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Research Paper

Body composition in relation to economic status among adult females

■ PRIYANKA SINGHAL AND RITA SINGH RAGHUVANSHI

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See end of the paper for authors' affiliations

PRIYANKA SINGHAL
Department of Foods and Nutrition, College of Home Science, G.B. Pant University of Agriculture and Technology, PANTNAGAR (UTTARAKHAND) INDIA
Email: psinghal160@gmail.com

■ **ABSTRACT :** This cross-sectional nature of research investigation consists of assessing nutritional status and body composition of 629 young women in the age range of 18-28 years. Mean BMI and waist hip ratio was revealed 20.3±3.4 and 0.83±0.05, respectively. Fat per cent showed an increasing trend in accordance with income slab. A decreasing trend was observed for fat free mass (%) and total body water (%) in relation to income range. Mean observations for fat (%) have been found to be 21.27±6.55, 22.74±6.77 and 23.91±6.86 at three corresponding income ranges. FFM (%) and fat (%) had significant difference ($p<0.01$) at 1 per cent level for the groups *viz.*, low income group-middle income group and middle income group-high income group. Anthropometric characteristics such as weight, BMI, waist circumference, hip circumference, triceps, biceps, sub-scapular and sum of skin fold thickness had rising trend with advancing income ranges while height, MUAC, WHR and supra-iliac revealed no such trend. Waist circumference showed to have significant difference ($p<0.05$) at 5 per cent level for the groups *viz.*, low income group-middle income group and low income group-high income group. Waist hip ratio revealed significant difference ($p<0.05$) at 5 per cent level for the group low income group–middle income group.

■ **KEY WORDS:** Nutritional status, Body composition, Economic status, Adult females

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Body composition analysis by bioelectrical impedance gives estimates of total body water (TBW), fat-free mass (FFM), and fat mass by measuring the resistance of the body as a conductor to a very small alternating electrical current (Chumlea and Guo, 1994). Body composition assessment is useful in nutritional evaluation. Bioelectrical impedance analysis (BIA), which has been known for more than 50 years, has become widely used in clinical settings during the last 10 years (Lukaski *et al.,* 1985; Lukaski *et al.,* 1986; Jebb and Elia, 1993). In human body, fat has physiological and medical importance. Women have larger body fat mass and lower lean body mass in comparison to men at entry to adulthood. Changes in body composition occur over time. Average body fat increases with age. Average body fat for young man is considered to be about 15 per cent and 18-23 per cent for young women. As age increases, the amount of muscle tends to drop, and fat accounts for a greater percentage of weight (Passmore and Eastwood, 1979).

It is considered that BMI is a good indicator of nutritional status and the socio-economic condition of adult population of developing countries (Ferro-Luzzi *et al.,* 1992; Khongsdier, 2002; Shetty and James, 1994). In low-income countries, BMI can be used in the assessment of differences in standards of living between population groups (Nub *et al.,* 1998). Household income has considerable impact on nutritional status of individuals as well as plays a very important role in making food choices (Bowman, 2007). Changes in eating habits and sedentary life styles are attributed to the increased prevalence of overweight and obesity (Aranceta, 2003). The increased consumption of foods with higher energy content e.g. convenience meals may cause conditions of overweight and obesity (Prentice and Jebb, 2001). The objective of the present study is to explore trend of body composition and anthropometric indices with respect to income.

■ RESEARCH METHODS

Sample selection :

In the age range of 18-28 years, University young female students were selected for the present study.

Sampling design :

Simple random sampling without replacement technique was used for sample selection. To get access to subjects, a table of random number was used. For this, a list of subjects was taken and random numbers were assigned.

Criteria for inclusion and exclusion of study participants :

Study participants were those falling in the age range of 18-28 years; devoid of any apparent or known health problems. Study subjects were clearly explained purpose of the study prior to inclusion. Study subjects those given their written consent were included in the present research. Respondents those did not meet out inclusion criteria were excluded from the study.

Sample size :

According to NFHS-3 (2005-06), approximately 52 per cent women had normal nutritional status in India measured by BMI. There were 4367 students in University out of which around 2800 were girl students. To have estimates on percentage of normal population, a sample size of 637 was taken at 99 per cent confidence interval with precision level of 5 per cent assuming that it might give estimate on normal population up to 60 per cent. In this way, calculation for sample size was made. In the present study, 629 young adult were agreed to participate in the study. Data could not be collected from 8 subjects as they refused to provide information at a later stage.

Income slab :

As per National Council of Applied Economic Research's Market Information Survey of Households, 2005 (Anonymous, 2005), various income categories comprised of Low Income Group (LIG) (Rs.<90,000), Middle Income Group (MIG) (Rs.90,000-200000) and High Income Group (HIG) (Rs.>200000).

Birth weight :

Survey schedule was prepared to gather general information, anthropometric, birth weight and income group profile. Data on birth weight from 433 respondents was self-reported**.** The range of birth weight was <2.5 (underweight), 2.5-3 (average weight), 3-3.5 and $\geq$ 3.5 kg.

Nutritional status :

Nutritional status was assessed using BMI proposed by international obesity task force (IOTF). BMI was calculates as weight (kg)/height $(m)^2$. Height and weight data were obtained as per standard procedures (Gibson, 1990). BMI cut-offs used as<18.5 (underweight), 18.5-22.9 Normal, 23.0-24.9 at risk of obesity; 25.0-29.9 Obese I and > 30.0 Obese II (Weisell, 2002).

Body composition assessment :

Information on body composition parameters was obtained using Bioelectrical Impedance Analysis (Maltron Bioscan Analyser, 916). For body composition assessment, study subjects were subjected to lie down in a supine position. The impedance to the current flow is measured. BIA measurements using four electrodes attachments two electrodes attached at the wrist and two at the ankle are performed. Through pair of electrodes, a weak alternating current (50 kHz) is passed. The electrical impedance of body tissues is measured by BIA and used to have estimates on fluid volumes, TBW, Body Cell Mass, (BCM) and FFM (National Institute of Health, 1996).

Statistical analysis :

Statistical analysis was done using SPSS programme for body composition indices using mean, standard deviation and ANOVA.

■ RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

General information :

In the present research, 98.09 per cent were unmarried; the remaining 2 per cent were married in last six months. Maximum subjects *i.e.* 85.69 per cent belonged to nuclear family. Out of total population of 629, maximum subjects *i.e.* around 44.67 per cent were observed as vegetarian (Table 1).

Annual per capita income :

As per market information survey household, various income categories were divided in LIG, MIG and HIG. All the

Table 1 : Background information parameters

Sr. No.	Background information characteristics	18-28 (n=629) n (%)
1.	**Marital status**	
	Married	12 (1.90)
	Unmarried	617 (98.09)
2.	**Type of family**	
	Nuclear	539 (85.69)
	Joint	90 (14.30
3.	**Food habits**	
	Vegetarian	281 (44.67)
	Non-vegetarian	219 (34.82)
	Ova-vegetarian	129 (20.51)

study participants were University students and 8.74 per cent belonged to LIG (Rs.<90,000 $ 1665.89), 36.4 per cent belonged to MIG (Rs.90,000-200000 $ 1665.89-3701.98) and 54.84 per cent belonged to HIG (Rs. >200000 $ 3701.98). All the students were getting monthly expenditure from their families.

Birth weight, nutritional status and body composition :

All the subjects could not find their birth weight from their respective families. Of the total respondents, data were available for 433 respondents. It was found that highest percentage *i.e.* 30.71 of participants (normal weight) had mean birth weight 2.56±0.11 kg, followed by approximately 26.78 per cent (low birth weight), 26.78 per cent and 15.70 per cent subjects had mean birth weights 1.76±0.42, 3.02±0.07 and 3.78±0.38 kg, respectively. The range of birth weight was <2.5, 2.5-3, 3-3.5 and $\geq$ 3.5 kg.

Average body weight and height obtained were 49.9±8.9 kg and 156.6±5.8 cm, respectively (Table 2). Mean BMI was observed to be 20.3±3.4 kg/m^2. As per IOTF cut off points, normal populations were recorded to be about 54.21 per cent, undernourished; 29.73 per cent and over nourished; 16.06 per cent. Undernourished population comprised of chronic energy deficiency-mild; 17.65 per cent, chronic energy deficiency-moderate; 7.31 per cent and chronic energy deficiency-severe; 4.77 per cent. Mean per cent body fat was shown to be 22.0±6.7.Average estimates on fat free mass per cent and total body water were 77.9±6.7 and 54.1±4.5, respectively. Means obtained *viz.,* 0.73±0.06 and 20.7±1.9 for extracellular water: intracellular water ratio and body cell mass (kg), respectively.

Nutritional status in relation to income :

Data analysis exhibited that anthropometric characteristics such as weight, BMI, waist circumference, hip circumference, triceps, biceps, sub-scapular and sum of SFT were shown to have increasing trend with increasing income ranges while height, MUAC, WHR and supra-iliac revealed no such trend. Mean values for BMI were observed to be 20.05±3.09, 20.65±4.13 and 20.88±2.84 (kg/m^2) at these three corresponding income ranges. Weight showed to have significant difference ($p<0.05$) at 5 per cent level for the groups LIG -MIG and LIG-HIG. BMI revealed significant difference ($p<0.05$) at 5 per cent level for the group LIG –MIG. Waist circumference was represented to have significant difference ($p<0.05$) at 5 per cent level for the groups *viz.,* LIG -MIG and LIG-HIG. Hip circumference had significant difference ($p<0.01$) at 1 per cent level for the group LIG-HIG, and it had significant difference ($p<0.05$) at 5 per cent level was observed for the group MIG-HIG.

WHR was observed to have significant difference ($p<0.05$) at 5 per cent level for the group LIG–MIG. Biceps revealed significant difference ($p<0.01$) at 1 per cent level for the groups *viz.,* LIG-MIG and LIG-HIG, and significant difference at 5 per cent level was observed for the group MIG-HIG. Subscapular had significant difference ($p<0.01$) at 1 per cent level for the groups *viz.,* LIG –MIG, and significant difference ($p<0.05$) at 5 per cent level was observed for the group LIG-HIG. Sum of skinfold thickness was shown to have significant difference ($p<0.05$) at 5 per cent level for the group LIG –HIG (Table 2).

Body composition in accordance with income :

Body composition parameters like fat (%) have been exhibited to have an advancing trend with increased income ranges. A decreasing trend has been observed for fat free mass (%) total body water (%) and body calcium. Mean observations for fat (%) have been found to be 21.27±6.55, 22.74±6.77 and 23.91±6.86 at income ranges. FFM (%) and fat (%) had significant difference ($p<0.01$) at 1 per cent level for the groups *viz.,* LIG-MIG and MIG-HIG. Fat (kg) and TBW (%) revealed to have significant difference ($p<0.05$) at 5 per cent

Table 2 : Anthropometric indices as per annual per capita income

Sr. No.	Anthropometric characteristics	Income group: Rs.<90,000 $ 1665.89 (LIG)	Rs.90,000-200000 $ 1665.89-3728.56(MIG)	Rs.>200000 $ >3728.56 (HIG)	f value
1.	Height (cm.)	156.55±6.04	156.52±5.8	158.15±4.76	1.928^{NS}
2.	Weight (kg.)	49.05±7.38	50.63±10.83	52.38±8.68	4.476*
3.	BMI (kg/m^2)	20.05±3.09	20.65±4.13	20.88±2.84	2.747^{NS}
4.	Mid upper arm circumference	25.31±10.06	26.4±12.16	25.14±2.67	0.828^{NS}
5.	Waist circumference(cm.)	75.08±8.3	76.83±8.27	77.87±8.83	4.640*
6.	Hip circumference (cm.)	90.79±5.9	91.6±6.12	93.49±6.64	5.123**
7.	WHR	0.83±0.06	0.84±0.06	0.83±0.06	2.936^{NS}
8.	Triceps (mm.)	20.29±4.43	20.87±4.11	21.13±3.23	1.810^{NS}
9.	Biceps (mm.)	7.63±3.04	8.59±3.2	9.59±3.55	12.618**
10.	Subscapular (mm.)	13.5±3.82	14.43±4.06	14.65±4.42	4.746*
11.	Surailiac (mm.)	17.53±5.74	17.21±5.37	18.11±5.13	0.647^{NS}
12.	Sum of SFT (mm.)	58.97±14.29	61.1±13.56	63.48±13.03	3.356*

* and ** indicate significance of values at P=0.05 and 0.01, respectively NS=Non-significant (p>0.05)

level for the group LIG-MIG and significant difference at ($p<0.01$) 1 per cent level was present for the group LIG-HIG. BCM (kg) and body potassium (g) had significant difference ($p<0.05$) at 5 per cent level for the group LIG-HIG. ECM (kg) was noted to have significant difference ($p<0.05$) at 5 per cent level for the group MIG-HIG. Body protein and body mineral were having significant difference ($p<0.05$) at 5 per cent level for the groups *viz.*, LIG-HIG and MIG-HIG. Muscle (kg) was noted to have significant difference ($p<0.01$) at 1 per cent level for the group LIG-HIG, and significant difference ($p<0.05$) at 5 per cent level was observed for the group MIG-HIG. Body calcium (g) represented significant difference ($p<0.01$) at 1 per cent level for the group LIG-HIG (Table 3).

Present research investigation demonstrates that young adult female population of the study had normal BMI, average normal body fat percentage but elevated mean WHR. WHR >0.8 indicates abdominal obesity which implies that there is visceral fat. It has been reported by Brochu *et al.* (2000) that visceral fat may lead to chronic diseases in future life. Body fat per cent of the three income groups was statistically significant being more in higher income group. However, WHR was not significantly different in above three groups. This can be concluded that with increase in income, body fat per cent is increasing but not making any difference in WHR. Probably the higher WHR in Indian population is indicative of physical inactivity in college going females. Of the study population, 29.73 were having abdominal adiposity. Subjects those with higher body fat per cent, higher BMI and higher WHR coupled with sedentary life style will be prone to metabolic aberrations in later life. FFM per cent decreased and fat per cent increased with increase in income group. Body protein, body muscle, body mineral and body potassium had slight increase for LIG and MIG whereas HIG has shown more increased. Increase in body mineral may be because the average height of HIG group around 2 cm which is more than other two income groups. Waist and hip circumference both are increasing across the income group because of WHR in all the three groups were non-significantly different or similar. Elevated mean WHR indicated that young adults are at risk of getting chronic diseases in future life.

Analysis of the data revealed undernourished 29.73 per cent and over-nourished 16.06 per cent. Study respondents represent University students having sedentary life style were at risk of developing future metabolic aberrations as evident from percentage of over nourished population. Even though anthropometric indices *viz.*, BMI, MUAC, triceps, and suprailiac were not affected but mean values of body composition parameters *viz.*, FFM (%), fat (%), TBW (%), BCM (kg), body protein, body mineral, muscle, body potassium and body calcium remained change as evident from significant difference within income slabs (Table 3). This observation indicates that BMI mean values within income ranges were not significantly different as evident from *f* value but body fat per cent was significantly different in accordance with income ranges implying that BMI is a crude indicator of nutritional status however body fat per cent as a good measure of nutritional status because it is more sensitive indicator. Rao *et al.* (1986) observed that the dietary and nutritional status of urban population groups revealed socio-economic differences. With high income group showing higher levels

Table 3 : Body composition characteristics as per annual per capita income

Sr. No.	Body composition characteristics	Rs. <90,000 (LIG)	Rs. 90,000-200000 (MIG)	Rs. >200000 (HIG)	f value
1.	Fat free mass (kg)	38.19±3.25	38.27±3.64	39.31±3.23	2.610^{NS}
2.	Fat free mass (%)	78.74±6.55	77.26±6.77	76.09±6.86	5.764**
3.	Fat (kg)	10.9±5.2	11.86±5.36	13.06±6.02	5.020**
4.	Fat (%)	21.27±6.55	22.74±6.77	23.91±6.86	5.748**
5.	Total body water (lt)	26.49±2.22	26.62±2.58	27.14±2.35	1.814 ^{NS}
6.	Total body water (%)	54.6±4.44	53.73±4.55	52.5±4.61	6.370**
7.	Extracellular water (lt)	11.23±1.02	11.19±1.03	11.42±0.86	1.197 ^{NS}
8.	Extracellular water (%)	42.43±2.24	42.1±2.22	42.16±1.91	1.626^{NS}
9.	Intracellular water (lt)	15.26±1.52	15.43±1.82	15.72±1.69	2.159^{NS}
10.	Intracellular water (%)	57.56±2.24	57.89±2.22	57.83±1.91	1.562^{NS}
11.	Extracellular water: Intracellular water ratio	0.74±0.07	0.73±0.07	0.73±0.06	1.689^{NS}
12.	Body cell mass (kg)	20.66±1.82	20.82±2.09	21.35±1.98	3.035*
13.	Extracellular mass (kg)	17.5±1.59	17.42±1.69	17.92±1.4	2.206^{NS}
14.	Body protein (kg)	8.3±1.02	8.26±1.05	8.63±0.89	2.999*
15.	Body mineral (kg)	3.39±0.42	3.37±0.43	3.52±0.36	3.025*
16.	Muscle (kg)	17.32±1.55	17.44±1.74	17.97±1.61	3.719*
17.	Body potassium (g)	91.21±8.01	91.91±9.2	94.21±8.71	3.022*
18.	Body calcium (g)	778.02±62.47	783.94±68.56	802.89±63.9	3.589*

* and ** indicate that significance of values at P=0.05 and 0.01, respectively NS=Non-significant (p>0.05)

of nutrient consumption and better nutrition profile than the other groups and slums registering the poorest levels. The profile of middle income group was seen closed to that of high income group. Low income group and industrial labour group showed similarity in most of the nutritional parameters studied. Ghosh and Bandyopadhyay (2006) reported that monthly household income, birth order, and number of siblings were having significant effects on anthropometric variables indicating differences in adult body dimensions, the adiposity index, and body composition in relation to income, birth order, and number of siblings.

Mean observations for weight parameter were found to be 49.05±7.38 (LIG), 50.63±10.83 (MIG) and 52.38±8.68 (HIG). Weight revealed increment of 1.5 kg within income values. These mean values were significantly different ($p<0.05$) at 5 per cent level at income groups (Table 2). It indicates that economic status affected weight of young adult female population. It may be said that weight measurement could be indicator of assessing economic condition and standard of living.

Sum of SFT showed variation of around 2.5 cm within income slabs. Waist circumference have been used as measures of central obesity (where visceral adipose tissue is stored) (Molarius and Seidell, 1998). Waist circumference showed difference of 1.75 cm between LIG and MIG; and 1.04 between MIG and HIG. It significantly increased with income in the present study. Although mean values at income ranges were observed to be normal. Hip circumference represented variation of 0.81 cm between LIG and MIG; and 1.89 cm between MIG and HIG. WHR revealed increment of 0.01 cm between LIG and MIG. A decrease of 0.01 has been observed between MIG and HIG. Higher mean values were obtained at income ranges *viz.*, 0.83±0.06 (LIG), 0.84±0.06 (MIG) and 0.83±0.06 (HIG) indicating that study participants were at risk of evolving chronic diseases later in life (Table 2). These mean values for waist hip ratio were higher than that of standard cut off points *i.e.* 0.80 proposed for Asian Indians. There is no relationship of WHR with income groups. Therefore, it can be said that waist circumference is more sensitive than WHR. Body compositional changes after exercise intervention or physical activity could not be detected by BIA technique which was the limitation of the study.

Conclusion :

Result analysis of the present investigation showed a clear cut rising trend of particulars *viz.*, weight, waist circumference, hip circumference and sum of SFT indicating economic condition exert its influence on nutritional status. In the present study, individuals with HIG having better nutritional status although there was not apparent nutritional deficiency seen in MIG and LIG. Likewise body composition attributes *viz.*, fat (%), FFM (%), TBW, BCM, ECM, body protein, body mineral body potassium and body calcium were significantly different in income group *viz.*, HIG, MIG and LIG.

Authors' affiliations:
RITA SINGH RAGHUVANSHI, Department of Foods and Nutrition, College of Home Science, G.B. Pant University of Agriculture and Technology, PANTNAGAR (UTTARAKHAND) INDIA
Email: rita_raghuvanshi@yahoo.com

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