

## What factors influence the long-term survival of nursing home residents with severe disabilities?

ANNA KAŃTOCH<sup>1</sup>, JADWIGA WÓJKOWSKA-MACH<sup>2</sup>, BARBARA WIZNER<sup>1</sup>, PIOTR HECZKO<sup>2</sup>,  
TOMASZ GRODZICKI<sup>1</sup>, BARBARA GRYGLEWSKA<sup>1</sup>

<sup>1</sup>Department of Internal Medicine and Gerontology, Faculty of Medicine, Jagiellonian University Medical College, University Hospital in Kraków, Kraków, Poland

<sup>2</sup>Department of Microbiology, Faculty of Medicine, Jagiellonian University Medical College, Kraków, Poland

**Corresponding author:** Barbara Gryglewska, M.D., Ph.D.

ORCID ID: <https://orcid.org/0000-0001-6590-3559>

Department of Internal Medicine and Gerontology,

Faculty of Medicine, Jagiellonian University Medical College, University Hospital in Kraków

ul. Jakubowskiego 2, blok/building I, 30-688 Kraków, Poland

Phone: +48 12 400 29 00; Fax: +48 12 400 29 17

E-mail: [barbara.gryglewska@uj.edu.pl](mailto:barbara.gryglewska@uj.edu.pl); [bgrygle@su.krakow.pl](mailto:bgrygle@su.krakow.pl)

**Abstract:** Background / Aim: Factors influencing the survival of the nursing home population have not yet been clearly defined. The aim of the study was to investigate the impact of nutritional, mental, functional, disease and pharmacological factors on the survival of nursing home residents with severe disabilities.

**Material and Methods:** A retrospective cohort study was conducted with a 9-year follow-up period among nursing home residents with a Barthel score  $\leq 40$ . The initial assessment included the following scales: Mini Nutritional Assessment Short-Form (MNA-SF), Abbreviated Mental Test Score (AMTS), the Barthel Index, and blood pressure (BP) measurements. Comorbidities, medications and all-cause mortality were extracted from medical records. The analyzed cohort was divided into two groups: Deceased — residents who died  $\leq 3$  years and Survivors — those who survived  $> 3$  years of observation.

**Results:** Survivors ( $n = 40$ ) and Deceased ( $n = 48$ ) did not differ significantly in terms of age, sex, systolic and diastolic BP, the Barthel Index, number of diseases and medications used. Survivors had significantly higher scores in MNA-SF ( $p < 0.001$ ) and AMTS ( $p < 0.003$ ) than Deceased. Moreover, Survivors had hypertension significantly more often and took aspirin and ACE inhibitors ( $p < 0.05$ ). The multivariable logistic regression analysis showed that the MNA-SF score significantly affected mortality [OR = 0.62, (95%CI, 0.46–0.84),  $p < 0.001$ ].

**Conclusion:** Higher MNA-SF scores were a factor that significantly affected the survival of nursing home residents, while functional status assessed using the Barthel Index had no effect on survival. MNA-SF was found to be a useful tool for assessing the risk of death in a nursing home.

**Keywords:** MNA-SF, survival, nursing home, disability, mortality.

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## Introduction

During the global pandemic health crisis associated with COVID-19 (Coronavirus Disease 2019) and increased mortality among geriatric populations, especially in nursing homes [1], healthcare professionals should seek new knowledge on factors that may affect survival among the most vulnerable people — institutionalized older individuals. In 2001, Dale *et al.* found that poor appetite, pressure sores, cancer and number of medications could be considered predictors of death with 4 weeks after nursing home admission [2]. There are also studies reporting that lower Activities of Daily Living (ADL) scores, in addition to socio-demographic and clinical factors, are associated with a higher risk of death in geriatric nursing home residents [3–4]. However, Levy *et al.* (2015) demonstrated that comorbid diagnoses predicted 6-month mortality more accurately than functional status among nursing home populations [5]. One of the latest research disclosed by Vetrano *et al.* (2018) revealed that higher mortality among nursing home residents was associated with underweight and frequent family visits [6].

Notwithstanding, there is a gap in the literature regarding the survival determinants among residents of nursing homes with severe disabilities, determined by the Barthel Index, which more accurately assesses the elements of functional independence in activities of daily living and mobility than the ADL score [7]. Such data may be clinically useful, especially in times of global pandemic, for planning professional interventions.

In this study, we decided to focus on nursing home residents with severe disabilities because disability is one of the most characteristic features of the nursing home population and is estimated to occur among 80% of institutionalized older people [8–9]. Older adults with disabilities have a poorer quality of life and are more at risk of death than their non-disabled counterparts [10]. The percentage of nursing home residents who need help in activities of daily living is increasing every year among long-stay residents [11]. The course of disability at the end of life among community-dwelling elderly persons could be defined as five distinct trajectories, from no disability, through catastrophic, accelerated and progressive to persistently severe disability. However, in the majority of the decedents, the course of disability in the last year of life was not consistent with the predictable pattern based on the state leading to death [12].

The main aim of the study was to investigate the impact of nutritional, mental, functional, disease and pharmacological factors on the survival of nursing home residents with severe disabilities.

## Material and Methods

### *Study design*

The presented study is a 9-year retrospective follow-up analysis (2009–2018) performed among 88 older residents of one of the largest nursing homes in Kraków, Poland. The study is a continuation to our prospective preliminary study conducted in 2009 [13]. The inclusion criteria were: age (65 years and older), severe disability with a Barthel score below 40 and the ability to give written informed consent at the beginning of the observation. The study protocol was approved by the local ethics committee at the Jagiellonian University, the management of the selected institution and was consistent with the guidelines set forth by the Declaration of Helsinki.

An initial clinical assessment, which was conducted in 2009, among all 88 study participants included: a nutritional status assessment using the Mini Nutritional Assessment Short-Form (MNA-SF), cognitive capacity according to the Abbreviated Mental Test Score (AMTS), and the functional status according to the Barthel Index. In addition, blood pressure measurements were performed by standard procedures. All questionnaires and study measurements were carried out by qualified nursing staff at the facility at the beginning of the study. Medical records were used to extract information on socio-demographic data, health status of residents, comorbidities and medications used.

Later, at the end of the follow-up period, available medical documentation was used to obtain information on the health status of residents and all-cause mortality.

### *Tests and Measures*

#### Functional status

In our study, we chose the Barthel Index for functional assessment, because in Poland a Barthel score below 40, due to the provisions of the National Health Fund, is the basis for admission to a long-term skilled nursing facility. The Barthel Index is a validated scale which consists of 10 elements that measure functional independence in activities of daily living (bathing, grooming, dressing, eating, toileting, urinary and fecal continence) and mobility (ambulation, transferring and stair use) [14]. The total Barthel Index score is 100 [0–100], with lower scores indicating a reduced ability to perform basic activities of daily living. Scores of 0–20 indicate “total” dependency, 21–60 indicate “severe” dependency, 61–90 indicate “moderate” dependency, and 91–99 indicate “slight” dependency [7].

The limitation of the selected index may be the numerical range for the “severe” dependency (21–60), because in our study we included residents with a Barthel score  $\leq 40$ , so we could not observe residents with a Barthel score in the range  $>40 \leq 60$ , because with this result in Poland, it is not possible to place a person in a nursing home.

### Nutritional status

To assess the risk of malnutrition, validated and recommended for older individuals — the Mini Nutritional Assessment Short-Form (MNA-SF) scale was used (results ranging from 0–14) [15]. Malnutrition is diagnosed at 0–7 points, the risk of malnutrition at 8–11 points, and normal nutritional status at 12–14 points.

### Cognitive status

The possibility of dementia was estimated using the Abbreviated Mental Test Score (AMTS), the results of which range from 0 to 10 [16]. Severe cognitive impairment is diagnosed at 0–3 points, moderate cognitive impairment at 4–6, and normal mental status at more than 6 points.

### *Statistical analysis*

Based on previous studies [17–19], which showed that the highest number of deaths in nursing homes occurred before the third year of observation, and our median follow-up was 2.72 years, the analyzed sample was divided into two groups: Deceased (residents who died within the first three  $\leq 3$  years of observation) and Survivors (residents who survived  $> 3$  years). These groups were then compared using the t-student test and the U-Mann Whitney test. The Chi Square test was used to assess differences in the distribution of categorical variables between the groups. Descriptive statistics were based on mean, standard deviations (SD), median and quartile distributions. Logistic regression model was used to investigate mortality factors. Multi-variable model was adjusted for age, comorbidities, AMTS, MNA-SF and the Barthel Index. Logistic regression results were presented as Odds Ratios (OR) and 95% Confidence Intervals (CI). P-values of  $< 0.05$  were considered statistically significant. Statistical analysis was performed by using *Statistica 13*.

### *Terminology*

Throughout the text the authors use the following terms: **Deceased** to denote those residents who died within the first three  $\leq 3$  years of observation and **Survivors** to denote those residents who survived  $> 3$  years.

## Results

### General characteristics

The general characteristics of the analyzed total sample are as follows. The analyzed sample consisted of 88 nursing home residents with severe disabilities determined by the Barthel Index, aged  $79.6 \pm 8.1$ , Caucasian race, the majority of whom were women (68%). The median follow-up period was 2.72 years.

The study participants had four or more diagnosed diseases and took seven or more medications. The mean systolic and diastolic blood pressure values were:  $121 \pm 14.0$  mmHg and  $69.5 \pm 10.9$  mmHg, respectively. The median value of the MNA-SF score was 10 (the risk of malnutrition), while the Barthel Index score 20 (“total” dependency), and the AMTS result was 7 (normal mental status).

### Groups

As mentioned in the previous section, the analyzed population was divided into two groups: Deceased and Survivors. The general characteristics of the analyzed groups are summarized in Table 1.

**Table 1.** The general characteristics of Deceased and Survivors according to socio-demographic data, clinical measurements, pharmacotherapy and comorbidities at the beginning of the study.

	<b>DECEASED (n = 48)</b> <i>Residents who died during the first <math>\leq 3</math> years</i>	<b>SURVIVORS (n = 40)</b> <i>Residents who survived <math>&gt;3</math> years</i>	<b>P value</b>
Age [years]	$79.9 \pm 8.2$	$79.2 \pm 7.9$	NS
Female sex [%]	62.5%	75%	NS
<b>MEASUREMENTS</b> <b>means <math>\pm</math> standard deviation</b>			
SBP [mmHg]	$121.2 \pm 12.7$	$121.5 \pm 15.6$	NS
DBP [mmHg]	$69.4 \pm 10.1$	$69.6 \pm 11.8$	NS
<b>SCALES [score]</b> <b>median [quartile 1, quartile 3]</b>			
MNA-SF	8 [6, 11]	12 [9, 13]	$<0.001^*$
The Barthel Index	12.5 [0, 35]	30 [5, 40]	NS
AMTS	6 [2, 8]	8 [7, 10]	$<0.003^*$
<b>POLYPHARMACY</b> <b>and COMORBIDITIES,</b> <b>median [quartile 1, quartile 3]</b>			
Number of comorbidities	4 [3, 5]	4 [3, 5]	NS

Table 1. Cont.

	DECEASED (n = 48) <i>Residents who died during the first ≤3 years</i>	SURVIVORS (n = 40) <i>Residents who survived &gt;3 years</i>	P value
Number of medications	7 [4, 10]	7 [4, 9]	NS
Number of antihypertensive drugs	1 [0.5, 2]	2 [1, 3]	NS
<b>SELECTED DIAGNOSED DISEASES, n (%)</b>			
Hypertension	19 (43%)	25 (57%)	<0.05*
Diabetes	18 (60%)	12 (40%)	NS
Dementia	21 (68%)	10 (32%)	NS

\*statistically significant, NS — not significant

Abbreviations: SBP — Systolic Blood Pressure, DBP — Diastolic Blood Pressure, MNA-SF — Mini Nutritional Assessment Short-Form (scores range from 0 to 14; the normal nutritional status: 12–14 points), AMTS — Abbreviated Mental Test Score (scores range from 0 to 10; the normal mental status > 6 points).

Comorbidities history — based on medical records.

Data are presented as means ± standard deviation, numbers (percentages) or median [quartile 1, quartile 3].

Survivors (n = 40) and Deceased (n = 48) did not differ significantly in terms of age, sex, systolic and diastolic blood pressure, the Barthel Index, number of diseases and number of medications used. Survivors had a significantly higher MNA-SF score than Deceased (p <0.001). The median MNA-SF score among Survivors was 12 (normal nutritional status) and among Deceased was 8 (the risk of malnutrition). The AMTS score was also significantly higher among Survivors (p <0.003). The median AMTS score among Survivors was 8 (normal mental status) and among Deceased was 6 (moderate cognitive impairment).

Survivors could be characterized as severe dependent (the median Barthel Index score was 30) while Deceased were totally dependent (the median Barthel Index score was 12.5). However, the results did not reach statistical significance.

More than half of Survivors had hypertension (p <0.05), took ACE inhibitors (p <0.05) and aspirin (p <0.05) compared to Deceased. Figure 1 shows a comparison of the studied groups in terms of the taken cardiovascular medication.

As detailed in Table 2, the multivariable logistic regression analysis showed that the MNA-SF score significantly affected mortality (OR = 0.62, 95%CI: 0.46 to 0.84, p <0.001). Higher scores in MNA-SF were associated with a protective effect against death.

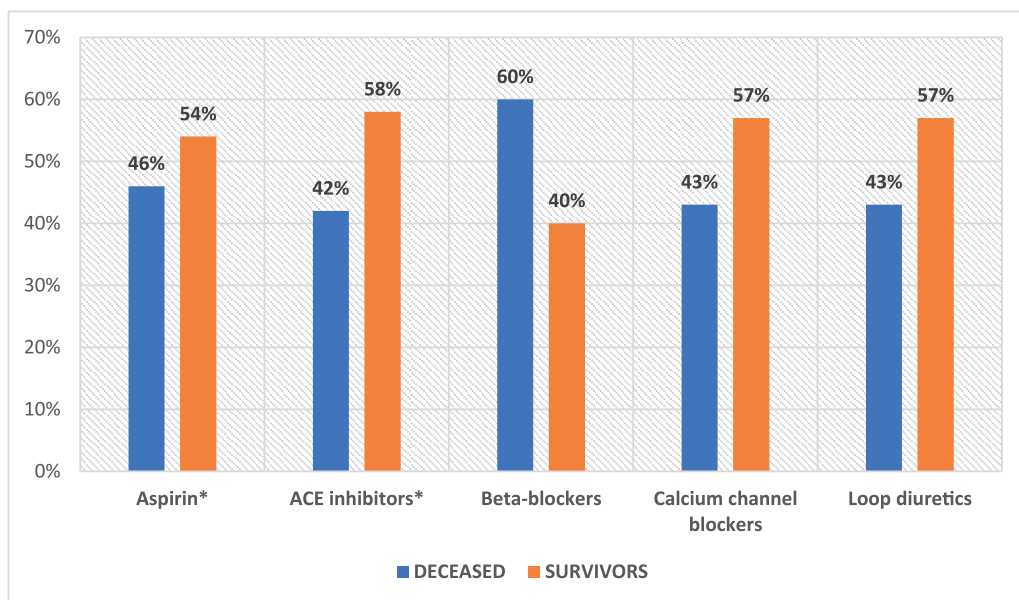


Fig. 1. Comparison of study groups in terms of taken cardiovascular medication.

\* p <0.05

Abbreviations: ACE inhibitors — Angiotensin-Converting Enzyme Inhibitors

Table 2. Multivariable logistic regression model.

The odds of death adjusted for age, MNA-SF, the Barthel Index, AMTS and comorbidities.

	OR (95% CI)	P value
Age	1.0 (0.94–1.07)	NS
MNA-SF	0.62 (0.46–0.84)	<0.001*
The Barthel Index	1.04 (0.99–1.09)	NS
AMTS	0.88 (0.72–1.08)	NS
Comorbidities	0.96 (0.71–1.31)	NS

\*statistically significant, NS — not significant

Abbreviations: MNA-SF — Mini Nutritional Assessment Short-Form (scores range from 0 to 14; the normal nutritional status: 12–14 points), AMTS — Abbreviated Mental Test Score (scores range from 0 to 10; the normal mental status >6 points), OR — odds ratio, CI — confidence interval.

Comorbidities — based on medical records

## Discussion

Our study revealed that the functional status assessed using the Barthel Index did not play a key role in predicting the survival of nursing home residents. Conversely to our study, Nakazawa *et al.* (2012) found a relationship between the Barthel Index score and annual mortality after adjustment to the main confounding factors, such as sex, age, BMI, and type of nursing home in Japanese population [20]. Then Nakazawa *et al.* (2012) stated that the ADL level assessed using the Barthel Index might effectively predict short-term mortality in institutionalized older adults [20]. Chan *et al.* (2013) showed that the impaired functional status measured using the Barthel Index was associated with higher short-term (1-year) and long-term (3-years) mortality with a dose-response relationship in Chinese nursing home older adults [9]. Both studied populations presented a broad spectrum of the Barthel Index scores from 100, through groups 75–95, 45–70 and 15–40 scores, to the Barthel Index score 0–10, but significant differences in mortality were observed even among more disabled groups [9]. However, we did not observe such a relationship. The differences between our results and others may be related to ethnicity, some national variations in admission to nursing homes, or analyzing the entire numerical range of the Barthel Index.

Our findings also showed that Survivors were in a better nutritional state than Deceased. According to the literature, the prevalence of malnutrition among nursing home residents is high and could be caused by many different factors including: multimorbidity, disability, cognitive impairment or decreased appetite [21]. Our study showed that most participants were at risk of malnutrition. Ulger *et al.* (2013) revealed that nursing home residents at risk of malnutrition in MNA-SF increased 18-months mortality rate [22]. Moreover, they observed a strong correlation between malnutrition and mortality. Lately, Kamo *et al.* showed that malnutrition and coexisting severe frailty are associated with all-cause mortality among the oldest old in nursing homes in Japan [23]. In 2015, Lilamand *et al.* suggested that MNA-SF could be an accurate predictor of annual mortality in nursing home residents and a tool for identifying those most at risk [24]. Next, a 30-month longitudinal study of Japanese nursing home residents also revealed that MNA-SF is an effective mortality predictor in this population [25]. These findings are consistent with the results of our research. In our study, residents who died during the follow-up period had poorer nutritional status on the MNA-SF scale than those who survived. What is more, they had lower scores in AMTS. Both nutritional and cognitive status could be interrelated because dementia could lead to loss of appetite, dysphagia and multiple life threatening events [26]. Malnutrition, dehydration, weight loss or infection could be other adverse consequences for people with dementia [26–27].

Diet and nutritional factors have a huge impact on maintaining an effective immune system throughout life or in reducing chronic inflammation [28]. Moreover, the relationship between nutrition and immunity is bidirectional. Nutrient deficiencies



and malnutrition have an impact on immunity and the risk of infection, but inflammation-associated loss of appetite and the reduction of food intake are observed during acute and chronic inflammatory states [28].

Ageing is also associated with many changes, including loss of taste, loss of thirst and deterioration of vision, which can lead to skipping meals [29]. Furthermore, ageing may be associated with nutrient and vitamin absorption disorders [30]. Eating disorders could also be caused by a deterioration of oral functions, such as toothless, denture problems, poor chewing ability or dry mouth [31–32]. Another cause of poor nutritional status may be a phenomenon known as anorexia of ageing, which could be defined as a reduction in food intake, resulting in a decrease in muscle mass and increased fat mass [33–34]. The proper functional status is also very important in preventing malnutrition, as suggested by Liu *et al.* (2019), who indicated that supporting resident's independence in eating performance to provide better food intake is more productive than providing full assistance to people with dementia [27].

In addition, our data may suggest that some pharmacological interventions may also play a crucial role. We observed that disabled subjects who lived longer than 3 years were more often treated with aspirin and angiotensin-converting enzyme inhibitors (ACE inhibitors). The diagnosis of hypertension was also more frequently observed in the group of Survivors. What is more, our previous results revealed that the treatment of hypertension was insufficient among some groups of institutionalized elderly subjects [35]. Secondary prophylaxis with aspirin and ACE inhibitors is effective in patients with coronary heart disease. However, the use of ACE inhibitors also has additional benefits among older residents. A meta-analysis of Caldeira *et al.* (2012) revealed the protective role of ACE inhibitors in the risk of pneumonia, especially in patients with previous stroke and patients from Asia [36]. It is also speculated that subgroups of older people, e.g. with heart failure or severe sarcopenia, may obtain a beneficial effect of ACE inhibitors on muscle strength and physical performance [37].

To our best knowledge, presented study was carried out for the first time among Caucasians in such a long period of observation and focused on a more homogenous population of nursing home residents with a very low Barthel Index scores.

Our study had some limitations. The analyzed sample was relatively small, but in relation to a very homogeneous population of nursing homes, it could be considered sufficient to carry out the analysis. In addition, the study focused solely on all-cause mortality. We also did not include laboratory data, which can also affect survival.

## Conclusion and clinical implications

Higher MNA-SF scores were a factor that significantly affected the survival of nursing home residents with severe disabilities, while functional status assessed using the Barthel Index had no effect on survival.

In our study, we identified factors that may affect the survival of nursing home residents. What is more, our research findings may suggest that healthcare professionals should focus on nursing home residents with lower MNA-SF scores and implement early intervention and specialist consultation if needed. MNA-SF can be easily implemented by healthcare professionals in long-term care facilities. In addition, systematic drug review provided by a geriatrician can also be very beneficial.

### **Contribution**

AK conceived the concept and design of the study, contributed to acquisition of data, performed analysis and interpretation of data, wrote the article and gave final approval of the version to be submitted. JWM contributed to acquisition of data, coordinated funding for the project, revised the article critically for important intellectual content and gave final approval of the version to be submitted. BW contributed to interpretation of data, revised the article critically for important intellectual content and gave final approval of the version to be submitted. PH contributed to acquisition of data, revised the article critically for important intellectual content and gave final approval of the version to be submitted. TG conceived the concept and design of the study, contributed to acquisition of data, performed interpretation of data, revised the article critically for important intellectual content and gave final approval of the version to be submitted. BG conceived the concept and design of the study, contributed to acquisition of data, performed interpretation of data, contributed to writing the article and revised it critically for important intellectual content and gave final approval of the version to be submitted.

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### **Conflict of interest**

None declared.

## Compliance with ethics guidelines — bioethical statement

The study protocol and written informed consent were approved by the local ethics committee at the Jagiellonian University (Bioethics commission of the Jagiellonian University, approval numbers: 1072.6120.27.2018, 1072.6120.28.2018) and management of chosen institution and conformed to the guidelines set forth by the Declaration of Helsinki.

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

## Abbreviations

ACE inhibitors	—	Angiotensin-Converting Enzyme Inhibitors
ADL	—	Activities of Daily Living
AMTS	—	Abbreviated Mental Test Score
COVID-19	—	Coronavirus Disease 2019
MNA-SF	—	Mini Nutritional Assessment Short-Form

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