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Original article

Patterning of Body mass index (BMI) and Arm span based BMI in Fisherman community of Sundarbon delta, India

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ABSTRACT

Background: Arm span and height are the proxy measure and BMI and arm span base BMI are also proxy measure to each other, but the patterning in the population yet facing few challenges due to sex differences.

Aim: The present study aims to identify the sex differences in the patterning of Body mass index (BMI) and Arm spanbased BMI in Fisherman community of Sundarbon delta, India.

Subjects and Methods: Data has been collected from the fisherman community of Sundarbon delta of both sexes from 2011-2013 including 300 male and 300 female, apparently healthy subjects. All anthropometric measurements were taken following the standard protocol.

Results: The result shown that there is significant relationship in arm span with height and BMI with arm span based BMI, and the other considered variables, but the patterning of the variable are different in both sexes due to some secular trends. Ratio of BMI and Arm span based BMI has shown the resemblance in sex differentiation as a good indicator.

Conclusion: It can be easily concluded that arm span based BMI and ratio between BMI and Arm span based BMI might be a very good indicator for assessing the nutritional status and population variation.

Keywords: Arm span, BMI, Height, Arm span based BMI, Ratio of BMI and Arm span based BMI

INTRODUCTION

BMI is a simple measure to describe the relationship between height and weight, and it is frequently recommended for screening and to monitor nutritional status (Lipschitz, 1996). BMI is calculated from height and weight (BMI=weight (kg)/height (m^2). Measuring height can be difficult in physically and mentally frail nursing home patients, e.g. patients that are

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wheelchair users or bedridden and patients with osteoporosis, squeal after hip fractures, leg amputation, or stroke. Several alternatives to height have been proposed for the assessment of nutritional state in older persons. One alternative – arm span – has been shown to be a practical substitute for skeletal size (Bassey et al, 1986; Allen et al, 1989; Kwok et al, 1991; Manonai et al, 2001). Estimation of stature from measurements of different body segments and bones are quite age-old investigations over centuries (cited in Salles et al. 2009). Some recent studies has estimated stature from upper and lower extremities (Ozaslan et al. 2006; Agnihotri et al. 2007; 2008; Krishan and Sharma 2007; Krishan 2008; Krishan et al. 2010; Nygaard, HA. 2008; DuttaBanik,2011), cephalo-facial measurements (Krishan and Kumar 2007; Krishan 2008b; Sahni et al. 2010), sternum (Menezes et al. 2009) and iliac spine (Nachiket et al. 2010). Individual and ethnic variations in respect of height and its relation with arm span were observed in European (Reeves et al. 1996) and African populations (Lucia et al. 2002). Estimation of stature from arm span was also reported in other studies (Steele and Mattox 1987; Steele and Chenier 1990; Chumlea et al. 1998; Aggarwal et al. 2000; Brown et al. 2000; Manonai et al. 2001; Mohanty et al. 2001; Shahar and Pooy 2003; Zverev 2003; Ofluoglu et al. 2008). However, most of these studies were done among adults and the children separately shows the important and thought provoking results (Dutta Banik, 2011; Chaterjee et al, 2006; Ghosh et al, 2006; Chatterjee et al, 2009; Chatterjee, 2013). The aim of the present study is to assess relationship between measurement of arm span based BMI and BMI and it's patterning in the studied population in both sexes and also to assess the state of result of some other derived variables as the ratio between BMI and Arm span based BMI over sex.

MATERIAL AND METHODS

Data for this present study collected from a study conducted among the Fisherman community, belongs to Hindu-Caste population in Sundarbon Delta of West Bengal, India in the year 2012-2013. The data comprised of 600 subjects including 300 0f each sexes. Consent from the subjects has been taken following all the rules and regulations. All anthropometric measurements were taken following the standard proocol (Lohman, 1988). Various ways of measuring arm span have been proposed in different studies(Bassey, 1986; Kwok, 1991; Manonai, 2001). In this connection arm span was measured from sternal notch to the tip of the middle finger, times two (Kwok, 1991; Manonai, 2001. The author (DC) performed all measurements. The fisherman community live in the mangrove forest villages in extreme saline environment and involved in very hard work to spent their livelihood. Sundorbon is one of the biggest mangrove forest with a very hard accebility condition of man. They are mostly land less and only involved in fishing by both sexes for the whole year. The males are involved in shallow and deep sea fishing and females are involved in collecting the prawn seedlingd (locally known as – 'Min') from sea.

RESULTS

Table - 1 shows descriptive statistics mean with standard deviation (SD) anthropometric measurements and Actual height (cm), estimated height from arm span (cm) and difference between the two. The predicted height from arm span was computed through multiplication factor at in both sexes in Table : 4. Males were found to be taller in height compared to the women, and significant difference has been seen I the present study. Significant sex difference with respect to the relative proportion of height to arm span was found. It is depicted (table : 1) that arm span based BMI and the estimated height is higher than the actual measurements taken. Significant correlationhas been seen between heith and arm span, BMI and arm span based BMI and the ratio between BMI and arm span based BMI with Arm span based BMI and BMI in both sexes, except the BMI and arm span based BMI in Male (Table : 2). A clear difference is seen in both sexes between height and estimated height (Table: 3). There is also significant difference in both sexes between the height and estimated height (Table : 3). Multiplication factor in both sexes has neen estimated(Table : 3). The significant diffeence between the all variables except the BMI has been seen in both sexes (Table : 1). Z score has been estimated in both sexes (Table: 4). Figure : 1 shows the comparison of variables in both sexes and Figure: 2 shows the relative effectiveness of two derived variables of BMI and Arm span based BMI in both sexes. Receiver operating characteristic analysis (ROC) done with Arm span based BMI and the Ratio of BMI and Arm span based BMI in both sexes differences in patterning has been seen (Table: 5) curve has shown the patterning in both sexes (Figure: 3 and Figure: 4).

DISCUSSION

Height and arm span exhibited similar trends of significant differences in both sexes. Distribution of height based and arm span based BMI at same cut-off levels of BMI (WHO 1995) showed similar results in adults. These results therefore confirmed that arm span substituting height in BMI could exhibit similar output evaluating nutritional status among children, adolescents (Dutta Banik, 2011) and adults (present study). Males were taller and had longer arm span shown in the present study which is corroborative to the previous studies. Significant correlations between height and arm span were observed. However, The estimated equations might be tested in similar studies in other communities of this region. However, multiple regression analysis had also been done (not presented in this report). Hence, in this study it was preferred to estimate height from arm span by sex separately that estimated height with less difference from actual height. In adults, differential patterning was obvious in either sex. There were studies that mentioned height losses in post-menopausal women who had osteoporosis (Manonai et al. 2001). The results of the present study exhibited similar trends of earlier reports. In Malawian children (Zverev and Chisi 2005, Dutta Banik, 2011), significant correlation coefficients were recorded between height and arm span in both sexes has been also seen in the present study. Arm span was found to be higher than height (Tores et al. 2003; Zverev and Chisi 2005, cited in Yabanci et al. 2010, Dutta Banik, 2011). Nevertheless, Yabanci et al. (2010) reported shorter length of arm span than height and a strong correlation between the two variables in Turkish children aged 7–14 years. The significant result also seen in the Dhimal population by Dutta banik, (2011) in India. In adult the similar relationship has been seen (Nygaard HA. 2008). Arm span can also be used to estimate maximum adult height for adult people. This had been proposed by many other studies also (Steele and Mattox 1987; Reeves et al. 1996; some other references are available from the author). However, the correlation decreased with advancing age (Dutta

Banik, 2011). A study conducted in four ethnic groups, namely Oromo, Amhara, Tigre and Somali in Ethiopia (Lucia et al. 2002), also reported higher mean arm span than height in males and females. Arm span-to-height ratio exceeded 1.00 in either sex and in regression equation, R 2 values ranged between 0.84–0.86 in males and 0.80–0.86 in females in those four samples. In a study among Malaysian elderly people, from three major ethnic groups, Malayas, Chinese and Indians (Shahar and Pooy 2003), height was estimated from arm span. Arm span as the appropriate proxy measure for height in cases of age-related loss of height in women was also supported by other studies (Ofluoglu et al. 2008). Arm span and stature were found to have high correlations (0.93 in males and 0.91 in females) in a study carried out in adult sportspersons (Canda 2009). In the present studt it is depicted from the result that general adiposity measured by BMI is might not a good parameter for sex differenciaion due to secular trends. The derived variables used in the present study the ratio of arm span based BMI and BMI and ratio of BMI and arm span based BMI shown significant differences in both sexes. So, it may be concluded that the persons having disability, arm span based BMI might be a effective parameter to assess the nutritional status and also for population variation as because disability due to different non-communicable diseases will be a threat to the mankind. When calculating BMI the denominator is the square of height or arm span in metres. Changes in stature erroneously lead to a larger BMI index; an equivalent change in arm span does not occur (Reeves, 1996). BMI calculations based on arm span are therefore likely to be more accurate. The WHO has established reference values for BMI: BMI ≥25 kg/m^2 overweight, BMI 18.5–24.99 kg/m^2 normal range, and BMI ≤18.49 kg/m^2 underweight (WHO, 1995). The references are considered to be relevant also "for the elderly"; however, it is stated that other cut-offs may be more appropriate for persons above 70 years of age (WHO, 1995). There is no clear BMI score which is agreed upon as a lower limit of the normal range, and reports on malnutrition in older people operate with various cut-off scores between 18.5 kg/m^2 and 20 kg/m^2, (Bergman et al, 2007; Brownie et al, 2006; Leslie et al, 2006; Beck et al, 2002). Review of the literature indicates that the optimal BMI range for elderly people should be 24–29 kg/m^2, (Beck, 1998). BMIs below and above these limits are for example associated with increase in mortality (Beck, 1998). A BMI of less than 24.9 kg/m^2 is therefore considered an appropriate cut-off with regard to intervention in order to reduce nutrition-related complications (Beck, 1998). The mentioned studies are based on measure of height making some measurement bias likely as a result of stature decrease. Several caveats must be considered when using BMI as a measure of nutritional state in a clinical setting. BMI says nothing about body composition, e.g. whether changes in BMI are a result of change in stature, muscle, or fat mass, or due to oedema. In daily work, additional information must be gathered, e.g. eating habits, medical condition, appetite, and drug use and weight changes. This has led to the development of more detailed assessment instruments for malnutrition. BMI is part of several of these instruments, for example the Mini Nutritional Assessment (long and short form) (Vallas, 1999) and Malnutrition Universal Screening Tool (Stratton, 2004). Although arm span usually remains stable throughout life, It is very important to note that hormone, genetics and other factors might play a great role in differences in patterning of the variables as depicted in the present study. The figure: 1 depicted that the difference in ratio of BMI with Arm span based BMI and Arm span based BMI is very less than the BMI. Figure: 2 show the effectiveness of the derived variables in assessing the nutritional status and population variation. ROC analysis (Table: 5) shows the patterning in both the variables in both sexes (Figure: 3 and Figure: 4). It can be easily concluded that arm span based BMI and ratio between BMI and Arm span based BMI might be a very good indicator for assesing the nutritional status and population variation.

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Table: 1 – Descriptive statistics Mean (SD) for the studied population in both sexes

	Male		Female	
Height (cm)	161.47*	(6.18)	150.52*	(6.13)
Weight (kg)	56.05*	(9.74)	47.48*	(8.55)
Arm Span (cm)	163.39*	(5.30)	148.69*	(6.91)
BMI (kg/m^2)	21.39**	(3.90)	20.92**	(3.41)
ArspBMI	33.28*	(1.42)	22.38*	(1.63)
Ratio of ArspBMI with BMI	0.87*	(0.946)	1.017*	(0.126)
Ratio of BMI With ArspBMI	1.47*	(0.125)	0.993*	(0.089)
Estimated Height (cm)	167.79*	(6.19)	148.46*	(6.21)

ArspBMI = Arm span based BMI, BMI = Body Mass Index; *P<0.01 **p>0.01

Table: 2 – Correlation coefficient in both sexes

	Height with arm span	BMI with ArspBMI	Ratio of ArspBMI vs BMI
Male	0.227**	-0.047	-0.807**
Female	0.309**	0.286**	-0.942**

** Significant at 0.01 level

Table 3: Descriptive statistics Mean (SD) of actual and estimated height and differences

	Actual Height (cm)	Estimated Height (cm)	Difference in Height (cm)	Multiplication factor with Arm span and actual height
Male	161.47 (6.18)	163.27 (7.76)	2.43* (1.51)	0.98
Female	150.52 (6.13)	148.46 (6.21)	2.06* (1.68)	1.01

*P<0.01

Table: 4 – Z Statistics (Score) on the basis of BMI cutt off value 24.9 kg/m^2 (WHO,1995)

	Male	Female
BMI	0.8186	0.9463
ArspBMI	0.9982	0.5040

Table: 5: Receiver Character Operative Characteristics Analysis (ROC), considering BMI Cutoff 24.9 kg/m^2

	Sensitivity	Specificity	Area under curve	z-statistics	Youden index
Male					
ArspBMI	90.5	65.6	0.848	14.85	0.560
Ratio of BMI And ArspBMI	60.3	58.6	0.602	2.52	0.189
Female					
ArspBMI	96.2	89.4	0.97	34.78	0.85
Ratio of BMI And ArspBMI	88.5	34.5	0.544	0.740	0.233

Figure : 1: Sex differences in Anthropometric variables

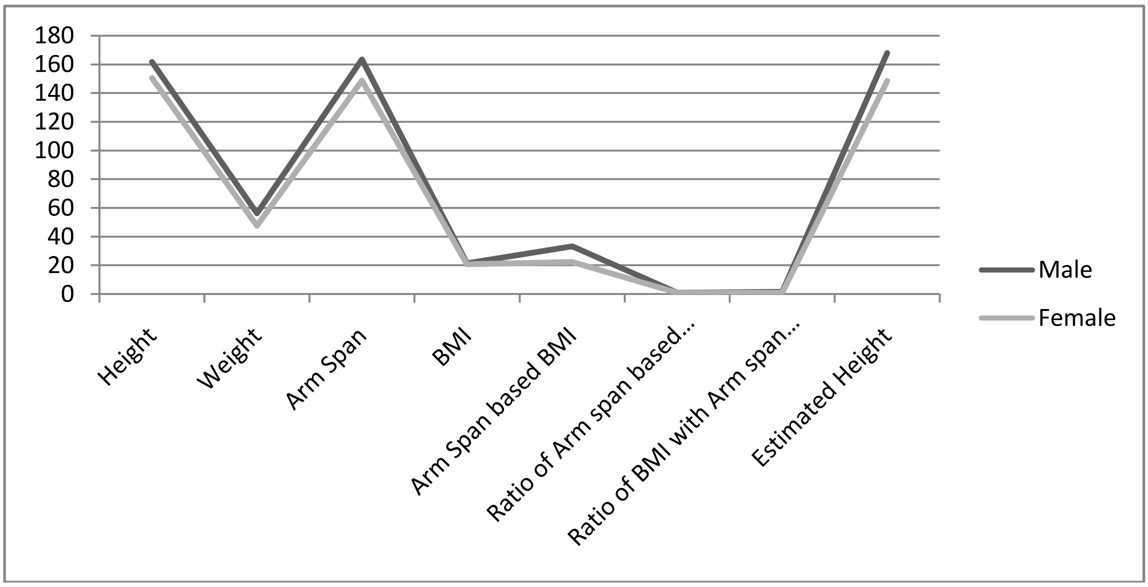

Figure : 2: Relative effectiveness of two derived variables of BMI and Arm span based BMI in both sexes

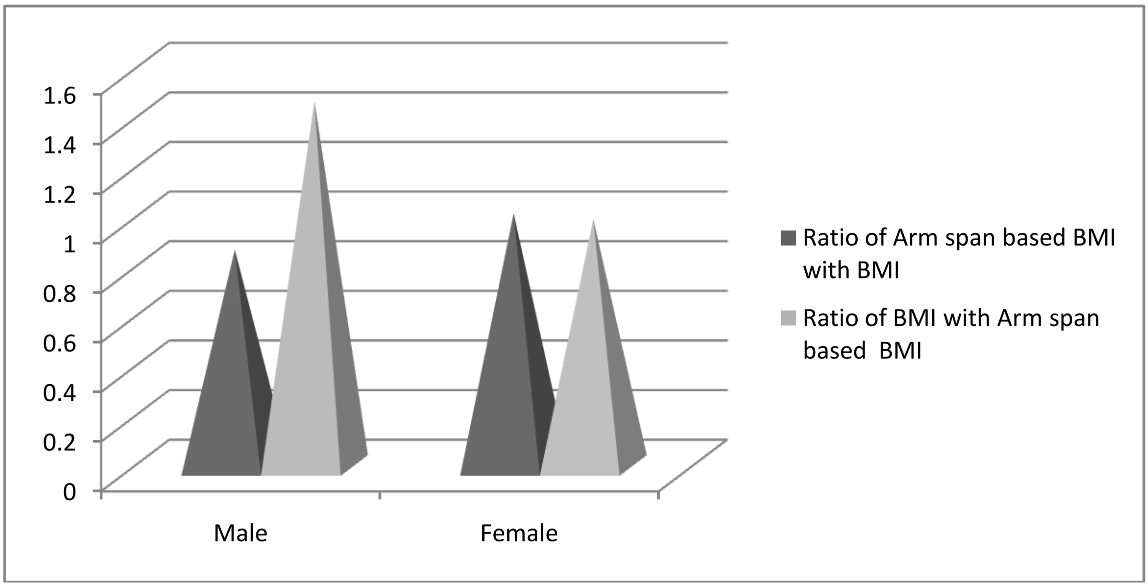

Figure: 3: Receiver Operating Characteristics (ROC) Curve analysis in Male

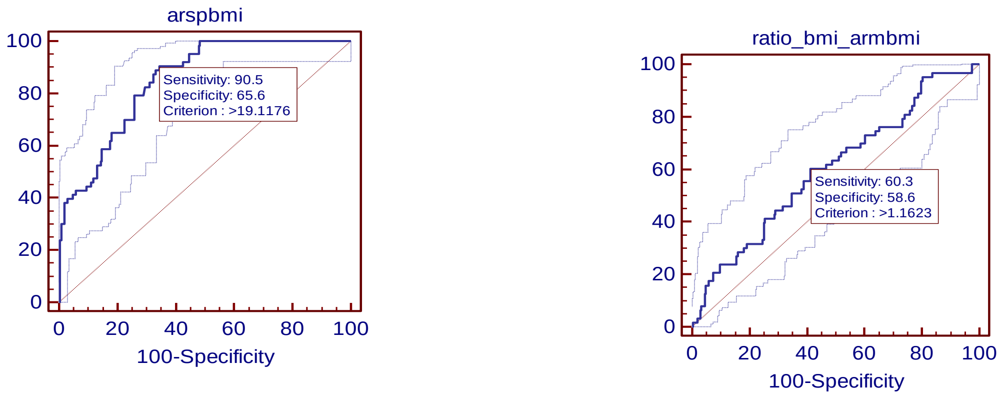

Figure: 4: Receiver Operating Characteristics (ROC) Curve analysis in Female