. Aging and the satisfaction of psychological needs. Psychol Inq 2000; 11(4): 291-293. https://www.jstor.org/stable/1449623

DuGoff EH, Canudas-Romo V, Buttorff C, Leff B, Anderson GF. Multiple chronic conditions and life expectancy: a life table analysis. Med Care 2014; 52(8): 688-694. doi: 10.1097/MLR.0000000000000166

Ehni HJ, Kadi S, Schermer M, Venkatapuram S.Toward a global geroethics - gerontology and the theory of the good human life. Bioethics 2018; 32(4): 261-268. doi: 10.1111/bioe.12445

Eronen J, Paakkari L, Portegijs E, Saajanaho M, Rantanen T. Assessment of health literacy among older Finns. Aging Clin Exp Res 2019; 31(4): 549-556. doi: 10.1007/s40520-018-1104-9

Fabbri E, Soli M, Gonzalez-Freire M, Salive ME, Studenti SA, Ferruzzi L. Aging and Multimorbidity: New Tasks, Priorities and Frontiers for Integrated Gerontological and Clinical Research. J Am Med Dir Assoc 2015; 16(8): 640-647. doi: 10.1016/j.jamda.2015.03.013

Folstein MF, Folstein SE, McHigh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiat Res 1975; 12: 189-198. doi: 10.1037/t07757-000

Foster L, Walker A. Active and Successful Aging: A European Policy Perspective. Gerontologist 2015; 55 (1): 83-90. doi: 10.1093/geront/gnu028

Gattuso S. Becoming a wise old woman: resilience and wellness in later life. Health Sociol Rev 2003; 12(2): 171-177. doi: 10.5172/hesr.12.2.171

Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol A-Biol 1994; 49: M85-94. doi: 10.1093/gerona/52A.5.M275

Hedman M, Pöser U, Mamhidir A-G, Nilsson A, Kristofferson M-L, Häggström E. Life memories and the ability to act: the meaning of autonomy and participation for older people when living with chronic illness. Scand J Caring Sci 2015; 29(4): 824-833. doi: 10.1111/scs.12215

van der Heide I, Poureslami I, Mitic W, Shum J, Rootman I, FitzGerald JM. Health literacy in chronic disease management: a matter of interaction. J Clin Epidemiol 2018; 102: 134-138. doi: 10.1016/j.jclinepi.2018.05.010

Heijmans M, Waverjin G, Rademakers J, van der Vaart R, Rijken M. Functional, communicative and critical health literacy of chronic disease patients and their importance for self-management. Patient Educ Couns 2015; 98(1): 41-48. doi: 10.1016/j.pec.2014.10.006

Hirvensalo M, Heikkinen E, Lintunen T, Rantanen T. Recommendations for and warnings against physical activity given to older people by health care professionals. Prev Med 2005; 41(1): 342-347. doi: 10.1016/j.ypmed.2004.11.020

Holstein MB, Minkler M. Self, society and the "new gerontology". Gerontologist 2003; 43(6): 787-796. doi: 10.1093/geront/43.6.787.

Iwasa H, Yoshida Y. Actual Conditions of Leisure Activity Among Older Community-Dwelling Japanese Adults. Gerontol Geriatr Med 2018; 4: 1-11. doi 10.1177/2333721418781677

Kaper MS, de Winter AF, Bevilacqua R, Giammarchi C, McCusker A, Sixsmith J, Koot JAR, Reijnevald SA. Positive Outcomes of a Comprehensive Health Literacy Communication Training for Health Professionals in Three European Countries: A Multi-centre Pre-post Intervention Study. Int J Env Res Pub He 2019; 46(20): 3923. doi: 10.3390/ijerph16203923

Kobayashi LC, Wardle J, Wolf MS, von Wagner C. Health Literacy and Moderate to Vigorous Physical Activity During Aging, 2004-2013. Am J Prev Med 2016; 51(4): 463-472. doi: 10.1016/j.amepre.2016.02.034

Koroukian SM, Schiltz N, Warner DF, Sun J, Bakaki PM, Smyth KA, Stange KC, Given CW. Combinations of Chronic Conditions, Functional Limitations, and Geriatric Syndromes that Predict Health Outcomes. J Gen Intern Med 2016; 31(6): 630-637. doi: 10.1007/s11606-016-3590-9

Marengoni A, Angleman S, Melis R, Mangialasche F, Karp Am Garmen A, Meinow B, Fratiglioni L. Aging with multimorbidity: A systematic review of the literature. Ageing Res Rev 2011; 10(4): 430-439. doi: 10.1016/j.arr.2011.03.003

McGilton KS, Vellani S, Yeung L, Chishtie J, Commisso E, Ploeg J, Andrew MK, Ayala AP, Gray M, Morgan D, Froehlich Chow A, Parrot E, Stephens D, Hale L, Keatings M, Walker J, Wodchis WP, Dube V, McElhaney J, Puts M. Identifying and understanding the health and social care needs of older adults with multiple chronic conditions and their caregivers: a scoping review. BMC Geriat 2018, 231. doi: 10.1186/s12877-018-0925-x

Morgan A, Ziglio E. Revitalizing the evidence for public health: an assets model. Glob Health Promot 2007; 14(2): 17-22. doi: 10.1177/10253823070140020701x

Musich S, Wang SS, Kraemer S, Hawkins K, Wicker E. Purpose in Life and Positive Health Outcomes Among Older Adults. Popul Health Manag 2018; 21(2): 139-147. doi: 10.1089/pop.2017.0063

Nutbeam D. The evolving concept of health literacy. Soc Sci Med 2008; 67(12): 2072-2078. doi: 10.1016/j.socscimed.2008.09.050

Osborn CY, Paasche-Orlow M, Cooper Bailey S, Wolf MS. The mechanisms linking health literacy to behavior and health status. Am J Health Behav 2011; 35(1): 118-128. doi: 10.5993/AJHB.35.1.11

Pelikan J, Röthlin F, Ganahl K. Measuring comprehensive health literacy in general populations: validation of instrument, indices and scales of the HLS-EU study. Presentation at the 6th Annual Health Literacy Research Conference, November 3-4, 2014, Bethesda, Maryland, US. https://www.bumc.bu.edu/healthliteracyconference/files/2014/06/Pelikan-et-al-HARC-2014-fin.pdf . Accessed September 10, 2020.

Portegijs E, Karavirta L, Saajanaho M, Rantalainen T, Rantanen T. Assessing physical performance and physical activity in large population-based aging studies: home-based assessments or visits to the research center? BMC Public Health 2019, 1570. doi: 10.1186/s12889-019-7869-8

Radloff LS. The CES-D scale - a self-report depression scale for research in the general population. Appl Psych Meas 1977; 1(3): 385-401. doi: 10.1177/014662167700100306

Rantanen T, Saajanaho M, Karavirta L, Siltanen S, Rantakokko M, Viljanen A, Rantalainen T, Pynnönen K, Karvonen A, Lisko I, Palmberg L, Eronen J, Palonen E-M; Hinrichs T, Kauppinen M, Kokko K, Portegijs E. Active aging - resilience and external support as modifiers of the disablement outcome: AGNES cohort study protocol. BMC Public Health 2018; 565. doi: 10.1186/s12889-018-5487-5

Rantanen T, Portegijs E, Kokko K, Rantakokko M, Törmäkangas T, Saajanaho M. Developing an assessment method of active aging: University of Jyvaskyla Active Aging Scale. J Aging Health 2018, 31(6): 1002-1024. doi: 10.1177/0898264317750449

Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and wellbeing. Am Psychol 2000; 55(1): 68-78. doi: 10.1037/0003-066X.55.1.68

Siltanen S, Portegijs E, Saajanaho M, Poranen-Clark T, Viljanen A, Rantakokko M, Rantanen T. The combined effect of lower-extremity function and cognitive performance on perceived walking ability among older people: a 2-year follow-up study. J Gerontol A-Biol 2018; 73(11): 1568-1573. doi: 10.1093/gerona/gly103

Smith SG, O'Connor R, Curtis LM, Waite K, Deary IJ, Paasche-Orlow M, Wolf M. Low health literacy predicts decline in physical function among older adults: findings from the LitCog cohort study. J Epidemiol Commun H 2015; 69(5): 474-480. doi: 10.1136/jech-2014-204915

Sorensen K, van de Broucke S, Fullam J, Doyle G, Pelikan J, Slonska S, Brand H. Health literacy and public health: A systematic review and integration of definitions and models. BMC Public Health 2012, 80. doi: 10.1186/1471-2458-12-80

Sorensen K, van den Broucke S, Pelikan J, Fullam J, Doyle G, Slonska S, Kondilis B, Stoffels V, Osborne RH, Brand H. Measuring health literacy in populations: illuminating the design and development process of the European Health Literacy Survey Questionnaire (HLS-EU-Q). BMC Public Health 2013, 948. doi: 10.1186/1471-2458-13-948

Stephens C, Breheny M, Mansvelt J. Healthy aging from the perspective of older people: A capability approach to resilience. Psychol Health 2015; 30(6): 715-731. doi: 10.1080/08870446.2014.904862

Tiller D, Herzog B, Kluttig A, Haerting J. Health literacy in an urban elderly East-German population - results from the population-based CARLA study. BMC Public Health 2015, 833. doi: 10.1186/s12889-015-2210-7

Tourunen A, Siltanen S, Portegijs E, Eronen J, Rantanen T, Saajanaho M. Assimilative and Accommodative Coping and Older People's Leisure Activities. J Aging Health 2019; e-pub ahead of print. doi: 10.1177/0898264319852002

Vogt D, Schaeffer D, Messer M, Berens EM, Hurrelmann K. Health literacy in old age: results of a German cross-sectional study. Health Promot Int 2017; 33(5): 739-747. doi: 10.1093/heapro/dax012

Wijers IGM, Ayala A, Rodrigues-Blazquez C, Rodrigues-Laso A, Rodrigues-Garcia P, Prados-Torres A, Rodrigues-Rodrigues V, Forjaz MJ. The Disease Burden Morbidity Assessment in older adults and its association with mortality and other health outcomes. Eur J Ageing 2019; 16(2): 193-203. doi: 10.1007/s10433-018-0491-2

World Health Organization. Towards a common language for functioning, disability and health: ICF. WHO 2002. https://www.who.int/classifications/icf/icfbeginnersguide.pdf?ua=1 . Accessed September 10, 2020.

World Health Organization. Multimorbidity. Technical Series on Safer Primary Care. WHO 2016. https://apps.who.int/iris/bitstream/handle/10665/252275/9789241511650-eng.pdf?sequence=1 . Accessed September 10, 2020.

World Health Organization Regional Office for Europe. Draft WHO European Roadmap for implementation of health literacy initiatives through the life course. WHO 2019. https://www.euro.who.int/__data/assets/pdf_file/0003/409125/69wd14e_Rev1_RoadmapOnHealthLiteracy_190323.pdf Accessed September 10, 2020.

Zaidi A, Gasior K, Hofmarcher MM, Lelkes O, Marin B, Rodrigues R, Schmidt A, Vanhuysse P, Zolyomi E. Active Ageing Index 2012 Concept, Methodology and Final Results. European Centre for social welfare policy 2013. http://citeseerx.ist.psu.edu/viewdoc/versions?doi=10.1.1.360.9488 Accessed 10 September, 2020.

Zaidi A, Gasior K, Zolyomi AS, Rodrigues R, Marin B. Measuring active and healthy aging in Europe. J Eur Soc Policy 2017; 27(2): 138-157. doi: 10.1177/0958928716676550