

Body Mass Index, Blood Pressure and Haemoglobin in Jat Sikh Children Ranging in Age from 10 to 16 Years

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Abstract

In the present investigation body mass index, blood pressure and haemoglobin have been studied among Jat-Sikh children of Patiala district. The sample consists of 251 boys and 306 girls ranging in age from 10 to 16 years. All the variables have shown a general tendency towards increase with age. The boys are significantly heavier and taller than girls at most of the age levels from 12 to 16 years. The value of BMI is also slightly more in boys in all age groups except at 11 and 15 years and significantly more in boys at 14 years of age. Blood pressure has also been found to be more in boys at all age levels except at 12 and 13 years. The differences reach a level of significance at 16 years in systolic blood pressure and at 11 and 14 years in diastolic blood pressure. The haemoglobin level has been found to be significantly more in boys in all age groups. After 12 years the level of haemoglobin has increased more markedly in boys.

Key Words: Body Mass Index, Blood Pressure, Haemoglobin

Introduction

Body Mass Index (BMI) is a reliable indicator of health and nutritional status of human beings (*Garrow and Webster, 1985; Rookus et al., 1987; Must et al., 1991; Naidu et al., 1991; Cole et al., 1995; Pishdad, 1996 and Yanai, 1997*). Body Mass Index also known as the "Quetlet's Index" expresses the relationship between the two most widely used parameters to monitor linear and ponderal growth, viz., height and weight. BMI does not measure fat directly, but research has shown that BMI correlates to direct measures of body fat, such as by under water weighing and dual energy X-ray absorptiometry (*Mei et al., 2002*).

There are preliminary evidences that hypertensive processes begin in the childhood (*DeSweit et al., 1992*), with numerous studies finding co-relations between blood pressure levels from early to late childhood (*Lauer and Clark, 1989*)

and from childhood to adulthood (*Nelson et al., 1992*). These reports suggest the importance of tracking blood pressure in children to detect the early stages of hypertension.

As association between age, height, weight, body mass index and blood pressure has been studied by various investigators (*Siervogel et al., 1982; Kaas, 1985; Dyer and Elliott, 1989; Lauer and Clark, 1989; Sandin et al., 1990; Stamler, 1991; Roche and Siervogel, 1991; Chen et al., 1995; Rona et al., 1996; Kaufman et al., 1997; Luke et al., 1997; Vijayalakshmi et al., 1997; Steyn et al., 2000; Venkataramana et al., 2001; Mufunda et al., 2006 and Mzayek et al., 2007*).

Haemoglobin concentration is an important diagnostic indicator for the well being of an individual. In prepubertal period no major differences have been reported between the sexes in haemoglobin concentration. It is only

after the onset of menstruation that the differences emerge (Velberg *et al.*, 1976). The total amount of haemoglobin in the body increases more in boys than in girls at puberty (Sjostrand, 1953). Menstruation is the principle cause of iron loss in women (Hallberg *et al.*, 1966; Simon *et al.*, 1981 and Frassinelli *et al.*, 1985). Evaluation of the haemoglobin concentration of women from India, Canada, Central America, China and the United States shows that this situation is wide spread (Cook *et al.*, 1986; Ji *et al.*, 1987 and Looker *et al.*, 1997). Women worldwide are at risk of being in a negative iron balance and by current criteria if their haemoglobin concentration is less than 11.5g/ml they are deemed to be anaemic, whereas in men the cut off point is 13g/100ml (Hoffbrand and Pettit, 1993).

In the present investigation an attempt has been made to study body mass index, blood pressure and haemoglobin levels in Jat Sikh children ranging in age from 10 to 16 years.

Material and Method

The present cross-sectional study has been conducted on 557 Jat Sikh children (251 boys and 306 girls) ranging in age from 10 to 16 years. The decimal age of the subjects has been calculated up to three decimal places (Weiner and Lourie, 1969). The data have been grouped in yearly age groups i.e. 9.500-10.499, 10.500-11.499 and so on. The measurements taken on subjects are weight, height, blood pressure and haemoglobin. The equipment used for taking the various measurements are weighing machine, anthropometer rod, sphygmomanometer, stethoscope and Sahil’s haemometer. The statistical tests

viz., mean, standard deviation, standard error of mean and test of significance ‘t’ have been applied.

Results:

Weight, Height and Body Mass Index

Table 1: Mean and standard deviation of weight, stature and body mass index of Jat Sikh children from 10 to 16 years of age.

Age	N	Weight (Kg)		Stature (Cm)		BMI (Kg/M ²)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Boys							
10	24	31.28	9.61	141.57	9.41	15.37	3.39
11	30	30.21	6.71	141.50	9.78	14.95	1.88
12	34	36.07	5.80	145.35	6.07	17.02	2.26
13	33	41.10	7.50	151.60	10.50	17.81	2.61
14	42	44.15	4.59	155.58	7.14	18.27	1.94
15	48	46.84	7.57	161.08	10.84	17.96	1.92
16	40	53.55	8.71	164.95	10.31	19.69	2.76
Girls							
10	30	28.56	4.59	137.53	7.15	15.04	1.83
11	40	28.68	5.80	138.00	8.56	14.97	2.33
12	39	32.83	5.16	141.96	7.90	16.33	2.51
13	52	37.00	5.85	147.87	7.51	16.89	2.19
14	58	39.86	5.24	152.69	5.64	16.98	1.89
15	49	42.43	4.44	152.54	5.66	18.22	1.60
16	37	47.60	4.78	154.00	5.82	19.37	1.54

Table 1 represents the mean and standard deviation values of weight, height and body mass index of boys and girls ranging in age from 10 to 16 years. A continuous increase in weight has been reported in both boys and girls except at 11 years in case of boys. Boys have been found to possess more weight at all age levels as compared to girls with statistically significant differences from 12 to 16 years of age. Height has also shown a continuous increase in both boys and girls at almost all age levels. Boys have been found to be taller than girls at all age levels with significant differences at 12 and 14 to 16 year of age.

The mean value of body mass index has increased from 15.37 kg/m² at 10 years to 19.69 kg/m² at 16 years in boys and from 15.04 to 19.37 kg/m² in girls, thus making a total gain of 4.32 kg/m² in boys and 4.33 kg/m² in girls

from 10 to 16 years. The maximum gain in BMI has occurred at the same age group in both boys and girls i.e. between 11-12 years, 2.07 kg/m² in boys and 1.36 kg/m² in girls. The values for body mass index has been slightly more in boys in all age groups except 11 and 15 years and significantly more in boys at 14 years of age only.

Blood Pressure

Table 2: Mean and standard deviation of Systolic and Diastolic blood pressure and Haemoglobin in Jat Sikh children ranging in age from 10 to 16 years.

Age	N	SBP (mm/Hg)		DBP (mm/Hg)		Haemoglobin (Gm/dl of Blood)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Boys							
10	24	120.62	4.18	80.45	4.31	11.37	1.48
11	30	119.70	3.58	80.00	3.21	11.13	1.75
12	34	122.10	3.47	79.14	3.24	12.05	1.38
13	33	121.78	3.76	79.21	3.32	12.45	1.76
14	42	121.80	4.50	80.23	2.45	12.21	1.63
15	48	122.47	5.02	81.20	3.81	13.55	1.40
16	40	122.87	4.51	82.75	6.31	13.74	1.54
Girls							
10	30	119.00	2.66	78.86	1.66	10.34	1.66
11	40	119.07	4.29	77.45	4.32	10.05	1.82
12	39	121.30	3.39	80.00	3.42	10.42	1.64
13	52	122.21	3.61	80.13	3.88	10.18	1.77
14	58	120.72	2.38	78.86	3.98	10.32	1.92
15	49	121.87	4.40	79.63	4.20	10.52	1.50
16	37	120.70	4.41	80.49	3.57	11.30	1.54

Table 2 represents the values for the mean and standard deviation of systolic and diastolic blood pressure and haemoglobin in Jat Sikh children ranging in age from 10 to 16 years. It has been found that systolic blood pressure increases with age in both boys and girls, with intermittent fluctuations, from a value of 120.62 mm of Hg to 122.87 mm of Hg in boys from 10 to 16 years and from 119 mm of Hg to 121.87 mm of Hg in girls from 10 to 15 years of age. Sex differences have been found statistically significant at 16 years of age only, where value has been found more in boys.

Diastolic blood pressure has shown fluctuations with age in both boys and girls, the values have been found to

increase from 80.45 mm of Hg to 82.75 mm of Hg in boys and from 78.86 mm of Hg to 80.49 mm of Hg in girls from 10 to 16 years of age as evident from Table 2. Diastolic blood pressure has been observed to be slightly higher in boys than girls in all age groups except 12 and 13 years. Significant sex differences have been observed at 11 and 14 years of age.

Haemoglobin

It has been found that boys are ahead in having more haemoglobin content than girls at all age levels with significant differences (Table 2 to 3). In case of boys the maximum increase in haemoglobin has taken place from 14 to 15 years i.e. 1.34 g/100 ml of blood, while in girls increase has taken place from 15 to 16 years i.e. 0.78 gm/100 ml of blood.

Table 3: Sex Differences (t-test) in various measures of the body in Jat-Sikh children ranging in age from 10 to 16 years.

AGE	WT	HT	BMI	SBP	DBP	HB
10	1.27	1.74	0.44	1.65	1.71	2.43*
11	1.00	1.56	-0.04	0.67	2.85*	2.54*
12	2.52*	2.08*	1.25	1.00	-1.11	2.46*
13	2.67*	1.78	1.70	-0.52	-1.17	6.04*
14	4.52*	2.18*	3.36*	1.43	2.14*	5.23
15	3.50*	4.85*	-0.75	0.63	1.87	10.45*
16	3.77*	5.74	0.55	2.15*	1.96	7.04*

* indicates statistically significant at 5% level
- sign indicate more value in girls

Discussion:

In the present study an attempt has been made to study the age related changes in terms of morphological and physiological variables in Jat Sikh boys and girls ranging in age from 10 to 16 years. Weight and height have shown a trend of continuous increase in both boys and girls and boys are significantly heavier and taller than girls at most of the age levels from 12 to 16 years. The body mass index has also shown a trend of increase from 10 to 16 years in both boys and girls. A trend of increase in BMI has also been reported by *Steyn et al., 2000*;

Bose *et al.*, 2005 and Kaur, 2006. In the present investigation boys possess slightly more BMI than girls except at 11 and 15 years with significant differences at 14 years, whereas Dowda *et al.*, 2001 reported higher values in girls than boys ranging in age from 6-18 years. Kaur (2006) has also reported slightly more values of BMI in girls with non significant sex differences at all age levels from 5 to 16 years.

The total increase in BMI is more or less same i.e. 4.32 kg/m² and 4.33 kg/m² in boys and girls respectively. Maynard *et al.* (2001) and Kaur (2006) have reported more increase of BMI in girls than boys.

Blood pressure i.e. systolic and diastolic has been found to increase with age in both boys and girls with intermittent fluctuations. Lauer and Clark, 1989; Rosner *et al.*, 1993; Sinaiko, 1996; Hashimoto *et al.*, 1997; Kafali *et al.*, 1997 and Steyn *et al.*, 2000 have also reported a trend of increase in blood pressure with age.

References

- Bhatnagar, D.P., Singal, P., Verma, S.K., Wangoo, A.K. and Singal, T. 2003. A haematological study among the Vokkaligas of Mysore. *The Anthropologist*, **5(1)**: 45-48.
- Bose, K., Bhattacharya, S., Basu, K., Ghosh, S., Mukhopadhyay, A., and Bhara, M. 2005. Age trends in anthropometric characteristic among 6-9 years old Bengal Hindu School Girls of Kolkata, India. *Anthropol. Anz.*, **63(4)**: 439-448.
- Chen, J.Y., Chang, H.Y. and Pan, W.H. 2003. A modified locally weighted method for developing references standards for health, weight and body mass index of boys and girls aged 4 to 18 in Taiwan. *Hum. Biol.*, **75(5)**: 749-770.
- Chen, Y., Rennie, D.C. and Reeder, B.A. 1995. Age-related associations between body mass index and blood pressure. The Humboldt study. *Int. J. Obesity*, **19**: 825-831.
- Cole, I.J., Freeman, J.V. and Preece, M.A. 1995. Body mass index curves for the U.K., 1990. *Arch. Dis. Child.*, **73**: 25-29.
- Cook, J.D., Skikne, B.S., Lynch, S.R. and Reusser, M.F. 1986. Estimates of iron sufficiency in the US population. *Blood*, **68**: 726-731.
- De, Swiet, M., Fayers, P. and Shinebourne, E.A. 1992. Blood pressure in first 10 years of life: the Brompton study. *Br. Med. J.*, **304**: 23-26.
- Dowda, M., Amsworth, E.B., Addy, C.L., Ruth, S. and William, R. 2001. Environmental influence, physical activity and weight status in 8 to 16 years olds. *Arch Pediatr. Adolesc. Med.*, **155**: 711-717.
- Dyer, A.R. and Elliott, R. 1989. The Intersalt study: relations of body mass index to blood

The blood pressure is slightly higher in boys than girls at all age levels except at 12 and 13 years. The differences reach a level of significance at 16 years in systolic and at 11 and 14 years in diastolic blood pressure. Ann *et al.* (1998) reported that from age 13 years onwards mean systolic blood pressure become higher in boys than girls.

The concentration of haemoglobin increases with advancement of age in both boys and girls as also reported by Bhatnagar *et al.* (2003). The increase in the amount of haemoglobin is more in boys as compared to girls from 10 to 16 years and is found to be significantly more in boys as compared to girls at all age levels. Bhatnagar *et al.* (2003) also reported more values in males as compared to females. The sex differences in haemoglobin have become more marked after the onset of menstruation in girls. Sjostrand (1953), Verberg *et al.* (1976) and Adalbert *et al.* (1976) have also reported larger increase in haemoglobin in boys than girls at puberty.

- pressure. Intersalt Co-operative Research Group. *J. Hum. Hypertens*, **3**: 299-308.
- Frassinelli-Gunderson, E.P., Margen, S. and Brown, J.R. 1985. Iron stores in users of oral contraceptive agents. *Am. J. Clin. Nutr.*, **41** : 703-712.
- Garrow, J.S. and Webster, J. 1985. Quetelet's index (W/H^2) as a measure of fatness. *Int. J. Obes.*, **9**: 147-153.
- Hallberg, L., Hogdahl, A.M., Nilsson, L. and Ryho, G. 1966. Menstrual blood loss – a population study variation at different ages and attempts to define normality. *Acta. Obstet. Gynec. Scand.*, **45**: 320-351.
- Hashimoto, N., Kawasaki, T., Kikuchi, T. and Uchiyama, M. 1997. Criteria of normal blood pressure and hypertension in Japanese preschool children. *J. Hum. Hypertens*, **11** : 351-354.
- Hoftbrand, A.V. and Pettit, J.E. 1993. *Essential haematology*. 3rd ed. Oxford, Blackwell Scientific, 1993. P. 419.
- Ji, G., Su, Z., Bo-ling, S., Hui-min, F. and Li-hui, H. 1987. Menstrual blood loss and hematologic Indices in healthy Chinese women. *J. Reprod. Med.*, **32**: 822-826.
- Kaas Ibsen, K. 1985 Factors influencing blood pressure in children and adolescents. *Acta. Paediatr. Scand.*, **74**: 416-422.
- Kafali, G., Toksoy, H. and Cevit, O. 1997. Blood pressure measurement in children aged 7-15 years in Sivas region – Turkiye. *J. Tropical Pediatrics*, **43**: 243-248.
- Kaufman, J.S., Asuzu, M.C., Mufunda, J., Forrester, T., Wilks, R., Luke, A., Long, A.E. and Cooper, R.S. 1997. Relationship between blood pressure and body mass index. *Hypertension*, **30**: 1511-1516.
- Kaur, I. 2006. *An Auxological study of Fat Lean Body Mass and Dental Development among Jat Sikh children of Public and Government Schools*. Ph.D. Thesis, Punjabi University, Patiala.
- Lauer, R.M. and Clarke, W.R. 1989. Childhood risk factors for high adult blood pressure: The Muscatine study. *Pediatrics*, **84**: 633-641.
- Looker, A.C., Dallman, P.R., Carroll, M.D., Gunter, E.W. and Johnson, C.L. 1997. Prevalence of iron deficiency in the United States. *JAMA*, **277**: 973-976.
- Luke, A., Durazo-Arvizu, R., Rotimi, C., Prewitt, T.E., Forrester, T., Wilks, R., Ogunbiyi, O.J., Schoeller, D.A., McGee, D.A. and Cooper, R.S. 1997. Relationship between body mass index and body fat in black populations from Nigeria, Jamaica and the United States. *Am. J. Epidemiol.*, **145**: 620-628.
- Mei, Z., Grummer-Strawn, L.M., Pietrobelli, A., Goulding, A., Goran, M.I. and Dietz, W.H. 2002. Validity of body mass index compared with other body composition screening indexes for the assessment of body fatness in children and adolescents. *Am. J. Clin. Nutr.*, **75**: 979-985.
- Mufunda, J., Mebrahtu, G., Usman, A., Nyarango, P., Kosia, A., Ghebrat, Y. *et al.* 2006. The prevalence of hypertension and its relationship with obesity : results from a national blood pressure survey in Eritsea. *J. Hum. Hypertens*, **20**: 59-65.
- Must, A., Dallal, G.E. and Dietz, W.H. 1991. Reference data for obesity : 85th and 95th percentile of body mass index (Wt/ht^2) and triceps skinfold thickness. *Am. J. Clin. Nutr.*, **53**: 839-846.
- Mzayek, F., Hassig, S., Sherwin, R., Hughes, J., Chen, W., Srinivasan, S. and Berenson, G. 2007. The association of birth weight with developmental trends in blood pressure from childhood through mid-adulthood : The Bogalusa Heart study. *Am. J. Epidemiol.*, **KWM098V** : 1-20.
- Naidu, A.N., Neela, J. and Rai, N.P. 1991. Maternal body mass index and birth weight. Nutrition News, National Institute of Nutrition, **12** (2), Hyderabad.
- Nelson, M.J., Ragland, D.R. and Syme, S.L. 1992. Longitudinal prediction of adult blood pressure from Juvenile Blood Pressure levels. *Am. J. Epidemiol.*, **136**: 633-645.
- Pishdad, G.R. 1996. Overweight and obesity in adults aged 20-74 in Southern Iran. *Int. J. Obes. Relat. Metab-Disord.*, **20** (10): 963-965.
- Roche, A.F. and Siervogel, R.M. 1991. Measure of body composition : their relationship to blood pressure and use in epidemiologic research. *Ann. Epidemiol.*, **1**: 313-320.
- Rona, R.J., Qureshi, S. and Chinn, S. 1996. Factors related to total cholesterol and blood pressure in British 9 year olds. *J. Epidemiol. Community Health*, **50**: 512-518.
- Rookus, A.M., Burema, J., Van't Hof, M.A., Deurenberg, P., Vander Wiel Wetzels, W.A.M. and Havtvast, J.G.A.J. 1987. The development of body mass index in young adults. I : Age reference curves based on four year mixed longitudinal study. *Hum. Biol.*, **59**(4): 599-615.

- Rosner, B., Prineas, R.J., Loggie, J.M.H. and Daniels, S.R. 1993. Blood pressure nomogram for children and adolescents, by height, sex and age in the United States. *J. Paediatr.*, **123**: 871-886.
- Sandin, M., Ugalde, M., Montero, P. and Sanchez, C. 1990. Relationship between blood pressure and variable of body composition in 6 to 15 years olds longitudinal study. *J. Hum. Ecol.*, **1**: 37-48.
- Siervogel, R.M., Roche, A.E., Chumlea, W.C., Morris, J.G., Webb, P. and Knittle, J.E. 1982. Blood pressure, body composition and fat tissue cellularity in adults. *Hypertension*, **4**: 382-386.
- Simon, T.L., Garry, P.J. and Hooper, E.M. 1981. Iron Stores in blood donors. *JAMA*, **245**: 2038-2043.
- Sinaiko, A.R. 1996. Hypertension in children. *New England J. Med.*, **26**: 1968-1973.
- Sjostrand, T. 1953. Volume and distribution of blood and their significance in regulating the circulation. *Physiol. Rev.*, **33**: 202-28.
- Stamler, J. 1991. Epidemiologic findings on body mass and blood pressure in adults. *Ann. Epidemiol.*, **1**: 347-362.
- Steyn, N.P., Senekal, M., Brits, S., Alberts, M., Mashego, T. and Nel, J.H. 2000. Weight and health status of black female students. *S. Afr. Med. J.*, **90(2)**: 146-152.
- Velberg, L.S., Sorbie, J., Ludwig, J. and Pelletier, O. 1976. Serum ferritin and the iron status of Canadian. *Can. Med. Assoc. J.*, **114**: 417-421.
- Venkatramana, P., Vam, C. and Chenga Reddy, P. 2001. Association of body mass index, body fat distribution and fat patterning with blood pressure in two populations of Andhra. *J. Hum. Ecol.*, **12**: 63-68.
- Vijayalakshmi, K., Krishna, T.P., Raghuram, T.C. and Krishnswamy, K. 1997. Abdominal adiposity and metabolic alterations in hypertension – A Case Control Study. *Asia Pacific J. Clin. Nutr.*, **6**: 180-185.
- Weiner, J.S. and Lourie, J.A. 1969. Human Biology: A Guide to Field Methods. *Oxford and Edinburg: Blackwell Scientific Publications.*
- Yanai, M., Kon, A., Kumasaka, K. and Kuwano, K. 1997. Body mass index variation by age and sex and prevalence of overweight in Japanese adults. *Int. J. Obes.*, **21(6)**: 484-488.