Correlative Study of wingspan (armspan) length and body length in Students of SEGi University Malaysia.

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Abstract

A cross-sectional, anthropometric survey was conducted among local students (154 males and 164 females, total = 315) of SEGi University, Malaysia to correlate wingspan length to body length. Measurements were recorded and statistical analysis were done using SPSS version 21.0. Males were taller and had longer wingspan than females. The wingspan – body length ratio was 1.016, indicating wing span to be longer than body length. Males (1.023) had a significantly higher ratio than females (1.001). A strong positive correlation between the two measurements was observed (r = 0.93). The correlation coefficient was not significantly different in males (r = 0.824) and females (r = 0.789).

Keywords: standing height, arm span, anthropometric measurements, stature.

Introduction

Height is an important clinical parameter along with BMI and body surface area calculation [1]. This measurement plays an inevitable role in drug dose adjustment [2] nutrition assessment and requirement [3], as well as for risk stratification.

The relationship between these two parameters have been studied by using wing span to estimate height in particular clinical situations where height is unobtainable such as immobilized patients, patients with deformity of limbs or amputation. This can be done by directly substituting height with wingspan, a fixed ratio, or specific regression equations [4].

It has been noted that height decreases with increasing age due to physiological changes, degenerative changes and osteoporosis while the arm span remain unchanged [5]. The wing span-height ratio can be used as a marker for age-related loss of height particularly in elderly.

The positive relationship between wing span length and height is not only important in prediction of height, but an abnormal wing span-length to height ratio also indicates several musculoskeletal diseases [6].

Wingspan is the maximum distance between tips of the middle fingers of both hands while the person extends both arms at the level of the shoulders. Height or body length is defined as the distance between the lowest and highest points of a person standing upright with bare feet and heels together [7].

The wingspan of a person is approximately equal to his height [1]. This can be used in clinical practice or even in mass health screening events, to facilitate the measurement of height of people. Height is an easily measured and widely used anthropometric parameter in clinical medicine and in field of scientific research, such as calculation of BMR. It is also used as an indicator of nutritional status [3, 8].

Assessment of various other anthropometric measures, include knee height, sitting height and demispan indicate that wingspan has the strongest correlation with standing height [9, 10]. As a result, wingspan is often used to estimate standing height in situations where standing height is unobtainable, such as in elderly people [11], patients with difficulty standing due to muscle weakness, amputees, congenital limb deformities and vertebral deformities. The measurements were used in predicting lung volume in patients unable to stand or with thoracic abnormalities [12]. Height loss with increasing year has been reported by Mark [4]. Therefore, standing height may not be a reliable indicator for stature in elderly subjects.

Wingspan that is significantly greater than the height should lead to further consideration. There are conditions that inhibit growth of the axial skeleton (spine) such as spondyloepiphyseal dysplasia, or those that lead to excessively long arms such as Marfan's syndrome, Klinefelter's syndrome [6]. The method employed for estimating height with wing span include direct substitution of wing span for height, correction with a fixed ratio and regression equations in increasing order of complexity and accuracy. The use of correction of wing span and height with a fixed ratio has been practiced for several decades due to reports by various studies involving predominantly caucasian adult populations, that the mean wingspan to height ratio for the population is 1.03 for men and 1.01 for women [4].

However, later studies observed the association of wingspan and height was varying from race to race [13, 14]. This suggests that any future studies attempting to use arm-span measurement as a proxy for height must consider the ethnic differences. The correlation differs between two genders of the same race [1]. It is observed that the males generally have higher anthropometric measurement than that of females [15].These differences may be due to gender associated genetic factors, hormonal factors and lifestyle factors.

Recent study had shown that equations derived from taller statured populations (e.g. Caucasians) may be less accurate when applied to shorter statured populations. For example, a

systematic error occurred when the equation developed for Caucasians was used to estimate stature in Japanese Americans [16].

The present study is undertaken to correlate the wingspan and body length and to establish the gender difference (male and female).

Subjects and Methods

315 students (161 females, 154 males) for this study were recruited for this study using convenience sampling method. Consent was obtained from participants prior to examination. Malaysian students, aged between 18-30 years were selected. Students having growth disorder such as skeletal deformities, physical disabilities, past history of skeletal injuries and those who cannot stand erect were excluded from the present study. Stadiometer (Model: Health O Meter Professional 402KL) and measuring tape were used for taking the measurements. All the measurements were taken according to standard measuring techniques. [4].

Wingspan was measured as the length between the tips of the middle finger of the right hand to the tip of the middle finger on the left hand. It was measured with both hands straight horizontally at 90° from the body and the candidate standing straight against the wall. Participants were checked by the examiner to make sure that his/her arms were extended fully. The labels were marked on the wall on each tip of the middle finger of one hand by the examiner and the distance between the two labels was measured by using tape measure (200.0± 0.1 cm).

Body length was measured using stadiometer (Health O Meter Professional 402KL) with the candidate standing erect with back, buttocks and heels against a stadiometer with both upper limbs by the side. The feet of candidate were checked to make sure that they were together and flat on the floor. The candidate's head was placed in the Frankfort plane and was instructed to take and hold a deep breath. At the same time, the headboard was placed firmly down on the vertex and the measurement was taken.

The examiner was assisted by the recorder to check the tension and horizontal position of the measuring tape for certain measurements. The recorder was ensured correct data was recorded. All measurements recorded to the nearest tenth of a centimeter or 1.0 mm.

Statistical Analysis

SPSS version 21.0 was used for statistical analysis. Microsoft applications (Word and Excel) were also employed. All anthropometric variables were given as mean ± standard deviation (M ± SD). Categorical data were described using count and percentage. The relationship between standing body length and wingspan were determined using simple correlation coefficient and their 95% confidence interval. Preliminary analysis was conducted to for normality assumption. A comparison of means and of body length and wing span and the ratio for each gender was carried out using independent and paired sample t-test. *P-value* less than α (α = 0.05) was consider as statistically significant.

Results

The mean age, wing span and body length of male and female are given in **Table 1**. Among the study subjects, the mean age is 20.26 (*SD* = 2.232). There is no significant difference between the age of males and females (t = -0.837, *p*< 0.0001).

Table 1: Descriptive statistic of age and anthropometric measurements (*M* ± *SD*) of SEGi students by gender

	All (n = 315)	Males (n = 154)	Females (n = 161)	t (*p* - value)
Age (years)	20.260 ± 2.232	20.150 ± 2.295	20.360 ± 2.172	-0.838 (0.403)
Wing span (cm)	165.870 ± 10.910	174.242 ± 7.213	157.862 ± 7.200	20.165 (<0.0001)
Body Length (cm)	163.251 ± 8.683	170.353 ± 5.473	156.457 ± 4.933	23.691 (<0.0001)

The mean wing span is 165cm while the mean body length is 163cm (Table 1). Wing span exceeded body length by a mean of 3.889 in males and 1.405 in females. In this analysis, an independent t-test was conducted to compare the wing span and the body length for males (mean wing span: 174.242, *SD* = 7.213; mean body length: 170.353, *SD* = 5.473) and females (mean wing span: 157.862, *SD* = 7.2; mean body length: 156.457, *SD* = 4.933). There is significant difference in the wing span (t = 20.165, *p*< 0.0001) and body length (t = 23.691, *p*< 0.0001) for males and females. Males have a higher wing span and body length than females. The mean ratio of wingspan to body length for each gender is shown in Table 2.

Table 2: Wing span to body length ratio (*M* ± *SD*) by gender

	Ratio (*M* ± *SD*)	t (*p* - value)
All (n = 315)	1.016 ± 0.027	660.208 (<0.0001)
Males (n = 154)	1.023 ± 0.024	529.762 (<0.0001)
Females (n = 161)	1.001 ± 0.029	447.378 (<0.0001)

The mean ratio for all participants is 1.016 (*SD* = 0.027; t (315) = 660.208, *p*< 0.0001). An independent t-test was conducted to compare the mean ratio of wing span to body length for males and females. There was significant difference in the ratio for males (*M* = 1.023, *SD* = 0.024) and females (*M* = 1.001, *SD* = 0.029; t (315) = 4.673, *p*< 0.0001, two-tailed). The magnitude of the mean differences was very small (mean difference = 0.022, 95% *CI*: 0.008 to 0.020). The eta squared statistic (0.065) indicated a moderate effect size according to the guidelines proposed by Cohen [3].

The relationship between wingspan and body length of study subjects were investigated using Pearson product-moment correlation coefficient shown in Table 3.

Table 3 **Pearson correlation coefficient between wing span and body length of participants**

	Correlation Coefficient (r)	Coefficient of determination (r^2)	*p* - value
All (n = 315)	0.920	0.846	<0.0001
Males (n = 154)	0.824	0.679	<0.0001
Females (n = 161)	0.789	0.623	<0.0001

Scatter plots were performed to ensure no violation of the linearity (Figure 1).

Figure. 1: Scatter plot of wingspan versus body length of (A) all participants (B) males (C) females.

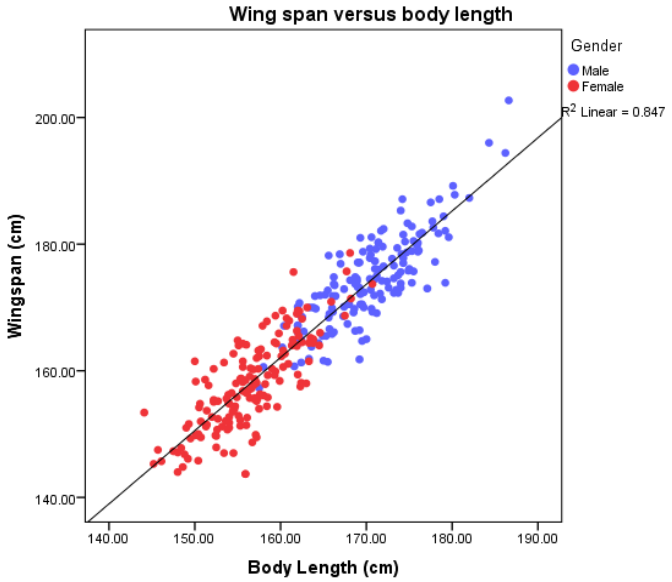

Fig.1A

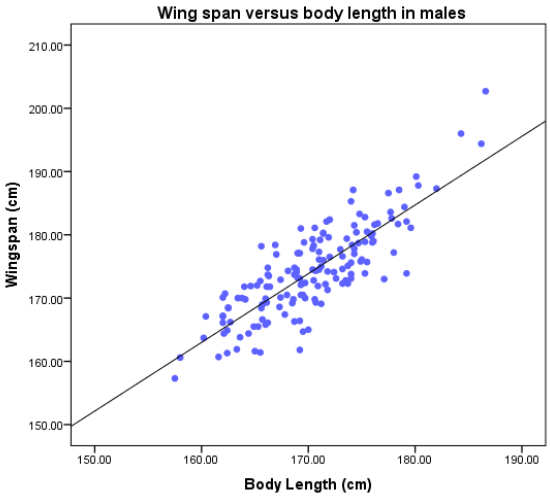

Fig. 1B

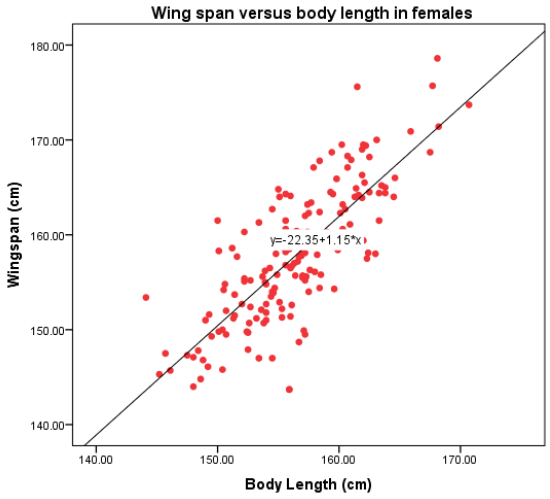

Fig. 1C

There is a strong positive correlation between the two variables, with r=0.920, n=315, p<0.0001, suggesting a strong relationship between wingspan and body length [3]. Increased in wingspan is associated with increased body length. Wingspan and body length also show a

strong positive correlation in males ($r=0.824$, $n=154$, $p<0.0001$) and females ($r=0.789$, $n=161$, $p<0.0001$).

Discussion

Height is a very important clinical indicator of body size for various uses including nutrition and health research. The major determinants of one's height are the length of the long bones and the height of the vertebral column. At the time of fusion of long bones and completion of growth of the vertebral column the maximum height is achieved. According to Cheng et al [17] growth in heights and long bone lengths plateau at the age of 16 years in both sexes.

Mean wing span is higher than body length in both males and females in present study. Similar result was reported by Varun et al [18] and in Chinese population by Kwok et al [19]. Arm span and height measurements differ significantly by gender, in the elderly Indian population [11] and their findings strongly suggested that the ratio of wing span to height is approximate or more than 1.

Present study shows that males have larger wing span and body length than females. Sudip Datta Banik [20] observed that Dhimal males were taller and had longer arm span than females.

Ratio of wing span to body length is obtained by dividing the two variables. The mean ratio is 1.016 in the present study with the ratio of males (1.023) significantly different from females (1.001), indicating wing span is longer than height in both gender. Eta squared statistic shows there is moderate effect of gender on the wing span – body length ratio. On average, the ratio is close to 1 which exhibit similar trends of previous report. Study by Kwok et al [19] in China showed significant different ratio recorded for adult males (1.04) and females (1.02). In the same study, older women without vertebral deformity had significantly greater ratio than young women which suggest height loss without vertebral deformity. There was no such difference between

older and young men. In another study by Ashutosh et al [12] the ratio in males (1.023) and females (1.024) was not statistically significant.

There is no statistically significant difference in the strength of correlation between wingspan and body length for males and females. Maheswar Chawla et al [21] reported similar findings. There is a strong positive correlation between the two variables, with r=0.920, n=315, p<0.0001, suggesting a strong relationship between wingspan and body length [22].

Among adult Chinese people, the correlation coefficient was 0.86 in males and 0.84 in females [23]. In Dhimals, the correlation between arm span and stature were significant in males (r = 0.862) and females (r = 0.826) [20].

While most of the studies were based on adult, arm span length was highly correlated with height in children and elderly. Nurcan Yabanci et al [24] reported that the two variables are significantly correlated in children aged 7-14. Similar result was observed in children by AK Yousafzai et al [25]. A local study by Suzana Shahana et al [16] deduced r = 0.67 – 0.78 in elderly. This result is similar but lower than that shown in India elderly above 60 years old [11] and Caucasian elderly [19].

The relationship of armspan and height varies in different ethnics different life-styles, socio-economic status, seasonal variations and environmental factors might have caused the differences anthropometric characteristics [3, 13].

Aging can lead to changes in body structure and thinning of vertebrate which can contribute to a reduction in height. According to Ansari et al [26] the actual height changed significantly over time in both genders while the armspan remain stable. Elderly Malaysian men were shorter as measured by standing height (P<0.05) and arm span
(P <0.05) their adult counterparts for males and females [16].

The age-related reduction in height is significantly more than that of arm span in elderly [11]. Thus, many studies suggest that arm span is a good predictor of height [26, 27]. Armspan had the strongest association among other parameters such as arm length and tibia length in India children [25] and Malaysian [16].

Arm span to height ratio had been used as marker for certain musculoskeletal deformities such as spondyloepiphyseal dysplasia Marfan's syndrome, Klinefelter's syndrome and homocystinuria [6]. Patient with Marfan syndrome showed a ratio of more than 1.05 [28].

Height is an important clinical parameter to access nutritional status, drug dose adjustment, and to determine growth and development. Wing span can be used as surrogate for height when height is unobtainable in certain conditions such as elderly and patients with musculoskeletal deformities. Arm span is the most reliable body parameter for predicting the height of an individual. It is useful in predicting age-related loss in stature and in identifying individuals with disproportionate growth abnormalities.

The importance of this equation lies in the fact that in situations where the exact height cannot be determined directly due to deformities of lower limbs or in patients who have undergone amputation or shortening due to fractures, by measuring the armspan length, height can be determined. It is also important in Forensic Sciences in cases of identification of person whose lower limbs are amputated due to accidents or mass disaster.

Conclusion

In the present study there is a strong positive significant correlation between wing span and body length. The correlation coefficient was not significantly different by gender. The ratio of wing span to body length was higher in males than females aged between 18-30 years. Since the present study is confined to local students to a limited number, further studies that include larger

population is also needed to determine similar anthropometric differences in different ethnic and age groups in Malaysia.

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