JAMDA 20 (2019) 988–994

JAMDA

journal homepage: www.jamda.com

Original Study

Using an Integrated Clinical and Functional Assessment Tool to Describe the Use of Social and Medical Care in an Urban Community-Dwelling Swedish Older Population

Giola Santoni PhD [a], Bettina Meinow PhD [b,c], Anders Wimo MD, PhD [d,e], Alessandra Marengoni MD, PhD [a,f], Laura Fratiglioni MD, PhD [b,c], Amaia Calderón-Larrañaga PhD [b,*]

[a] Department of Molecular Medicine and Surgery, Karolinska Institutet, Karolinska University Hospital, Sweden
[b] Aging Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet and Stockholm University, Sweden
[c] Stockholm Gerontology Research Center, Sweden
[d] Center for Alzheimer Research, Division of Neurogeriatrics, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Sweden
[e] Center for Research and Development Uppsala University and the County Council of Gävleborg, Sweden
[f] Department of Clinical and Experimental Sciences, University of Brescia, Italy

Keywords:
Geriatric assessment
delivery of healthcare
home care services
Sweden

A B S T R A C T

Objectives: To describe the use of social and medical care services in a community-dwelling older population from Stockholm, Sweden, using an integrated clinical and functional assessment tool.
Design: Study based on data from the longitudinal community-based Swedish National Study on Aging and Care in Kungsholmen.
Setting and Participants: Random sample of people >65 years of age living in the community in central Stockholm between March 2001 and June 2004 (N = 2368).
Measures: Health status was measured with a health assessment tool (HAT), which combines 5 indicators (gait speed, cognitive function, chronic multimorbidity, mild disability, severe disability) collected during Swedish National Study on Aging and Care in Kungsholmen clinical examinations. The amount of formal and informal social care was self-reported in hours per month and recorded by trained nurses at baseline and the 3-year follow-up for those ≥78 years of age at baseline. Data on hospital admissions, 30-day readmissions, days spent in the hospital, primary care visits, and specialist visits were obtained from Stockholm County Council registers (2001–2007).
Results: At baseline, 10% of the sample received formal social care and 11% received informal care. Annually between baseline and the 3-year follow-up, 15% were admitted to the hospital, 5% were readmitted, 78% visited a specialist, and 89% visited primary care. Those with the best HAT scores received 0.02 hours/month of formal care; those with the worst, 34 h/mo. The corresponding numbers for other variables were 0.02 vs 73 h/mo of informal care, 2 vs 11 hospital admissions per 10 persons/year, 44 vs 226 hospital days per 10 persons/y, 0.4 vs 2 30-day readmissions per 10 persons/y, 37 vs 78 specialist visits per 10 persons/y, and 50 vs 327 primary care visits per 10 persons/y.
Conclusions/Implications: Because of its high discriminative power, the easy-to-use HAT index could help decision makers to plan medical and social care services.

The older the age group, the greater the diversity found in whatever indicator of health or living condition is analyzed. Accordingly, a thorough measure of people's health and functional ability has proven to be a better predictor of medical and social care needs and use than chronological age.[1]

Health is a multidimensional concept and different health domains are related to the need for different types of care. Increasing age is related to an increasing number of diseases and a progressive decrease in mobility and strength, but the late appearance of mental and

This work was supported by the funders of the Swedish National study on Aging and Care (SNAC): the Ministry of Health and Social Affairs, Sweden; the participating County Councils and Municipalities; and the Swedish Research Council. A specific grant was obtained from the Swedish Research Council for Health, Working Life and Welfare (2017-01764).
The authors declare no conflicts of interest.
* Address correspondence to Amaia Calderón-Larrañaga, PhD, Aging Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Tomtebodavägen 18 A, floor 10, 171 65 Solna, Sweden.
E-mail address: amaia.calderon.larranaga@ki.se (A. Calderón-Larrañaga).

https://doi.org/10.1016/j.jamda.2018.11.017

physical impairment.[2] Disease-based clinical measures such as the presence of chronic conditions, and particularly the coexistence of such conditions in one person (ie, multimorbidity), are important determinants of medical care use.[3,4] However, such measures capture both individuals who, with treatment, are able to function well and live independently, and those who face extensive functional loss. On the other hand, health problems that imply a need for long-term care are not necessarily attributable to a specific disease and are not always treatable (eg, fatigue, dizziness, walking difficulties). Thus, to reflect a broader range of needs for medical and social care in older populations, there is a need for composite health measures that take into account several health dimensions, including diseases, physical, functional, and cognitive limitations as well as disabilities.[5–9]

These different dimensions of health, along with their varying distributions and potential cut-offs, were recently integrated into a comprehensive health assessment tool (HAT).[10] The HAT index combines 5 health indicators routinely collected as part of a comprehensive geriatric assessment (gait speed, cognitive function, chronic multimorbidity, mild disability, and severe disability). It can be used not only to assess and follow health and functioning in older adults, but also to estimate their present and future care needs. HAT has proven to consistently predict medical and social care service use better than any of its individual components.[11]

Sweden has a comprehensive, largely tax-financed system of social care for older people comprising home-based eldercare and nursing homes. Home-help aims to support older people in their daily life and enable them to stay in their own home as long as possible, which is in line with a general ambition of supporting people to "age in place".[12] It covers both personal care and practical help around the clock and can be complemented by primary care providing nursing care in the homes. A needs-assessor delegated by the municipal social welfare committee performs a needs-assessment of each person's social care needs.

Despite unchanged legislation and official aspirations since the 1980s, resources in the Swedish eldercare system have not kept pace with the growth of the number of the oldest old in the population.[13] The reduction in social care has been particularly pronounced regarding nursing homes, while the decrease in the provision of home-help has been more limited.[14] In addition, the number of hospital beds as well as the average length of stay has decreased drastically.[15,16] As an increasing number and proportion of older people with extensive care needs are living in the community, a more personalized characterization of their medical and social care needs is crucial, not only to guide future health and social policy, but also to provide decision- and policy-makers with tools to adapt care to the changing needs of older patients.

This study investigates medical and social formal and informal care use in relation to a multidimensional health assessment tool (ie, HAT) in a community-dwelling older population in the context of the Swedish welfare-regime, with its guiding principle of providing comprehensive, publicly subsidized, and needs-based services.

Methods

Study Population

The study is based on data from the Swedish National study on Aging and Care, Kungsholmen (SNAC-K),[17] a longitudinal study of the population ≥60 years of age living in an inner-city district of Stockholm. Baseline data were randomly collected from 11 age strata (60, 66, 72, 78, 81, 85, 87, 90, 93, 96, and 99+ years) between March 2001 and June 2004. The youngest and oldest age cohorts were oversampled. Of the 4590 people eligible and alive at time of examination, 3363 participated in the study (participation rate, 73%). Baseline differences between participants and nonparticipants have been reported elsewhere.[10] Briefly, nonparticipants were more likely than participants to die within 2 years of the start of the study than after 6 years in all age cohorts except the nonagenarian cohort. After baseline data collection, participants have been followed regularly every 6 years if they were <78 years of age and every 3 years if they were ≥78 years of age. Because nursing homes also provide some medical care, which hampers the comparability of medical care use between community-dwelling and institutionalized individuals, the analyses in this study were restricted to people aged >65 years living in the community both at baseline and at the 3-year follow-up (N = 2368). After excluding those missing HAT scores, 2179 participants (2179/2368 = 92%) were still available for the analyses. At the 3-year follow-up, out of the 1178 participants ≥78 years of age, 935 were still alive and 811 participated (811/935 = 86.7%). Figure 1 provides a detailed description of the study population and the sample used in each analysis.

The study was approved by the Regional Ethics Review Board in Stockholm. Participants in the study completed a written informed consent form as stipulated in the ethical approval. For participants with prevalent or incident cognitive impairment, consent was obtained from the next of kin.

HAT Scores

As described previously,[10] HAT combines 5 health indicators using nominal response models: (1) severe disability measured as the number of activities of daily living (ADL) (bathing, dressing, toileting, transferring, and eating) a person was not able to perform independently; (2) mild disability measured as the number of instrumental ADL (IADL) (grocery shopping, managing money, using the telephone, and using public transportation) a person was not able to perform independently; (3) cognitive functioning measured with the Mini-Mental State Examination scale, which ranges from 30 (good cognitive functioning) to 0 (poor cognitive functioning); (4) physical functioning measured as the time it takes to walk 6 meters (m) or 2.44 m if participants rated their walking speed as slow; and (5) morbidity status measured as the number of chronic diseases (diseases that were prolonged; that left residual disability; that worsened quality of life; or that required a long period of care, treatment, or rehabilitation). HAT scores range from 0 (bad health) to 10 (good health) and were divided into 5 categories: severe functional dependence (HAT = 0–2.9), mild functional dependence (HAT = 3–4.9), compromised physical functioning with morbidity or multimorbidity or medium cognitive functioning (HAT = 5–6.9), light decreased physical or cognitive functioning with some morbidities (HAT = 7–8.9), and good physical functioning with no or few diseases (HAT = 9–10). A more detailed description of the statistical methods applied to calculate HAT scores is provided in Supplementary Appendix.

Use of social care services

At baseline and the 3-year follow-up, participants reported whether they received formal or/and informal social care. Formal social care includes help with household chores and personal care. It is financed by the municipality and may be delivered either by the municipality or a private company that has a contract with the municipality. Informal social care is service or care assistance from relatives, friends, neighbors, or volunteer/nonprofit organizations. The amount of formal and informal care a person received was recorded as hours per month using the Resource Utilization in Dementia instrument, which has been extensively validated for analyzing time used for care.[18]

Use of Medical Care Services

The Stockholm County Council provided data on medical care use for the period 2001 to 2007. Three outcome variables were based on

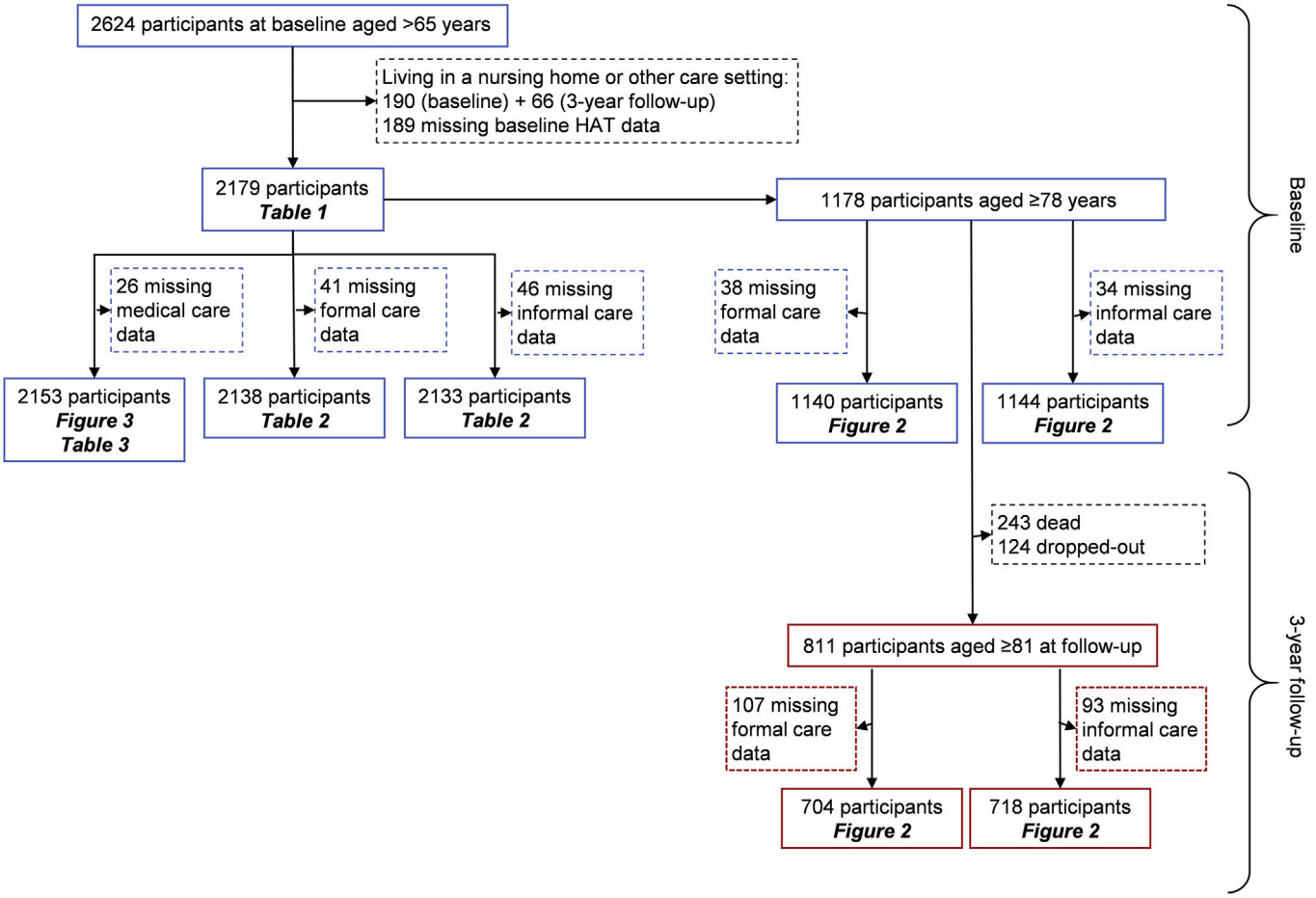

Fig. 1. Flowchart of the study population.

the inpatient register: (1) the number of hospital admissions during 3 years after baseline (data available for 2153 people), (2) the number of days spent in the hospital during the 3 years after baseline for those people admitted to the hospital at least once (data available for 983 people), and (3) the number of unplanned readmissions within 30 days of hospital discharge of people who were admitted to the hospital at least once (data available for 983 people). Two outcome measures were derived from the outpatient register: (1) the number of specialist visits during the 3 years after baseline (including physicians from all specialties except family medicine) and (2) the number of primary care visits during the 3 years after baseline (including visits to general practitioners, nurses, physiotherapists, occupational therapists, and other paramedical professionals).

Statistical Analyses

We used logistic regression to explore differences in demographic and educational characteristics of people missing information on any HAT indicator and people with complete data. Missing status was the dependent variable in this analysis; and age, sex, and education (ie, elementary school vs high-school or above) were the independent variables. Negative binomial regressions were used to estimate whether there was a difference in medical or baseline social formal/informal care use between participants with missing HAT and participants with complete HAT data. The analyses were adjusted data by age, sex, their interaction terms if significant, and exposure time.

Differences in personal characteristics and use of social and medical services by HAT score were analyzed with logistic regression for categorical variables and with linear regression for continuous variables. The HAT score was the independent variable, included as a 5-group categorical variable. To make the results representative of the original sampling population, the analyses were weighted with respect to the age and sex distribution of the community-dwelling population of Stockholm between 2001 and 2004.

The average hours/month of social formal and informal care at baseline and at the 3-year assessment was estimated with linear regression with robust standard error estimations. The baseline assessment was further analyzed to derive the average change in care use by the 5 HAT categories, stratified by age (dichotomized as people aged 66–72 and $\geq$ 78 years).

Likewise, the weighted annual average number of hospital admissions, hospital days, 30-day unplanned readmissions, specialist visits, and primary care visits per 10 people were estimated using negative binomial regression models including the 5 HAT categories as the independent variable. Exposure time was 3 years or the time between baseline and the date of death if shorter than 3 years. In further analyses, all models were stratified by age and sex to obtain the incidence rate ratios of medical care service use by HAT category.

Results

Analysis of Missing Data

Fifty-nine percent of the 189 participants missing a HAT score were missing data only on gait speed; 15% missed data only on IADL. Analyses of the differences between the participants missing a HAT

Table 1
Participants Living in the Community: Sociodemographic Characteristics, Clinical Characteristics, and Use of Social and Medical Services by the HAT Score

	Total	HAT Score				
		Better Health 10–9	8.9–7	6.9–5	4.9–3	Worse Health 2.9–0
Number of Participants	2179	661	840	364	239	75
Characteristics at baseline						
Age, mean ± SD	77.4 ± 3.4	73.1 ± 5.2	77.2 ± 4.7	80.5 ± 5.2	83.2 ± 5.8	84.8 ± 8.3
Women, n (%)	1351 (62.0)	383 (57.9)	489 (58.2)	231 (63.4)	194 (81.0)	55 (73.9)
Education: high school or above, n (%)	1536 (70.5)	553 (83.6)	590 (70.2)	226 (62.2)	142 (59.4)	25 (33.9)
Number of chronic diseases, mean ± SD	1.99 ± 1.6	0.98 ± 1.2	2.04 ± 1.4	2.85 ± 1.6	2.85 ± 1.9	2.82 ± 2.0
MMSE score, mean ± SD	28.4 ± 2.4	29.6 ± 0.8	28.7 ± 1.4	27.5 ± 2.8	26.8 ± 3.3	22.5 ± 8.7
Gait speed (m/s), mean ± SD	0.96 ± 0.4	1.31 ± 0.2	1.02 ± 0.3	0.65 ± 0.3	0.43 ± 0.3	0.21 ± 0.3
IADL, mean ± SD	0.22 ± 0.6	none	none	0.10 ± 0.4	1.52 ± 0.7	2.52 ± 0.9
ADL, mean ± SD	0.03 ± 0.3	none	none	none	0.01 ± 0.1	1.47 ± 1.5
Use of social services at baseline						
≥1 h/mo of formal care, n (%)	219 (10.2)	2 (0.3)	21 (2.5)	43 (11.9)	130 (58.9)	47 (77.6)
≥1 h/mo of informal care, n (%)	241 (11.2)	3 (0.4)	41 (4.9)	58 (16.5)	119 (53.8)	41 (63.7)
Hospital admissions between baseline and 3-y follow-up						
≥1 admission/y, n (%)	321 (14.9)	36 (5.5)	103 (12.5)	64 (17.8)	77 (32.5)	40 (55.5)
≥1 30-d readmission*/y, n (%)	48 (4.9)	2 (0.8)	9 (2.7)	15 (7.3)	18 (10.6)	4 (6.6)
Outpatient care visits between baseline and 3-y follow-up						
≥1 specialist care visit/y, n (%)	1684 (78.2)	452 (69.1)	642 (77.7)	322 (88.9)	201 (84.8)	67 (92.2)
≥1 primary care visit/y, n (%)	1923 (89.3)	542 (82.7)	747 (90.5)	343 (94.7)	221 (93.2)	71 (96.8)

MMSE, Mini-Mental State Examination; SD, standard deviation.
Results are weighted with respect to the age and sex distribution of the population in Stockholm (excluding those living in nursing homes or other care settings) between 2001 and 2004.
All differences were statistically significant (P value $< .001$).
*Readmissions within 30 days of discharge. Calculated for people admitted to the hospital at least 1 time in the 3 years after baseline assessment (n = 983).

score and those with complete information showed that older participants had higher odds (odds ratio = 1.09, 95% confidence interval 1.07–1.11) of missing a HAT score than younger participants, but there was no significant difference by sex or education after adjusting for age. Participants missing a HAT score used more medical and social formal/informal care than other participants, although these differences decreased with age (not shown).

Characteristics of the Participants

Thirty percent of all 2179 participants had a HAT score between 9 and 10, which corresponds to good physical functioning and morbidity status (Table 1). Decreasing HAT scores were associated with an increasing proportion of women (from 58% to 74% women), decreasing proportion of highly educated people (from 84% to 34%), increasing mean number of chronic diseases (from 1 to 3 chronic diseases), a decreasing mean Mini-Mental State Examination score (from 30 to 23), decreasing gait speed (from 1.3 m/s to 0.2 m/s), and an increasing mean number of IADL (from 0 to 2.5) and ADL (from 0 to 1.5) limitations.

Formal and Informal Care Use

At the baseline assessment, 10% of the sample reported that they received formal social care (ie, home-help), and 11% reported that they received informal care (Table 1). Between baseline and the 3-year follow-up, 15% were admitted to the hospital at least once per year, 5% were readmitted to the hospital within 30 days of discharge at least once per year, 78% visited a specialist at least once per year, and 89% visited primary care at least once per year.

The use of social care services increased with worse health status both at baseline and the 3-year follow-up assessment. During the 3 years between baseline and follow-up, the most vulnerable older adults in the sample died. Thus, fewer total hours of care (and especially of informal care) were provided to participants in all HAT score categories at the 3-year follow-up than at baseline (Figure 2). In participants ≥78 years of age, the average difference in hours per month of formal care used between those with the worst and those with the best HAT scores was similar for men and women (Table 2). Differences in informal care use according to participant HAT score category were more accentuated in men than in women.

Medical Care Use

The use of medical care services also increased with worsening health status (ie, lower HAT scores), following a clear dose-response trend: hospital admissions increased from 2 per 10 persons/y in those with a HAT score of 9–10 to 11 per 10 persons/y in those with a HAT score of 0–2.9, hospital days from 44 to 226 per 10 persons/y, 30-day readmissions from 0.4 to 2 per 10 persons/y, specialist visits from 37 to 78 per 10 persons/year, and primary care visits from 50 to 327 per 10 persons/year (Figure 3). The increase in the use of medical services associated with worse HAT scores was similar in older men and older women (Table 3), although comparisons were at times hampered by the small sample size of certain groups of participants.

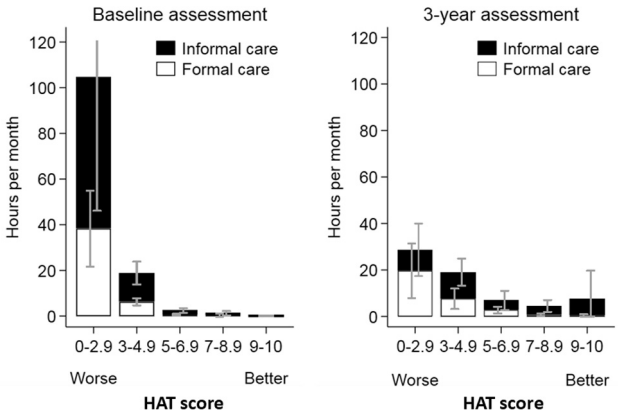

Fig. 2. Participants ≥78 years of age living in the community: hours per month of social formal and informal care at baseline assessment and at the 3-year follow-up assessment. Linear regression models were used to weigh results with respect to the age and sex distribution of the population of Stockholm (excluding those living in nursing homes or other care settings) between 2001 and 2004. The comparative analysis was limited to people ≥78 years of age at baseline because the 3-year follow-up outcome was available only for this group.

Table 2
Participants Living in the Community: Baseline Differences (with 95% CI) in Hours per Month of Social Formal and Informal Care by the HAT Score, Stratified by Sex and Age

		HAT Score	Formal Care		Informal Care	
			Number of Participants	Estimated Differences in h/mo (95% CI)	Number of Participants	Estimated Differences in h/mo (95% CI)
Men	66–72 y	0–2.9	2	4.00 (−1.59; 9.59)	1	7.98 (7.94; 8.02)
		3–4.9	5	3.20 (0.55; 5.85)	6	10.65 (−5.89, 27.19)
		5–6.9	33	0.24 (−0.23; 0.71)	32	23.23 (−17.66, 64.12)
		7–8.9	165	0.05 (−0.04; 0.15)	165	0.20 (−0.17; 0.57)
		9–10	207	Ref.	205	Ref.
	78+ y	0–2.9	9	29.78 (6.97; 52.58)	11	200.9 (−45.6, 447)
		3–4.9	31	4.87 (2.21; 7.53)	29	14.92 (1.04, 28.579)
		5–6.9	87	0.87 (0.26; 1.49)	87	0.69 (−0.11, 1.48)
		7–8.9	157	0.79 (−0.61; 2.19)	159	1.40 (−0.73, 3.53)
		9–10	53	Ref.	53	Ref.
Women	66–72 y	0–2.9	3	14.67 (−0.37; 29.70)	3	160.0 (62.71; 257)
		3–4.9	16	8.00 (0.75; 15.25)	16	12.56 (−1.17; 26.28)
		5–6.9	39	0.03 (−0.02; 0.08)	36	0.99 (−0.33; 2.32)
		7–8.9	219	0.03 (−0.00; 0.06)	217	0.20 (−0.07; 0.48)
		9–10	309	Ref.	308	Ref.
	78+ y	0–2.9	46	34.11 (22.80; 45.41)	50	40.60 (−11.76, 92.96)
		3–4.9	169	6.58 (5.03; 8.13)	171	10.64 (7.29, 13.99)
		5–6.9	201	0.59 (0.12; 1.07)	198	2.26 (1.01, 3.50)
		7–8.9	295	–0.02 (−0.22; 0.17)	294	0.66 (−0.11, 1.42)
		9–10	92	Ref.	92	Ref.

CI, confidence interval.

Discussion

In this Swedish urban community-dwelling population of older adults, we observed a clear gradient in the use of social and medical care services by health status as measured by HAT, an integrated clinical and functional assessment tool. People at the negative end of the health continuum used the most social formal and informal care and primary care, but also hospital and specialist care.

For decades, Sweden has had one of the world's fastest-growing older populations. Since the 1970s, the number of people above the age of 80 years has increased 3-fold and the rise in the oldest segment of the population will be particularly noteworthy from 2020, when the large cohorts born in the 1940s will enter ages of >80 years. Between 2000 and 2040, the proportion of people >80 years is projected to increase from 5.1% to 7.7%.[19] Providing high-quality care for older adults has been a priority on Sweden's health and social policy agenda since the 1960s and 1970s, when public services for older people, especially home-help, rapidly increased. Transferring public funding from hospital-based to outpatient and home-based care has become a hallmark of Swedish healthcare, topping European Union rankings for investment in long-term care for older adults and people with disabilities.[20] However, although Swedish eldercare is still extensive compared with other countries, since the late 1980s, despite unchanged official policy, budgetary restrictions have implied major changes, with reductions in formal social care and trends of deinstitutionalization and marketization of personal care and practical support.[14] Between 2000 and 2016, nursing home beds decreased by one-third and the coverage rate of those ≥65 (≥80) years of age decreased from 8% (21%) to 4% (13%). During the same period, there was a shift in home-help recipients toward older ages. Regarding hospital care, since the 2000s, Sweden has had one of the lowest number of hospital beds per 1000 among countries belonging to the Organisation for Economic Co-operation and Development (OECD): 2.4 compared with the OECD mean of 4.7. The ongoing trend of downsizing of institutional care and decrease in hospital-beds implies that very frail old people are increasingly cared for at home, and there is no sign of change of this trend.

Our results showed that more than 10% of older adults >65 years of age received home-help between 2001 and 2004. This is well in line with official figures for the whole city of Stockholm, slightly higher than the national average of 8% in 2003,[21] and well above the percentages observed in the few OECD countries for which data were available that same year, such as Australia (5.1%), France (3.1%), or Italy (2.5%).[22] Moreover, as shown previously with municipal register data from the same area as in this study,[23] our results confirm that HAT captures the allocation of self-reported formal social care according to need indicators; the ratio of the number of h/mo in those with severe functional dependence (ie, HAT 0–2.9) vs mild functional dependence (ie, HAT 3–4.9) was over 5. Still, Sweden faces considerable variation in how municipalities assess people's needs for home care, and measurements are still not based on standardized guidelines or tools.[24]

Informal care by family members, friends, and neighbors was another source of long-term social support for people in our study; 11% reported that they received this type of care. Although formal care for older people is extensive in Sweden, about two-thirds of the support to community-dwelling older people has been estimated to come from informal sources.[25–27] There is evidence that this proportion is increasing,[13] and that it is considerably higher among those with substantial care needs, such as people with dementia.[26] Our study also showed that informal care played a relatively greater role than formal care in older adults ≥78 years of age with worse health status, especially at baseline (ie, informal care 64.4 h/mo vs formal care 37.6 h/mo), but this was no longer the case after 3 years (ie, informal care, 10.9 h/mo vs formal care, 18.3 h/mo). Informal care may be predominant when older adults' functional capacity starts to decline, whereas the demand for formal care could increase as functional decline becomes more pronounced. This has important implications because informal carers are increasingly older adults themselves, as many older couples provide care for each other.

Despite efforts to reduce hospitalizations in older adults, Sweden has still high rates of avoidable admissions, which has led to poor technical efficiency in the public health sector.[28] In our study, people with HAT scores <3 (ie, severe functional dependence) were admitted to the hospital a mean of 11 times per year during the study period and spent a mean of 226 days per 10 persons/y in the hospital. In addition, throughout the follow-up, 31% of people with HAT scores <3 were readmitted to the hospital within 30 days of discharge, a finding in line with those of other population-based[29] and clinical[30] studies from the United States, one of the countries with highest readmission rates.[31]

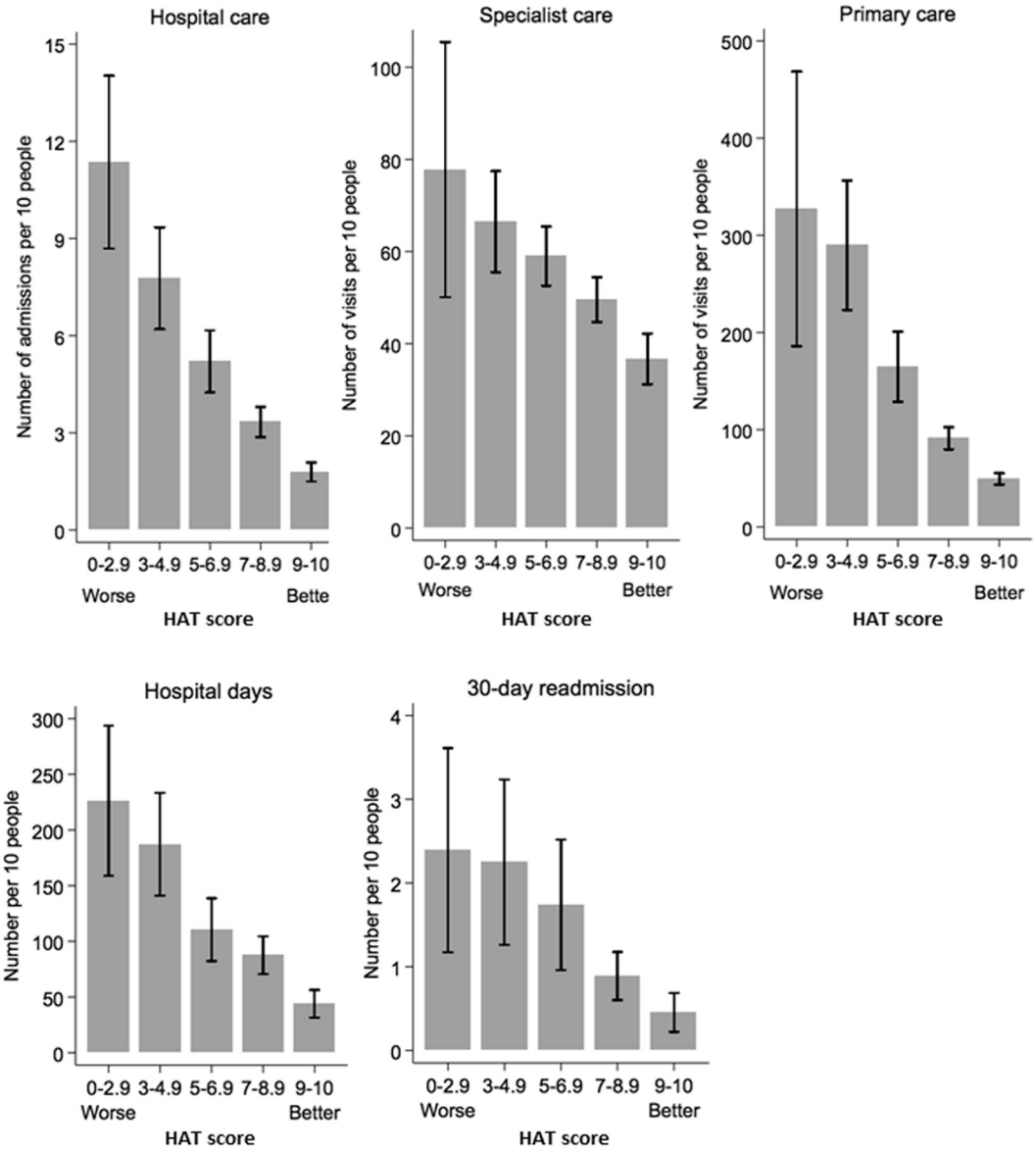

Fig. 3. Participants living in the community: number of annual hospital admissions, specialist visits, primary care visits, number of annual days in the hospital, and unplanned readmissions within 30 days of hospital discharge per 10 people in the 3 years after baseline assessment. Negative binomial regressions were used to weigh results with respect to the age and sex distribution of the population in Stockholm (excluding those living in nursing homes or other care settings) between 2001 and 2004. Hospital days and 30-day readmissions calculated only for people admitted to the hospital at least 1 time in the 3 years after baseline assessment (n = 983).

Early discharges as a result of few hospital beds could possibly increase readmissions within 1 month. Indeed, Swedish older adults often feel lack of confidence and support on discharge from hospital.[32]

More than 80% of our study population made at least 1 annual primary care visit, and the number of visits increased as health declined; the ratio of the number of visits in those with best vs worst health was almost 7. Care continuity, a well-known challenge in primary care, is an essential means to help patients and their families to navigate multiple services.[33]

Strengths and Limitations

The HAT index has the main advantage of assembling several health indicators into 1 single score, reducing data dimensionality and providing a comprehensive picture of the health continuum in old age. Moreover, unlike other self-reported multidimensional tools such as the Vulnerable Elders Survey (VES-13),[34] HAT is constructed based on almost only objective information that is usually available in different care settings, which enhances its applicability and reliability for care needs assessment and provision. With the exception of IADL, all the health indicators integrated in HAT were measured based on validated tests and professional appraisal. Still, the population used to derive the HAT index consists of a well-educated urban group of older adults with high levels of cognitive and physical function and a low prevalence of ADL disability compared with people of the same age in Sweden and other countries. Thus, the external validity of HAT should be tested in other populations. The size of certain age- and sex-stratified study groups was small, which calls for caution in interpreting the findings. Information on social formal and informal care use was based on self-report that could limit the reliability of the estimates.

Conclusions/Relevance

The HAT index adequately discriminates older adults use of medical and social care, both between and among people over time. It therefore has the potential to help increase the transparency of and

Table 3
Participants Living in the Community: IRRs (with 95% CI) of Hospital Admissions, Specialist Visits, and Primary Care Visits by the HAT Score, Stratified by Sex and Age

		HAT	Number of Participants	Hospital Admissions IRR (95% CI)	Specialist Visits IRR (95% CI)	Primary Care Visits IRR (95% CI)
Men	66–72 y	0–2.9	2	4.01 (0.39; 41.59)	4.63 (0.72, 29.65)	0.55 (0.10, 3.03)
		3–4.9	7	9.17 (2.40; 34.99)	3.10 (1.12, 8.55)	13.98 (5.81, 33.62)
		5–6.9	33	1.67 (0.84; 3.33)	1.43 (0.87, 2.35)	1.94 (1.26, 3.00)
		7–8.9	163	1.68 (1.12; 2.50)	1.32 (1.00, 1.74)	1.66 (1.30, 2.12)
		9–10	204	Ref.	Ref.	Ref.
	78+ y	0–2.9	10	5.83 (2.40, 14.17)	1.02 (0.52, 2.00)	3.57 (1.66, 7.68)
		3–4.9	30	4.56 (2.31, 8.98)	1.23 (0.78, 1.94)	4.93 (2.95, 8.23)
		5–6.9	90	4.23 (2.47 7.23)	2.09 (1.50, 2.91)	3.90 (2.65, 5.75)
		7–8.9	157	2.78 (1.67, 4.63)	1.72 (1.27, 2.33)	2.03 (1.42, 2.90)
		9–10	53	Ref.	Ref.	Ref.
Women	66–72 y	0–2.9	3	2.72 (0.29; 25.48)	1.57 (0.42; 5.96)	3.84 (1.12, 13.22)
		3–4.9	16	6.66 (2.94; 15.13)	3.08 (1.72; 5.49)	4.36 (2.53, 7.53)
		5–6.9	39	4.66 (2.61; 8.34)	3.21 (2.19; 4.72)	4.97 (3.46, 7.14)
		7–8.9	215	1.97 (1.39; 2.79)	1.36 (1.11; 1.67)	1.66 (1.37, 2.01)
		9–10	307	Ref.	Ref.	Ref.
	78+ y	0–2.9	58	5.43 (3.30, 8.95)	1.85 (1.28, 2.67)	4.64 (3.21, 6.70)
		3–4.9	184	3.29 (2.21, 4.91)	1.54 (1.17, 2.04)	4.43 (3.35, 5.86)
		5–6.9	200	2.35 (1.58, 3.50)	1.35 (1.03, 1.77)	2.17 (1.65, 2.86)
		7–8.9	291	1.14 (0.77, 1.69)	1.19 (0.92, 1.55)	1.45 (1.11, 1.89)
		9–10	91	Ref.	Ref.	Ref.

CI, confidence interval; IRR, incident rate ratio.

consistency in long-term care needs assessment. Moreover, the HAT index may be easily used to screen vulnerable frail patients in primary care to better adapt home-based care provision.

Acknowledgments

We thank the SNAC-K participants and the SNAC-K Group for their collaboration in data collection and management.

References

1. McClintock MK, Dale W, Laumann EO, Waite L. Empirical redefinition of comprehensive health and well-being in the older adults of the United States. Proc Natl Acad Sci U S A 2016;113:E3071–E3080.
2. Santoni G, Angleman S, Welmer A-K, et al. Age-related variation in health status after age 60. PLoS One 2015;10:e0120077.
3. Marengoni A, Angleman S, Melis R, et al. Aging with multimorbidity: A systematic review of the literature. Ageing Res Rev 2011;10:430–439.
4. Lehnert T, Heider D, Leicht H, et al. Review: Health care utilization and costs of elderly persons with multiple chronic conditions. Med Care Res Rev 2011;68:387–420.
5. Schiltz NK, Warner DF, Sun J, et al. Identifying specific combinations of multimorbidity that contribute to health care resource utilization. Med Care 2016;0:1.
6. Koroukian SM, Schiltz N, Warner DF, et al. Combinations of chronic conditions, functional limitations, and geriatric syndromes that predict health outcomes. J Gen Intern Med 2016;31:630–637.
7. Marengoni A, von Strauss E, Rizzuto D, et al. The impact of chronic multimorbidity and disability on functional decline and survival in elderly persons. A community-based, longitudinal study. J Intern Med 2009;265:288–295.
8. Landi F, Liperoti R, Russo A, et al. Disability, more than multimorbidity, was predictive of mortality among older persons aged 80 years and older. J Clin Epidemiol 2010;63:752–759.
9. Meinow B, Kåreholt I, Thorslund M, Parker MG. Complex health problems among the oldest old in Sweden: Increased prevalence rates between 1992 and 2002 and stable rates thereafter. Eur J Ageing 2015;12:285–297.
10. Santoni G, Marengoni A, Calderón-Larrañaga A, et al. Defining health trajectories in older adults with five clinical indicators. J Gerontol Ser A Biol Sci Med Sci; 2016:glw204.
11. Santoni G, Calderón-Larañaga A, Vetrano DL, et al. Geriatric health charts for individual assessment and prediction of care needs: A population based prospective study. J GerontolA BiolSci Med Sci; 2018 Dec 4 [Epub ahead of print].
12. Genet N, Boerma WG, Kringos DS, et al. Home care in Europe: A systematic literature review. BMC Health Serv Res 2011;11:207.
13. Szebehely M, Trydegård G-B. Home care for older people in Sweden: A universal model in transition. Health Soc Care Commun 2012;20:300–309.
14. Socialstyrelsen [National Board of Health and Welfare]. Vård Och Omsorg Om Äldre - Lägesrapport 2018 [Care and Services for Elderly People 2018]; 2018. Stockholm, Sweden: National Board of Health and Welfare; 2018.
15. Dahlberg L, Berndt H, Lennartsson C, Schön P. Receipt of formal and informal help with specific care tasks among older people living in their own home. National trends over two decades Soc Policy Adm 2018;52:91–110.
16. Socialstyrelsen [National Board of Health and Welfare]. Tillståndet Och Utvecklingen Inom Hälso-Och Sjukvård Och Socialtjänst [Annual Report of the Development of Social and Medical Care in Sweden]; 2015. Stockholm, Sweden: National Board of Health and Welfare; 2015.
17. Lagergren M, Fratiglioni L, Hallberg IR, et al. A longitudinal study integrating population, care and social services data. The Swedish National study on Aging and Care (SNAC). Aging Clin Exp Res 2004;16:158–168.
18. Wimo A, Jonsson L, Zbrozek A. The Resource Utilization in Dementia (RUD) instrument is valid for assessing informal care time in community-living patients with dementia. J Nutr Health Aging 2010;14:685–690.
19. Statistics Sweden. Available at: http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/?rxid=f45f90b6-7345-4877-ba25-9b43e6c6e299. Accessed December 26, 2018.
20. Molinuevo D. Services for Older People in Europe: Facts and Figures about Long Term Care Services in Europe. European Social Network; 2008.
21. Socialstyrelsen [National Board of Health and Welfare]. Äldre - Vård Och Omsorg År 2003 [Care and Services for Elderly People 2003]; 2004. Stockholm, Sweden: National Board of Health and Welfare; 2004.
22. OECD. Long-Term Care Resources and Utilisation. OECD Health Statistics (database). Available at: https://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_LTCR. Accessed December 26, 2018.
23. Meinow B, Kåreholt I, Lagergren M. According to need? Predicting the amount of municipal home help allocated to elderly recipients in an urban area of Sweden. Health Soc Care Commun 2005;13:366–377.
24. Trydegård G, Thorslund M. One uniform welfare state or a multitude of welfare municipalities? The evolution of local variation in Swedish elder care. Soc Policy Adm 2010;44:495–511.
25. Davey A, Johansson L, Malmberg B, Sundström G. Unequal but equitable: An analysis of variations in old-age care in Sweden. Eur J Ageing 2006;3:34–40.
26. Wimo A, Sjölund BM, Sköldunger A, et al. Incremental patterns in the amount of informal and formal care among non-demented and demented elderly persons: Results from a 3-year follow-up population-based study. Int J Geriatr Psychiatry 2011;26:56–64.
27. Larsson K. Care needs and home-help services for older people in Sweden: Does improved functioning account for the reduction in public care? Ageing Soc 2006;26:413–429.
28. Anell A, Glenngård AH, Merkur S. Sweden: Health System Review; 2012. Denmark.
29. Greysen SR, Stijacic Cenzer I, Auerbach AD, Covinsky KE. Functional impairment and hospital readmission in Medicare seniors. JAMA Intern Med 2015;175:559–565.
30. Friedmann PD, Jin L, Karrison TG, et al. Early revisit, hospitalization, or death among older persons discharged from the ED. Am J Emerg Med 2001;19:125–129.
31. Kociol RD, Lopes RD, Clare R, et al. International variation in and factors associated with hospital readmission after myocardial infarction. JAMA 2012;307:66–74.
32. Rydeman I, Törnkvist L, Agreus L, Dahlberg K. Being in-between and lost in the discharge process—an excursus of two empirical studies of older persons', their relatives', and care professionals' experience. Int J Qual Stud Health Well-being 2012;7:1–9.
33. Gurner U, Thorslund M. Dirigent saknas i vård och omsorg för äldre: Om nödvändigheten av samordning [Conductor is missing for care and services for older people. On the necessity of coorination of care services]. Natur och Kult; 2003.
34. Saliba D, Orlando M, Wenger NS, et al. Identifying a short functional disability screen for older persons. J Gerontol A Biol Sci Med Sci 2000;55:M750–M756.

Appendix. Statistical Analyses Used to Derive the HAT

A. Selection of the Best Nominal Response Model

To derive the HAT, multiple nominal response models (NRms) were run with health indicator categories defined in different ways in each model (Supplementary Table 1). Most of the cut-offs chosen for the categories were derived from the literature. Each model's internal consistency was verified by running the model on 10 samples (N = 3363) drawn randomly with replacement from the study population. Three hundred models were tested; the final model was chosen on the basis of a priori criteria reported in Supplementary Table 2.

Supplementary Table 1
Different Categorizations of the Health Indicators Tested in the NRm

Variables	Categories			
PADL	0	1+		
IADL	0	1+		
PADL + IADL	0	1	2	3+
MMSE	30–27	26–24	23–0	
	30–27	26–20	19–0	
	30–29	28–20	19–0	
	30	29–28	27–20	19–0
	30	29	28–20	19–0
Gait speed	≥1.0	1.0 – ≥0.4	<0.4	
	≥1.2	1.2 – ≥0.8	<0.8	
	≥1.2	1.2 – ≥0.4	<0.4	
	≥1.5	1.5 – ≥1.0	1.0 – ≥0.4	<0.4
	≥1.5	1.5 – ≥1.0	1.0 – ≥0.6	<0.6
Chronic diseases	0	1	2+	
	0	1–2	3+	
	0	1+		
	0–1	2	3+	
	0–1	2+		
	0–2	3+		

PADL, personal activities of daily living; MMSE, Mini-Mental State Examination.

Supplementary Table 2
A priori Criteria and Actions Performed to Select the Final Model

A Priori Criteria	Actions Performed
1. Difficulty values for variable with 2 or more cut-offs in the expected order.	Removed models with unordered difficulty levels in at least 1 of the samples.
2. Difficulty levels evenly spread across the latent variable trait as much as possible.	a) Calculate the distances among the different difficulty levels in a model.
3. High discrimination among people of similar levels of health.	b) Keep models for which, in all samples, the mean distance, the minimum distance, and the standard deviation of the distances are greater than the respective mean considering all models.
	c) Keep models with at least 30% of the difficulty values below zero (mean level of latent trait).
4. High precision over a large range of the latent trait.	Keep models with the largest total area of the TIF, largest area per unit height of the TIF, or largest health range for TIF above or equal to one.

TIF, test information function.

B. Calculation of the HAT scores

The discrimination and difficulty levels from the selected NRm are reported in Supplementary Table 3. The total characteristic curve (TCC, expected score) ranged from 0 to 10. The TCC was more precise for people whose health status was above average (positive values of the latent trait), and the relationship between score and health status was not linear. To obtain a continuous score, the weights for each category were derived by regressing the NRm TCC against the health indicators (Supplementary Table 4). The HAT score values were reversed so that they ranged from 0 (poor health) to 10 (good health). Because of the high discrimination power of the ADL variables, the regression was stratified by limitation status (no limitation, only IADL limitations, any ADL limitation). We tested for interactions between the variables and included those with the largest effects in the model.

Supplementary Table 3
Discrimination and Difficulty Parameters (95% CI) Derived from the NRm for Different Categories of the 5 Health Indicators

	N (%)*	Discrimination	Difficulty
PADL			
None vs 1+	250 (7.5)	11.0 (5.57; 16.5)	1.43 (1.36; 1.49)
IADL			
None vs 1+	618 (19.0)	6.79 (5.10; 8.49)	0.85 (0.80; 0.90)
Gait speed			
≥1.5 vs 1.49 to 1.0	1258 (39.5)	1.13 (0.74; 1.51)	–1.20 (–1.40; −1.01)
1.49 to 1.0 vs 0.99 to 0.4	861 (27.0)	3.97 (2.67; 5.28)	0.23 (0.18; 0.28)
0.99 to 0.4 vs <0.4	374 (11.8)	4.59 (3.33; 5.85)	1.19 (1.13; 1.26)
MMSE			
30 vs 29	975 (29.1)	0.45 (0.30; 0.59)	–0.08 (–0.30; 0.14)
29 vs 28–20	1018 (30.4)	1.16 (0.58; 1.73)	0.08 (–0.02; 0.17)
28–20 vs 0–19	231 (6.9)	3.91 (2.74; 5.08)	1.54 (1.46; 1.63)
Morbidities			
None vs 1–2 morbidities	1713 (51.9)	0.75 (0.62; 0.89)	–1.49 (–1.72; −1.26)
1–2 vs 3+ morbidities	928 (27.7)	0.59 (0.13; 1.05)	1.28 (1.05; 1.51)

CI, confidence interval; MMSE, Mini-Mental State Examination; PADL, personal activities of daily living.

*Number of people and percentage (%) with the worse outcome. The R-square values for the regressions were all above 0.99.

Supplementary Table 4
Regression Coefficients Relating the Single Health Indicators to the HAT in 3 Different Subgroups

	No PADL or IADL Impairment	Any IADL Impairment	Any PADL Impairment
IADL			
None			Ref.
Any			–1.7*
Gait speed			
≥1.5	Ref.	Ref.	Ref.
1.49 to 1.0	–0.6*	–0.3*	0
0.99 to 0.4	–2.4*	–1.5*	–0.9*
<0.4	–3.9*	–2.5*	–2.0*
MMSE			
30	Ref.	Ref.	Ref.
29	–0.2*	–0.1*	–0.1*
28–20	–0.8*	–0.4*	–0.4*
19–0	–1.5*	–1.3*	–1.3*
Morbidity			
None	Ref.	Ref.	Ref.
1–2	–0.4*	–0.2*	–0.2*
3+	–0.6*	–0.3*	–0.3*
MMSE × gait speed			
29 × 1.49 to 1.0	0.0*		
× 0.99 to 0.4	0.0*		
× <0.4	0.1*		
28–20 × 1.49 to 1.0	0.0*		
× 0.99 to 0.4	0.2*		
× <0.4	0.3*		
19–0 × 1.49 to 1.0	–0.8*		
× 0.99 to 0.4	–0.3*		
× <0.4			
Constant	10.0*	6.7*	5.3*

MMSE, Mini-Mental State Examination; PADL, personal activities of daily living.
*P value < .01.