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Anthropometric Parameters for Height Estimation in Egyptian Elderly Males

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ABSTRACT

Background: Aging as a natural physiological process is accompanied with nutritional and metabolic changes that is reflected by the anthropometric indices furthermore loss of muscular and fat masses rises. elderly individuals it is complex, and sometimes impossible, to measure standing height precisely because of standing straight difficulties arising from underlying mobility issues. Anthropometric indices and measuring formulas are greatly trustworthy when compared with more sophisticated methodologies such as hydro densitometry, electronic bio impedance. **Aim:** To assess which one of the three anthropometric measures (demi-span, ulna length and knee height) is the most accurate for height estimation in Egyptian elderly males, and to provide a nationally representative regression equation for stature prediction that could be applied to Egyptian elderly males. **Methodology:** A cross sectional research study was conducted to estimate height in community dwelling Egyptian ambulant elderly males. The study sample consisted of 226 community dwelling elderly males. **Results:** The model for using knee height to estimate standing height of Egyptian elderly males [$\text{Height} = 57.345 + 2.131 (\text{Knee height in cm})$], was found to be statistically significant reflecting 63.3% of standing height changes. [Table (5)] Besides there was strong statistically significant positive correlation between measured standing heights and study predicted standing heights ($P \text{ value} < 0.001$). [Table (6)] Finally it was revealed and displayed that by using the study equation, there is no statistically significant difference between measured and predicted heights. **Conclusions:** In the current research study, knee height was found to be more accurate than demi-span and ulna length for estimating height of Egyptian elderly males.

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INTRODUCTION

Population aging is a global concern that have arisen due to reduced mortalities, morbidities and reduced rates of fertility with delayed conception trends causing reduced percentage of children particularly in developed nations. 1,2 Older people percentage (aged 60 years and above) have been raised from 9.2 % in 1990 to 11.7 % in 2013 and is expected to reach 21.1 % by year 2050. 3,4

Aging as a natural physiological process is accompanied with nutritional and metabolic changes that is reflected by the anthropometric indices furthermore loss of muscular and fat masses rises. 5,6 Interestingly it was revealed and displayed by various researchers in prior research studies that redistribution of adipose tissue with increased fat accumulation within the trunk, changes in anatomical and physiological appearance and performance varies between both genders as the aging process progresses at various phases of life mirrored clinically in anthropometric indices. 7,8 Subsequently, diverse anthropometric tools for measurement are implemented at various phases of life. 9,10

Anthropometric indices commonly measured e.g. height is correlated in a statistically significant manner to nutritive behaviour, genetic constitution, environmental features, social, cultural, lifestyle, functional and general health statuses. 11,12 Privilege of using anthropometric indices is the low cost and being non-invasive supplying detailed clinical data reflecting various of body structure components, such as muscular and fat tissue distribution, aiding in geriatric nutritional assessment. 13,14 Anthropometric indices and measuring formulas are greatly trustworthy when compared with more sophisticated methodologies e.g. hydro densitometry, electronic bio impedance, for nutritional status determination furthermore it is implemented in assessment in a reliable clinical manner the prognosis of chronic and acute illnesses

guiding medical management protocols within elderly individuals. 15,16

Various researchers and many research clinical trials all over the globe investigated the best age-, gender - and population-specific anthropometric indices and their particular formulas for elderly height estimation. 17,18 On the other hand, there are no national Egyptian references concerning that issue of interest among Egyptian elderly population. research data and efforts are considered to be useful and of great value to raise the health care standards offered to that group of cases on a national basis among the Egyptian population. 19,20

In numerous elderly individuals it is complex, and sometimes impossible, to measure standing height precisely because of standing straight difficulties arising from underlying mobility issues e.g. kyphoscoliosis or arthritis alternatively other body segments measurements could be implemented as an alternative to standing height estimation such as include demi-span, ulnar length and knee height. 21,22

AIM OF THE WORK:

To assess which one of the three anthropometric measures (demi-span, ulna length and knee height) is the most accurate for height estimation in Egyptian elderly males, and to provide a nationally representative regression equation for stature prediction that could be applied to Egyptian elderly males.

METHODOLOGY:

A cross sectional research study was conducted to estimate height in community dwelling Egyptian ambulant elderly males. The study sample consisted of 226 community dwelling elderly males. Inclusive research criteria: Age: 60 years old or more, Sex: males only, ambulant, able to stand erect without spinal curvature. Exclusive research criteria: Individuals with a plaster cast, a prosthetic, an amputated limb or limb oedema. Frozen shoulder, kyphosis, bed or chair-bound, those

who refuse to participate in the study, uncooperative individuals.

The following research data was collected from all research study subjects: Informed oral consent was obtained after explanation of the aim and procedures used in current study to each research study subject.

Standing height measurement: It was measured with the subject standing barefoot in an upright posture looking forward with the informant stretching to the maximum height and head in the Frankfort horizontal plane, with heels together, arms at the side, legs straight, shoulders relaxed and with heels, buttocks, scapulae and back of the head lying against a vertical wall or a door.

Measuring the following parameters: **Demi-span:** It was measured with the left arm outstretched straight, palm forwards, from the base of the middle/ring fingers to the sternal notch using a non-stretch tape measure. **Knee height:** It was measured with the subject in the seated position. It is the distance from the sole of the foot to the anterior surface of the thigh with ankle and knee each flexed to a 90-degree angle. **Ulnar length:** Subjects were asked to bend their left arm and place it across the chest with the fingers pointing to the opposite shoulder. Measurements were taken between the point of the elbow (olecranon process) and the midpoint of the prominent bone of the wrist (styloid process). If the subject was wearing wristbands, bracelets or watch that could make the reading inaccurate, they were asked to remove them or change their position. All measurements were obtained by using a metal non-stretch retractable tape, taken to the nearest millimetre. Recorded by the operator to minimize errors in methodology.

Statistical Analysis:

The collected data was coded, tabulated, and statistically analysed using IBM SPSS statistics (Statistical Package for Social Sciences) (V. 22.0) software version 22.0, IBM Corp., Chicago, USA, 2013.

Descriptive statistics were done for quantitative data as minimum & maximum of the range as well as mean \pm SD (standard deviation) for quantitative parametric data, while it was done for qualitative data as number and percentage.

Inferential analyses were done for quantitative variables using independent t-test in cases of two independent groups with parametric data and paired t-test in cases of two dependent groups with parametric data. While correlations were done using Pearson Correlation. Linear regression model was used to find out independent factors affecting standing height.

The level of significance was taken at P value < 0.050 is significant, otherwise is non-significant. The p-value is a statistical measure for the probability that the results observed in a study could have occurred by chance.

RESULTS:

The current research study was conducted on 226 Egyptian elderly males aged 60 years and more to investigate the usage of 3 anthropometric measurements (demi-span, ulna length and knee height) in standing height estimation and to detect which one is the most precise in height estimation of Egyptian elderly males, and also for development of age-, sex- and population-specific regression equation that could be applicable for estimating height of Egyptian elderly males. The demographic research data of the study cohort revealed that 85.9% of the research study subjects were under seventy-five years old (mean age 67.9 ± 6.4 years). [Table (1)] And 84.1% of the research study subjects were between 155.0 and 175.0 cm (mean standing height 171.1 ± 7.1 cm). [Table (2)] Furthermore among the study cohort, 58 (25.6%) of them were diabetics, 94 (41.5%) were hypertensive, 37 (16.3%) were having ischemic heart disease, 28 (12.3%) were having chronic liver disease, 53 (23.4%) were having benign prostatic hyperplasia, 17 (0.07%) were having bronchial asthma and 57 (25.2%) were current smokers.

When height prediction of Egyptian elderly males was done by using equations developed from other populations such as the Mexican equation and other results were found to be statistically significantly different from measured standing height. [Table (3)]

When the usage of the three anthropometric measures (demi-span, ulna length and knee height) for standing height estimation was investigated, it was found that there were significant positive linear correlations between standing height and the 3 studied anthropometric measures with $P < 0.001$ for each. The correlation with knee height was stronger than those with demi-span and ulna length. [Table (4) and figures (1, 2, and 3)]

The current research study findings denote that the model for using knee height to estimate standing height of Egyptian elderly males [Height = $57.345 + 2.131$ (Knee height in cm)], to be statistically significant reflecting 63.3% of standing height changes. [Table (5)] Besides there was strong statistically significant positive correlation between measured standing heights and study predicted standing heights (P value < 0.001). [Table (6)] Finally it was revealed and displayed that by using the study equation, there is no statistically significant difference between measured and predicted heights. [Table (7)]

Table (1): Age distribution of the studied participants (years)

	Mean \pm SD	Range
Age	67.9 \pm 6.4	60.0–90.0
Categories	N	%
60.0 –	79	35.0
65.0 –	52	23.0
70.0 –	63	27.9
75.0 –	22	9.7
80.0 –	5	2.2
85.0 – 90.0	5	2.2

(N=226)

Table (1) shows that: 85.9% of the studied participants were under seventy-five years old. Table (2) shows that: 84.1% of the studied participants were between 155.0 and 175.0 cm.

1) Mexican (Mendoza-Nunez et al., 2002) :

$$\text{Height} = 52.6 + 2.17(\text{KH})$$

2) Chumlea's equations (Chumlea & Guo, 1992):

$$\text{Height} = 59.01 + 2.08 (\text{KH})$$

3) Bermudez's equations (Bermudez et al., 1999) :

$$\text{Height} = 71.16 + 2.61(\text{KH}) - 0.56 (\text{age})$$

4) Van Lier's equations (Van Lier et al., 2007) :

$$\text{Height} = 63.336 + 2.184(\text{KH}) - 0.122(\text{age})$$

Table (3) shows that: Height prediction of Egyptian elderly males done by using equations developed from other population is statistically significantly different than measured standing height.

Table (4) and figures (1, 2, and 3) show that: height measurements. The correlation with There were significant positive linear knee height was stronger than those with demi-correlations between standing height and other span and ulna length.

Table (2): Height measurements of the studied participants (cm)

Height	Mean \pm SD	Range
Standing	171.1 \pm 7.1	152.0–189.0
Knee	53.4 \pm 2.6	47.0–61.0
Demi-span	81.2 \pm 3.9	71.5–89.5
Ulnar	27.9 \pm 1.4	24.0–32.0
Standing grades	N	%
152.0–	9	4.0%
155.0–	35	15.5%
160.0–	42	18.6%
165.0–	61	27.0%
170.0–	52	23.0%
175.0–	22	9.7%
185.0–190.0	5	2.2%

(N=226)

Table (3): Height prediction by using equations developed from other populations

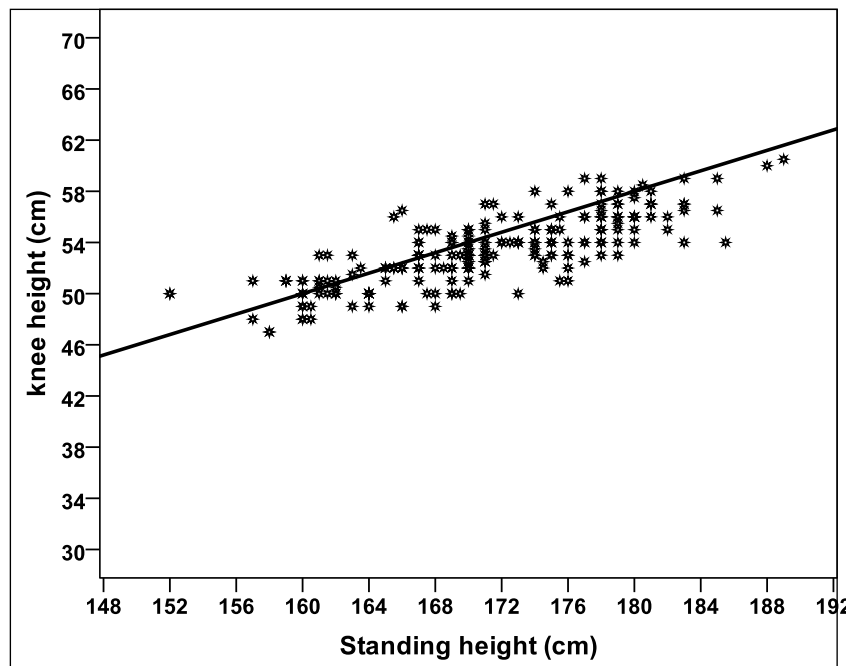
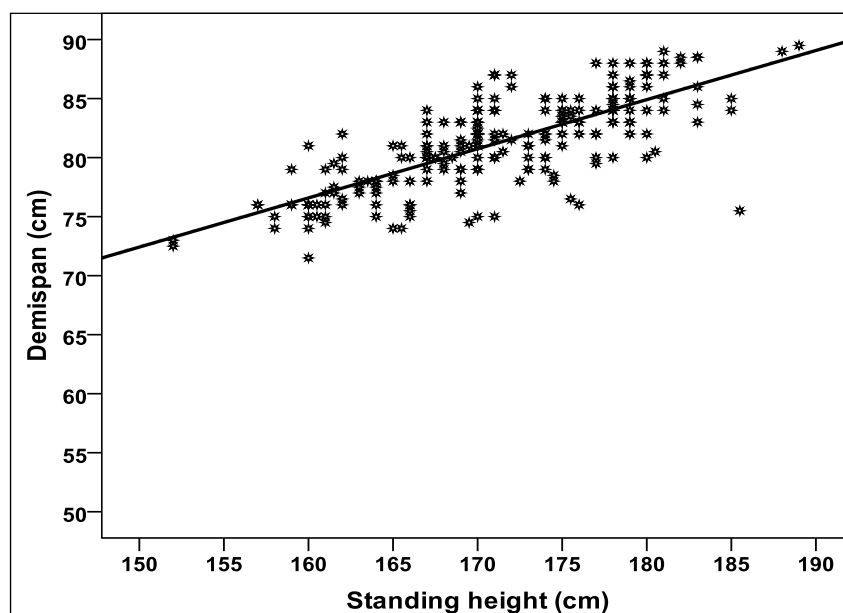
Equation	Measure	Measure	Difference	P
Equation 1	Mean \pm SD	168.4 \pm 5.7	2.7 \pm 4.3	<0.001*
	Range	155.0–184.0	-9.2–15.7	
	95% CI	167.6–169.2	2.1–3.2	
Equation 2	Mean \pm SD	170.0 \pm 5.5	-1.1 \pm 4.3	<0.001*
	Range	156.8–184.9	-14.2–11.0	
	95% CI	169.3–170.7	-1.6--0.5	
Equation 3	Mean \pm SD	172.4 \pm 7.9	1.3 \pm 5.3	<0.001*
	Range	153.9–189.3	-15.4–14.9	
	95% CI	171.4–173.4	0.6–2.0	
Equation 4	Mean \pm SD	171.6 \pm 5.9	0.5 \pm 4.3	<0.001*
	Range	158.5–185.6	-13.4–13.0	
	95% CI	170.8–172.4	0.0–1.1	

(N=226, Difference: Actual - predicted, P: P-value of Paired t-test, *Significant)

Table (4): Correlation between standing height and other height measurements

Height	R	p
Knee height	0.796	<0.001*
Demi-span	0.759	<0.001*
Ulna length	0.651	<0.001*

(N=226, Pearson correlation, *Significant)

**Figure (1): Correlation between standing height and knee height****Figure (2): Correlation between standing height and demi-span.**

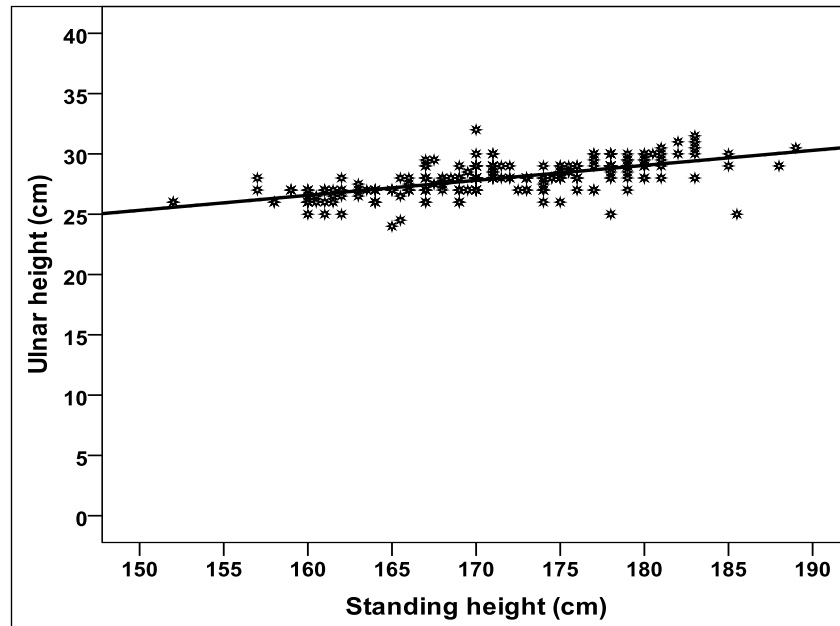


Figure (3): Correlation between standing height and ulna length.

Table (5): Linear regression for prediction of standing height

	B	SE	P	95% CI	R²
Constant	57.345	5.807	<0.001*	45.902–68.788	0.633
Knee (cm)	2.131	0.109	<0.001*	1.917–2.345	

(N=226, β : Regression coefficient, SE: Standard error, CI: Confidence interval, R²: Coefficient of determination, *Significant)

Table (5) shows that: The Suggested model [Height = 57.345 + 2.131 (Knee height in cm)] is significant and explains 63.3% of changes of standing height. Height is the predicted standing height (cm); Knee height is the measured knee height (cm)

Table (6) shows that: There was strong significant positive correlation between

measured and study predicted standing heights.

Table (7) shows that: By using the study equation, there is no significant difference between measured and study predicted heights.

Table (6): Correlation between measured standing heights and study predicted standing heights

R	P
0.769	<0.001*

(N=226, Pearson correlation, *Significant)

Table (7): Comparison between measured and predicted standing heights (cm)

		Mesure	Difference	P
Measured	Mean±SD	171.1±7.1	--	--
	Range	152.0–189.0	--	
Study	Mean±SD	171.1±5.6	0.0±4.3	0.982
	Range	157.5–186.3	-13.1–11.9	

(N=226, Difference: Measured - predicted, P: P-value of Paired t-test, *Significant; Study equation: Height = 57.345 + 2.131 (KH in cm)

DISCUSSION:

Height is crucial measurement implemented in BMI calculation which is clinically applied as a nutritional status indicator e.g. overweight, underweight, or healthy weight. Furthermore, height reflects the chronic and acute diseases prognosis guiding medical intervention predicting fracture and mortality risks within elderly individuals. 23,24

It is well known that height is required for body surface area (BSA) calculation that reflects metabolic rates, cardiac output, oxygen consumption levels, renal plasma flow, urea clearance, glomerular filtration rate (GFR), and organ size, superior to other direct physical measurements e.g. weight. 25

Since body height measurement in elderly is difficult due to either postural difficulties or cognitive disorders, it is acceptable to be conducted in an indirect manner. 26 Another critical fact that should be considered is the physical, genetic and environmental features of each population necessitating population-specific regression formula for estimation of height should be developed and applied only to the population from which data was collected and analysed. 27 Consequently, as equations formed from other populations were clinically applied for estimation of Egyptian elderly males height, great dissimilarities between the measured standing heights and the predicted heights were observed. 28

That's why an Egyptian-specific equation should be developed for predictability of Egyptian elderly males' stature more precisely. Demi-span, knee height and ulnar length have been applied in many prior research studies to predict height particularly in elderly individuals, and it was concluded that direct method underestimates body height indices within geriatric populations. 29

The aim of the current research study is to evaluate which one of the three investigated anthropometric indices (demi-span, ulnar length and knee height) is the most accurate for height estimation among elderly Egyptian males, and to have a reliable regression equation for predictability of stature that could be applied to elderly Egyptian males.

The current research trial, anthropometric data was collected and analysed from Egyptian males aged 60 years and above as reference to formulate age-, sex- and population-specific equation for estimating stature.

Statistically significant positive linear correlations between standing height and the 3 priorly investigated anthropometric measurements have been observed in the current research study (P values <0.001). The statistical correlation with knee height was found to be stronger than those with demi-span and ulnar length.

Results of the current research study were found to be in harmony with a prior research study performed in Atlanta, in which knee

height and gender were found to be the strongest tools for stature estimation, on the other hand many similar prior research studies similar to the current study came to the conclusion that age is a minimal factor for height prediction. Besides another Turkish research have shown that lower extremity has a greater correlation to body stature more than that with upper extremity. Furthermore, many researchers have observed that knee height could be implemented with adequate precision as an alternative for standing height. 1,5,7

Only fewer research studies revealed that demi-span could be an acceptable reliable alternative to obtain precise standing height, however those clinical research trials investigated only demi-span implemented for standing height estimate and none of the other anthropometric indices e.g. knee height or ulnar length were investigated. Notably, the samples of latter studies were collected from both males and females in which the number of female participants was greater than the number of males. Concerning ulnar length measurement, a prior Japanese research study involving 123 males (20–91 years, mean: 60.3 ± 17.4 years) and 122 females (19–95 years, mean: 61.7 ± 19.5 years) revealed that that ulnar length measured from 3D CT images is statistically significantly correlated to stature. 3,10,18

The difference between results of the previously mentioned Japanese research study and the current study is the small number of males recruited within the Japanese research study ($n=123$), the wide age range of the male research group (range =20–91 years, mean \pm SD = 60.3 ± 17.4 years) making the research study not exclusive for elderly population, while the last issue is the major difference in the method by which ulna length was measured (3D CT images rather than using a non-stretch tape measure). Another prior research study revealed and displayed that measuring ulnar length is precise and reliable, providing an accurate prediction tool of height among paediatric population. However, the age

category investigated within that research study was totally different from the targeted age category in the current research study, and these will make results differ considerably. 9,15,22

Advantages of the used method (knee height measurement) and used tool (non-stretch tap measure): The tool is available, simple, economic and any physician can get it easily. The measuring protocol is simple to apply in a sitting or a recumbent position in almost all elderly persons, regardless of mobility status. Both method and tool are suitable to be implemented on cases attending outpatient clinic, ward and ICU. 12,28

Restrictions of the current research study involve that the present study is carried out among Egyptian elderly males only, while Egyptian elderly females are not included. since the design of this study was solely for elderly males, the extent to which the results are applicable to other age groups or elderly females remains unknown. Only three anthropometric indices were investigated to be used for height estimation in Egyptian elderly males, while many other anthropometric measures were not tested. Also, it's important to know that the predicted stature is not reflective of past stature (adult stature) because we used current stature (after shortening) rather than adult stature (before shortening). So, the fact of on-going shortening of elderly is considered as a limiting factor for using the currently established equation. For example, when the equation is applied on an elderly person when he is 60 years old and then applied on same person after 10 years, the equation will give the same predicted standing height, although his actual standing height will not be the same. 24,29

CONCLUSIONS AND RECOMMENDATIONS:

In the current research study, knee height was found to be more accurate than demi-span and ulna length for estimating height of Egyptian elderly males.

The present study concluded an age-, sex- and population-specific regression equation which is easy and simple for predicting height of Egyptian elderly males. This newly developed equation is using only gender and knee height as predictors for height estimation. [Height= 57.345+ 2.131 (Knee height in cm)] When standing height measurement in older people is difficult to obtain, impossible or inaccurate because of an inability to stand straight or steadily due to pain, weakness, disability, or spinal deformities such as kyphosis or due to osteoporosis or any other factors, it's recommended to estimate standing height rather than measuring it. A big randomized clinical study is recommended in order to put this formula in practice for validation. Another equivalent study should be carried out among Egyptian elderly females aged 60 years and older to detect which anthropometric measure is the most accurate for height prediction in such population, and to develop a sex-specific equation for estimating stature of Egyptian elderly females. Other anthropometric measures rather than (demi-span, ulna length and knee height) have to be investigated if they can be used as suitable surrogates for height estimation in Egyptian elderly.

References

1. Al-Gindan, Y. Y., Hankey, C., Govan, L., Gallagher, D., Heymsfield, S. B., & Lean, M. E. (2014). Derivation and validation of simple equations to predict total muscle mass from simple anthropometric and demographic data. *Am J Clin Nutr*; 100(4): 1041-1051.
2. Anstey, K. J., Cherbuin, N., Budge, M., & Young, J. (2011). Body mass index in midlife and late-life as a risk factor for dementia: a meta-analysis of prospective studies. *Obes Rev*; 12(5): e426-437.
3. Ju Lee, B., & Yeol Kim, J. (2015). Indicators of hypertriglyceridemia from anthropometric measures based on data mining. *Comput Biol Med*; 57: 201-211.
4. Payne, K. D., & Hall, R. G., 2nd. (2014). Dosing of antibacterial agents in obese adults: does one size fit all? *Expert Rev Anti Infect Ther*; 12(7): 829-854.
5. Pelosi, P., & de Abreu, M. G. (2012). Tidal volumes during general anesthesia: size does matter! *Anesthesiology*, 116(5): 985-986.
6. Asayama, K., Sato, A., Ohkubo, T., Mimura, A., Hayashi, K., Kikuya, M., Imai, Y. (2009). The association between masked hypertension and waist circumference as an obesity-related anthropometric index for metabolic syndrome: the Ohasama study. *Hypertens Res*; 32(6): 438-443.
7. Ashwell, M., Gunn, P., & Gibson, S. (2012). Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. *Obes Rev*; 13(3): 275-286.
8. Backholer, K., Pasupathi, K., Wong, E., Hodge, A., Stevenson, C., & Peeters, A. (2012). The relationship between body mass index prior to old age and disability in old age. *Int J Obes (Lond)*; 36(9): 1180-1186.
9. Bhatti, U., Rani, K., & Memon, M. Q. (2014). Variation in lung volumes and capacities among young males in relation to height. *J Ayub Med Coll Abbottabad*, 26(2): 200-202.
10. Sabah, K. M., Chowdhury, A. W., Khan, H. I., Hasan, A. T., Haque, S., Ali, S., Mahabub, S. M. (2014). Body mass index and waist/height ratio for prediction of severity of coronary artery disease. *BMC Res Notes*, 7: 246.
11. Bojmehrani, A., Bergeron-Duchesne, M., Bouchard, C., Simard, S., Bouchard, P. A., Vanderschuren, A., Lellouche, F. (2014). Comparison of usual and alternative methods to measure height in mechanically ventilated patients: potential impact on protective ventilation. *Respir Care*, 59(7): 1025-1033.
12. Maskin, L. P., Attie, S., Setten, M., Rodriguez, P. O., Bonelli, I., Stryjewski, M. E., & Valentini, R. (2010). Accuracy of weight and height estimation in an intensive care unit. *Anaesth Intensive Care*, 38(5): 930-934.
13. World Health Organization (WHO) (2013). Global Health Observatory of the World Health Organization. (Accessed 15 October 2013).
14. Bridges, M. J., & Ruddick, S. (2010). Can self-reported height and weight be used to calculate 10 year risk of osteoporotic fracture? *J Nutr Health Aging*, 14(8): 611-613.
15. Lim, R. B., Chen, C., Naidoo, N., Gay, G., Tang, W. E., Seah, D., Lim, W. Y. (2015). Anthropometrics indices of obesity, and all-cause and cardiovascular disease-related

- mortality, in an Asian cohort with type 2 diabetes mellitus. *Diabetes Metab*; 11:251-262.
16. Madden, A. M., Tsikoura, T., & Stott, D. J. (2012). The estimation of body height from ulna length in healthy adults from different ethnic groups. *J Hum Nutr Diet*; 25(2): 121-128.
 17. Torimitsu, S., Makino, Y., Saitoh, H., Sakuma, A., Ishii, N., Hayakawa, M., Iwase, H. (2014). Stature estimation based on radial and ulnar lengths using three-dimensional images from multidetector computed tomography in a Japanese population. *Leg Med (Tokyo)*, 16(4): 181-186.
 18. Oonishi, R., Fujii, K., Tsuda, H., & Imai, K. (2012). Development of weight-estimation formulae for the bedridden elderly requiring care. *Nihon Ronen Igakkai Zasshi*; 49(6): 746-751.
 19. Chew, M. S., Ihrman, L., During, J., Bergenzaun, L., Ersson, A., Unden, J., Larsson, M. (2012). Extravascular lung water index improves the diagnostic accuracy of lung injury in patients with shock. *Crit Care*, 16(1): R1.
 20. Dehlendorff, C., Andersen, K. K., & Olsen, T. S. (2014). Body mass index and death by stroke: no obesity paradox. *JAMA Neurol*; 71(8): 978-984.
 21. Huber, W., Mair, S., Gotz, S. Q., Tschirdewahn, J., Siegel, J., Schmid, R. M., & Saugel, B. (2013). Extravascular lung water and its association with weight, height, age, and gender: a study in intensive care unit patients. *Intensive Care Med*; 39(1): 146-150.
 22. R. I. Davidson, E. J. D., & J.N.Metzmaker (2012). "The shoulder, cervical, extradural compressive monoradiculopathies, S., vol. 6., no. 5, p., 1981. Kelly, J. C., Groarke, P. J., Butler, J. S., O'Byrne, J. M. (2012). The natural history and clinical syndromes of degenerative cervical spondylosis. *Adv Orthop*; 393-642.
 23. Gavrilidou, N. N., Pihlgard, M., & Elmstahl, S. (2014). High degree of BMI misclassification of malnutrition among Swedish elderly population: Age-adjusted height estimation using knee height and demispan. *Eur J Clin Nutr*; 18:113-124.
 24. Hirani, V., & Aresu, M. (2012). Development of new demi-span equations from a nationally representative sample of older people to estimate adult height. *J Am Geriatr Soc*; 60(3): 550-554.
 25. Nakazawa, A., Nakamura, K., Kitamura, K., & Yoshizawa, Y. (2013). Association between body mass index and mortality among institutionalized elderly adults in Japan. *Environ Health Prev Med*; 18(6): 502-506.
 26. Ngoh, H. J., Sakinah, H., & Harsa Amylia, M. S. (2012). Development of demi-span equations for predicting height among the Malaysian elderly. *Malays J Nutr*; 18(2): 149-159.
 27. Jaber, S., Coisel, Y., Chanques, G., Futier, E., Constantin, J. M., Michelet, P., Marret, E. (2012). A multicentre observational study of intra-operative ventilatory management during general anaesthesia: tidal volumes and relation to body weight. *Anaesthesia*, 67(9): 999-1008.
 28. Jang, E., Kim, J. Y., Lee, H., Kim, H., Baek, Y., & Lee, S. (2012). A study on the reliability of sasang constitutional body trunk measurement. *Evid Based Complement Alternat Med*; 604-842.
 29. Karadag, B., Ozturk, A. O., Sener, N., & Altuntas, Y. (2012). Use of knee height for the estimation of stature in elderly Turkish people and their relationship with cardiometabolic risk factors. *Arch Gerontol Geriatr*; 54(1): 82-89.

