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ORIGINAL ARTICLE

Measuring body mass index (BMI) in nursing home residents: The usefulness of measurement of arm span

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Abstract

Objective. To study whether arm span can be used as substitute for measurement of height in nursing home patients for calculating body mass index (BMI). **Design.** Explanatory observational study. **Setting.** Assessment of 35 nursing home residents admitted to long-term stay in a nursing home. **Main outcome measures.** Correlation between measured height and arm span and of BMI based on both measures. **Results.** Measured height and arm span, and BMI calculated from either measure were significantly correlated, $r_s = 0.75$, $p < 0.001$ and $r_s = 0.89$, $p < 0.001$, respectively. The ratios of measured height and arm span and between BMIs based on height or arm span are close to 1, but the dispersion is rather large. **Conclusion.** Arm span is a reliable substitute for measurement of height in nursing home patients. In persons with severe height reduction, arm-span-based BMI is probably more accurate than conventional height-based BMI.

Key Words: Arm span, body mass index, BMI, nursing home

Malnutrition related to older people in the Western world has become an issue of increasing concern [1]. When a definitive diagnosis can be made, the most common causes of weight loss in older persons are depression, benign gastrointestinal disease, and cancer. In addition, the use of various drugs is associated with weight loss [2]. Several drugs commonly prescribed to nursing home residents come into this group, leading to a call for a system for quality assurance [3]. Common risk factors for malnutrition in older people are poor dentition, disability, impaired mobility, loneliness, stroke, drug interactions, confusion, depression, anxiety, bereavement, and dementia [4]. Studies using body mass index (BMI) as a measure of malnutrition report prevalence rates of malnutrition between 18% and 70% [5–8]. However, different BMI cut-off scores are applied in these studies.

Malnutrition is associated with poor health, impaired immunity, increased mortality, and impairment of quality of life [4]. As risk factors for malnutrition are common among nursing home residents, there is a good reason for screening

The nursing home physician has an important task in establishing routines, which includes assessment of nutritional status, a topic which is frequently neglected in nursing homes.

- Measuring body mass index (BMI) can be the first step in assessing nutritional state in nursing home residents.
- Illnesses and sequelae after illnesses are a common obstacle to measuring height.
- Arm span is a valid and reliable substitute for measuring height in frail older people.

when older individuals are admitted to a nursing home. Drug review is one obvious issue, and it has been shown that systematic drug review and drug reduction is feasible in daily practice [9].

Guidelines for screening for malnutrition have been established in several countries [10]. According to Norwegian guidelines nursing home residents should have their weight checked at admission and thereafter monthly, and BMI is recommended as a reliable measure of the nutritional state [11].

Evidence of the extent to which these guidelines are being adhered to is, however, scarce. A recent survey reported that weight control on admission had not been carried out in 54% of 298 residents [12]. Similar figures have also been reported by others [13].

BMI is a simple measure to describe the relationship between height and weight, and it is frequently recommended for screening and to monitor nutritional status [14]. BMI is calculated from height and weight ($\text{BMI} = \text{weight (kg)} / \text{height (m)}^2$). Measuring height can be difficult in physically and mentally frail nursing home patients, e.g. patients that are wheelchair users or bedridden and patients with osteoporosis, sequelae after hip fractures, leg amputation, or stroke. Several alternatives to height have been proposed for the assessment of nutritional state in older persons. One alternative – arm span – has been shown to be a practical substitute for skeletal size [15–18].

The aim of the present study is to assess whether measurement of arm span is a practical substitute for height for calculation of BMI in nursing home residents.

Material and methods

Data for this study originate from a longitudinal study conducted in 12 nursing homes in Bergen, Norway between December 1999 and January 2001. Data from 148 persons consecutively admitted for permanent stay were registered. Apart from an individual interview with each patient, relevant information was collected from medical and nurses' records. Measurement of arm span was part of the study. Height measurement, which was not available for any of the patients, was measured by the author for patients in whom it was practically feasible ($n = 35$).

Various ways of measuring arm span have been proposed [15,17,18]. In this connection arm span was measured with the patient sitting or in recumbent position, from sternal notch to the tip of the middle finger, times two [17,18]. This is a reliable

procedure with 1% coefficient of variation of measurements on two separate occasions [17]. Equipment to measure height was not available in any of the institutions. To measure height the patient stood upright at the wall without shoes, and height was marked at the wall. Both arm length and height were measured with the same steel measuring tape. The author performed all measurements of height and arm span. Weight was collected from nurses' records.

Statistics

Non-parametric tests were applied to compare continuous variables between categories; a Mann–Whitney test and Spearman's rank correlation were used to study correlations. Statistical significance was set to 5%.

Ethical approval

The Regional Ethics Committee approved the study protocol and consent procedures.

Results

Clinical and anthropometric data for the whole group and by genders are shown in Table I. According to medical records, 19 residents (54%) were demented. Age was significantly correlated with height ($r_s = -0.42$, $p = 0.01$), but not with arm span ($r_s = -0.28$, $p = 0.11$) or weight ($r_s = -0.03$, $p = 0.89$). There was a significant correlation between arm span and measured height, $r_s = 0.75$, $p < 0.001$, and between BMI based on measured height and BMI based on arm span, $r_s = 0.89$, $p < 0.001$. The ratio between arm span and height, and BMI based on arm span and height was 1.01 and 0.98, respectively (Table I).

Discussion

The present study of nursing home residents confirms studies showing a significant correlation

Table I. Clinical and anthropometric characteristics for 35 nursing home patients, median (range).

	All $n = 35$	Women $n = 26$	Men $n = 9$	p^1
Age	85 (54–96)	85 (65–96)	84 (54–96)	0.75
Weight (kg)	30.0 (56–107)	51 (30–78)	63 (54.3–107)	0.008
Height	1.57 (1.42–1.76)	1.54 (1.42–1.73)	1.65 (1.57–1.76)	<0.001
Arm span (m)	1.59 (1.38–1.78)	1.55 (1.38–1.78)	1.68 (1.65–1.74)	<0.001
Ratio arm span/height	1.01 (0.91–1.18)	1.005 (0.91–1.18)	1.02 (0.94–1.11)	0.67
BMI (height)	22.37 (12.98–40.27)	21.00 (12.98–33.76)	22.77 (17.53–40.27)	0.38
BMI (arm span)	20.69 (15.62–37.91)	19.90 (15.62–36.10)	22.32 (18.50–37.91)	0.38
Ratio BMIs based on height and arm span	0.98 (0.72–1.21)	0.99 (0.72–1.21)	0.96 (0.81–1.12)	0.67

¹Mann–Whitney test.

between arm span and measured height and a highly significant correlation between BMI when measured by height and arm span, respectively [15–19]. On average, the ratio between arm span and height was close to 1, which is comparable to a study among younger individuals (average 23 years) [19]. The dispersion is, however, greater in the present population. This is most probably due to greater inter-individual variations in loss of stature in older persons [20]. In addition, the ratio of BMIs based on arm span and height, respectively, was close to 1, but with rather great dispersion. By itself, reduction of stature leads to an increase in BMI. When calculating BMI the denominator is the square of height or arm span in metres. Changes in stature erroneously lead to a larger BMI index; an equivalent change in arm span does not occur [19]. BMI calculations based on arm span are therefore likely to be more accurate.

Only a few of the participants in the present study were able to recall their historic height. One of them, an 86-year-old woman, reported a historic height of 1.66 m. Arm span was 1.69 m, and measured height was 1.43 m. Her weight was 51.0 kg. Based on the three measurements of height, BMI was 18.51, 17.86, and 24.94, respectively.

The WHO has established reference values for BMI: BMI ≥ 25 kg/m² overweight, BMI 18.5–24.99 kg/m² normal range, and BMI ≤ 18.49 kg/m² underweight [21]. The references are considered to be relevant also “for the elderly”; however, it is stated that other cut-offs may be more appropriate for persons above 70 years of age [21]. There is no clear BMI score which is agreed upon as a lower limit of the normal range, and reports on malnutrition in older people operate with various cut-off scores between 18.5 kg/m² and 20 kg/m² [3–6]. Review of the literature indicates that the optimal BMI range for elderly people should be 24–29 kg/m² [22]. BMIs below and above these limits are for example associated with increase in mortality [22]. A BMI of less than 24 kg/m² is therefore considered an appropriate cut-off with regard to intervention in order to reduce nutrition-related complications [22]. The cited studies are based on measure of height making some measurement bias likely as a result of stature decrease.

Several caveats must be considered when using BMI as a measure of nutritional state in a clinical setting. BMI says nothing about body composition, e.g. whether changes in BMI are a result of change in stature, muscle, or fat mass, or due to oedema. In daily work, additional information must be gathered, e.g. eating habits, medical condition, appetite, and drug use and weight changes. This has led to the development of more detailed assessment

instruments for malnutrition. BMI is part of several of these instruments, for example the Mini Nutritional Assessment (long and short form) [23] and Malnutrition Universal Screening Tool [24].

Although arm span usually remains stable throughout life, impaired movement in shoulder and elbow, and contractures may sometimes be a problem if both arms are affected.

Medical services in nursing homes are usually carried out by general practitioners. Nursing staff and physicians have an obligation to ensure that nursing home residents receive appropriate and timely care. The nursing home physician has the authority to carry out and to require assessments appropriate to ensure adequate medical services to the residents. Surveying nutritional state of the residents is a major task in this respect.

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