Body mass index, waist to hip ratio and body fatness correlation in urban adults of Dharwad

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ABSTRACT

IThe objective of the present investigation was to study the correlation between Body Mass Index, Waist to hip ratio and body fatness in urban adults of Dharwad. A total of 1013 subjects aged between 19-60+ years belonging to 340 families were covered for the study. The parameters studied for the investigation were height, weight, waist circumference and hip circumference which were recorded once during the study period. There was a significant positive correlation with Body Mass Index and all other body fat components in all the age groups except for per cent body fat in female obese grade II subjects of 41-60 years and male subjects of 41-60 years. A significant positive correlation of waist circumference with all the body fat components was evident except for fat free mass in all the age groups.

Body Mass Index (BMI: weight in kg/height in meters2) provides the most useful population level of measure of obesity. Within populations a BMI greater than 30 is associated with elevated blood pressure and an increased risk of Non Insulin Dependent Diabetes Mellitus (NIDDM) and Coronary Heart Disease (CHD).The criterion for the clinical diagnosis of abdominal obesity has been the use of waist to hip ratio (WHR). A high WHR is indicative of android obesity and has been directly related to hyperinsulinemia, impaired glucose tolerance, atherosclerosis, diabetes and gout. It is also associated with an increased risk of cardio vascular disease (CVD) even when the Body Mass Index is within the normal range. An attempt was made to study the correlation between Body Mass Index, Waist to hip ratio and body fatness in urban adults of Dharwad.

RESEARCH METHODS

A total of 1013 subjects belonging to 340 families were covered for the study. The parameters studied for the investigation were height, weight, waist and hip circumference using standard procedures suggested by Jelliffe (1966). The anthropometric measurements were recorded once during the study.

The classification as given by Garrow (1987) was used to classify them into obesity.

Measures of body fat:

Using the anthropometric measurements, three measures of body fat composition *viz.,* Percentage Body Fat (PBF), Fat Mass (FM) and Fat Mass Index (FMI) were calculated for obese subjects and for an equal number of normal subjects.

BMI clssification

BMI Class	Presumption diagnosis
<18.5	Undernourished
>18.5-25.0	Normal
25.0-30.0	Obese grade-I
>30.0	Obese grade-II

The abdominal obesity was judged by waist-to-hip ratio (Lean *et al.,* 1995).

WHR = Waist circumference (cm)/Hip circumference (cm)

Reference range: Male ≥ 0.95
Female ≥ 0.80

Measures of body fat:

Using the anthropometric measurements, three measures of body fat composition *viz.*, Percentage Body Fat (PBF), Fat Mass (FM) and Fat Mass Index (FMI) were calculated for obese subjects and for an equal number of normal subjects.

Percentage body fat (PBF):

PBF was calculated using BMI as a criterion, as

given by Deurenberg *et al.* (1991) and using waist circumference as a criterion as given by Lean *et al.* (1996).

Using PBF, fat mass (FM) was calculated as given by Bose (1999). Fat Mass Index (FMI) was calculated as given by Vanlatallie *et al.*,(1990). Fat Free Mass (FFM) was calculated as follows.

FFM= Weight (kg) - Fat Mass (kg)

The correlation coefficients were calculated to find out the degree of relationship between body mass index and body fat components *viz.*, per cent body fat, fat mass (kg), fat mass index and fat free mass (kg).They were also computed between waist circumference and body fat components to know the degree of relationship between them.

RESEARCH FINDINGS AND DISCUSSION

Distribution of adults based on Body Mass Index is depicted in Table 1. A decrease in the percentage of subjects belonging to underweight and normal category was noticeable from 19 to 60+ years. However, there was increase in the percentage of subjects belonging to obese grade I and obese grade II category from 19 to 60 years after which there was a decline.

Distribution of adults based on waist to hip ratio levels is shown in Table 2. In all the age groups, a clear gender demarcation was evident, a higher percentage of female subjects leaning towards abdominal obesity compared to their gender counterparts.

Body fat composition characteristics of urban adults computed based on Body Mass Index is noted in Table 3.

Obese subjects exhibited higher values for all the body fat components *viz.*, per cent body fat, fat mass(kg),fat mass index and fat free mass(kg), except for obese grade I subjects of 19-40 years.

There was a significant positive correlation with body mass index and all other body fat components in all the age groups except for per cent body fat in female obese grade II subjects of 41-60 years and male subjects of 41-60 years. However, body mass index correlated positively with fat free mass only in normal and obese subjects of 19-60 years, except for obese grade II subjects of 19-40 years and obese male subjects of 41-60 years.

Body fat components of urban adults computed based on waist circumference is presented in Table 4. The obese subjects had higher values for all the body fat components compared to the normal subjects. A clear gender demarcation was evident for all the body fat components, females registering higher values compared to their gender counterparts.

A significant positive correlation of waist circumference with all the body fat components was evident except for fat free mass in all the age groups. However, a significant correlation was not evidenced for fat mass index in 41-60 year obese grade II and 60+ year normal males. There was a significant and negative correlation of waist circumference with fat free mass (kg) noted only in normal males of 19-60 years, obese grade II males of 19-40 years and grade I males of 41-60 years.

The body fat components *viz.*, per cent body fat, fat mass (kg) and fat mass index increased with the increase in age and also with the degree of obesity. However, the fat free mass (kg) decreased with the increase in age among both genders. A decrease in fat free mass in both

Table 1: Distribution of adults based on body mass index (BMI)								(n=1013)
BMI Class	Age groups (years)							
	19-40			41-60			60+		
	M	F	C	M	F	C	M	F	C
Underweight	15 (1.48)	67(6.61)	82(8.09)	5(0.49)	17(1.68)	22(2.17)	1(0.10)	3(0.30)	4(0.39)
Normal	176(17.37)	201(19.84)	377(37.22)	130(12.83)	78(7.70)	208(20.53)	27(2.66)	16(1.58)	43(4.24)
Obese Grade-I	57(5.63)	57(5.03)	108(10.66)	64(6.32)	51(5.03)	115(11.35)	7(0.69)	7(0.69)	14(1.38)
Obese Grade-II	5(0.49)	6(0.59)	11(1.08)	8(0.79)	18(1.78)	26(2.57)	2(0.20)	1(0.10)	3(0.30)

M: Male, F: Female, C: Male+Female, Figures in parenthesis indicate percentage

Table 2: Distribution of adults based on waist to hip circumference								(n=1013)
Gender	Age groups (years)							
	19-40		41-60		60+		Total	
	Obese	Non obese	Obese	Non obese	Obese	Non obese	Obese	Non obese
Male	17 (1.68)	236 (23.3)	32 (3.16)	175 (17.28)	9 (0.89)	28 (2.76)	58 (5.72)	439 (43.34)
Female	159 (15.70)	166 (16.39)	95 (9.38)	69 (6.81)	18 (1.78)	9 (0.89)	272 (26.85)	244 (24.09)
Male+Female	176 (17.37)	402 (39.68)	127 (12.54)	244 (24.09)	27 (2.67)	37 (3.65)	330 (32.58)	683 (67.42)

Figures in parenthesis indicate percentage

Table 3: Body fat composition characteristics computed based on body mass index

Age groups (years)	Body fat composition							
	Per cent body fat		Fat mass (kg)		Fat mass index		Fat free mass(kg)	
	Male	Female	Male	Female	Male	Female	Male	Female
19-40								
Normal	17.72±2.91	27.99±2.37	10.17±2.19	14.72±2.54	3.92±0.90	6.01±0.99	46.88±3.87	37.69±2.80
'r' value	0.83**	0.85**	0.89**	0.91**	0.92**	0.96**	0.35**	0.74**
Obese grade I	24.04±2.77	34.80±2.45	17.11±3.06	22.62±3.60	6.61±1.26	9.50±1.37	42.08±4.19	63.69±4.48
'r' value	0.75**	0.67**	0.83**	0.84**	0.90**	0.93**	0.48**	0.57**
Obese grade II	29.90±0.90	41.83±2.74	22.57±2.29	31.28±4.14	9.33±0.44	13.61±1.48	52.83±3.98	43.30±2.56
'r' value	0.89**	0.80**	0.51NS	0.80**	0.96**	0.93**	0.14NS	0.17NS
41-60								
Normal	22.11±2.42	32.08±2.40	13.22±2.09	17.28±2.84	4.96±0.86	7.10±1.09	46.33±3.12	36.32±3.19
'r' value	0.87**	0.87**	0.90**	0.90**	0.95**	0.97**	0.32**	0.59**
Obese grade I	27.92±1.79	38.48±2.94	19.73±2.56	25.30±3.89	7.52±0.80	10.41±1.49	50.76±3.83	40.27±3.69
'r' value	0.47*	0.60**	0.67**	0.81**	0.85**	0.91**	0.55**	0.36NS
Obese grade II	33.91±4.57	45.21±6.67	28.18±5.33	34.66±6.21	10.45±1.59	14.56±2.27	54.57±4.49	41.89±6.92
'r' value	-0.24NS	0.45NS	0.20NS	0.74**	0.56NS	0.90**	0.89**	0.33NS
60+								
Normal	26.93±2.63	35.89±1.82	16.90±2.88	18.66±2.69	6.19±1.14	7.79±0.92	45.53±2.84	33.19±2.98
'r' value	0.97?**	0.87**	0.86**	0.92**	0.99**	0.98**	0.24NS	0.65NS
Obese grade I	33.57±2.95	42.18±2.33	24.82±3.41	27.51±4.10	9.40±1.36	11.38±1.25	48.89±2.80	37.49±4.99
'r' value	0.86**	0.94**	0.91**	0.80**	0.94**	0.99**	0.27NS	0.37NS
Obese grade II	38.27±2.01	47.28	32.28±0.73	35.46	11.88±0.74	14.38	52.22±5.63	38.54
'r' value+	-	-	-	-	-	-	-	-

Note: values are mean±SD   'r'values were calculated between body mass index and body fat components
* and ** indicate significance of values at P=0.01 and P=0.05, respectively
NS: non-significant, + 'r' values are not calculated due to small sample

Table 4: Body fat composition characteristics computed based on waist circumference

Age groups (years)	Body fat composition							
	Per cent body fat		Fat mass (kg)		Fat mass index		Fat free mass(kg)	
	Male	Female	Male	Female	Male	Female	Male	Female
19-40								
Normal	19.58±3.63	33.75±2.94	11.22±2.57	17.76±2.87	4.31±0.95	7.25±1.08	45.83±4.01	34.65±2.87
'r' value	0.98**	0.91**	0.92**	0.82**	0.92**	0.84**	-0.42**	0.13NS
Obese grade I	21.94±4.45	36.18±3.95	15.69±4.11	23.55±4.58	5.93±1.37	9.89±1.72	55.11±4.53	41.15±3.82
'r' value	0.99**	0.93**	0.94**	0.91**	0.99**	0.94**	-0.88**	-0.25NS
Obese grade II	22.93±4.87	40.19±4.23	17.14±3.24	30.1±5.50	7.13±1.45	13.09±1.99	58.26±7.09	44.45±2.18
'r' value	0.99**	0.93**	0.94**	0.91**	0.99**	0.94**	-0.88**	-0.25NS
41-60								
Normal	22.68±3.60	37.17±3.42	13.56±2.79	19.97±3.10	5.06±0.93	8.21±1.23	45.98±3.33	33.63±3.61
'r' value	0.99**	0.95**	0.93**	0.77**	0.90**	0.85**	-0.27*	-0.17NS
Obese grade I	25.03±4.47	40.39±3.26	17.72±4.03	26.56±3.93	6.74±1.31	10.89±1.24	52.77±4.60	39.02±3.77
'r' value	0.99**	0.93**	0.92**	0.74**	0.95**	0.76**	-0.42**	-0.15NS
Obese grade II	28.47±2.92	45.77±3.90	23.64±3.67	35.13±5.39	8.78±1.15	14.70±1.75	59.11±4.19	41.42±4.95
'r' value	0.99**	0.95**	0.81*	0.65**	0.57NS	0.68**	-0.15NS	-0.36NS
60+								
Normal	26.22±1.89	42.27±5.04	16.39±1.84	22.18±4.68	5.99±6.76	9.24±1.71	46.04±3.62	29.68±2.62
'r' value	0.94**	0.99**	0.94**	0.94**	0.56NS	0.94**	-0.35NS	-0.25NS
Obese grade I	31.49±3.88	44.54±3.96	23.33±4.00	29.22±6.54	8.81±1.42	12.02±1.60	50.38±2.70	35.78±3.57
'r' value	0.99**	0.98**	0.95**	0.93**	0.93**	0.88**	-0.33NS	0.53NS
Obese grade II	29.07±0.63	49.09	24.59±1.84	36.82	9.02±0.13	14.94	59.90±2.66	38.18
'r' value	-	-	-	-	-	-	-	-

Note: values are mean±SD   'r'values were calculated between waist circumference and body fat components
* and ** indicate significance of values at P=0.01 and P=0.05, respectively.   NS= non-significant

men and women is also well documented by Novak (1972) and Roubenoff and Kehayias(1991).The decrease is attributed to the loss of muscle, bone, viscera and skin. The loss of these tissues is accompanied by reduction of body water, minerals and protein. The rate and degree of loss of FFM has been found to vary considerably with gender, decade, level of activity, hormonal correlates and from one individual to another.

A high correlation of body mass index with body fat components was observed. Our results are also in line with Keys *et al.* (1972) who have suggested when using a weight height index to assess body fat, the index should have high correlation with per cent body fat.

Females registered higher values for per cent body fat, fat mass (kg) and fat mass index except for fat free mass (kg). One might invent a hormonal explanation for this trend (Garn *et al.,* 1975).Testosterone maintains prior fat cell size but estrogens reverse the dimensions.

Conclusion:

There was increase in the percentage of subjects belonging to obese grade I and obese grade II category from 19 to 60 years after which there was a decline. In all the age groups, a clear gender demarcation was evident, a higher percentage of female subjects leaning towards abdominal obesity compared to their gender counterparts. There was a significant positive correlation with body mass index and all other body fat components in all the age groups except for per cent body fat in female obese grade II subjects of 41-60 years and male subjects of 41-60 years. A significant positive correlation of waist circumference with all the body fat components was evident except for fat free mass in all the age groups.

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REFERENCES

Bose, B. (1999). Body fat composition and its relationship with subcutaneous adiposity in adult Caucasian and migrant Pakistani men residents in Peterborough, England. *J. Human Ecology,* **10**:47-51.

Deurenberg, P., Westrate, J.A. and Seidell, J.C. (1991). Body mass index as a measure of body fatness: age and sex specific prediction formulas. *British J. Nutrition,* **65**(2):105-114

Garn, M.S., Clark, D.C. and Guire, K.E. (1975). Growth, body composition and development of obese and lean children. In: *Childhood obesity*, (Ed.) Winick M., John Wiley and Sons, Inc., Canada, pp.23-46.

Garrow, G.H. (1987). Quetelets index as measure of fatness. *Internat. J. Obesity*, **9**:147-153

Jelliffe, D.B. (1966). The assessment of nutritional status of community, WHO monograph series No.53, WHO Geneva, pp. 50-78.

Keys, A., Fidanza, F., Karvonen, M.J., Kimura, N. and Taylor, H.L. (1972). Indices of relative weight and obesity. *J. Chronic Diseases,* **25**:329-343.

Lean, M. E. J., Han, T.S. and Deurenberg, P. (1996). Predicting body composition by densitometry from simple anthropometric measurements. *American J. Clinical Nutrition,* **63**:4-14.

Lean, M.E.J., Han, T.S. and Morrison, C.E. (1995). Waist circumference as a measure for indicating need for weight management. *British Medical J.*, **11**:638-642

Novak, L.P. (1972). Aging, total body potassium fat free mass and cell mass in males and females between ages 18 and 85 years. *J. Gerontology*, **27**:438-445.

Roubenoff, R. and Kehayias, J.J. (1991). The meaning and measurement of lean body mass. *Nutrition Reviews*, **49**:163-174.

Vanlatallie, F.B. , Yang, M.U., Heymsfiled, S.B., Funk, R. C. and Boileau, R.A. (1990). Height normalized indices of the body's fat free mass and fat mass: potentially useful indicators of nutritional status. *American J. Clinical Nutrition,* **52**: 953-959.

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