A Comparison of Measured Height and Demi-span Equivalent Height in the Assessment of Body Mass Index among People Aged 65 Years and Over in England

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Objectives: To examine differences between measured height and demi-span equivalent height (DEH) among people aged ≥65 and investigate the impact on body mass index (BMI) of using DEH.

Design and setting: Nationally representative cross-sectional sample of adults living in England.

Participants: 3346 non-institutitionalised adults aged ≥65, taking part in the Health Survey for England (HSE) 2001.

Measurements: Height, weight and demi-span measurements were taken according to standardised HSE protocols. DEH was calculated using Bassey's equation.

Results: The height measurement was lower than the DEH from age group 70-74 years onwards in men and in each age group in women. No significant differences in mean DEH and measured height were found for men (-0.46) or women (-2.64). BMI derived from measured height did not differ significantly from BMI derived from DEH. The prevalence of underweight was lower when using measured height than when using DEH in women aged ≥65, particularly in those aged 80 years and over. The prevalence of overweight and obesity was higher using measured height than DEH in women aged ≥65.

Conclusion: We confirmed in a large nationally representative sample that demi-span measurement may be a useful estimate of stature in people (particularly women) aged ≥65 to use for BMI calculations.

Keywords: demi-span, anthropometry, nutritional status, older people, population survey

INTRODUCTION

Height and weight are important measurements used in the calculation of body mass index (BMI), an indictor of nutritional status. Loss of height occurs with ageing and is due to the thinning of the discs of the spinal column and diminution in the height of the vertebrae [1] [2].These changes can vary in individuals but may be quite significant. Estimates from longitudinal studies show that loss of height of up to 5cm in men and 8cm in women occurs from the age of 30 to 80 years [3].Standing height measurements in older people can be difficult to obtain due to an inability to stand straight or steadily due to pain, weakness, disability, or spinal deformities such as kyphosis (curvature of the spine) or due to osteoporosis. Therefore height measurements in some older people can be impossible or inaccurate and may not necessarily reflect their maximum attained height. Alternative height measurements such as arm-span [4], knee height [5] [6], and demi-span [7] [8] have been shown to be useful surrogate measures of stature in older people and may be more accurate because the length of long bones, i.e. those in arms and legs, do not change with age, unlike vertebral height [3].

The demi-span measurement was chosen over other proxy measures of height in the Health Survey for England (HSE) because it can be easily measured without causing discomfort or distress. It has been shown to be superior to arm length (span) [4].There is also evidence to suggest that knee-span can be a good predictor of height [5] [6], but may be less reliable [9] and time consuming [10].

Arm-span measurements (i.e. the largest distance across the middle fingers when the arms are stretched horizontally sideways) have been used in the assessment of nutritional status in adults aged 18-50 years [11] and in older hospitalized patients [12]. Demi-span (defined as the distance between the mid-point of the sternal notch and the finger roots with the arm outstretched laterally) has been used as an alternative measure of stature in some epidemiological studies among older people [13] [14] [15], for interpretation of spirometric data [16], and is included in nutritional assessment tools to identify elderly patients at risk of malnutrition when standing height measurements are not possible [17] [18].However, it is not yet clear whether demi-span should be used in the absence of a valid height measurement or as the measure of choice for older people. If the National Institute for Health and Clinical Excellence guideline [19] is to be implemented for screening hospital patients in England for malnutrition, then there is a need to clarify the usefulness of demi-span as an alternative measurement to assess nutritional status.

The aim of this paper is to look at the differences between measured height and DEH in a large, nationally representative, random population sample and investigate the impact of using DEH to calculate body mass index (BMI) in people aged ≥65 years.

METHODS

Data

The HSE is a continuous survey that examines the health of people living in England.As in previous years, the 2001 HSE [20] was designed to be a representative sample of the population living in private households. In the multi-stage stratified sampling process, 13,680 addresses were drawn randomly from the Postcode Address File (PAF).Up to 10 resident adults (aged 16 and over) at each selected private household address were eligible for inclusion in the survey. Full details of sampling methodology can be found elsewhere [20].

A valid height measurement was obtained from 1,192 men and 1,492 women of the total private household sample aged ≥65 years (3,346).A valid demi-span measurement was obtained from 2401 of informants (1,098 men and 1,303 women).Those who had a valid height and demi-span measurement were representative of those that were interviewed i.e. of the whole population aged ≥65 years in the survey.

At the interview stage (Stage 1), informants had a height and weight measurement taken using standardised procedures. Height was measured using a portable stadiometer. One measurement was taken without shoes, with the informant stretching to the maximum height and the head positioned in the Frankfort plane. The reading was recorded to the nearest millimetre. Weight was measured using Soehnle, Seca or Tanita electronic scales with a digital display. A single measurement was recorded to the nearest 100g with informants removing shoes and bulky clothing (see Appendix for the full protocol).

At the nurse visit (Stage 2), demi-span and waist was measured in informants aged ≥65 years. The demi-span measurement used on the HSE was based on the method described by Bassey [21]. Measurements were made with the right arm outstretched using a metal retractable tape. Two measurements were taken to the nearest even millimetre. The mean of the two valid measurements was used in the analysis (see Appendix for the full protocol). Data for two women in whom the demi-span measurements were unusually high (> 90cm) were excluded from the main analyses because the difference between demi-span equivalent height and height was very large (> 45cm).

Waist was defined as the midpoint between the lower rib and the upper margin of the iliac crest, measured using a tape with an insertion buckle at one end. The measurement was taken twice and recorded to the nearest even millimetre. The mean of the two valid measurements was used in the analysis.

The DEH was calculated using regression equations as shown below [21]. Highly significant correlations ($r = 0{\cdot}74$) were obtained between the two variables. These equations have been used in other studies [14] [8] [10]

Females: Height (cm) = (1.35x demi-span in cm) + 60.

Males: Height in (cm) = (1.40x demi-span in cm) + 57.8.

Statistical Analysis

Data were analysed using SPSS v13.The normality of the distribution for each of the measurements was confirmed by a Kolmogorov Smirnov-test, histogram and QQ-plot. The mean differences between measured height and DEH, by five-year age groups and for each sex were examined. Pearson's correlation coefficient was calculated to demonstrate the degree of association between the two measures. Agreement analysis as described by [22] was used to further investigate how closely the results of DEH compared with measured standing height at an individual level. In addition, this last method was also used to compare BMI calculated using DEH with BMI calculated using measured height (BMI (weight (kg)/ [Height (m)]^2). Significance was accepted at a p value of <0.05. Agreement was assessed by plotting the difference between the two measurements against the mean of the two measurements. The limits of agreement were defined as the mean difference ± 2 SD.

We assessed the effect of using DEH instead of measured height to calculate BMI (weight (kg)/[DEH (m)]^2) using the sex-specific regression equations. T-tests were used to compare measurements of height and DEH and BMI measurements, and Z tests were used to compare proportions underweight, overweight and obese.

RESULTS

A valid height measurement was obtained from 82.0% of the total private household sample aged ≥65 years (3,346). A valid demi-span measurement was obtained from 71.8% of informants (2,401).Those who had both a valid height and demi-span measurement were representative of those aged ≥65 interviewed. The mean ages were not significantly different for either sex aged ≥65 years interviewed (men 73.4, SD 6.31; women 74.8, SD 6.98) in comparison with those that had a valid height (men 72.8, SD 5.97; women 73.7, SD 6.42) or demi-span measurement (men 73.0, SD 6.13; women 74.1, SD 6.59).The characteristics of the 2082 subjects in this study are presented in Table 1. There were no significant age differences between the sexes. Men had significantly higher values of weight, height, demi-span, waist circumference and BMI calculated using DEH in the total group as well as in the five- year age groups. There were significant decreasing linear trends for all measurements, by age and sex except for the waist measurement (Table 1).

The results show a strong correlation between DEH and measured height for men (r= 0.71) and women (r= 0.72) aged ≥65 years. The correlation coefficients for each five-year age-group and sex were between 0.63 and 0.73. The Bland-Altman analysis of agreement showed that DEH estimates current height with a mean difference of -0.46, in men and -2.64 in women. The limits of agreement are however wide, (8.73cm and -9.65cm in men and for women 6.10cm and -11.38cm in women, Figure 1a and 1b, in Appendix).

Examining the difference between height and DEH by sex and five-year age group showed that in men aged 65-69 years, height was significantly greater than DEH (Table 2). Thereafter, from age group 70-74 years onwards, the height measurement was lower than the DEH. Among women, the height measurement was lower than the DEH in each age group (Table 2).

The differences between BMI calculated using height and weight measurements (BMI-HT) and BMI calculated using DEH (BMI-DEH) and weight measurements by sex and five-year age group showed that in men aged 65-69 years, BMI-HT was significantly lower than BMI-DEH, but from age group 70-74 years onwards BMI-HT was significantly greater than BMI-DEH (Table 2). Among women, in each age group, the BMI-HT was significantly greater than BMI-DEH (Table 2). The Bland-Altman analysis of agreement showed that BMI calculated using DEH overestimates BMI by on average by 0.12 in men and 1.52 in women The limits of agreement were between 3.04 kg/m^2 and -2.74 kg/m^2 cm in men and between 3.88 kg/m^2 cm and -2.08 kg/m^2 in women (Figures 1c and 1d, in Appendix).

Among men, there was little difference in the proportion classified as underweight (using cut-offs BMI < 18.5 kg/m^2 and >20 kg/m^2), overweight or obesity using height measurements to calculate BMI than when using DEH (Table 3).Among women, the prevalence of underweight (<18.5 kg/m^2) was lower when using measured height to calculate BMI in those aged 65-69 and ≥80 years (1.9%, and 3.4%, respectively). Using the BMI cut-off of <20 kg/m^2, the prevalence of underweight was markedly lower when using measured height to calculate BMI in those aged ≥80 years (9.4%, Table 3).The percentages of women aged ≥65 classified as overweight and obese were higher when using height in the calculation of BMI than when using DEH (Table 3).The differences were more apparent for overweight including obesity in the oldest group ≥ 80 years (9.8%) and for obesity among those aged 70-74 years (7.2%, Table 3).

It is known that BMI does not distinguish between mass due to body fat, mass due to muscular physique and does not take account of the distribution of fat. Using the waist measurement as a proxy for body fat we examined the relationship between BMI and waist circumference. BMI calculated using demi-span equivalent height showed a close correlation with waist circumference (r=0.84 in men and r=0.83 in women); similarly, the correlation between BMI calculated using measured height and waist circumference was also very close (r=0.82 in men and r=0.83).

DISCUSSION

Height is used in clinical situations for BMI calculations to assess nutritional status in the elderly. Inaccurate height estimates can lead to discrepancies in BMI classification. Our data shows that using measured height underestimates the prevalence of underweight and overestimates the prevalence of overweight including obesity in women aged ≥65, particularly in the oldest age group, and overestimates obesity in women aged 70-74 years, compared with using DEH.

There is some controversy as to whether BMI measurements in the elderly have the same significance at the same cut off values for overweight, obesity, and underweight as in a younger population. Although BMI may remain the same with ageing, there are changes in body composition i.e. loss of muscle mass [23] and an increase in fat mass with age. We found that BMI was strongly correlated with waist circumference whether height or DEH was used in the calculation of BMI. To determine body fatness, BMI could be used alongside other measures such as waist circumference and body fat impedance measurements to assess health risks associated with obesity.

Management of obesity is considered important in older people (aged ≥65) [24] and can improve obesity-related complications; both obesity (aged ≥75) and underweight are shown to be associated with increased mortality [26] but it has also been shown that higher BMI in people aged ≥65 is associated with lower mortality rates [25].

Price et al [27] state that current BMI-based health risk categories used by the World Health Organization are not appropriate for people aged ≥75.There is also no consensus [27] on an appropriate cut off for underweight in people aged ≥65. However, we have shown that whether the cut off of BMI <18.5 kg/m^2 or <20 kg/m^2 is used, older women aged $\geq$ 80 years may be missed in any malnutrition screening or assessment process if height measurements are used to calculate BMI.

Few studies have used demi-span in the assessment of nutritional status but these have either been carried out in smaller samples, among sick elderly people in clinical settings, when a height measurement was not possible, or have used different mass indices to that used in our study. We used direct substitution of DEH into the BMI formula (kg)/height (m^2). Other studies [14] [15], use Mindex (weight/demi-span) for women and Demiquet (weight/demi-span^2) for men.. It is not clear whether this method is more accurate than calculation of BMI using DEH or whether it provides a better diagnosis of under nutrition.

Using the formulae [21] for estimating height from demi-span showed that DEH was greater than measured height, for men aged $\geq$70 years, and in women $\geq$65 years, increasing with age, as in other studies [3] [28], and probably due to clinical conditions such as osteoporosis. Although cross-sectional surveys have shown demi-span is also lower in older people, the difference with age is considerably less than the height measurement [7] [3] [29]; it is most likely to be a cohort effect reflecting the increasing height of successive cohorts during the 20th century [7] [3]. It needs to be taken into account that secular trends may explain our observations, since it is difficult to show the true difference between measurements with this type of study design.

It is important to note that other than the Bassey equations [21], there are no other equations available for our use to estimate standing height from demi-span. These equations are very limited since they are derived from a small sample of people and there is a need for new and potentially more robust equations to be derived from a larger dataset. Weinbrenner et al [29] derived new equations to predict height in older people based on an elderly Spanish population from whom height would be difficult to measure, however these are population specific and so not useful for our purposes.

As expected, our results show a close correlation between DEH and height in those aged ≥65 years, as have other studies [14] [10]. Our results from agreement analysis [22] show that BMI calculated using DEH and BMI calculated using measured height shows a closer agreement for both men and women than DEH and height measurements but results are very similar, especially for men to a recent study [29].

There are no clear ‘gold standards’ on the usefulness of the demi-span measurements but suggestions are that it estimates maximum standing height achieved at around the age of 30 years [21] and does not decline with age as much as height, thus may be a better measure to use for determining BMI values [10]. Several screening tools, [18] include ulna, knee height or demi-span measurements. The Mini Nutritional Assessment tool [17] includes demi-span measurements when a height measurement cannot be obtained to calculate BMI. Demi-span, has the advantages that it can be measured in people who can straighten only one arm and can be measured on people who have problems with straightening the fingers, unlike arm-span.

There is a limitation that the HSE only takes one measurement of height and weight. It is recognised that taking two measurements and using the mean would provide a more precise estimate. However, the study has continued to use this protocol from when it was first designed. There are attempts to assess quality control through a large number of quality control measures built into the survey data collection and through computer program checks to alert interviewers of unlikely or extreme measurements.

The NICE guidelines [19] specify that hospital patients should be assessed for malnutrition using weight and height measurements to calculate their BMI. This may potentially result in malnourished older people being misclassified in nutrition assessment and therefore not receiving nutritional support. We conclude that demi-span may provide a good estimate of stature in older people and suggest that DEH is useful in the assessment of nutritional status, in conjunction with other anthropometric and biochemical measures.

Short title: Demi-span in the assessment of body mass index

Key points box:

- The use of alternative measurements of stature such as demi-span are easier to obtain in older people and may be more accurate and than standing height measurements.
- We showed that the height measurement was lower than the demi-span equivalent height (DEH) from age group 70-74 years onwards in men and in each age group in women.
- The prevalence of underweight was lower when using measured height than when using DEH in women aged ≥65, particularly in those aged 80 years and over. The prevalence of overweight and obesity was higher using measured height than DEH in women aged ≥65.
- We showed in a large nationally representative sample that using measured height in the BMI calculation places women aged ≥65 (particularly those aged ≥80 into a higher BMI category.
- Demi-span measurement may be a useful estimate of stature in older people aged ≥65 and may be a useful measure to calculate BMI in the assessment of nutritional status.
- The Bassey equations from which DEH was calculated have limitations in that they were derived from a small sample (125 people).

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Competing interests: None declared.

Informed consent: Participants gave verbal consent to the interviewer and the nurse for having measurements taken. Ethical approval for the survey was obtained from the North

Thames Multi-centre Research Ethics Committee (MREC) and from relevant Local Research Ethics Committees (LRECs) in England.

TABLES

Table 1

Table 1: Main characteristics of the study subjects by age and sex				
Variables	**Men (n=956)**		**Women (n=1126)**	
	Mean ± SD	**p (trend)**	**Mean ± SD**	**p (trend)**
Age, years	72.5 ± 5.8		73.4 ± 6.3	
Weight (kg)				
65-69 years	83.2 ± 11.6		70.6 ± 12.8	
70-74 years	80.0 ± 12.1		68.0 ± 12.5	
75-79 years	77.4 ± 12.2		65.8 ± 11.7	
≥ 80 years	73.6 ± 10.1	<0.001	61.3 ± 12.0	<0.001
Total	79.8 ± 12.1		67.2 ± 12.8	
Measured height (cm)				
65-69 years	173.2 ± 6.2		158.8 ± 5.9	
70-74 years	170.5 ± 6.2		157.5 ± 6.3	
75-79 years	169.2 ± 6.6		156.1 ± 5.8	
≥ 80 years	167.1 ± 6.3	<0.001	153.0 ± 6.4	<0.001
Total	170.8 ± 6.6		156.8 ± 6.4	
Estimated height (cm) -DEH*				
65-69 years	172.6 ± 5.2		161.0 ± 4.6	
70-74 years	171.2 ± 5.2		159.8 ± 4.6	
75-79 years	170.4 ± 5.4		158.6 ± 4.8	
≥ 80 years	168.8 ± 5.0	<0.001	157.2 ± 4.7	<0.001
Total	171.2 ± 5.3		159.5 ± 4.9	
Demi-span (cm)				
65-69 years	82.0 ± 3.7		74.7 ± 3.4	
70-74 years	81.0 ± 3.7		73.9 ± 3.4	
75-79 years	80.4 ± 3.9		73.0 ± 3.6	
≥ 80 years	79.3 ± 3.6	<0.001	71.9 ± 3.5	<0.001
Total	82.0 ± 3.8		73.6 ± 3.6	
BMI using height (kg/m^2)				
65-69 years	27.7 ± 3.4		28.0 ± 4.9	
70-74 years	27.5 ± 3.8		27.4 ± 4.9	
75-79 years	27.0 ± 3.6		27.0 ± 4.4	
≥ 80 years	26.3 ± 2.9	0.001	26.1 ± 4.7	<0.001
Total	27.3 ± 3.5		27.3 ± 4.8	
BMI using DEH* (kg/m^2)				
65-69 years	27.9 ± 3.7		27.2 ± 4.7	
70-74 years	27.3 ± 3.9		26.6 ± 4.7	
75-79 years	26.6 ± 3.9		26.2 ± 4.3	
≥ 80 years	25.8 ± 3.2	<0.001	24.8 ± 4.8	<0.001
Total	27.2 ± 3.8		26.4 ± 4.7	
Waist circumference (cm)				
65-69 years	101.4 ± 9.5		89.7 ± 11.8	
70-74 years	100.7 ± 10.4		88.7 ± 11.7	
75-79 years	99.5 ± 10.7		89.5 ± 11.0	
≥ 80 years	99.2 ± 10.4	0.08	87.3 ± 10.8	0.09
Total	100.5 ± 10.2		88.9 ± 11.5	

* DEH: Demi-span equivalent height

Table 2

Table 2: T-test analysis to examine difference between height measurements and DEH[a] and differences between BMI calculated using height measurements and BMI calculated using DEH[a], by sex and age group

	Men				**Women**			
Age group	**65-69**	**70-74**	**75-79**	**80+**	**65-69**	**70-74**	**75-79**	**80+**
Mean difference in height: Height–DEH[a] (SD)	0.51 4.28	-0.68 4.57	-1.17 5.24	-1.57 4.72	-2.17 4.37	-2.32 4.30	-2.55 4.16	-4.15 4.92
P value and 95% confidence intervals	P=0.03 (0.06,0.96)	P=0.01 (-1.20,-0.16)	P=0.002 (-1.90, 0.45)	P=0.0004 (-2.42,-0.71)	P<0.0001 (-2.61,-1.73)	P<0.0001 (-2.78,-1.86)	P<0.0001 (-3.09,-2.01)	P<0.0001 (-4.83,-3.48)
N	***352***	***301***	***202***	***120***	***377***	***336***	***230***	***205***
Mean difference in BMI: using height– BMI using DEH[a] (SD)	-0.21 1.36	0.21 1.41	0.34 1.56	0.48 1.49	0.78 1.54	0.82 1.48	0.83 1.43	1.32 1.57
P value and 95% confidence intervals	P=0.005 (-0.35,-0.06)	P=0.01 (0.05, 0.37)	P=0.002 (0.12, 0.56)	P=0.0007 (0.21, 0.75)	P<0.0001 (0.62, 0.94)	P<0.0001 (0.66, 0.98)	P<0.0001 (0.64, 1.02)	P<0.0001 (1.11, 1.54)
N	***344***	***296***	***199***	***117***	***368***	***332***	***223***	***203***

a DEH: Demi-span equivalent height

Table 3

Table 3: Comparison of prevalence underweight (BMI < 18.5kg/m^2 and BMI < 20kg/m^2), overweight, including obesity and obesity calculated using DEH[a] and height measurements, by sex and age group										
% Underweight (BMI < 18.5kg/m^2)	**Men**					**Women**				
Age group	**65-69**	**70-74**	**75-79**	**80+**	**All 65+**	**65-69**	**70-74**	**75-79**	**80+**	**All 65+**
DEH[a] (%)	0.6	0.7	2.0	-	0.8	2.2	2.4	1.8	5.4	2.8
Measured height (%)	0.3	0.3	2.0	-	0.6	0.3	1.5	1.3	2.0	1.2
Difference between DEH[a] and measured height (%)	0.3	0.4	0	-	0.2	1.9	0.9	0.5	3.4	1.6
Significance :NS or S (95% CI, p value)	NS	NS	NS	-	NS	S 0.30,3.50, p=0.02	NS	NS	S** 0.30,7.10, p=0.07	S* 0.10,3.10, P<0.0001
% Underweight (BMI < 20kg/m^2)										
DEH[a] (%)	1.5	2.7	5.0	2.6	2.7	4.3	5.7	5.8	16.3	7.2
Measured height (%)	1.2	2.4	4.0	0.9	2.1	3.3	3.6	5.4	6..9	4.4
Difference between DEH[a] and measured height (%)	0.3	0.3	1.0	1.7	0.6	1.0	2.1	0.4	9.4	2.8
Significance :NS or S (95% CI, p value)	NS	NS	NS	NS	NS	NS	NS	NS	S* 1.40,17.4, P<0.0001	S* 0.30,5.30, P<0.0001
% Overweight, including obesity (BMI ≥ 25kg/m^2)										
DEH[a] (%)	79.1	75.3	68.3	60.7	73.4	66.6	61.1	59.6	47.3	60.1
Measured height (%)	77.3	76.0	73.9	66.7	74.9	71.2	66.9	66.8	57.1	66.5
Difference between DEH[a] and measured height (%)	1.8	-0.7	-5.6	-6.0	-1.5	-4.6	-5.8	-7.2	-9.8	-6.4
Significance :NS or S (95% CI, p value)	NS	NS	NS	NS	NS	NS	NS	NS	S 0.10,19.5, P=0.04	S* 1.3,11.5, P<0.0001
% Obese (BMI ≥ 30kg/m^2)										
DEH[a] (%)	25.9	20.9	17.1	8.5	20.4	26.4	20.5	15.2	13.3	20.1
Measured height (%)	22.1	24.3	19.1	10.3	20.7	30.4	27.7	18.8	19.2	25.3
Difference between DEH[a] and measured height (%)	3.8	-3.4	-2.0	-1.8	-0.3	-4.0	-7.2	-3.6	-5.9	-5.2
Significance :NS or S (95% CI, p value)	NS	NS	NS	NS	NS	NS	S 0.70,13.7, P=0.03	NS	NS	S* 0.70, 9.70, P<0.0001
N	***344***	***296***	***199***	***117***	***956***	***368***	***332***	***223***	***203***	***1,126***

a DEH: Demi-span equivalent height
NS: Non Significant differences between DEH and measured height tested using z tests.
S: Significant differences between DEH and measured height, S= p<0.05 S*=p<0.001, S**=p<0.01, tested using z tests.

Appendix -supplementary data
Figures 1a-c

Figure D

Measurement Protocols

Height

Height was measured using a portable stadiometer with a sliding head plate, a base plate and three connecting rods marked with a metric measuring scale. Informants were asked to remove their shoes. One measurement was taken, with the informant stretching to the maximum height and the head positioned in the Frankfort plane. The reading was recorded to the nearest millimetre. Informants who were ill, chairbound, unsteady on their feet etc. to obtain a reliable height measurement were not measured.

Weight

Weight was measured using Soehnle, Seca or Tanita electronic scales with a digital display. Informants were asked to remove shoes and any bulky clothing. A single measurement was recorded to the nearest 100g. Informants who were chairbound, or unsteady on their feet were not weighed. Informants who weighed more than 130 kg were asked for their estimated weights. Eight informants in the sample who had estimated weights were excluded from the BMI calculation.

Demi-span

Measurements were made with the right arm outstretched using a metal retractable tape. Two measurements were taken to the nearest even millimetre. The mean of the two valid measurements was used in the analysis. Measurements considered unreliable, for example, due to excessive clothing, or if only one measurement was obtained were excluded from the analysis.

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