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Use of BMI in the assessment of undernutrition in older subjects: reflecting on practice

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In recent years there has been a proliferation of nutrition screening tools but undernutrition remains prevalent amongst older subjects. Screening tools commonly include BMI as the widely-accepted 'gold standard' indicator of malnutrition. Whilst BMI may be an appropriate tool for population studies when it can be measured accurately in research conditions, the use of BMI in clinical practice may mask important weight changes and result in a failure to alert healthcare staff to a nutritional problem. The inclusion of BMI has been identified as a barrier to completing the screening process at ward level. Also, feedback from dietitians working with older subjects indicates that 72·5 % of those using BMI express concerns that it is of limited use for practical reasons or that the reference range (20–25 kg/m^2) is not appropriate to older subjects. Further evidence questions whether or not BMI is applicable for inclusion in methods used to identify an older subject at risk of undernutrition in a variety of care settings. In view of these findings it is advocated that weight change over a period of time together with clinical judgement is a far superior prognostic indicator of undernutrition. Despite screening, there is evidence that inpatients continue to lose weight before discharge. Further experiential evidence from both community and ward settings suggests that inadequacies in care planning, food provision and a lack of assistance with feeding are common. In order to improve the management of undernutrition in older subjects it is therefore recommended that the focus of attention should be on addressing these practical issues and on the effective monitoring of these processes.

Undernutrition: BMI: Older subjects

BMI is widely accepted within professional groups as the 'gold standard' for determining whether a patient is underweight or overweight. Indeed, screening tools such as the 'Mini Nutrition Assessment' (Beck *et al*. 1999), Malnutrition Advisory Group tool (British Association for Parenteral and Enteral Nutrition Malnutrition Advisory Group, 2000) and the 'Malnutrition Universal Screening Tool' (British Association for Parenteral and Enteral Nutrition Malnutrition Advisory Group, 2003) all use BMI as a criterion for assessing undernutrition. Many of the computerised patient information systems used in general practice calculate and store BMI data when height and weight are recorded for patients. Some examples of the single-assessment process derived as a result of a recommendation of the National Service Framework for Older People (Department of Health, 2001*c*) also include this variable. The most recent report from the Royal College of Physicians (2002) also describes the use of BMI.

Despite the widespread inclusion of the BMI in screening tools as a measure of nutritional status there is evidence that practitioners lack confidence in its use. A recent survey of forty-six specialist dietitians working with older subjects (members of the Nutrition Advisory Group for the Elderly) has indicated that 87 % are using BMI in the assessment of nutritional status. However, only 26 % of this group are totally happy with its use, while 69 % are using BMI but feel it is limited for practical reasons or that the reference ranges are not applicable to older subjects. Indeed, 5 % are using it because there is 'nothing better' or because it is written into their department policy and is regularly audited. BMI tends to be viewed as a quantitative,

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and hence an objective, measure of nutritional status, but there are many variables that question this objectivity, especially in older subjects.

The present paper results from a review of the evidence conducted in 2001–2 together with local evidence gathered more recently. The findings have led the authors to reflect on their current practice. It is recommended that professionals assessing nutritional status in older subjects using BMI consider carefully the following questions:

what is BMI?
is BMI a practical measure?
is BMI an objective and reliable measure?
is BMI a sensitive measure of nutritional status?
is the BMI reference range of 20–25 kg/m^2 appropriate for older subjects?
does knowledge of BMI improve morbidity and mortality outcomes in older subjects?

What is BMI?

BMI is an index of weight-for-height that is commonly used to classify overweight and obesity in adults. The Belgian astronomer and statistician Adolphe Quetelet (1796–1874) first suggested using an index based on the 'length' and 'weight' of individuals, the Quetelet Index, that could be used to predict aspects of their health. The Quetelet Index was later renamed BMI (Keys *et al*. 1972). BMI is calculated from weight (kg) divided by the square of height (m). Reference ranges have been defined according to the extent of adiposity and the level of morbidity risk. The World Health Organization (1998) classifies normal weight as a BMI of 18·5–24·9 kg/m^2, overweight as 25–29·9 kg/m^2 and obesity as ≥30 kg/m^2.

Although BMI is almost universally used to describe obesity, it has also been extrapolated to describe extents of undernutrition; a BMI of <18·5 kg/m^2 is considered underweight and hence indicates undernutrition. The scientific basis of this extrapolation and the evidence to support the use of BMI in defining undernutrition is unclear.

Is BMI a practical measure?

Experience in clinical practice suggests it is unrealistic to request and expect height to be measured in many inpatient or care home settings. Indeed, if requested they frequently are not carried out because of work pressures, the practicalities of measuring height on the non-ambulatory or unwell older subject or the lack of equipment (ME Thomas, S Banks and CA Wright, unpublished results). This situation has been demonstrated in an audit of weighing scales conducted in the Leeds Mental Health Trust by K Johnson (unpublished results). It was found that twenty-two sets of scales were available on fifteen units but no hoist or wheelchair scales were identified. Only fifteen of the twenty-two sets of scales were accurate and only seven of these sets had been recently calibrated.

Surrogate height measurement such as knee height and demi-span can be successfully carried out in research study or audit situations in which intensive support and resources are made available for that purpose, but to expect such measures to be used routinely in many care settings is unrealistic and attempts are often unsuccessful. This situation has been demonstrated in a pilot study that has looked at the practicalities of implementing a validated screening tool on surgical wards in a large teaching hospital (S Kelsey, unpublished results). It was found that height is difficult to measure as stadiometers are not always available and immobile patients or those in pain are unable to stand upright. It was also found that weighing and measuring patients including conducting proxy measurements such as knee height and demi-span increases the time required to screen subjects. This factor has resulted in the tool being less acceptable to the ward staff and hence less likely to be used routinely. Demi-span can be difficult to measure in older subjects because of poor joint movement or an inability to fully extend the arms horizontally. It may also be impossible for older subjects to attain good positioning in order to measure a knee height (Kirk *et al*. 2003).

Is BMI an objective and reliable measure?

Berke in 1878 (Bastow, 1982) observed that 'nothing is measured with greater error than the human body'. Despite the age of this observation, from experience of supervising student research projects and anecdotal evidence from practice, this statement remains pertinent. In the pilot study outlined earlier it was found that there is often error in converting imperial measurements to metric measurements. There is anecdotal evidence of poor numeracy skills amongst some staff in care homes; for example, a weight of 48 kg was reported when the reading was actually 40·8 kg. Such inaccuracies have been noted even after staff training has been undertaken.

There is an association between BMI and morbidity and mortality (de Onis & Habicht, 1996). However, the reference ranges used to determine level of risk are often based on data from healthy adults and data for older groups is scarce (Lehmann *et al*. 1991). BMI values were intended for use with populations, and tables of normal values give little credibility to the widespread variation between individuals; however, comparisons are often made between the individual and a population. The norms used are derived from different ethnic and geographical data or historical population statistics (Burr & Phillips, 1984), and the values will vary considerably depending on age, gender and ethnicity. Considerable absolute error is possible in individual patients because of kyphosis, oedema and enhanced muscularity. BMI is therefore not an appropriate tool for use with individuals or in populations for whom body composition may be different from that of healthy younger adults, such as older subjects.

Stature decreases with age because of senile kyphosis, shortening of the spinal vertebrae and thinning of weight-bearing cartilages. In addition, there has been an increase in average height and body size over recent generations (Jebb, 1998). Physiological changes, equipment variability and observer error (Bastow, 1982) lead to height being a measure fraught with inaccuracy.

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Professionals often rely on self-reporting of adult height because of a lack of staff or difficulty measuring ill or immobile patients. However, it has been shown that height is often over-reported (and weight is often under-reported) and, if translated to BMI, this discrepancy would give an inaccurate value (Jebb, 1998). This problem was acknowledged in the pilot study on the surgical wards when self-reporting was considered because very few subjects had weight and/or height recorded in their records (S Kelsey, unpublished results). Researchers using secondary data from the National Health and Nutrition Examination Survey (Galanos *et al*. 1994) used height collected in adulthood to calculate BMI in elderly subjects. In clinical practice it has been observed that BMI in older subjects is calculated using the current height. The use of an historic height and a current height in the same individual will provide a different BMI reading. These two measurements are different and clarification is required on the appropriate height measurement to select in this population.

A small pilot study of seventeen residents in a Leeds care home, which compared measured height with height calculated from demi-span and knee height, has demonstrated that the limits of agreement between the methods varies by ≤100 mm (Kirk *et al*. 2003). In over half the seventeen subjects an accurate measurement of standing height was difficult to obtain, because of difficulties encountered by the subjects in standing fully upright as a result of frailty or spinal deformity. Problems were also encountered with demi-span and knee-height measurements, since some subjects had poor movement in their arms and were unable to extend their arms horizontally, and eleven of the seventeen subjects were unable to get themselves into the correct position for measuring knee height. All measurements were taken by the same researcher, which removes error that may be introduced when measurements are made by more than one individual.

These findings support the results of previously-conducted larger-scale studies in older subjects (Coroni-Huntley *et al*. 1991; Beck & Ovesen, 1998) and challenge the view of the Malnutrition Advisory Group (British Association for Parenteral and Enteral Nutrition Malnutrition Advisory Group, 2000) that BMI is a simple and reproducible measure for assessing malnutrition in older subjects.

Is BMI a sensitive measure of nutritional status?

BMI is not sensitive enough to recognise small yet clinically-significant weight losses. For example, a patient who experiences a 10% weight loss would not always be deemed by BMI to be at risk. Thus, if an individual who is 1·58 m tall and initially weighs 67 kg loses 10% of their body weight their BMI would change from 27 kg/m^2 to 24 kg/m^2, i.e. the BMI would be within the normal range but the weight loss would be clinically significant in terms of increased risk of mortality.

The cut-off points for BMI, if used, should be set at 100% sensitivity to ensure that all those at risk who would benefit from nutritional support are treated. In their discussion paper Beck & Ovesen (1998) suggest that using the same cut-off points for BMI and weight loss in all age-groups could mean that they are not sensitive enough for use in the older subjects and that at-risk patients in this group are detected too late for nutrition-related complications to be prevented.

Nightingale *et al*. (1996) have found that more patients are detected as malnourished by the percentage weight loss than by BMI or mid-arm muscle circumference.

Is the BMI reference range of 20–25 kg/m^2 appropriate for older subjects?

The survey conducted amongst members of the Nutrition Advisory Group for Elderly People of the British Dietetic Association (S Lawrenson, Z Cook and S Sandford, unpublished results) indicates that dietitians working with older subjects are using varying reference ranges when assessing clients. The majority acknowledge that a range of 20–25 kg/m^2 is not appropriate for the older adult but the reference ranges chosen are not always based on robust evidence.

Older subjects are a very heterogeneous group, and therefore a 65-year-old subject cannot be compared with an 80-year-old subject (de Onis & Habicht, 1996). The best BMI for subjects >60 years of age has been shown to be >27 kg/m^2 (Wynn & Wynn, 1995), and in a study of body weight and 3-year prognosis in older subjects aged 84–88 years it was observed that mortality is increased when BMI is <22 kg/m^2, but is not increased when BMI is >30 kg/m^2 (Rajala *et al*. 1990). BMI ranges with the lowest risk for 15-year mortality in non-smokers >70 years of age has been suggested to be 27–29 kg/m^2 for men and 25–27 kg/m^2 for women (Dey *et al*. 2001).

Nightingale *et al*. (1996) have reported a BMI of >25 kg/m^2 for four patients detected as malnourished using percentage weight loss, and Beck & Ovesen (1998) have concluded that in older subjects a BMI of <24 kg/m^2 or any extent of weight loss should be used in combination with other variables when aiming for the most favourable outcome.

As an alternative to using BMI in older individuals current weight can be compared with acceptable weight ranges (Caroline Walker Trust, 1995; Voluntary Organisations Involved in Caring for Elderly Sector, 1998).

It is acknowledged that weighing patients and obtaining weight history can be difficult but, where available, comparison of current weight with usual body weight is a sensitive and personal measure and is less likely to be diluted and misinterpreted, as may occur when calculating BMI.

Does knowledge of BMI improve morbidity and mortality outcomes in older subjects?

BMI cannot distinguish between loss of lean body mass and loss of fat mass and is not an indicator of protein–energy malnutrition (Landi *et al*. 1999).

Beck & Ovesen (1998) have explained that a high percentage of older subjects, especially those initially malnourished, would not benefit from nutritional support.

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These authors recognise that early detection of a risk of malnutrition developing is most pertinent. They suggest that the cut-off point for BMI currently used to screen for undernutrition is not effective and that the key to effective screening is to anticipate nutritional depletion, and thus prevent its onset, or to rectify it before clinical significance is reached. Jensen *et al*. (2001) have recognised a lack of consistency in the interpretation of results when subjects are screened for nutritional risk.

Despite many years of screening and screening tool development, further weight loss often occurs before patients are discharged from hospitals back into the community (McWhirter & Pennington, 1994). Jensen *et al*. (2001) share the view of Beck & Ovesen (1998) that screening for nutritional risk once a patient has been admitted to a care setting is not timely and is of limited value in improving nutritional outlook.

It is suggested that screening and calculating BMI in an acute setting does not always have a positive effect on mortality and morbidity, and monitoring of weight changes in the community would highlight problems in a more timely manner.

In an acute setting it may be more pertinent to observe food quality and intake (Baker *et al*. 1982; Department of Health, 2001*a*,*b*).

Conclusion

Further development of appropriate reference ranges for body weight is required for older subjects. It is suggested that where accurate measurements are obtained, e.g. in large population studies such as the National Diet and Nutrition Survey (Finch *et al*. 1998), these national data sets could be used to define ranges of acceptable weights by gender and age-band. These reference ranges could be regularly updated to reflect changing population trends, as data are collected at 10-yearly intervals. Until reference ranges based on such data are defined, it is recommended that acceptable minimum–maximum weights be adopted in practice, as defined by the Caroline Walker Trust (1995).

Converting weight to a BMI using a height measure or proxy requires additional time and equipment, and is likely to be inaccurate; it is therefore not recommended for use in screening older individuals. Evidence from practice, in addition to literature searches, does not support the use of BMI when assessing undernutrition in individual older subjects. Disease history and physical changes, including weight measurement where possible, need to be considered. Weight and weight change over a period of time are dynamic sensitive measures requiring least observer effort (Katalin *et al*. 1995).

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