

THE USE OF KNEE HEIGHT TO ESTIMATE MAXIMUM STATURE IN ELDERLY CHINESE

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Abstract: Loss of height occurs in the elderly. Not only is this height valuable to assess, but it creates difficulty for comparisons using equations based on estimates of stature in adult populations which often overlook the loss of height with age. Alternatives, such as the use of arm-span or hip length as surrogates for maximum stature (MS) during adulthood, have been proposed. In a study of 247 (130 men and 117 women) adult ethnic Chinese living in Melbourne, Australia, we tested the hypothesis that knee height is independent of age and attempted to devise an equation for the estimation of maximum stature (MS) in the this elderly group (aged 65 yrs) of this population. Anthropometric indices, including body weight, stature, arm-span, and knee height were twice measured using standard methods described by Lohman et al., and averaged for use in the analysis. In both men and women, the younger adults were taller and had a greater arm-span than their elderly counterparts; however, there was no difference in knee height or body weight between the two groups. Knee height was not associated with age, while stature and arm-span correlated negatively with age. These findings suggest that knee height provides for a valid estimate of MS during early adulthood than arm-span. Knee height is independent of age and does not appear to decreased over time, in spite of an expected cohort effect in this population. Arm-span, however, appears to change with a cohort as well as with age. Thus, there is a place in a life-time nutritional assessment of the aged to measure both arm-span as an index of cohort status and knee height for an individual's maximum achieved stature. (Journ. of Nutr. Health & Aging 1998; 2:)

Key words: Stature; Knee height; Arm span; Maximum stature; BMI; Elderly Chinese.

Introduction

Body composition indices are important measurements in the assessment of human nutritional status and some chronic diseases such as diabetes and cardiovascular disease. The loss of height which that occurs in the elderly results in difficulties in applying the many equations based on estimates from adult populations. Alternatives, such as arm-span or hip length have been used by other researchers to estimate current stature (6,8,9,11,13,14,19). Knee height or lower leg length have also been proposed in order to estimate the statures of in the elderly people by Chumlea et.al., (13) and Han and Lean (12). This report tests the hypothesis that knee height is independent of age and attempts to devise an equation for the estimation of maximum stature in elderly Chinese (aged 65 yrs). The maximum stature signifies the peak body length/height one achieves during early adulthood.

Method

Subjects

The Melbourne Chinese Health study was first conducted in 1988-89. It investigated food acculturation and risk for coronary heart disease. The recruitment method used in this study was based on telephone directory services and has been reported elsewhere (10). Briefly, a set of Chinese surnames (in

various dialects) was compiled from membership surname lists of several Chinese community organisations in Melbourne. A sampling list was then drawn from the 1988 Melbourne telephone directory listings of presumptive Chinese surnames. The study population was representative of Melbourne Chinese at the time of survey. Eligible subjects were individuals of Chinese ethnicity, aged 25 and over with Australian citizenship or permanent resident status. A total 547 subjects was included in the baseline study (3).

Two hundred and forty-seven study subjects (130 male and 117 female), aged 30-90 years were assessed during a follow-up examination of the Melbourne Chinese Health Study in 1995-1996. The average follow-up period was eight years and the traceable rate was about 65 %. Data presented in this paper are from this follow-up. Subjects were divided into two groups: those aged 30 to 65 years (the adults) and those aged 65 years and over (the elderly).

Anthropometric measurements

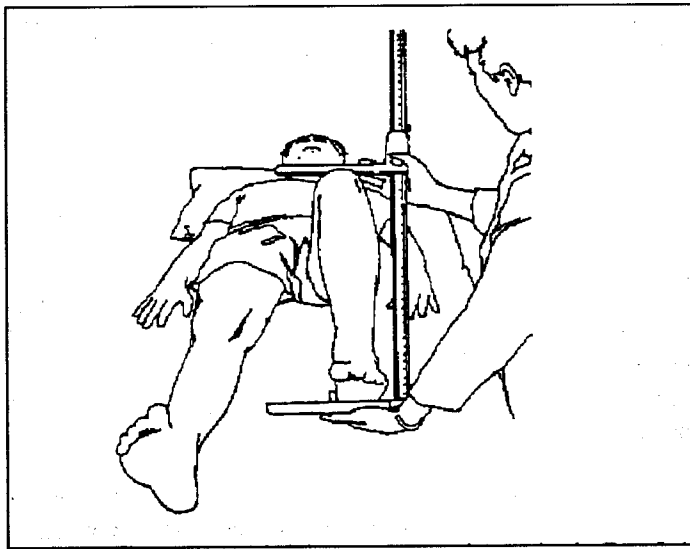
Body weight was measured using scales (Soehnle, Germany) calibrated to the nearest 0.1Kg. Stature was measured by a moveable stadiometer in free standing mode to the nearest centimetre/centimetre. Subjects stood barefoot on a flat floor and wore a thin examination gown (1). Arm span was measured at shoulder level between the tips of the longest fingers and recorded to the nearest 0.1cm. Using a convenient

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wall with a corner, as a flat surface, subjects stood with their back against the wall, feet together, arms outstretched maximally and palms facing forwards (1). Knee Height was defined as the distance from the heel of the foot to the top of the patella. Subjects were asked to lie flat down flat on their back with the knees and lower legs exposed. The right knee and ankle were bent at 90°. The recumbent measurement of knee height was obtained in accordance with instructions for use of Ross knee height caliper (see figure 1) with a modified horizontal fixed blade and recorded in centimetres (2).

Figure 1

Knee height measurement instruction by Ross Laboratories



Statistical analysis

All measurements were made in duplicate. Statistical analysis was performed using SAS software (SAS Institute, 1996). General linear regression analyses were used to obtain estimates of maximum stature. Included in the regression models were knee height and arm span. Pearson's correlation analysis was used to test relationship between age and cohort effects on the stature and the student t-test was used to assess differences in group means.

Results

Differences in stature between adults and elderly subjects

The average age in this study was 53.8 for men and 52.0 years for women. Table 1 shows mean body weight, stature, arm-span, and knee height of the adults (30-65 yrs) and the elderly (65+ yrs). In both men and women, the «adults» were taller and had a greater arm-span than their elderly counterparts; there was no differences in knee height or body weight between the two age groups.

Table 1

Mean value of body weight and statures in adult and elderly subjects by gender

	Mean ± SD in Men (n=130)		Mean ± SD in Women (n=117)	
	Adults	Elderly	Adults	Elderly
Body weight (kg)	66.6±9.4	64.5±6.8	55.4±8.6	52.0±8.9
Stature (cm)	166.6±6.4*	163.2±5.5*	155.8±5.4**	151.5±5.2**
Arm-span (cm)	168.7±7.0***	162.8±6.0***	154.2±6.2*	150.0±6.7*
Knee height (cm)	49.0±2.5	48.3±2.4	45.1±2.2	44.0±2.4

Same superscript indicates significant difference between young adults and the elderly. *, p<0.05; **p<0.01; ***, p<0.001

The age factor in stature

Knee height was not associated with age, while stature and arm-span were correlated negatively with age (Table 2). There was a decline in stature amongst the elderly during the eight year follow-up period. The mean stature decreased 0.60 cm (±0.31cm) in men and 0.70cm (±0.30cm) for women. There was no difference in the decline of stature between men and women, but there was a significantly difference in decline of stature between «adult» (-0.53cm±0.38cm) and elderly (-0.95cm±0.26cm) (P< 0.01) in men.

Table 2

Pearsons Correlation (r) between age and body length in study population

	Men (130)	Women (117)
Stature	-0.21**	-0.19*
Arm Span	-0.27***	-0.26***
Knee Height	-0.06	-0.15

*, p<0.05; **p<0.01; ***, p<0.001

Predicting maximum stature (MS) in the elderly

Table.3 shows the regression equations which provide estimates of MS using knee height, arm span and age for men and women. Age estimate parameters did not make a significant difference for the knee height equation in men, while in women, the difference was reached significance (P=0.05). The age parameter was not included in the equations used to estimate maximum stature for the elderly. Figure 2 shows the estimates of MS in the elderly using knee height and arm span comparing with the current stature of the adults. The elderly MS, estimated using knee height, was not significantly different from the current stature of their adult counterparts, while the elderly MS, estimated by arm span, was significantly shorter than the current stature of the adults.

Table 3
Equations to predict Stature (S) by Knee Height (KHT) and Arm Span (AS) in men and women

Sex	Knee Height (X)		Arm Span (Z)	
	Equations	root MSR/R ²	Equations	root MSE/R ²
Men	S=67.78+2.01KHT	4.07/0.59***	S=39.56+0.75AS	3.55/0.69***
	S=71.70+1.98X - 0.044Age	4.03/0.59***	S=37.67+0.76AS + 0.015Age	3.57/0.69***
Women	S=74.08+1.81KHT	4.17/0.55***	S=38.21+0.76AS	3.026/0.71***
	S=78.46+1.79X - 0.066Age	4.01/0.56***	S=37.86+0.76AS + 0.0026Age	3.011/0.72***

Age in years; A: age in years; ***: P<0.001; S = stature; KHT = knee height; AS = arm span

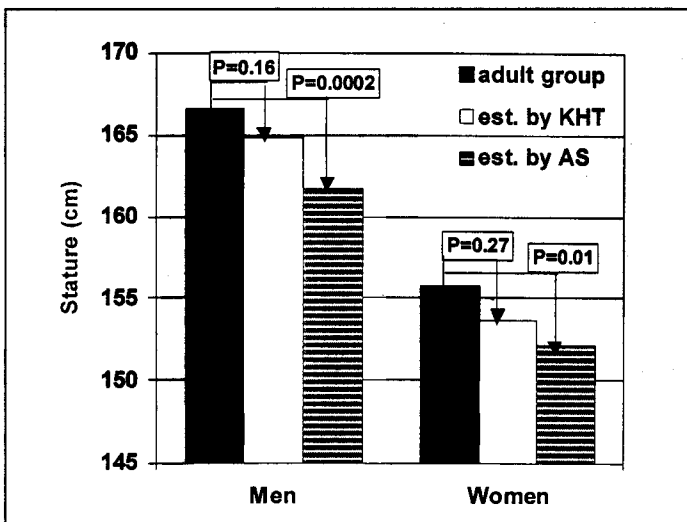
Table 4

Various equations developed to predict stature using knee height or lower leg length

Study population	Men	Women
French elderly (5) &	74.69+2.07*KHT-0.21*Age	67.00+2.20*KHT-0.251*Age
American White (18) &	71.85+1.88*KHT	70.25+1.87*KHT-0.06*Age
American Black (18) &	73.42+1.79*KHT	68.10+1.86*KHT-0.06*Age
Caucasian elderly (13) &	64.19+2.02*KHT-0.04*Age	84.88+1.83*KHT-0.24*Age
Japanese-American elderly (15) &	53.69+2.57*KHT-0.23*Age	69.10+2.11*KHT-0.22*Age
Scottish (12) &	51.1+2.31*LLL	70.2+1.84*LLL
Melbourne Chinese #	67.78+2.01*KHT	71.70+1.98*KHT-0.044*Age
	74.08+1.81*KHT	78.46+1.79*KHT-0.066*Age

#, to obtain stature during early adulthood; &: to estimate present stature. LLL =, Lower leg length (cm); KHT =, Knee Height (cm); age in years

Figure 2
Maximum stature of elderly estimated by knee height (KHT) and arm span (AS) were compared with mean stature of adult sub-group



Discussion

Several studies report current stature estimates using knee height or lower leg length for elderly (5,13,15) and for all-age (12,18) populations. The knee height parameter has been found significantly different between genders, but not consistently with age or ethnicity. Myer et al.,(5) concluded that the statistical regression model of stature prediction using knee height was highly gender- and racial-specific. In present study, the reason to include an age parameter, especially in women and/or elderly, was to adjust the estimation to current stature and account for cohort effects as well as age-related biological effect.

Conclusion

Knee height is independent of age and does not appear to alter substantially over time, in spite of a possible cohort effect (such as improvements in nutritional status) in the Chinese population studied. Arm-span, however, appears to change with age more than does stature. Using Knee height as an estimate parameter, a maximum stature estimate comparable to current stature of adults in this elderly Chinese population is obtained. Application of maximum stature estimates using knee height to assess nutritional status in the elderly may be recommended for various population especially in the parallel ethnic group. Thus,

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there is a place in the life-time nutritional assessment of the aged to measure both arm-span as index of cohort status and knee height for an individual's maximum achieved stature.

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