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Research Article

Prediction of Adverse Outcomes in Nursing Home Residents According to Intrinsic Capacity Proposed by the World Health Organization

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Abstract

Background: This study aimed to evaluate the predictive value of the domains of intrinsic capacity (ie, cognition, locomotion, sensory, vitality, and psychosocial) proposed by the World Health Organization (WHO) on the 3-year adverse health outcomes of nursing home residents.
Methods: A 3-year incidence of mortality, falls, repeated falls, and autonomy decline (ie, a one-unit increase in the Katz score) was assessed in a cohort of Belgian nursing home residents. Cognition was assessed using the Mini-Mental State Examination (MMSE). For locomotion, balance, gait speed and chair stand performance were evaluated by the Short Physical Performance Battery test. The sensory domain was measured using the Strawbridge questionnaire for audition and vision. For vitality, abdominal circumference, body mass index, nutritional status (by Mini Nutritional Assessment [MNA]) and handgrip strength were assessed. Psychosocial status was evaluated by the EQ-5D and the Center for Epidemiological Studies Depression scale. Missing data were handled by multiple imputations. Cox proportional hazard models, logistic regressions, and analysis of variance were used for the analyses.
Results: In the multivariable model, a one-unit increase in balance performance and in the nutrition score decreased the probability of death by 12% (Hazard ratio [HR] = 0.88; 95% confidence interval [CI] 0.78–0.99) and 4% (HR = 0.96; 95% CI 0.93–0.99), respectively. The risk of falling decreased when there was a one-unit increase in balance performance (HR = 0.87, 95% CI 0.79–0.96) and in the nutrition score (HR = 0.96, 95% CI 0.93–0.98). No association was found for intrinsic capacity and repeated falls. Low scores in nutrition (odds ratio = 0.86, 95% CI 0.77–0.96) were associated with a higher probability of autonomy decline.
Conclusion: Some domains of intrinsic capacity predicted health outcomes among nursing home residents. Nutrition and balance should be regularly checked among this population.

Keywords: Mortality, Falls, Balance, Nutrition, Nursing home issues

The World Health Organization (WHO) published two important papers on the operationalization of intrinsic capacity, a relatively new concept defined as "*the composite of all the physical and mental capacities of an individual*" (1,2). The Integrated Care for Older People approach proposed by the WHO has the ambition of reorienting public health and clinical practice to a more effective person-centered and holistic approach and to prevent decline in intrinsic capacity (1). This approach highlights the importance of focusing on the intrinsic capacity of subjects to establish effective interventions. Five key domains of intrinsic capacity have been defined by

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the WHO: cognition, locomotion, sensory, vitality, and psychosocial, each of which is composed of subdomains (2). These subdomains should capture the components that are most influential on the health status of individuals and that determine their health trajectory (3). Recommendations regarding the most accurate tools and measures to evaluate intrinsic capacity in clinical practice have been provided in several reports (2,4). It is now necessary to validate the measures of each identified subdomain of intrinsic capacity.

In the literature, each separate component of intrinsic capacity is known to be a predictor of adverse health events in community-dwelling older people, but few studies have analyzed these components together (5–8). Moreover, the concept of intrinsic capacity has been used in very few observational studies (9), and, to the best of our knowledge, no studies have been conducted in a nursing home setting. However, it is important to focus on this specific population in order to adapt the general management of this and target the key elements of prevention in nursing homes. Therefore, the major aim of this study was to investigate the predictive value of subdomains of intrinsic capacity proposed by the WHO on the incidence of 3-year mortality. The secondary objectives were to evaluate the association between these subdomains and the incidence of falls, repeated falls, and autonomy decline.

Methods

Study Population

The data used in this study were collected from the SENIOR (Sample of Elderly Nursing home Individuals: an Observational Research) cohort, a Belgian cohort composed of nursing home residents. The methodology and study design of this cohort have been fully described elsewhere (10). Briefly, this longitudinal study, which began in 2013, aimed to follow a total of 662 subjects living in 28 nursing homes. All subjects met the following inclusion criteria: living in a nursing home, being mobile with or without walking aids and being oriented and able to give an informed consent. Evaluations of clinical characteristics, physical performance, functional and cognitive status, quality of life and frailty status were performed every year by a trained research assistant. The Ethics Committee of the University Teaching Hospital of Liège approved this research under protocol number 2013/178.

Outcomes

The adverse health outcomes used in the analyses were incidence of death, falls, multiple falls and autonomy decline. These outcomes were recorded annually over 3 years.

Mortality

The date of death was recorded from the medical file.

Falls

Falls, assessed from the falls registry in each nursing home, were analyzed in two steps. First, for the incidence of falls, we used the date of the first fall that occurred during the 3-year follow-up. Then, for the occurrence of repeated falls during the follow-up, the subjects were categorized into three groups as a function of the number of falls experienced (11): the repeated-fall group, in which subjects fell two times or more over 3 years; a one-time fall group, in which participants had one fall over the follow-up; and a non-fall group, in which participants had never experienced any fall.

Autonomy decline

Autonomy was assessed with the Katz Index (12), which includes six items: bathing, dressing, toileting, transferring to and from a chair, maintaining continence, and feeding. For each item, a score ranging from 1 (total independence) to 4 (total dependence) is awarded as a function of the level of dependence of the subject. Higher scores indicate higher dependency in activities of daily life (ADL). Autonomy decline has been defined as an increase of at least 1 point in the Katz Index during the follow-up (between the baseline assessment and 3-year follow-up).

Intrinsic Capacity

To evaluate the five domains of intrinsic capacity defined by Integrated Care for Older People guidelines, possible subdomains are provided in a report of the WHO published in 2017 (2). We took all components emerging from the report and available in our cohort.

Cognition

Cognition was evaluated by Mini-Mental State Examination (MMSE) (13). Two subparts of the test, recommended by the WHO (2), were used: assessment of orientation ability in time and memory retention capacity. Orientation in time is rated on a 5-point scale; the subject must answer questions about day, month, year, place, and floor. Memory retention is noted on three points; the patient must remember the three words previously said by the interviewer. The higher the score, the better the performance.

Locomotion

The Short Physical Performance Battery test was used to assess locomotion capacity. This test was divided into three parts: a hierarchical standing balance test, a gait speed test over 4 meters and 5 timed, repetitive chair stand tests. For each test, categorical scores (0–4) were based on previously established criteria developed by Guralnik and colleagues (14). Higher scores indicate higher performance.

Sensory

The sensory domain was measured using the self-report Strawbridge questionnaire (15). The items for audition and vision were used. Audition is coded from 1 to 12 and vision from 1 to 8, such that the lower the score is, the better the sensory ability.

Vitality

Abdominal circumference to the nearest 0.1 cm and body mass index were measured in each subject. Handgrip strength was evaluated with a hydraulic hand-dynamometer in kilograms, according to the protocol defined by Roberts and colleagues (16). Participants performed three measurements with each hand, and the maximum value was recorded. Nutritional status was assessed using the Mini Nutritional Assessment (MNA) (17). This test is composed of 18 items with a maximum score of 30. The higher the score, the better the nutrition status.

Psychosocial

Depression was evaluated by the item “anxiety/depression” of the EuroQol-5D using a 3-point Likert scale (1 = “I am not anxious or depressed”, 2 = “I am moderately anxious or depressed”, 3 = “I am extremely anxious or depressed”). Fatigue was estimated using two questions from the Center for Epidemiological Studies Depression scale (18): “I felt that everything I did was an effort” and “I could not get going” during the past week. When subjects replied “always

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or most of the time" to at least one of the two questions, they were considered to have low energy.

Covariables

The collected data also included clinical characteristics such as age, sex, number of medications, number of comorbidities and level of education. Medical records were used to collect these data, and only the level of education was self-reported.

Statistical Methods

Multiple imputations were applied to manage missing data according to a Markov chain Monte Carlo method (19). We computed five imputation datasets. Pooled estimates from these datasets were used to report the results of our analyses. Preliminary analyses were also performed to determine whether it was necessary to perform our analyses by separating men from women, according to the methodology of Nowak and colleagues (20). Descriptive statistics for participants' characteristics were summarized by the use of means, standard deviations for continuous variables and counts and proportions for categorical variables. Normality was verified using the Q-Q plots and Shapiro–Wilk test. Chi-square tests and *t*-tests were performed to compare baseline characteristics according to outcomes of interest.

Mortality and falls

Cox proportional hazard models were performed to evaluate the association between subdomains of intrinsic capacity and the incidence of death and falls during the 3-year follow-up. Survival times were measured by the interval from the time of the first evaluation to the adverse incident. For subjects not subjected to death or falls, the follow-up time was the last assessment in the study. Hazard ratios (HRs) and 95% confidence intervals (95% CIs) were reported.

Repeated falls

To compare intrinsic capacity among older people who did not fall, those who had fallen one time and those who experienced recurrent falls during the follow-up, the chi-square test and analysis of variance were conducted.

Autonomy decline

Logistic regressions were performed to evaluate the association between intrinsic capacity and autonomy decline. Odds ratios and 95% CI were reported.

For each outcome, multivariable analyses were performed. All variables (intrinsic capacity and baseline characteristics) were included in the multivariable models. Multicollinearity was tested beforehand by calculating the variance inflation factor for all included variables. The normality of the residues and the heterogeneity of the variances have also been verified. The decision to include confounders in the multivariable regression models was based on previous literature.

All statistical analyses were performed using SPSS statistical software version 25 (IBM, Armonk, NY), and the level of statistical significance was set at $p < .05$.

Results

Study Population

In this study, there was 3.3% of missing data in total and the variable with the most missing information was the number of comorbidities. The survival analyses were conducted in 604 subjects after the exclusion of two nursing homes (ie, 58 subjects) that dropped out of the study after 1 year of follow-up. We excluded these subjects from the analyses because their data were not randomly missing. The analyses regarding the incidence of autonomy decline and repeated falls were performed on 373 subjects, because for these analyses, we imputed the data only for people alive during the 3 years of follow-up. The flow-chart of the study is illustrated in Supplementary Figure S1. Among the 604 participants, the mean age was 82.9 ± 9.1 years, and 73.0% were female. The main characteristics of the study participants are presented in Table 1. Except for age ($p < .001$), the main clinical characteristics (ie, sex, body mass index, and medication) of the study sample did not differ significantly from those of the subjects excluded ($p < .05$). The preliminary analyses showed that our analyses had to cover the whole population study without stratifying according to gender because the odds ratios obtained in each stratum of confounding factors were similar.

Mortality

Among the 604 subjects included in survival analyses on mortality, 231 (38.2%) individuals died within 3 years of follow-up. The mean survival was 2.6 ± 1.1 years. Except the effect of age (85.5 ± 7.8 years vs 81.3 ± 9.5 years, $p = .01$), no other clinical characteristics differed between deceased and non-deceased subjects. In the univariate analyses, Table 2 shows that low scores in time orientation, memory, balance, gait speed, chair stand, handgrip strength, nutritional status, abdominal circumference, body mass index, and poor audition were significantly associated with 3-year mortality ($p < .05$). Variables that were significantly associated with 3-year mortality were entered into a multivariable Cox regression model and were further adjusted for age and sex. Although some variables were rather strongly correlated, there were no multicollinearity issues in the Cox regression analyses, as indicated by a maximum variance inflation factor of 2.64. The results of the multivariable model indicate that a one-unit increase in balance performance on the Short Physical Performance Battery and in the nutrition score on the MNA decreased the probability of death within 3 years by 12% (HR = 0.88; 95% CI 0.78–0.99) and 4% (HR = 0.96; 95% CI 0.93–0.99), respectively (Table 2).

Falls

Among the 604 subjects included in survival analyses on falls, 345 (57.1%) individuals experienced at least 1 fall within 3 years of follow-up. The comparison of the characteristics between fallers and

Table 1. Baseline Characteristics of Population ($N = 604$)

Variables	Mean ± SD or *N* (%)
Age (years)	82.9 ± 9.1
Sex (women)	441 (73.0)
Body mass index (kg/m^2)	26.1 ± 5.4
Comorbidities (number)	5.6 ± 3.8
Medication (number)	9.9 ± 4.3
Education	
Primary/elementary school	106 (17.6)
Secondary/comprehensive school	392 (64.9)
Bachelor/college	78 (12.9)
Master/university	28 (4.6)

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non-fallers indicated that the fallers were older (84.1 ± 8.4 years vs 81.3 ± 9.8 years, $p < .001$) and more likely to be women ($N = 268$ [77.7%] vs $N = 173$ [64.3%], $p < .001$) than were the non-fallers. There was no difference in the number of medications, number of comorbidities, and education between the two groups. As given in Table 3, when variables were taken separately, the results suggested that low scores in balance, gait speed, chair stand, handgrip strength and nutrition status, poor vision and abdominal circumference increased the risk of falling ($p < .05$). When all variables were entered into a multivariable Cox regression model, the results showed that the risk of falling decreased when there was a one-unit increase in balance performance (HR = 0.87, 95% CI 0.79–0.96) and the nutrition status score obtained on the MNA (HR = 0.96, 95% CI 0.93–0.98).

Repeated Falls

Among 373 subjects, 162 (43.4%) subjects experienced repeated falls, 49 (13.2%) had fallen one time, and 162 (43.4%) had never experienced any fall. Comparing the characteristics of these three groups, members of the repeated-fall group were older ($p < .001$), were more likely to be women ($p = .002$) and consumed more medications ($p = .03$) than members of the two other groups. Concerning the intrinsic capacity, the results illustrated in Supplementary Table S1 show that balance, gait speed, chair stand performance, vision, handgrip strength, and nutrition status were significantly different among the three groups. However, in the multivariable model, no more variables were significant ($p > .05$).

Autonomy Decline

Among 373 subjects included in analyses on autonomy decline, 242 (64.9%) experienced an autonomy decline during the follow-up. When we compared the main characteristics between subjects with autonomy decline and those without, we found that there were differences between groups concerning the number of medications consumed (10.3 ± 4.2 vs 9.0 ± 4.1, $p = .007$) and education ($p = .001$). The multivariable model presented in Supplementary Table S2 showed that only low score in nutrition (odds ratio = 0.86, 95% CI 0.77–0.96) were associated with a higher probability of autonomy decline.

Discussion

In the present study, the combination of low balance performance and a low MNA score, adjusted for age, sex, and other confounding variables, predicted the incidence of 3-year mortality and falls.

Table 2. Intrinsic Capacity and 3-Year Mortality ($N = 604$)

DOMAINS	Subdomains	Univariate Model HR (95% CI)	*p* value	Multivariable Model[a] HR (95% CI)	*p* value
Cognition	Time orientation	0.90 (0.83–0.97)	**.01**	0.94 (0.84–1.04)	.21
	Memory	0.86 (076-0.98)	**.02**	0.93 (0.80–1.08)	.36
Locomotion	Balance	0.78 (071-0.86)	**<.001**	0.88 (0.78–0.99)	**.03**
	Gait speed	0.77 (0.70–0.86)	**<.001**	0.89 (0.76–1.03)	.11
	Chair stand	0.76 (0.66–0.87)	**<.001**	0.97 (0.82–1.15)	.77
Sensory	Audition	1.11 (1.05–1.16)	**<.001**	1.04 (0.98–1.10)	.22
	Vision	1.01 (0.94–1.08)	.84	0.98 (0.95–1.01)	.08
Vitality	Abdominal circumference	0.99 (0.98–0.99)	**.03**	1.00 (0.98–1.01)	.62
	Body mass index	0.96 (0.93–0.99)	**.002**	0.98 (0.94–1.03)	.37
	Handgrip strength	0.98 (0.96–0.99)	**.006**	0.99 (0.97–1.01)	.22
	Nutrition	0.93 (0.90–0.96)	**<.001**	0.96 (0.93–0.99)	**.04**
Psychosocial	Depression	1.08 (0.91–1.32)	.44	0.99 (0.81–1.23)	.97
	Fatigue	1.20 (0.88–1.63)	.24	1.10 (0.78–1.55)	.58

The significance of the bold values are <.05.
Notes: CI = confidence interval; HR = hazard ratio.
[a]Including age, sex, comorbidities, medication and education.

Table 3. Intrinsic Capacity and Falls Over 3 Years ($N = 604$)

DOMAINS	Subdomains	Univariate Model HR (95% CI)	*p* value	Multivariable Model[a] HR (95% CI)	*p* value
Cognition	Time orientation	0.95 (0.89–1.02)	.12	0.98 (0.90–1.06)	.57
	Memory	0.90 (0.82- 1.00)	.05	0.98 (0.86–1.10)	.69
Locomotion	Balance	0.81 (0.75–0.88)	**<.001**	0.87 (0.79–0.96)	**.009**
	Gait speed	0.84 (0.78–0.91)	**<.001**	1.03 (0.91–1.16)	.68
	Chair stand	0.80 (0.72–0.89)	**<.001**	0.93 (0.81–1.076)	.29
Sensory	Audition	1.04 (0.99–1.09)	.07	0.99 (0.81–1.07)	.57
	Vision	1.08 (1.02–1.15)	**.01**	1.05 (0.99–1.13)	.13
Vitality	Abdominal circumference	0.99 (0.98–0.99)	**.008**	0.99 (0.98–1.01)	.28
	Body mass index	0.98 (0.96–1.00)	.06	1.00 (0.97–1.04)	.82
	Handgrip strength	0.98 (0.97–0.99)	**<.001**	0.99 (0.98 -1.00)	.29
	Nutrition	0.95 (0.92–0.97)	**<.001**	0.96 (0.93–0.98)	**.03**
Psychosocial	Depression	0.95 (0.81–1.11)	.48	0.92 (0.78–1.10)	.38
	Fatigue	0.98 (0.75–1.27)	.87	0.85 (0.63–1.14)	.28

The significance of the bold values are <.05.
Notes: CI = confidence interval; HR = hazard ratio.
[a]Including age, sex, comorbidities, medication and education.

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Moreover, a low MNA score was associated with autonomy decline after 3 years of follow-up.

These results are in line with the literature showing an association of adverse health outcomes with nutrition and balance. Physical performance is known to be a strong predictor of mortality (21,22). More specifically, the study of Nufuji and colleagues (23). showed that poor standing balance predicted all-cause mortality in older community-dwelling people aged 65 to 89 years. Other studies have suggested that nutritional status predicts mortality in community-dwelling older people (24,25) and in nursing homes (26). The results of a systematic review and meta-analysis showed that balance and nutrition was associated with the incidence of falls (27). Moreover, malnutrition is known to be a risk factor for falls in nursing homes (28). In contrast to our analyses showing that both nutrition and balance performance independently predict the occurrence of falls, Lannering and colleagues (29). found that mobility was the most important predictor of falls compared to nutritional status in nursing home settings. A study conducted in Korea with older people receiving home care service indicated that balance was better in the non-fallers group than in the repeated-fall group (11). In a study including 10,199 nursing home residents, Bürge and colleagues confirmed the association between these two components of intrinsic capacity and the loss of autonomy (30). Previous studies have also demonstrated that poor nutritional status was associated with a decline in functional capacity, which is consistent with our results (31,32).

However, the association of adverse health outcomes with other components of intrinsic capacity could not be confirmed in this study. This is probably due to the difference in the study design, the used method, the population, which may differ depending on the country and the living environment; the duration of follow-up; and the difference in the variables included in the analyses. We also did not confirm the results of the previous study performed in the SENIOR cohort about the incidence avec falls and death after 1 year of follow-up (33). We hypothesize that the duration of follow-up and the use of other statistical methods could explain this divergence.

With a more global view of the health system in nursing homes, the implementation of a systematic screening test at the resident's arrival has been shown to be beneficial (34). Early identification of people at risk of experiencing adverse health events is indeed necessary. However, there are no formal data about evaluation guidelines in nursing homes (ie, specific tools, recommendations for the frequency of evaluation) (35). In light of our results, and if they are confirmed, it could be important to organize at least body balance and nutrition screening.

The practical implications of these findings highlight that more attention to nutrition and body balance in nursing homes is needed. Our results can help clinicians to focus on the most important components of intrinsic capacity in order to implement specific therapeutic approach. Several studies focusing on nutrition improvement and balance training have been published. It was previously shown that balance training is effective in the prevention of falls in nursing home (36). A systematic review showed that nutritional supplementation in nursing homes had a significant effect on handgrip strength (37). Veronese and colleagues found that nutritional supplementation seems to improve physical performance in older people (38). However, there was no evidence about the effect on nutritional supplementation on death or autonomy decline (37). In addition, the WHO established general recommendations about the management of nutrition and physical performance in 2017 (39). The WHO recommends in particular oral nutritional supplementation with dietary advices of a professional for older people with malnutrition and multimodal exercises, including strength resistance, balance, aerobic training, and flexibility, for older people at risk of falls. However, the terms are unclear as to the frequency of intervention, the type of oral nutritional supplementation or the definition of specific exercises. The characteristics of the responders to these interventions must also be better defined. Therefore, further research should be undertaken to investigate specific intervention concerning balance and nutrition in nursing homme setting.

The strengths of the study include its innovation. Indeed, this is the first study to group together the different subdomains of intrinsic capacity recommended by the WHO in nursing home settings. Then, the use of multiple imputations allowed us to maximize the power of our analyses, which helped to limit the attrition bias often present in cohorts composed of nursing home residents. Finally, this study contains longitudinal data over 3 years of follow-up, a relatively long period of time, and was performed in a large sample of older nursing home residents in Belgium. However, certain limitations should be noted. First, our study population might not be representative of the general nursing home population in Belgium. Only nursing home residents able to stand and walk with or without a walking aid, to provide informed consent and to be a volunteer were included. Thus, the incidence of adverse health outcomes is probably underestimated. Second, the subdomains used in our study are based on Integrated Care for Older People guidelines, but some of the recommended tools are not available in our cohort (ie, the full Center for Epidemiological Studies Depression questionnaire). Therefore, we chose a self-report alternative for the subdomains of depression, vision and hearing. Third, there is no operationalization of the comorbidities. We used the number of comorbidities noted by the physician in the medical records of each resident.

To conclude, two subdomains of intrinsic capacity proposed by the WHO, namely, nutrition status and balance, predicted the incidence of mortality and falls among nursing home residents over a 3-year follow-up period. An association was also found between low MNA scores and 3 years of autonomy decline. Malnutrition and balance seem to be key issues in nursing homes, given its association with all adverse health outcomes. Interventions aimed at improving nutritional status and balance among nursing home residents must be targeted to prevent mortality, falls, and autonomy decline. Nevertheless, further studies are needed to confirm our findings in other nursing home cohorts.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

Conflict of Interest

None reported.

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