



Estimation of Nutritional Status by Body Indices in School-going Children of Bathinda, Punjab

Shyamal Koley and Itinder Kaur Mann

*Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University,
Amritsar 143005, Punjab, India*

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ABSTRACT The present study deals with the estimation of the nutritional status using four body indices—Quetelet's Index, Oliver's Typologic Index, Lorenz's Constitutional Index and Muscle Index in randomly selected 300 school-going children (150 boys and 150 girls) of Bathinda, Punjab, aged between 11 to 15 years. A total of fourteen anthropometric characteristics, namely, height, weight, BMI, Quetelet's Index, ideal body weight, relative body weight, circumference of the upper arm during an isometric contraction, as well as in relaxed position of biceps brachii, Muscle Index, circumference of thorax, circumference of abdomen, Lorenz's Constitutional Index, shoulder width and Olivier's Typologic Index were measured for the subjects. The findings of the present study indicated that the school-going children of the above mentioned age groups (from 11 to 15 years) of Bathinda, Punjab, were under-nutritional as assessed by these body indices.

INTRODUCTION

Nutritional status is the current body status of a person or a population group, related to their status of nourishment. The nutritional status is determined by a complex interaction between internal and constitutional factors (like age, sex, nutrition, behavior, physical activity and diseases) and external environmental factors (like, food safety, cultural, social and economic circumstances) (WHO 1990). The nutritional status is a powerful indicator of health and well-being. It is a major, modifiable and powerful element in promoting health, preventing and treating diseases and improving the health and quality of life.

Nutritional status is assessed by two methods: direct and indirect. The direct methods deal with the individual and measure objective criteria, while indirect methods use community nutritional status. Direct methods of assessing the nutritional status include anthropometric, clinical, dietary evaluation and biochemical (WHO 1990).

There are a number of measures to assess the nutritional status of a person or a population. BMI is widely used for this purpose (Adak et al. 2006; Khongsdier 2001; Ferro-Luzzi et al. 1991). Handgrip strength is also used as a nutritional indicator (Kaur and Koley 2010). Various body indices were also used to assess the nutritional status of the populations (Celan and Turk 2005). The objectives of the present study was

to use some body indices, like Quetelet's Index, Oliver's Typologic Index, Lorenz's Constitutional Index and Muscle Index for the assessment of nutritional status of school-going children of Bathinda, Punjab, aged between 11 to 15 years.

MATERIAL AND METHODS

The present study was based on randomly selected 300 unrelated, normal, healthy school-going children (150 boys and 150 girls) aged between 11 to 15 years of M.H.R. Public School and Rose Mary Convent School, Bathinda, Punjab, India. The age of the subjects were according to the records in their respective schools. The subjects were divided in such a way that those of age 11 years, for instance, refers to the children aged 10 years and 6 months through 11 years and 5 months and 29 days. Numerous physical and physiological changes occur in the early adolescent period of a person. Good nutritional status is essential for the proper growth and development of adolescents. That's why the age group 11-15 years was considered in the present study. A written consent was obtained from the subjects. The data was collected under natural environmental conditions in the morning, between 8am and 12 noon. The local ethics committee approved the study.

Anthropometric Measurements

Fourteen anthropometric characteristics, as follows were considered in the study:

1. Height,
2. Weight,
3. BMI,
4. Quetelet's Index (QI),
5. Ideal body weight (IBW),
6. Relative body weight (RBW),
7. Circumference of the upper arm during an isometric contraction of biceps brachii (CCB),
8. Circumference of the upper arm in relaxed position of muscle biceps brachii (CRB),
9. Muscle Index (MI),
10. Circumference of thorax (CT),
11. Circumference of abdomen (CA),
12. Lorenz's Constitutional Index (LCI),
13. Shoulder width, and
14. Olivier's Typologic Index (OTI).

All the anthropometric variables of the subjects were measured using the standard techniques (Lohmann et al. 1988) and were measured in triplicate with the median value used as the criterion.

The height was recorded using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm, and weight was measured using the digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. BMI was then calculated using the formula:

$$\text{Weight (kg)} / \text{Height}^2 (\text{m})^2$$

The following body indices were calculated after Celan and Turk (2005):

Quetelet's Index (Devenport-Kaup's Adaptation)

Quetelet's Index (QI) represented a measure of nutritional status. It was calculated using the formula:

$$\text{QI} = \text{BW} / \text{BH}^2$$

Where, BW stands for body weight (g) and BH for body height (cm). Children with normal nutritional status had QI values between 2.15 – 2.56.

Relative Body Weight

Relative body weight (RBW) was another possibility to describe a nutritional status using the following formula:

$$\text{RBW} = (\text{ABW} / \text{IBW}) \times 100$$

Where, ABW stands for measured body weight (kg) and IBW for ideal body weight, the formula for which is:

$$\text{IBW} = (\text{BH} - 100) - \{(\text{BH} - 150) / 4\} + \{(\text{AY} - 20) / 4\}$$

Where, AY stands for age (years) and BH for body height (cm). The values between 90-110 represent a normal nutritional status.

Muscle Index

Muscle Index (MI) was an orientation method for one's muscle development. It was calculated using the formula:

$$\text{MI} = \{(\text{CCB} - \text{CRB}) / \text{CRB}\} \times 100$$

Where, CCB stands for circumference of the upper arm during an isometric contraction of muscle biceps brachii at a 90° elbow flexion (cm) and CRB circumference of the upper arm in relaxed position of muscle biceps brachii at 90° elbow flexion (cm). Values between 5 and 12 were considered normal, values under 5 represented obese subjects with weak muscles and values over 12 represented children with strong muscles.

Lorenz's Constitutional Index

Lorenz's Constitutional Index (LCI) gave information about the body's components with a following formula:

$$\text{LCI} = \text{CT} - \text{CA} - 14$$

Where, CT stands for circumference of thorax (cm) and CA for circumference of abdomen (cm). If a calculated value was positive, then an increase in a body mass went on the account of muscles and bone. On contrary, if it was a negative then the adipose tissue was responsible for an increased body mass.

Olivier's Typologic Index

Olivier's Typologic Index (OTI) represented a quick orientation measure about body constitution. It was calculated as below:

$$\text{OTI} = (\text{SW} / \text{BW}) \times 100$$

Where, SW stood for shoulder width (cm) and BW for body weight (kg). Values over 67 suggested an asthenic constitution, values from 58 to 67 indicated muscular constitution and values under 58, were a picnic constitution.

Statistical Analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. A student's t-test was used for the comparison of various anthropometric variables between boys and girls.

Data was analyzed using the SPSS (Statistical Package for Social Science) version 14.0. A five percent level of probability was used to indicate a statistical significance.

RESULTS AND DISCUSSION

The descriptive statistics of 14 anthropometric variables in school-going children of Bathinda aged 11 years is shown in Table 1. Girls were reported to be taller and heavier than boys, with significant differences ($p < 0.01 - 0.001$) in height, weight, ideal body weight, circumference of thorax, circumference of abdomen and Olivier's Typologic Index.

Tables 2 and 3 showed the descriptive statistics of 14 anthropometric variables in school-going children of Bathinda aged 12 and 13 years. Boys were found to have significantly higher muscle mass ($p < 0.005 - 0.001$) than girls. No significant differences were noted in any case for rest of the variables between the boys and girls of these age groups.

The descriptive statistics of 14 anthropometric variables in school-going children of Bathinda aged 14 and 15 years are shown in Tables 4 and 5. Statistically significant differences ($p < 0.026 - 0.001$) were reported only in height, ideal body weight, muscle mass and shoulder width between the two sexes.

Table 1: Descriptive statistics of 14 anthropometric variables in school going children of age 11 years

Variables	Boys		Girls		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Height (cm)	142.56	5.95	148.42	6.80	3.53	0.001
Weight (kg)	31.72	7.10	36.84	9.01	2.43	0.018
BMI (kg/m ²)	15.48	2.51	16.63	3.44	1.46	NS
Quetelet's Index	1.55	0.25	1.66	0.34	1.46	NS
Ideal body weight(kg)	42.19	4.46	46.56	5.10	3.53	0.001
Relative body weight(kg)	74.80	8.33	78.92	9.85	1.15	NS
CCB(cm)	20.15	2.93	21.32	2.62	1.63	NS
CRB(cm)	18.71	2.68	19.87	2.63	1.70	NS
Muscle Index	7.76	3.61	7.49	3.18	0.32	NS
CT(cm)	69.60	5.33	74.23	9.37	2.15	0.036
CA(cm)	68.14	5.96	72.40	8.60	2.22	0.031
LCI	-12.53	3.97	-12.18	8.50	0.21	NS
Shoulder width(cm)	33.72	2.82	33.97	2.54	0.35	NS
OTI	109.41	9.90	95.98	9.23	3.13	0.003

CCB = Circumference of the upper arm during an isometric contraction of biceps brachii; CRB = Circumference of the upper arm in relaxed position of muscle biceps brachii; CT = Circumference of thorax; CA = Circumference of abdomen; LCI = Lorenz's Constitutional Index; OTI = Olivier's Typologic Index

Table 2: Descriptive statistics of 14 anthropometric variables in school going children of age 12 years

Variables	Boys		Girls		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Height (cm)	150.48	8.385	150.74	7.27	0.130	NS
Weight (kg)	39.03	9.81	39.39	7.36	0.161	NS
BMI (kg/m ²)	17.04	2.89	17.30	2.81	0.36	NS
Quetelet's Index	1.70	0.29	1.73	0.28	0.35	NS
Ideal body weight(kg)	48.36	6.28	48.56	5.45	0.13	NS
Relative body weight(kg)	80.09	9.90	81.27	9.17	0.36	NS
CCB(cm)	21.66	2.98	21.87	2.78	0.29	NS
CRB(cm)	19.73	2.74	20.43	2.65	1.04	NS
Muscle Index	9.87	2.66	7.07	2.31	4.43	0.001
CT(cm)	74.05	7.40	75.53	8.23	0.75	NS
CA(cm)	72.00	7.03	72.42	8.28	0.21	NS
LCI	-11.95	4.40	-10.89	4.96	0.89	NS
Shoulder width(cm)	35.69	3.52	34.39	2.83	1.61	NS
OTI	94.73	9.34	89.23	9.08	1.57	NS

Table 3: Descriptive statistics of 14 anthropometric variables in school going children of age 13 years

Variables	Boys		Girls		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Height (cm)	157.74	9.27	154.64	5.15	1.50	NS
Weight (kg)	43.45	8.94	42.74	7.44	0.30	NS
BMI (kg/m ²)	17.29	3.06	17.83	2.70	0.72	NS
Quetelet's Index	1.73	0.31	1.78	0.27	0.70	NS
Ideal body weight(kg)	54.06	7.70	51.73	3.86	1.50	NS
Relative body weight(kg)	80.08	9.91	82.53	9.40	0.73	NS
CCB(cm)	22.37	3.16	22.39	2.42	0.02	NS
CRB(cm)	20.66	2.72	21.32	2.48	1.00	NS
Muscle Index	8.28	5.48	5.11	2.72	2.89	0.005
CT(cm)	75.84	8.08	76.05	7.89	0.10	NS
CA(cm)	76.14	8.35	76.31	7.10	0.08	NS
LCI	-14.31	3.51	-14.26	4.69	0.05	NS
Shoulder width(cm)	36.90	3.36	35.32	3.04	1.94	NS
OTI	88.53	9.42	84.39	9.30	1.12	NS

Table 4: Descriptive statistics of 14 anthropometric variables in school going children of age 14 years

Variables	Boys		Girls		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Height (cm)	164.64	8.50	156.26	6.72	4.31	0.001
Weight (kg)	49.39	9.14	45.42	9.70	1.66	NS
BMI (kg/m ²)	18.21	3.29	18.57	3.52	0.41	NS
Quetelet's Index	1.82	0.33	1.86	0.35	0.39	NS
Ideal body weight(kg)	59.48	6.37	53.19	5.04	4.31	0.000
Relative body weight(kg)	83.26	9.17	85.44	9.18	0.55	NS
CCB(cm)	24.10	3.23	22.95	2.74	1.50	NS
CRB(cm)	22.05	2.70	21.84	3.02	0.29	NS
Muscle Index	9.20	3.86	5.73	8.34	2.10	0.040
CT(cm)	78.52	6.20	77.82	9.18	0.35	NS
CA(cm)	79.66	7.03	76.68	9.20	1.43	NS
LCI	-15.14	5.78	-12.85	5.12	1.65	NS
Shoulder width(cm)	38.87	2.89	35.84	2.53	4.39	0.001
OTI	80.76	9.61	81.41	9.46	0.20	NS

Table 5: Descriptive statistics of 14 anthropometric variables in school going children of age 15 years

Variables	Boys		Girls		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Height (cm)	164.28	6.77	156.77	5.63	4.78	0.001
Weight (kg)	48.19	9.87	46.45	7.03	0.80	NS
BMI (kg/m ²)	17.80	3.18	18.96	3.18	1.44	NS
Quetelet's Index	1.78	0.32	1.90	0.32	1.46	NS
Ideal body weight(kg)	59.46	5.08	53.83	4.22	4.78	0.001
Relative body weight(kg)	80.95	9.42	86.73	9.74	1.57	NS
CCB(cm)	25.77	3.78	23.90	2.55	2.28	0.026
CRB(cm)	23.56	3.57	22.66	2.51	1.15	NS
Muscle Index	9.60	7.27	5.58	3.12	2.83	0.006
CT(cm)	79.94	7.68	80.31	7.13	0.20	NS
CA(cm)	79.73	4.93	80.87	8.48	0.65	NS
LCI	-13.80	5.05	-14.56	4.20	0.65	NS
Shoulder width(cm)	39.50	2.94	36.87	2.06	4.10	0.001
OTI	84.16	9.86	80.87	9.96	1.14	NS

Tables 6 and 7 showed the annual increments of the 14 anthropometric variables in boys and girls. In boys, the maximum annual increments for almost all the variables were noted to be in the age group of 11 to 12 years, except circumference of the upper arm during an isometric contraction of biceps brachii and circumference of the upper arm in relaxed position of muscle biceps brachii (where the maximum annual increments were found in the age group of 13-14 years) and in Lorenz's Constitutional Index (where the maximum annual increment was noted in the age group of 12-13 years (Table 6). But in girls, no such specific trend was found. The maximum annual increments of height, weight, ideal body weight, circumference of the upper arm in relaxed position of muscle biceps brachii, and Lorenz's Constitutional Index were noted in

the age group of 12-13 years, Quetelet's Index, relative body weight and Muscle Index in the age group of 13-14 years and circumference of the upper arm during an isometric contraction of biceps brachii, circumference of thorax, circumference of abdomen and shoulder width in the age group of 14-15 years.

The scientific methods of assessing nutritional status were put together after World War II, when there was widespread malnutrition across Europe. Since then numerous methods are being used for this purpose. Among the various body indices, BMI is widely used to assess the nutritional status of various populations (Cole 1991; Ferro-Luzzi et al. 1991; Khongsdi et al. 2001; Adak et al. 2006). The findings of the present study indicated an under-nutrition status of the school-going children of Bathinda, Punjab, mea-

Table 6: Annual increments of the selected anthropometric variables in boys

Variables	11-12 years		12-13 years		13-14 years		14-15 years	
	A.I.	GR %	A.I.	GR %	A.I.	GR %	A.I.	GR %
Height (cm)	7.89	5.53	7.26	4.82	6.90	4.37	-0.36	-0.22
Weight (kg)	7.31	23.04	4.42	11.32	5.94	13.67	-1.20	-2.43
BMI (kg/m ²)	1.56	10.08	0.25	1.47	0.92	5.32	-0.41	-2.25
Quetelet's Index	0.15	9.68	0.03	1.76	0.09	5.20	-0.04	-2.20
Ideal body weight(kg)	6.17	14.62	5.70	11.79	5.42	10.02	-0.02	-0.03
Relative body weight(kg)	5.29	7.07	-0.01	-0.01	3.18	3.97	-2.31	-2.77
CCB(cm)	1.51	7.49	0.71	3.28	1.73	7.73	1.67	6.93
CRB(cm)	1.02	5.45	0.93	4.71	1.39	6.73	1.51	6.85
Muscle Index	2.11	27.19	-1.59	-16.11	0.92	11.11	0.40	4.35
CT(cm)	4.45	6.39	1.79	2.42	2.68	3.53	1.42	1.81
CA(cm)	3.86	5.66	4.14	5.75	3.52	4.62	0.07	0.09
LCI	-0.58	-4.63	2.36	19.75	0.83	5.80	-1.34	-8.85
Shoulder width(cm)	1.97	5.84	1.21	3.39	1.97	5.38	0.63	1.62
OTI	-14.68	-13.42	-6.20	-6.54	-7.77	-8.78	3.40	4.21

Table 7: Annual increments of the selected anthropometric variables in girls

Variables	11-12 years		12-13 years		13-14 years		14-15 years	
	A.I.	GR %	A.I.	GR %	A.I.	GR %	A.I.	GR %
Height (cm)	2.32	1.56	3.90	2.59	1.62	1.05	0.51	0.33
Weight (kg)	2.55	6.92	3.35	8.50	2.68	6.27	1.03	2.27
BMI (kg/m ²)	0.67	4.03	0.53	3.06	0.74	4.15	0.39	2.10
Quetelet's Index	0.07	4.22	0.05	2.89	0.08	4.49	0.04	2.15
Ideal body weight(kg)	2.00	4.29	3.17	6.53	1.46	2.82	0.64	1.20
Relative body weight(kg)	2.37	3.00	1.26	1.55	2.91	3.53	1.29	1.51
CCB(cm)	0.55	2.58	0.52	2.38	0.56	2.50	0.95	4.14
CRB(cm)	0.56	2.82	0.89	4.36	0.52	2.44	0.82	3.75
Muscle Index	-0.42	-5.61	-1.96	-2.77	0.62	12.13	-0.15	-2.62
CT(cm)	1.30	1.75	0.52	0.69	1.77	2.33	2.49	3.20
CA(cm)	0.02	0.03	3.89	5.37	0.37	0.48	4.19	5.46
LCI	-1.29	-10.59	3.37	30.94	-1.41	-9.89	1.71	13.31
Shoulder width(cm)	0.42	1.24	0.93	2.70	0.52	1.47	1.03	2.87
OTI	-6.75	-7.03	-4.84	-5.42	-2.98	-3.53	-0.54	-0.66

sured by Quetelet's Index, Oliver's Typologic Index, Lorenz's Constitutional Index and Muscle Index.

Under-nutrition is one of the major health problems, especially in developing countries. So the information relating to the nutritional status of a community is necessary, especially for the school-going children who are the future citizens of the nation, to have a comprehensive idea about its overall developmental process. Literature related to the nutritional status of various Indian populations was reported (Rao and Satyanarayana 1976; Anand et al. 1999; Yadav and Singh 1999; Singh and Mishra 2001; Sankhala et al. 2004; Goyle et al. 2004; Sidhu et al. 2007; Prashant and Chandan 2009). It was reported that the basic causes of under-nutrition and infections in developing countries were poverty, poor hygienic conditions and little access to preventive healthcare (Mitra 1985; WHO 1990). It might be concluded from the present study that selected body indices may successfully be used for the assessment of nutritional status of different populations.

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