

ASSOCIATION OF PHYSICAL ATTRIBUTES WITH BODY MASS INDEX: A STUDY IN RURAL ODISHA

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Abstract

The present study was undertaken in Dharmasala block of Jajpur District of Odisha to assess the degree of association of physical attributes like age, height, weight, mid arm circumference, chest circumference, waist circumference, thigh circumference, waist-hip ratio (W/H) with Body Mass Index (BMI). The sample size was 120 out of which 60 boys and 60 girls were selected purposively. The respondents were teenagers between 13 to 18 years. They were grouped into early teenagers (13-15 years) and late teenagers (16-18 years).

It was observed that BMI showed significant positive correlation with chest, weight hip, mid-arm, thigh, waist in that order in both the age group of boys & girls and there was also significant *Inter Se* correlation among bodily factors namely mid arm, chest, waist, hip and thigh. It was revealed through path analysis that body weight had the highest direct positive effect (1.159) on BMI in both boys and girls group. Mid arm, chest, waist, hip and thigh attribution had indirect contribution towards BMI via body weight. The residual effect (0.103) indicated that the most of the important attributes included had major contribution for BMI.

Key Words: Obesity, Residual Effect, Body Mass Index, Physical Attributes, Path Analysis

1. Introduction:

Obesity is a disorder of energy metabolism involving excessive adipose tissue stores which is associated with medical or psychosocial morbidity. The prevalence as well as the severity of obesity in adolescents, who represent about one quarter of India's population is increasing at an alarming rate making it one of the most serious health problems affecting this age group. The World Health Organization (WHO) estimates that 1.9 million deaths worldwide are attributed to physical inactivity and at least 2.6 million deaths are a result of being overweight or obese. Research result revealed that 50-80% of obese children will continue as obese adults with health risks such as hypertension, type 2 diabetes, cardiovascular diseases, arthritis and behavioral problem etc. Adult obesity was as high as 35 per cent in Egypt while in USA obesity among

children and young adult was 13 per cent. On the other hand the obesity among children was found to be 15.3 million in china followed by India (14.4 million). These obese children will become obese adolescents and adults in their latter part of life, thus concerning health hazard in the country.

. Prevalence of obesity among teenagers is a major problem in developed and developing countries. It is a product of energy imbalance (imbalance between energy intake and energy output) in the body. Body mass Index (BMI) is a measure of weight in relation to height (kg/m^2) indicating an approximation of total body fat. Also body fat can be measured by waist circumference.

Basing on the BMI value the National Institute of Health classified persons into under-weight (≤ 19 for women and <20 for men), normal (20to24), over-weight (25to 29), obese (30to 39), and extremely obese (≥ 40). Besides BMI, waist measurement is also an indicator of obesity. The WHO states that abdominal obesity as measured by Waist Hip Ratio (W/H) is above 0.90 for males and above 0.85 for females.

Keeping above facts in view, the present study was undertaken in Dharmasala block of Jajpur District to study the magnitude of obesity among teenagers of both boys and girls, assess the degree of association among physical attributes such as age, height, weight, mid-arm, chest, waist, hip, thigh, waist hip ratio and BMI, and measure the direct and indirect effects of physical attributes leading to obesity.

2. Materials and methods:

Primary data was collected through a pre-tested and validated questionnaire distributed to 120 teenagers belonging to the age group of 13 to 18 years by applying random sampling technique. The teenagers were grouped into early teenagers (13 to 15 years) and late teenagers (16 to 18 years). 60 samples comprising of 30 boys and 30 girls from each teenage category were taken for the study. The investigation was undertaken in Dharmasala block of Jajpur district of Odisha .

Information on age, height, weight, thigh, mid arm, chest, waist, hip, waist-hip ratio (W/H) was collected from teenagers of both boys and girls. Weighing machine was used to record the weight in kg of the respondents without footwear. Height, mid arm, chest, waist, hip, thigh, were measured in cm using measuring tape. BMI was calculated using the formula $\text{weight}/\text{height}^2$ (kg/m^2). Waist hip ratio was calculated from the collected data. The data was analyzed and estimated correlation coefficient values were tested against table values (Fisher & Yates, 1967). In the present investigation, BMI was taken as the “effect” with other attributes like height, weight, mid arm, chest, waist, hip, thigh and waist/hip ratio related to obesity as causal factors. The path coefficients were estimated indicating the basic relationship between correlations and path coefficients in a system of correlated causes (Wright 1921, Dewey & Lu, 1959).

3. Results and Discussions:

The mean values of 10 attributes of two groups of teenagers of both boys and girls presented in

Table 1, indicates that the mean values for boys were found to be higher than that of girls in respect of all the attributes studied except age and hip.. Average value of BMI inferred that all the boys and girls are considered to have normal health. However, irrespective of age group boys are considered under abdominal obese having waist/hip ratio >0.85 .

Estimation of correlation coefficient among 10 attributes with respect to different groups of teenagers for both boys and girls provides useful information on obesity (Table 2a-d). BMI showed significant positive correlation with chest, weight, hip, mid-arm, thigh, waist in that order in both the age group of boys and girls.

Table 1. Mean Value of Attributes of Respondents

SL. No	Attributes	BOYS			GIRLS			Pooled over BOYs & Girls
		LAG	HAG	Pooled Over	LAG	HAG	Pooled Over	
1	Age	14.03	16.50	15.27	14.13	16.53	15.33	15.30
2	Height (in cm)	155.23	169.83	162.53	148.40	155.97	152.18	157.36
3	Weight (in Kg)	41.13	60.10	50.62	36.10	51.03	43.57	47.09
4	Midarm(incm)	28.37	33.63	31.00	27.20	31.00	29.10	30.05
5	Chest(in cm)	75.73	87.97	81.85	75.10	86.17	80.63	81.24
6	Waist(in cm)	71.47	84.67	78.07	67.97	78.37	73.17	75.62
7	Hip(in cm)	81.17	93.90	87.53	83.17	96.77	89.97	88.75
8	Thigh(in cm)	48.30	59.20	53.75	46.03	56.27	51.15	52.45
9	Waist/Hip	0.88	0.90	0.89	0.82	0.81	0.81	0.85
10	BMI	16.76	20.87	18.82	16.35	20.95	18.65	18.73

Also it is observed that bodyweight of the respondents of all groups of boys and girls showed significant positive correlation with mid arm, chest, hip and thigh. *Inter Se* correlation among mid arm, chest, waist, hip and thigh were found to be significantly positive. In Lower Age Group of Boys Table 2(a), Lower Age Group of Girls & Higher Age Group of Girls Table 2(b) and in pooled over age group of girls and pooled over age group of boys Table 2(c), BMI showed positive correlation with height, but in case of Higher Age Group of Boys Table 2(a) showed negative correlation with height. It was also revealed that BMI showed positive correlation with age of all groups of respondents except higher age boys (HAGB) and higher age girls (HAGG).

**Table 2. Correlation Coefficient among 10 factors studied for different groups of Boys & Girls
(a) Lower(above diagonal) and Higher(below diagonal) age group of Boys**

LAGB \ HAGB	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	BMI
Age	*****	0.587**	0.599**	0.718**	0.482**	0.459*	0.542**	0.571**	-0.042	0.504**
Height	0.090	*****	0.865**	0.760**	0.715**	0.654**	0.795**	0.685**	-0.108	0.596*
Weight	*-0.401	0.179	*****	0.927**	0.936**	0.869**	0.976**	0.914**	-0.011	0.914**
Mid arm	**-.589	-0.065	0.897**	*****	0.895**	0.839**	0.890**	0.880**	0.083	0.894**
Chest	*-0.42	0.058	0.937**	0.912**	*****	0.923**	0.925**	0.926**	0.186	0.947**
Waist	-0.355	0.082	0.903**	0.813**	0.872**	*****	0.870**	0.869**	0.441*	0.887**
Hip	**-.523	-0.021	0.925**	0.908**	0.897**	0.883**	*****	0.932**	-0.057	0.930**
Thigh	**-.512	-0.167	0.837**	0.830**	0.741**	0.777**	0.876**	*****	0.058	0.920**
W/H	0.074	0.202	0.444*	0.292	0.427*	0.704**	0.291	0.268	*****	0.099
BMI	*-0.438	-0.265	0.900**	0.912**	0.894**	0.848**	0.910**	0.890**	0.353	*****

(b) Lower (above diagonal) and Higher (below diagonal) age group of Girls

LAGG \ HAGG	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	BMI
Age	*****	0.385*	0.005	-0.073	0.227	0.082	0.042	0.051	0.082	-0.195
Height	0.302	*****	0.624**	0.431*	0.457*	0.390*	0.522**	0.394*	-0.024	0.232
Weight	-0.207	0.374*	*****	0.839**	0.878**	0.725**	0.921**	0.820**	0.006	0.904**
Mid arm	-0.113	0.087	0.823**	*****	0.739**	0.693**	0.811**	0.867**	0.093	0.806**
Chest	-0.149	0.171	0.929**	0.835**	*****	0.631**	0.887**	0.815**	-0.094	0.849**
Waist	-0.119	0.073	0.806**	0.761**	0.927**	*****	0.766**	0.672**	0.619**	0.690**
Hip	-0.141	0.389*	0.957**	0.779**	0.884**	0.769**	*****	0.886**	-0.028	0.864**
Thigh	-0.023	0.245	0.844**	0.681**	0.806**	0.720**	0.864**	*****	-0.034	0.808**
W/H	-0.026	-0.303	0.258	0.380*	0.522**	0.752**	0.160	0.239	*****	0.017
BMI	-0.338	0.034	0.938**	0.856**	0.935**	0.833**	0.889**	0.813**	0.375*	*****

(c) Pooled over age group of Girls (above diagonal) and Boys (below diagonal)

GIRLS BOYS	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	BMI
Age	****	0.655**	0.539**	0.479**	0.521**	0.477**	0.607**	0.642**	-0.056	0.410**
Height	0.717**	****	0.661**	0.505**	0.531**	0.463**	0.677**	0.608**	-0.199	0.415**
Weight	0.638**	0.791**	*****	0.885**	0.944**	0.859**	0.965**	0.908**	0.082	0.954**
Mid arm	0.520**	0.644**	0.935**	****	0.873**	0.826**	0.870**	0.847**	0.171	0.887**
Chest	0.537**	0.680**	0.956**	0.934**	*****	0.898**	0.920**	0.876**	0.214	0.943**
Waist	0.562**	0.663**	0.930**	0.884**	0.935**	*****	0.847**	0.809**	0.534**	0.864**
Hip	0.584**	0.731**	0.973**	0.926**	0.943**	0.921**	****	0.941**	0.005	0.911**
Thigh	0.622**	0.659**	0.935**	0.899**	0.898**	0.897**	0.944**	*****	0.034	0.869**
W/H	0.182	0.131	0.272*	0.262*	0.352**	0.558**	0.194	0.252	*****	0.173
BMI	0.474**	0.506**	0.922**	0.932**	0.939**	0.905**	0.930**	0.920**	0.297*	*****

(d) Pooled over Age group & Sex

Total B&G	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	BMI
Age	***									
Height	0.573**	***								
Weight	0.564**	0.755**	***							
Mid arm	0.477**	0.625**	0.920**	***						
Chest	0.526**	0.564**	0.929**	0.891**	***					
Waist	0.501**	0.613**	0.907**	0.865**	0.905**	***				
Hip	0.593**	0.535**	0.889**	0.833**	0.916**	0.825**	***			
Thigh	0.617**	0.623**	0.922**	0.876**	0.884**	0.863**	0.899**	***		
W/H	0.034	0.311**	0.306**	0.311**	0.261**	0.563**	0.001	0.221*	***	
BMI	0.441**	0.405**	0.900**	0.875**	0.938**	0.862**	0.909**	0.884**	0.197*	***

*and** significant at 5% and 1% level, respectively.

The estimates of direct & indirect effects of attributes age wise & sex wise on BMI as presented in (Table 3 a –g) reveals that body weight had major positive direct effect on BMI in case of both boys and girls in all groups irrespective of sex and age and also had major positive indirect effect via mid arm, chest, waist, hip, and thigh. On the contrary height had negative direct effect on BMI.

Table 3 Path Analysis Indicating direct (diagonal) and indirect effects of attributes on BMI for different age group of Boys & Girls.

(a) Lower Age Group of Boys

Effects of Attributes	Effect via Attributes									
	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	Cor BMI
Age	<u>0.032</u>	-0.411	0.666	0.060	0.109	0.194	-0.097	-0.068	0.019	0.504**
Height	0.019	<u>-0.701</u>	0.961	0.063	0.161	0.277	-0.142	-0.081	0.038	0.596*
Weight	0.019	-0.606	<u>1.111</u>	0.077	0.211	0.368	-0.174	-0.108	0.016	0.914**
Mid arm	0.023	-0.532	1.030	<u>0.083</u>	0.202	0.355	-0.159	-0.104	-0.004	0.894**
Chest	0.015	-0.501	1.040	0.074	<u>0.225</u>	0.391	-0.165	-0.109	-0.024	0.947**
Waist	0.015	-0.458	0.966	0.070	0.208	<u>0.423</u>	-0.155	-0.103	-0.078	0.887**
Hip	0.017	-0.557	1.085	0.074	0.208	0.368	<u>-0.178</u>	-0.110	0.023	0.930**
Thigh	0.018	-0.480	1.016	0.073	0.208	0.368	-0.166	<u>-0.118</u>	0.001	0.920**
W/H	-0.003	0.131	-0.087	0.001	0.026	0.162	0.020	0.000	<u>-0.205</u>	0.099

P(R)=.082

R SQR (%)= 99.33

(b) Higher Age Group of Boys

Effects of Attributes	Effect via Attributes									
	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	Cor BMI
Age	<u>-0.014</u>	-0.040	-0.413	-0.027	0.008	0.139	-0.116	0.012	0.014	*-0.438
Height	-0.001	<u>-0.449</u>	0.185	-0.003	-0.001	-0.032	-0.005	0.004	0.038	-0.265
Weight	0.005	-0.080	<u>1.031</u>	0.041	-0.017	-0.354	0.205	-0.019	0.088	0.900**
Mid arm	0.008	0.029	0.925	<u>0.045</u>	-0.016	-0.319	0.202	-0.019	0.057	0.912**
Chest	0.006	-0.026	0.966	0.041	<u>-0.018</u>	-0.342	0.199	-0.017	0.085	0.894**
Waist	0.005	-0.037	0.931	0.037	-0.016	<u>-0.392</u>	0.196	-0.018	0.141	0.848**
Hip	0.007	0.009	0.954	0.041	-0.016	-0.346	<u>0.222</u>	-0.02	0.059	0.910**

Thigh	0.007	0.075	0.863	0.038	-0.013	-0.305	0.195	-0.023	0.054	0.890**
W/H	-0.001	-0.086	0.458	0.013	-0.008	-0.278	0.066	-0.006	0.199	0.353

P(R)=.039

R SQR (%)= 99.85

(c)Lower Age Group of Girls

Effect of Attributes	Effect via Attributes									
	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	Cor BMI
Age	-0.003	-0.207	0.006	0.001	0.006	-0.001	0.000	0.001	0.001	-0.195
Height	-0.001	-0.537	0.76	-0.007	0.012	-0.004	0.005	0.005	0.000	0.232
Weight	0.000	-0.335	1.217	-0.014	0.023	-0.008	0.009	0.010	0.000	0.904**
Mid arm	0.000	-0.231	1.021	-0.016	0.020	-0.008	0.008	0.011	0.001	0.806**
Chest	-0.001	-0.245	1.069	-0.012	0.026	-0.007	0.009	0.010	-0.001	0.849**
Waist	0.000	-0.209	0.883	-0.011	0.017	-0.011	0.008	0.009	0.006	0.690**
Hip	0.000	-0.280	1.121	-0.013	0.023	-0.008	0.010	0.011	0.000	0.864**
Thigh	0.000	-0.211	0.998	-0.014	0.022	-0.007	0.009	0.013	0.000	0.808**
W/H	0.000	0.005	0.019	-0.001	-0.002	-0.007	0.000	0.000	0.010	0.017

P(R) = 0.055

R SQR (%) = 99.70

(d)Higher Age Group of Girls

Effect of Attributes	Effect via Attributes									
	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	Cor BMI
Age	-0.005	-0.111	-0.210	-0.001	-0.008	-0.007	0.002	0.000	0.002	-0.338
Height	-0.001	-0.369	0.380	0.001	0.009	0.004	-0.007	-0.004	0.021	0.034
Weight	0.001	-0.138	1.016	0.010	0.048	0.047	-0.016	-0.013	-0.017	0.938**
Mid arm	0.001	-0.032	0.836	0.013	0.043	0.045	-0.013	-0.011	-0.025	0.856**
Chest	0.001	-0.063	0.944	0.011	0.052	0.055	-0.015	-0.013	-0.036	0.935**
Waist	0.001	-0.027	0.819	0.010	0.048	0.059	-0.013	-0.011	-0.052	0.833**
Hip	0.001	-0.144	0.972	0.010	0.046	0.045	-0.017	-0.013	-0.011	0.889**
Thigh	0.000	-0.090	0.857	0.009	0.042	0.042	-0.014	-0.016	-0.017	0.813**
W/H	0.000	0.111	0.257	0.005	0.027	0.044	-0.003	-0.004	-0.069	0.375*

P(R)=0.054

R SQR (%)= 99.71

(e) Pooled over Age Group of Girls

Effect of Attributes	Effect via Attributes									
	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	Cor BMI
Age	<u>0.005</u>	-0.246	0.573	0.024	0.030	0.008	0.022	-0.007	0.001	0.410**
Height	0.004	<u>-0.376</u>	0.702	0.025	0.031	0.008	0.024	-0.007	0.003	0.415**
Weight	0.003	-0.248	<u>1.062</u>	0.044	0.055	0.015	0.034	-0.010	-0.001	0.954**
Mid arm	0.003	-0.190	0.940	<u>0.050</u>	0.051	0.014	0.031	-0.009	-0.003	0.887*
Chest	0.003	-0.200	1.003	0.044	<u>0.058</u>	0.015	0.033	-0.009	-0.004	0.943**
Waist	0.003	-0.174	0.913	0.041	0.052	<u>0.017</u>	0.030	-0.009	-0.009	0.864**
Hip	0.003	-0.254	1.025	0.043	0.054	0.014	<u>0.036</u>	-0.010	0.000	0.911**
Thigh	0.003	-0.228	0.965	0.042	0.051	0.014	0.034	<u>-0.011</u>	-0.001	0.869**
W/H	0.000	0.073	0.084	0.008	0.012	0.009	0.000	0.000	<u>-0.017</u>	0.173

P(R)= 0.078 R SQR (%) = 99.39

(f) Pooled over Age Group of Boys

Effect of Attributes	Effect via Attributes									
	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	Cor BMI
Age	<u>0.039</u>	-0.386	0.568	0.046	0.092	0.032	0.054	0.034	-0.005	0.474**
Height	0.028	<u>-0.538</u>	0.704	0.057	0.116	0.037	0.068	0.036	-0.003	0.506**
Weight	0.025	-0.426	<u>0.891</u>	0.082	0.164	0.052	0.090	0.052	-0.008	0.922**
Mid arm	0.020	-0.347	0.833	<u>0.088</u>	0.160	0.050	0.086	0.050	-0.008	0.932**
Chest	0.021	-0.366	0.851	0.082	<u>0.171</u>	0.053	0.087	0.049	-0.010	0.939**
Waist	0.022	-0.357	0.828	0.078	0.160	<u>0.056</u>	0.085	0.049	-0.017	0.905**
Hip	0.023	-0.394	0.867	0.081	0.162	0.052	<u>0.093</u>	0.052	-0.006	0.930**
Thigh	0.024	-0.355	0.833	0.079	0.154	0.051	0.087	<u>0.055</u>	-0.007	0.920**
W/H	0.006	-0.046	0.215	0.020	0.054	0.030	0.016	0.012	<u>-0.033</u>	0.297*

P(R)=0.105 R SQR (%)= 98.91

(g) Pooled over Age Group & Sex

Effects of Attributes	Effect via Attributes									
	Age	Height	Weight	Mid arm	Chest	Waist	Hip	Thigh	W/H	Cor

										BMI
Age	0.016	-0.334	0.654	0.011	0.060	-0.124	0.158	-0.003	0.003	0.441**
Height	0.009	-0.583	0.875	0.015	0.065	-0.151	0.142	-0.003	0.036	0.405**
Weight	0.009	-0.440	1.159	0.021	0.107	-0.224	0.236	-0.004	0.036	0.900**
Mid arm	0.008	-0.364	1.066	0.023	0.102	-0.213	0.221	-0.004	0.036	0.875**
Chest	0.008	-0.329	1.077	0.021	0.115	-0.223	0.243	-0.004	0.030	0.938**
Waist	0.008	-0.357	1.051	0.020	0.104	-0.247	0.213	-0.004	0.068	0.862**
Hip	0.009	-0.312	1.030	0.019	0.105	-0.203	0.266	-0.004	-0.001	0.909**
Thigh	0.010	-0.363	1.068	0.020	0.102	-0.213	0.239	-0.005	0.026	0.884**
W/H	0.000	-0.173	0.340	0.007	0.028	-0.136	-0.003	-0.001	0.123	0.197*

P(R)=0.103

RSQR(%)= 98.95

Conclusion:

It is concluded that on the basis of BMI value all the teenagers were found to have normal health. On the basis of waist/hip ratio in comparison to girls, boys were considered to have abdominal obese due to comparatively lower age of boys than girls among the sample respondents. Teenagers of both sex BMI showed significant positive correlation with chest, bodyweight, hip, mid arm, thigh, and waist where as height exhibit negative direct correlation with BMI, thus suggesting their importance (bodily factors) in managing obesity. Body weight of teenagers showed significant positive correlation with mid arm, chest, hip and thigh. The estimates of direct & indirect effects of attributes on BMI reveals that body weight had major positive direct effect on BMI and also major positive indirect effect via mid arm, chest, waist, hip, and thigh in teenagers irrespective of sex and age. On the contrary height had major negative direct effect on BMI, thus suggesting the importance of weight and height of teenagers leading to determining the degree of obesity.

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