

# Selected anthropometric measurements and mini nutritional assessment in relation to some predictive factors of undernourishment in the elderly

## Wybrane pomiary antropometryczne i MNA (mini nutritional assessment) a niektóre czynniki predykcyjne niedożywienia osób starszych

Mariola Głowacka<sup>1</sup>, Beata Haor<sup>2</sup>, Paulina Zabielska<sup>3</sup>✉, Anna Jurczak<sup>4</sup>, Monika Biercewicz<sup>5</sup>, Renata Jabłońska<sup>2</sup>, Katarzyna Karakiewicz-Krawczyk<sup>4</sup>, Beata Karakiewicz<sup>3</sup>

<sup>1</sup> Uniwersytet Mikołaja Kopernika w Toruniu, Collegium Medicum im. Ludwika Rydygiera w Bydgoszczy, Pracownia Podstaw Umiejętności Klinicznych i Symulacji Medycznej, ul. Jagiellońska 13–15, 85-067 Bydgoszcz

Nicolaus Copernicus University in Toruń, Ludwik Rydygier Collegium Medicum in Bydgoszcz, Laboratory of Clinical Skills and Medical Simulation

<sup>2</sup> Uniwersytet Mikołaja Kopernika w Toruniu, Collegium Medicum im. Ludwika Rydygiera w Bydgoszczy, Wydział Nauk o Zdrowiu, Katedra Pielęgniarstwa Zabiegowego, Zakład Pielęgniarstwa Neurologicznego i Neurochirurgicznego, ul. Łukasiewicza 1, 85-821 Bydgoszcz  
Nicolaus Copernicus University in Toruń, Collegium Medicum in Bydgoszcz, Faculty of Health Science, Department of Treatment Nursing, The Division of Neurological and Neurosurgical Nursing

<sup>3</sup> Pomorski Uniwersytet Medyczny w Szczecinie, Zakład Medycyny Społecznej i Zdrowia Publicznego, Katedra Medycyny Społecznej, ul. Żołnierska 48, 71-210 Szczecin  
Pomeranian Medical University in Szczecin, Department of Social Medicine and Public Health, Chair of Social Medicine

<sup>4</sup> Pomorski Uniwersytet Medyczny w Szczecinie, Zakład Pielęgniarstwa Specjalistycznego, Żołnierska 48, 71-210 Szczecin  
Pomeranian Medical University in Szczecin, Department of Clinical Nursing

<sup>5</sup> Uniwersytet Mikołaja Kopernika w Toruniu, Collegium Medicum im. Ludwika Rydygiera w Bydgoszczy, Katedra i Klinika Geriatrii, ul. M. Curie Skłodowskiej 9, 85-094 Bydgoszcz

Nicolaus Copernicus University in Toruń, Ludwik Rydygier Collegium Medicum in Bydgoszcz, Department and the Clinic of Geriatrics

✉ paulina.zabielska@pum.edu.pl

### ABSTRACT

**Introduction:** To a vast extent the body's ageing process affects changes in the human nutritional status and body composition. The nutritional status of elderly people is assessed by means of nutritional history, physical examinations, somatometric measurements, biochemical and immunological tests. Moreover, survey tools (questionnaires, scales) are used in order to perform a screening and in-depth analysis of food intake and nutrition in the elderly. Today, an accurate assessment of body composition is conducted by means of specialist devices, such as those used for bioelectrical impedance analysis and dual X-ray absorptiometry. The objective of the thesis was to analyse the usage of selected anthropometric measurements in correspondence with a mini nutritional assessment (MNA) in studies on the identification of undernourishment in seniors, with consideration of some of the initiating factors of nourishment disorders in the population of the elderly.

**Methods:** A review of articles considered essential from the point of view of the study objective was performed by analysing

the PubMed database. The search query used was: "mini nutritional assessment MNA elderly".

**Results:** Nutritional status measured with the MNA may evaluate the way seniors feel. Overweight and obesity usually results in a worse assessment of the quality of the elderly's life. A disordered nutritional status could stem from a range of medical, psychological and social factors.

**Conclusions:** The results of anthropometric measurements are essential for an optimal identification of the risk of undernourishment in senior citizens by means of an MNA. They also complement information on the initiating factors of eating disorders in the population of elderly people. In order to be able to widely use anthropometric measurements to complement knowledge on the nutritional status of the elderly, it is indispensable to conduct studies among healthy senior citizens to obtain information that will serve as reference data.

**Keywords:** elderly; mini nutritional assessment; undernourishment; anthropometric measurements.

### ABSTRAKT

**Wstęp:** W dużym stopniu proces starzenia się organizmu wpływa na zmiany w stanie odżywienia człowieka i składu ciała. Stan odżywienia osób starszych ocenia się za pomocą historii żywienia, badań fizycznych, pomiarów somatometrycznych, testów biochemicznych i immunologicznych. Ponadto w celu przeprowadzenia badań przesiewowych i dogłębnej analizy odżywiania u osób starszych stosowane są narzędzia ankietowe (kwestionariusze, skale). Obecnie dokładną ocenę składu ciała przeprowadza się za pomocą specjalistycznych urządzeń, takich

jak te wykorzystywane do analizy impedancji bioelektrycznej i podwójnej absorpcjometrii rentgenowskiej.

Celem pracy była analiza wykorzystania wybranych pomiarów antropometrycznych oraz mini oceny żywienia (*mini nutritional assessment* – MNA) w badaniach służących rozpoznaniu niedożywienia u seniorów, z uwzględnieniem niektórych czynników inicjujących zaburzenia odżywiania w populacji osób starszych.

**Metody:** Przegląd artykułów istotnych z punktu widzenia celu badań przeprowadzono poprzez analizę bazy PubMed. Zastosowano następujące hasło: „mini ocena żywieniowa osób starszych”.

**Wyniki:** Stan odżywienia mierzony za pomocą MNA może decydować o samopoczuciu osób starszych. Nadwaga i otyłość zwykle skutkują gorszą oceną jakości życia osób starszych. Nieprawidłowy stan odżywienia może wynikać z wielu czynników medycznych, psychologicznych i społecznych.

**Wnioski:** Wyniki pomiarów antropometrycznych są niezbędne dla prawidłowego rozpoznania ryzyka niedożywienia seniorów za pomocą MNA. Uzupełniają również informacje na temat czynników inicjujących zaburzenia odżywiania w populacji

osób starszych. Aby móc w szerokim zakresie wykorzystywać pomiary antropometryczne w celu uzupełnienia wiedzy o stanie odżywienia osób starszych, niezbędne jest prowadzenie badań wśród zdrowych osób starszych w celu uzyskania informacji, które będą służyć za punkt odniesienia w postaci danych referencyjnych.

**Słowa kluczowe:** osoby starsze; mini ocena żywienia; niedożywienie; pomiary antropometryczne.

## INTRODUCTION

To a vast extent the organism's ageing process affects the changes in the human nutritional status and body composition. The nutritional status of elderly people is assessed by means of nutritional history, physical examinations, somatometric measurements, biochemical and immunological tests. Moreover, survey tools (questionnaires, scales) are used in order to perform a screening and in-depth analysis of food intake and nutrition in the elderly. Today, an accurate assessment of body composition is conducted with by means of specialist devices, such as those used for bioelectrical impedance analysis and dual X-ray absorptiometry [1, 2, 3].

Anthropometric measurements used for decades to assess nutritional status pertain to body height and mass, arm, waist and hips circumference and to skin and subcutaneous adipose layer thickness over the triceps and below the scapula [4]. The following prove helpful in assessing undernourishment in elderly patients: body mass index (BMI), mid-arm circumference (MAC), calf circumference (CC) and body mass assessment. Other popular measurements refer to waist circumference (WC), which is used to assess the central fat distribution and the waist-to-hip ratio [1, 2, 4, 5]. The advantage of anthropometric measurements is their simplicity and safety of use. They do not call for complex measuring devices and are therefore inexpensive and allow for a relatively quick procedure of nutritional status analysis [2, 5]. However, one needs to bear in mind that using them in the population of senior citizens requires relating them to the reference data based on testing similar model groups of healthy individuals in old age. However, there is still little data available of this kind [1]. Moreover, conducting the above-mentioned measurements in older patients may prove difficult due to them being e.g. immobilised, due to swelling or ethnic differences in body composition [3]. Indisputably though, the data may be used to calculate other indexes, scales, questionnaires and tests used for nutritional status assessment [1].

An example application of anthropometric measurements for the purposes of a questionnaire used to identify undernourishment in senior population is the mini nutritional assessment (MNA). Since 1994 (the first publication of study results obtained using the MNA) it has been the most popular tool in clinical practice related to senior citizens and a crucial element in comprehensive geriatric assessment [6, 7]. In turn, a shortened version of the questionnaire, the MNA-SF (MNA – short form) questionnaire, was validated [7, 8] and has been in use

since 2001. In 2009 the MNA-SF was modified, creating an option to replace the BMI with the CC measurement for the elderly in whose case conducting height and weight measurements proves difficult [9].

Even when using the full version of the MNA, if undernourishment or risk of undernourishment is diagnosed, one needs to conduct further biochemical, immunological and anthropometric tests. A single parameter does not ensure accurate nourishment diagnostics [10]. One ought to take into account that the factors of undernourishment in the population of older people are very complex. They stem from such phenomena as the organism's ageing processes, loss of appetite, deteriorated sense of taste and/or smell, changes in food preferences, absorption disorders, dental and denture problems, diseases of the intestinal tract, chronic systemic diseases, medicine intake, sensory deficit, changed functional capability, weakened social activity, poor financial status, cognitive disorders, dementia and depression [3]. The objective of the thesis was to analyse the usage of selected anthropometric measurements in correspondence with the MNA in the studies on the identification of undernourishment in seniors, with consideration of some initiating factors of nourishment disorders in the population of the elderly.

## METHODS

The review of articles which are essential from the point of view of the studies' objective was performed by analysing the PubMed database. The entry used was: "mini nutritional assessment MNA elderly".

In order to select the criteria which would enable achieving the objective of the analysis in an optimal way, a group interview was conducted with the participation of the authors of the thesis. The group was comprised of both the representatives of the world of science and of practitioners – experts in health sciences dealing with issues related to elderly care. Additionally, significant studies found as references of the verified articles were also included in the review.

The inclusion criteria defined by the authors are as follows:

1. Year of publication – 2017.
2. Studies with the application of the MNA and MNA-SF scale and its BMI and CC versions.
3. Open access to the entire text of a publication as "Free PMC Article" from PubMed Central (PMC).
4. Original article.

5. Article presenting study results in Europe considering people aged  $\geq 55$ .

6. Publication written in English.

In the PubMed database in 2017 – as of 7<sup>th</sup> August 2017 – there were 45 articles to be found using the “mini nutritional assessment MNA elderly” entry. The above-mentioned articles were verified against the defined inclusion criteria. Eventually, only 4 articles met the said criteria. An analysis was performed

on the results of 4 studies pertaining to a group of 1264 elderly people whose nutritional status had been assessed.

## RESULTS

Table 1 presents an overview of results in a population of senior citizens with the use of selected anthropometric measurements

**TABLE 1. Characteristics of studies on the analysis of nutritional status (own study)**

Article I	
Authors	Montejano Lozoya et al.
Study period	October 2008–November 2009
Size of the studied group	660 people, including 47 people (7.1%) $\geq 85$ years of age M: 319 (48.3%); F: 341 (51.7%)
Age of the studied group	$\geq 65$ years of age, average age: $74.3 \pm 6.6$
Comorbidities	no data – not determined
Study's / patient's location	home environment
Anthropometric measurement results	BMI: $29 \pm 4.1$ MAC (cm): $29.6 \pm 3.1$ CC (cm): $36.1 \pm 3.3$
MNA MNA-SF results	MNA – average no. of points $25.3 \pm 2.4$ BMI-MNA-SF – average no. of points $12.4 \pm 1.6$ CC-MNA-SF – average no. of points $12.3 \pm 1.7$ MNA: 23.3% – 154 seniors at risk of undernourishment 76.7% – 506 properly nourished 0 undernourished people BMI-MNA-SF – 26.5% and CC-MNA-SF – 26.2% seniors were at risk of undernourishment BMI-MNA-SF 0.9% and CC-MNA-SF – 1.5% people were undernourished
Article II	
Authors	Cova et al.
Study period	December 2014–January 2016
Size of the studied group	151 people AD – 59 people; MCI – 34; CG – 58: – healthy people – spouses, relatives of neurology ward patients – outpatients F: AD – 35 people; MCI – 20 people; CG – 29 people M: AD – 24 people; MCI – 14 people; CG – 29 people
Age of the studied group	F: AD – $82.1 \pm 4.8$ ; MCI (mild cognitive impairment) – $76.9 \pm 4.5$ ; CG – $75.1 \pm 6.4$ ; M: AD – $77.5 \pm 8.2$ ; MCI – $78.6 \pm 4.4$ ; CG – $74.3 \pm 5.3$
Comorbidities	MCI patients with the mild and moderate variety – AD CG – most frequently: CIDP, MCI
Study's / patient's location	hospitalised seniors (AD, MCI); CG – outpatients relatives of hospitalised MCI patients, AD visiting the ill
Anthropometric measurement results	BMI: M: AD – $24.8 \pm 3.0$ ; MCI – $26.5 \pm 3.0$ ; CG – $26.6 \pm 2.5$ F: AD – $25.1 \pm 3.9$ ; MCI – $25.8 \pm 4.3$ ; CG – $27.2 \pm 4.5$ F: Arm Circumference (cm) AD – $25.0 \pm 3.1$ ; MCI – $25.4 \pm 2.8$ ; CG – $26.9 \pm 3.2$ F: Calf Circumference (cm) AD – $30.9 \pm 3.5$ ; MCI – $33.1 \pm 2.7$ ; CG – $33.9 \pm 2.8$ M: Arm Circumference (cm) AD – $24.0 \pm 3.0$ ; MCI – $26.1 \pm 2.0$ ; CG – $26.9 \pm 2.8$ M: Calf Circumference (cm) AD – $32.9 \pm 2.3$ ; MCI – $33.6 \pm 3.1$ ; CG – $35.2 \pm 2.8$ F: Waist Circumferences (cm) AD – $86.4 \pm 10.5$ ; MCI – $86.4 \pm 9.5$ ; CG – $93.01 \pm 12.2$ M: Waist Circumferences (cm) AD – $90.4 \pm 10.6$ ; MCI – $99.1 \pm 9.4$ ; CG – $96.7 \pm 7.9$

MNA MNA-SF results	MNA total score M: AD – 24.1 ±2.3; MCI – 27.1 ±1.9; CG – 28.0 ±1.1 F: AD – 23.4 ±2.7; MCI – 25.4 ±3.1; CG – 27.1 ±4.5
<b>Article III</b>	
Authors	Ziebolz et al.
Study period	March–August 2011
Size of the studied group	87 people; F –68 (78%); M – 19 (22%)
Age of the studied group	age ≥55 years average age: 84.1±8.6
Comorbidities	dementia – 48 people (55%), 41 people (47%) – without dentition, 46 people (53%) – with a varied number of teeth, 5 people (6%) – completely immobilised
Study's / patient's location	inhabitants of nursing homes
Anthropometric measurement results	BMI: 26.2 ±5.0 <19: 2 people (2%); 19–21: 11 people (13%); 21–23: 19 people (22%); > +23: 55 people (63%) BMI patients without teeth: 26.0 ±4.8; BMI patients with dentition: 26.3 ±5.2
MNA MNA-SF results	MNA 52% (45 people) –at risk of undernourishment (80% of them take more than 3 medicines, whereas 22% require assistance in feeding themselves); 48% (42 people) are properly nourished, no undernourished people patients at risk of undernourishment: without teeth: 25 people (56%) with dentition: 20 people (44%)
<b>Article IV</b>	
Authors	Perna et al.
Study period	2011–2015
Size of the studied group	366 people; F – 251; 81.90 ±6.72; M – 115; 80.48 ±6.09
Age of the studied group	age >65 average age: 81.46 ±6.55
Comorbidities	patients with no acute disease, acute liver, heart or kidney failure and with body mass which had been stable for 6 months patients diagnosed based on the EFS (Edmonton Frail Scale) 19.7% – non frail; 66.4% – apparently vulnerable; 13.9% – severe frailty
Study's / patient's location	seniors – patients of a rehabilitation centre
Anthropometric measurement results	BMI: 25.05 ±4.84 M: 24.80 ±4.02; F: 25.17 ±5.18 non frail patients BMI: 24.96 ±4.17 apparently vulnerable patients BMI: 25.16 ±5.01 severe frailty patients BMI: 24.85 ±5.46
MNA MNA-SF results	MNA 18.10 ±3.47 moderate risk of undernourishment M: 18.20 ±3.2; F: 18.06 ±3.60 non frail patients albumins: 3.73 ±0.44 MNA: 20.33 ±3.35 age: 78.93 ±7.19 apparently vulnerable patients albumins: 3.64 ±0.50 MNA: 17.96 ±3.13 age: 81.80 ±6.41 severe frailty patients: albumins: 3.62 ±0.44 MNA: 15.48 ±3.11 age: 82.92 ±5.47

M – male; F – female; BMI – body mass index; MAC – mid-arm circumference; CC – calf circumference; MNA – mini nutritional assessment; MNA-SF – short form of mini nutritional assessment; AD – Alzheimer's disease; MCI – mild cognitive impairment; CG – control group; CIDP – chronic inflammatory demyelination polyneuropathy



in correspondence with the MNA, taking into account certain initiating factors of eating disorders in the population of older people.

The studies of Montejano Lozoya et al. [10] were conducted among 660 seniors staying at home, with the use of a full version of the MNA scale, the MNA-SF and its 2 variations: BMI-MNA-SF and CC-MNA-SF. The average results obtained on the aforementioned scales proved high. Nutritional status assessment in the full MNA indicated that 23.2% – 154 elderly people – were at risk of undernourishment. A great majority of subjects, i.e. 76.7% – 506 people – were properly nourished. Undernourishment status was not diagnosed among the respondents. The average number of points gained by the seniors in their nutritional status assessment in both versions of the MNA-SF was similar: the average of BMI-MNA-SF amounted to 12.4 points (SD = 1.6) and that of CC-MNA-SF amounted to 12.3 (SD = 1.7). According to the BMI-MNA-SF there were 0.9% undernourished respondents and 1.5% according to CC-MNA-SF. It needs to be emphasised that in the case seniors who scored low in both versions of the MNA-SF (below 11 points), another assessment of the respondents was carried out using the MNA. Therefore, the studies confirmed that the BMI-MNA-SF and CC-MNA-SF scales are similar in their diagnostic effectiveness in assessing the nutritional status of elderly people, while a slightly lower one in the case of CC.

Cova et al. [11] conducted studies on 151 people, including: 59 senior citizens staying at hospitals due to diagnosed (mild and moderate) Alzheimer's disease (AD), 34 neurological patients with mild cognitive impairment (MCI) and 58 healthy people (treated as a control group) comprised of spouses and relatives of the patients hospitalised owing to MCI, AD, and of outpatients. The nutritional status assessment was performed based on the MNA and anthropometric measurements: CC, MAC, WC. The MNA result was considerably lower in AD patients comparing to the control group seniors. At the same time elderly people with MCI scored average results. The global and total MNA result, independent of the respondents' sex, was lower among the seniors suffering from AD in comparison to the control group (MNA total score – men: AD – 24.1 ± 2.3, control group – 28.0 ± 1.1; women – AD – 23.4 ± 2.7, control group – 27.1 ± 4.5). On the other hand, the nutritional status of the older people with MCI were not significantly different from the control group, except a lower result in an MNA screening test in a group of men and a lower result of the MNA total score for women.

The social and demographic variables did not differ among the 3 groups (AD, MCI and control group) with the exception of the women's age. In terms of anthropometric measurements the AD seniors, independent of their sex, showed significantly lower MAC and CC compared to the elderly people from the control group. At the same time, men with AD had significantly lower WC results than the elderly from the control group and the MCI group.

Ziebolz et al. [12] conducted studies on the nutritional status of 87 inhabitants of a nursing home at the average age of 84.1 (SD 8.6). The studies made use of the MNA and BMI. Among the respondents there were 48 people (55%) with dementia, 5 people (6%) that were completely immobilised, 41 people (47%) without dentition, 46 people (53%) with a varied number of teeth. The MNA nutritional status assessment concluded that:

52% – 45 people – were at risk of undernourishment (80% of them took more than 3 medicines and 22% needed assistance in feeding), 48% – 42 people – were properly nourished. Undernourishment was diagnosed in none of the seniors. However, in the case of 17 people (40%) risk of undernourishment was stated and dementia was confirmed.

By analysing the respondents' dentition it was established that among the people at risk of undernourishment there were 25 people (56%) without teeth and 20 inhabitants (44%) of the nursing home had teeth. In turn, in the group of properly-nourished seniors 16 (38%) had no teeth, whereas 26 (62%) did. At the same time, the average value of BMI with SD amounted to: 26.0 (4.8) for patients with no teeth and 26.3 (5.2) for patients with dentition. Therefore, the results show that as far as the risk of undernourishment is concerned in the case of nursing home inhabitants dementia was a stronger predicative factor than the lack of dentition.

Perna et al. [13] carried out studies among 366 patients of a rehabilitation centre with no diagnosis of an acute disease, acute liver, heart or kidney failure whose body mass had been stable throughout a period of 6 months. The studies aimed at the frailty syndrome diagnosis with the use of the Edmonton Frail Scale (EFS) and determining numerous factors of the syndrome. In order to do that the nutritional status of seniors by means of the MNA scale was assessed. The average MNA result together with SD amounted to 18.10 points ± 3.47, which indicated a moderate risk of undernourishment both in men (18.20 ± 3.2) and women (18.6 ± 3.60). The average value of BMI with SD, in turn, amounted to 25.05 ± 4.84. The result was confirmed independent of the sex of the seniors: men – 24.80 ± SD 4.02, women – 25.17 ± SD 5.18. Whereas patients classified on the EFS scale as "non frail" ones scored 20.33 points ± 3.35 in the MNA and their average age was 78.93 ± 7.19. The elderly with an age average of 81.80 ± 6.41 described as "apparently vulnerable" were assessed in the MNA on the level of 17.96 points ± 3.13, whereas the "severe frailty" patients scored 15.48 points ± 3.11 in the MNA and their age average was 82.92 ± 5.47. The study emphasised the significance of using the EFS scale to identify the Frailty Syndrome among seniors who are staying at institutions. The occurrence of the Frailty Syndrome assessed with the EFS showed a relation with the independence of seniors in daily living and instrumental activities of daily living, the number of medicines they take, their mood, mental health (the condition of their cognitive functions), their functional capability and nutritional status.

## DISCUSSION

Nutritional status measured with the MNA may determine the way seniors feel. Overweight and obesity usually results in a worse assessment of the quality of the elderly's life [14]. A disordered nutritional status could stem from a range of medical, psychological and social factors [1]. It also pertains to institutionalisation, hospitalisation and inhabiting rural areas, which finds confirmation in a variety of studies [1, 14,

15, 16]. The results of a Polish PolSenior study [17], the first epidemiological analysis referring to the nutritional status of Poles in old and very old age, confirmed that the frequency of the occurrence of underweight in young old and old people was actually similar (1.3 and 1.5% respectively) but that it increased significantly with the advancement of ageing processes, independent of sex. It pertained more often to the inhabitants of the countryside. In a population of Polish elderly citizens living at home, underweight was diagnosed with similar frequency of occurrence as in the countries of Western Europe.

The PolSenior programme was conducted within the framework of the project entitled "Medical, psychological, sociological and economic aspects of aging in Poland", which included 5695 people.

It also needs to be emphasised that in the Polish study nutritional status was assessed based on the BMI and WC. The measurements thanks to which it was possible to do calculations were carried out in the case of 708 young old people (55–59) and 4624 people aged ≥65. The frequency of occurrence of overweight or obesity (especially abdominal obesity) among Polish senior citizens increased with age, mainly among city inhabitants. Abdominal obesity diagnosed based on WC occurred significantly more often (twice more often in women, whereas 2.5 times more often in men) than the BMI-based result indicating obesity. The above-mentioned type of obesity was diagnosed more frequently in the group of seniors aged 65–69 and 70–74, in comparison to the young old people. On the other hand, its frequency of occurrence was significantly lower among the elderly people at the age of 85–89 and those at least 90 years old [17].

The numerous study results demonstrated in reference literature refer to determining the relation between nutrition of senior citizens of different backgrounds and the MNA and its shorter versions: BMI-MNA-SF and CC-MNA-SF [10, 18, 19]. Kaiser et al. [9] validated the MNA-SF in reference to the full version of the MNA, indicating the shortened tool's sensitivity is assessing the nutritional status of senior citizens. The research team used data from international databases on 27 studies conducted by means of the full MNA in people aged over 65 to eventually include 12 of them in their analysis, referring to 2032 subjects at the average age of 82.3. It was stated that the MNA-SF enables one to use the BMI and/or CC better for the purposes of the nutritional status assessment. At the same time, the CC measurement is an optimal solution in a situation when the senior citizen's body mass and height measurement cannot be carried out [9].

Similar results to those arrived at by Montejano Lozoya et al. [10] were obtained by the Polish team studying a population of 2603 senior citizens coming from different backgrounds who were staying both at home and nursing homes, in order to validate the MNA-SF-BMI and MNA-SF-CC and to compare the results of nutritional status assessment with the full version of the MNA [18]. Despite the very high scores and diagnostic concordance of the MNA, the researchers emphasise that further analyses are necessary. It refers to the CC scale, as slightly lower scores were obtained by the elderly staying at nursing homes [18]. However, the researchers indicate the ease with

which CC may be applied at primary care facilities thanks to the shorter measurement time and a smaller number of devices than in the case of BMI assessment [10]. Similar associations as far as a certain degree of underestimation while using the MNA-SF-CC is concerned are made in the studies conducted by Kaiser et al. [19] who assessed 675 senior citizens from various backgrounds, both those staying at rehabilitation centres or nursing homes and those staying at home.

Apart from the obvious fact of diagnosing the nutritional status in a population of seniors, it may prove crucial to use the MNA, MNA-SF, BMI, CC scales when designing care for senior citizens [14].

Middle and advanced stages of AD are often related to loss of body mass. However, loss of weight may be preceded by MCI [20]. After a few years approximately half of dementia patients who are staying at care facilities require assistance in eating meals or enteral or parenteral nutrition, which is also due to swallowing disorders [1, 21, 22].

The results of Cova et al. [11] were in a sense confirmed by Saragat et al. [23]. An analysis of the nutritional and psycho-functional status in 83 patients with moderate AD staying at their place of residence and the control group of 91 senior citizens showed that the nutritional status of people suffering from AD was worse. The study included e.g. the MNA, WC and MAC. The Polish PolSenior study [17] assessed nutritional status based on the BMI and WC, demonstrating a larger relation between WC and abdominal obesity in comparison to the obesity results measured by BMI. This correlation is also confirmed in the international IDEA (International Day for the Evaluation of Abdominal Obesity) study on 168 thousand patients aged 18–80 who contact their GP in 63 countries [24]. In the PolSenior study [17] the measurements which made it possible to do calculations were performed in the case of 708 young old people (55–59 years of age) and 4624 people aged ≥65. The frequency of occurrence of overweight and obesity (especially of the abdominal kind) among Polish senior citizens increased with age, mainly among city inhabitants. Abdominal obesity diagnosed based on WC occurred significantly more often (twice more often in women, 2.5 times more often in men) than the result indicating obesity based on BMI. The above-mentioned type of obesity was diagnosed more frequently in the group of seniors aged 65–69 and 70–74, in comparison with the young old people. On the other hand, its frequency of occurrence was significantly lower among the elderly people at the age of 85–89 and those at least 90 years old [17].

Trouble chewing food, salivation disorders, a bad condition of the oral cavity may contribute to weight loss in elderly people. This fact is confirmed in studies conducted by Sullivan's [25] team in a group of 110 senior citizens hospitalised at a geriatric rehabilitation centre and taken into consideration the reasons for weight loss from before the patients were admitted to the institution. A strong connection was shown between loss of body weight in elderly people and a bad condition of the oral cavity. Lopez-Jornet et al. [26] carried out studies among 465 senior citizens both those staying in institutions and others. The MNA was used to assess their nutritional status, also the

condition of the oral cavity was assessed together with dentition and dentures. No significant differences were stated in terms of undernourishment or risk of undernourishment between the elderly with dentition and those with missing teeth or the people who used dentures or those who did not. Nevertheless, the risk of undernourishment was more frequent in the case of very old people living in an institution. Ziebolz et al. [27] indicated that dementia was a stronger predicative factor of the risk of undernourishment than lack of dentition. Alzheimer's disease and other types of dementia may cause a deterioration of improper hygiene and of the condition of the oral cavity [28]. In the Polish study PolSenior [17] a worse condition of dentition in senior citizens was shown compared to the elderly from Western Europe. Such assessment was conducted on a group of 651 young old people (55–59 years of age) and 4453 people aged ≥65. Lack of dentition and a less frequent use of dentures was observed mainly among inhabitants of rural areas. However, in people with no dentition who used dentures overweight and obesity occurred more often.

In their study Perna et al. [29] emphasised the connection between the occurrence of the Frailty Syndrome and the nutritional status of senior citizens living in institutions. Thus the researchers showed that an assessment of an elderly person by means of the MNA is related to the EFS and is of clinical significance. One should also remember that people with the frailty syndrome may be overweight or obese [30]. Patophysiological changes in the course of the Frailty Syndrome result in loss of body weight and muscle strength, activity slowdown, anaemia, cardiovascular diseases, eating disorders, anorexia and even an increased risk of death [31]. Undernourishment prolongs hospital stay, the course of chronic diseases, it increases the cost of treatment and care of the elderly and contributes to lowering the quality of their lives [1, 32].

## CONCLUSIONS

1. The results of anthropometric measurements are essential for an optimal identification of the risk of undernourishment in senior citizens by means of the MNA. They also complement information on the initiating factors of eating disorders in a population of elderly people.

2. In order to be able to widely use anthropometric measurements to complement the knowledge on the nutritional status of the elderly, it is indispensable to conduct studies among healthy senior citizens to obtain information which will serve as a reference point in the form of reference data.

## REFERENCES

1. Wojszel ZB. Niedożywienie i dylematy leczenia żywieniowego w geriatric. *Post Nauk Med* 2011;8:649-57.
2. Mziray M, Żuralska R, Książek J, Domagała P. Niedożywienie u osób w wieku podeszłym, metody jego oceny, profilaktyka i leczenie. *Ann Acad Med Gedan* 2016;46:95-105.
3. Antczak-Domagała K, Magierski R, Wlazło A, Sobów T. Stan odżywienia oraz sposoby jego oceny u osób w podeszłym wieku i u chorych otyłych. *Psychiatr Psychol Klin* 2013;13(4):271-7.
4. Roszkowski W, Chmara-Pawlińska R. Somatometria osób starszych jako wskaźnik stanu odżywienia. *Rocz Panstw Zakł Hig* 2003;54(4):399-408.
5. Ożga E, Małgorzewicz S. Ocena stanu odżywienia osób starszych. *Geriatrics* 2013;7:1-6.
6. Guigoz Y, Vellas B, Garry PJ. Mini Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. *Facts Res Gerontol* 1994;Suppl 2:15-59.
7. Vellas B, Villars H, Abellan G, Soto ME, Rolland Y, Guigoz Y, et al. Overview of the MNA – Its history and challenges. *J Nutr Health Aging* 2006;10(6):456-65.
8. Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for under-nutrition in geriatric practice: developing the short-form Mini Nutritional Assessment (MNA-SF). *J Gerontol A Biol Sci Med Sci* 2001;56(6):M366-72.
9. Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. *J Nutr Health Aging* 2009;13(9):782-8.
10. Montejano Lozoya R, Martínez-Alzamora N, Clemente Marín G, Guirao-Goris SJA, Ferrer-Diego RM. Predictive ability of the Mini Nutritional Assessment Short Form (MNA-SF) in a free-living elderly population: a cross-sectional study. *PeerJ* 2017;5:e3345. doi: 10.7717/peerj.3345
11. Cova I, Pomati S, Maggiore L, Forcella M, Cucumov, Ghiretti R, et al. Nutritional status and body composition by bioelectrical impedance vector analysis: A cross sectional study in mild cognitive impairment and Alzheimer's disease. *PLoS One* 2017;12(2):e0171331. doi: 10.1371/journal.pone.0171331.
12. Ziebolz D, Werner C, Schmalz G, Nitschke I, Haak R, Mausberg RF, et al. Oral Health and nutritional status in nursing home residents-results of an explorative cross-sectional pilot study. *BMC Geriatr* 2017;17(1):39. doi: 10.1186/s12877-017-0429-0.
13. Perna S, Francis MD, Bologna C, Moncaglieri F, Riva A, Morazzoni P, et al. Performance of Edmonton Frail Scale on frailty assessment: its association with multi-dimensional geriatric conditions assessed with specific screening tools. *BMC Geriatr* 2017;17(1):2. doi: 10.1186/s12877-016-0382-3.
14. Kostka J, Borowiak E, Kostka T. Nutritional status and quality of life in different populations of older people in Poland. *Eur J Clin Nutr* 2014;68(11):1210-5. doi: 10.1038/ejcn.2014.172.
15. Saletti A, Lindgren EY, Johansson L. Nutritional status according to mini nutritional assessment in an institutionalized elderly population in Sweden. *Gerontology* 2000;46(3):139-45. doi: 10.1159/000022149.
16. Wojszel ZB. Determinants of nutritional status of older people in long-term care setting on the example of the nursing home in Białystok. *Adv Med Sci* 2006;51:168-73.
17. Olszanecka-Glinianowicz M, Chudek J, Kołtajis-Dołowy A, Milewicz A, Krzyżanowska-Świniarska B, Więcek A. Stan odżywienia i uzębienia u osób w wieku podeszłym w Polsce. In: Mossakowska M, Więcek A, Błędowski P, editors. *Aspekty medyczne, psychologiczne, socjologiczne i ekonomiczne starzenia się ludzi w Polsce*. Poznań: Termedia Wydawnictwa Medyczne; 2012. p. 335-58.
18. Kostka J, Borowiak E, Kostka T. Validation of the modified mini nutritional assessment short-forms in different populations of older people in Poland. *J Nutr Health Aging* 2014;18(4):366-71. doi: 10.1007/s12603-013-0393-0.
19. Kaiser MJ, Bauer JM, Uter W, Donini LM, Stange I, Volkert D, et al. Prospective validation of the modified mini nutritional assessment short-forms in the community, nursing home, and rehabilitation setting. *J Am Geriatr Soc* 2011;59(11):2124-8. doi: 10.1111/j.1532-5415.2011.03659.x.
20. Sergi G, De Rui M, Coin A, Inelmen EM, Manzato E. Weightloss and Alzheimer's disease: temporal and aetiological connections. *Proc Nutr Soc* 2013;72(1):160-5. doi: 10.1017/S0029665112002753.
21. Easterling CS, Robbins E. Dementia and dysphagia. *Geriatr Nurs* 2008;29(4):275-85. doi: 10.1016/j.gerinurse.2007.10.015.
22. Reed PS, Zimmerman S, Sloane PD, Williams CS, Boustani M. Characteristics associated with low food and fluid intake in long-term care residents with dementia. *Gerontologist* 2005;45,1(1):74-80.
23. Saragat B, Buffa R, Mereu E, Succa V, Cabras S, Mereu RM, et al. Nutritional and psycho-functional status in elderly patients with Alzheimer's disease. *J Nutr Health Aging* 2012;16(3):231-6.

24. Balkau B, Deanfield JE, Després JP, Bassand JP, Fox KA, Smith SC Jr, et al. International Day for the Evaluation of Abdominal Obesity (IDEA): a study of waist circumference, cardiovascular disease, and diabetes mellitus in 168,000 primary care patients in 63 countries. *Circulation* 2007;116(17):1942-51.
25. Sullivan DH, Martin W, Flaxman N, Hagen JE. Oral health problems and involuntary weight loss in a population of frail elderly. *J Am Geriatr Soc* 1993;41(7):725-31. doi: 10.1111/j.1532-5415.1993.tb07461.x.
26. Lopez-Jornet P, Saura-Perez M, Llevat-Espinosa N. Effect of oral health dental state and risk of malnutrition in elderly people. *Geriatr Gerontol Int* 2013;13(1):43-9. doi: 10.1111/j.1447-0594.2012.00853.x.
27. Ziebolz D, Werner C, Schmalz G, Nitschke I, Haak R, Mausberg RF, et al. Oral health and nutritional status in nursing home residents-results of an explorative cross-sectional pilot study. *BMC Geriatr* 2017;17(1):39. doi: 10.1186/s12877-017-0429-0.
28. Syrjälä AM, Ylöstalo P, Ruoppi P, Komulainen K, Hartikainen S, Sulkava R, et al. Dementia and oral health among subjects aged 75 years or older. *Gerodontology* 2012;29(1):36-42. doi: 10.1111/j.1741-2358.2010.00396.x.
29. Perna S, Francis MD, Bologna C, Moncaglieri F, Riva A, Morazzoni P, et al. Performance of Edmonton Frail Scale on frailty assessment: its association with multi-dimensional geriatric conditions assessed with specific screening tools. *BMC Geriatr* 2017;17(1):2. doi: 10.1186/s12877-016-0382-3.
30. Strandberg TE, Pitkälä KH. Frailty in elderly people. *Comment. Lancet* 2007;369(9570):1328-9.
31. Espinoza S, Walston JD. Frailty in older adults: insights and interventions. *Cleve Clin J Med* 2005;72(12):1105-12.
32. Heersink JT, Brown CJ, Dimaria-Ghalili RA, Locher JL. Undernutrition in hospitalized older adults: patterns and correlates, outcomes, and opportunities for intervention with a focus on processes of care. *J Nutr Elder* 2010;29(1):4-41. doi: 10.1080/01639360903574585.