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Blood Pressure, Fitness and Fatness in School Aged Children in Sharkia

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Abstract

There is no doubt that many adult disorders including cardiovascular diseases have their origins in early life. So, it is of interest to examine the influence of fitness, fatness and fat patterning on blood pressure (BP) of children. This work was carried out on 100 clinically healthy school aged children (38 O &62 O with ages 7-13 yr). They were subjected to clinical examination, anthropometric measurements, laboratory investigations including plasma lipids and aerobic body fitness test. It was found that in young age group (7-9 yr), there was no sex difference regarding aerobic fitness but in older groups (9-13 yr), boys were fit than girls. Girls had significantly higher results of skin folds thickness than boys specially in truncal and summated central skin folds in older groups. The mean total cholesterol (TC) levels of our children were higher than that of American children of the same age and sex. There was no significant sex difference in high density lipoprotein cholesterol (HDL-C) but its level appears to be lower in preadolescent boys. In 7-14 yr age groups the low density lipoprotein cholesterol (LDL-C) levels were higher in females than males but in older age it showed a highly significant decrease. The systolic BP (BPs) is higher in preadolescent boys than girls, and it is strongly related to physical fitness, while diastolic BP (BPd) is unrelated. In preadolescent age, we found a highly significant -ve correlation between BPs and fitness in males but not in females. There was a significant -ve correlation between fatness as expressed by quetelet index (QI) and BPs in both sexes while the relation between QI and BPd showed significance for boys only. There was a tendency of the central skin folds to show a high significant +ve correlation with BP except for girls in older ages. Older groups have -ve correlation between BP and HDL-C and +ve one between BP and triglycerides (TG). For both sexes there were an inverse relation between fitness and fatness and between fitness and HDL-C and -ve correlation between fitness and TG. Above 11 yr QI was negatively associated with HDL-C and positively with TG.

Introduction

THERE is evidence that cardiovascular disease originates during childhood [1]. Aerobic fitness, degree for body fatness and fat patterning are important predictors of cardiovascular disease [2]. Blood pressure (BP) is a major cardiovascular risk factor which in adults is related inversely to aerobic fitness and directly to fatness [3]. There is tendency for BP fatness and plasma lipids and to some degree, physical activity to track over the years [4]. Thus understanding and controlling BP in young children may contribute to BP control later in life. The aim of that work is to study the separate and combined relations of fitness and fatness (including fat patterning and plasma lipids) with BP in school aged children in Sharkia.

Material and Methods

The work was carried out on 100 clinically healthy Sharkian school aged children (38 0 & 62 0 with age range 7-13 yr). They were selected from the waiting room of the Outpatient Clinic of Zagazig University Hospital. They were subjected to total medical history and complete clinical examinations including:

- *Anthropometric Measurements*: including body weight, standing height, skin folds (SF) thickness of right side at triceps, subscapular, suprailiac and thigh regions according to Jellife [5], body mass index (BMI) using the quetelet index ($QI = \frac{Weight}{Height^2}$) according to Roche and Mackigney [6], and resting BP by mercury gravity sphygmomanometer [7].

- *Laboratory investigations*: in the form of urine and stool analysis by simple sedimentation methods [8], hemoglobin concentration using the Sahli acid haematin method [9], to exclude abnormal cases and lastly plasma lipids level which included:

* Total cholesterol (TC) by Richmond method [10].
* High density lipoprotein cholesterol (HDL-C) [11].
* Triglycerides (TG) [12].
* Low density lipoprotein cholesterol (LDL-C) by Fredrickson Friedwald [13] $LDL\text{-}C = TC - [HDL\text{-}C + \frac{TG}{5}]$
* Very low density lipoprotein cholesterol (VLDL-C) by Edward $VLDL\text{-}C = \frac{TG}{5}$ [14].

- *Body Fitness Test*: using the bicycle ergometer (Body gaurd 955). The continuous, maximal exercise protocol according to modified Balke protocol [15] was used. Standards of test condition were taken into consideration [16,17]. The % degree of fitness was assessed using the normogram of maximum work load (Max. W. L.) against body surface area by Albert [18].

- *ECG*: was done at rest and at the last 15 sec of the exercise test using the Siemens, Cardiostat II. V_5-chest lead was used for recording because it is the most valuable for detecting early left ventricular function changes.

- *Statistical analysis of the data*: was done according to Swinson [19].

Results

Children were divided into 3 groups according to the age (7-9,9-11 & 11-13). Tables (1-3), show that girls have significantly higher results of skin folds thickness than boys specially in truncal and summated central skin folds in older groups. The mean TC level is 193.3, 169.6 & 160.3 in boys and 203.4, 204.3 & 216.2 in girls respectively in the 3 age groups. There is no significant sex difference in HDL-C but its level appears to be lower in preadolescent boys. In the 1st two groups the LDL-C level is higher in females than males but in the 3rd group it shows a highly significant decrease. The BPs is higher in preadolescent boys than girls. Tables (4-6) show that BPs is strongly related to physical fitness except in females of the 3rd group while BPd is unrelated. There is a significant -ve correlation between fatness as expressed by QI and BPa in both sexes while the relation between QI and BPd shows significance for boys only. There is a tendency for the central skin folds to show a high significant +ve correlation with BP except for girls in older ages. Older groups have -ve correlation between BP and HDL-C and -ve one between BP and TG. Table (7) shows an inverse correlation between fitness and fatness (QI) and between fitness and HDL-C and a negative one between fitness and TG for both sexes. Table (8) shows that in the 3rd age group, QI is negatively associated with HDL-C and positively with TG.

Discussion

In the young age (7-9 yr) there was no sex difference regarding aerobic fitness but in older children (9-11 yr & 11-13 yr) boys were aerobically fit than girls (Tables 1-3). This may be partially explained by their difference in practising physical activities which are more in older boys than girls. Girls had significantly higher results of skin folds thickness than boys specially in truncal and the summated central skin folds in older groups. The mean TC levels of our children were higher than that of American children of the same age groups as regards Robert et al. [20]. This can be explained by the heridetary/genetic factors or more likely the pattern of children's diet. Kwiterovich [21] observed that compared with adults, plasma lipids and lipoprotein levels in the first 2 decades of life are relatively constant particularly for TC and LDL-C which undergo only a small decrement during adolescence. HDL-C levels do not change during this period in females but fall significantly in males between the ages of 15-19 yr. TG levels increase in the second decade and males have higher levels than females. The VLDL-C levels parallel the TG levels. These results match with our results at a younger age (11-13 yr).

Table (1): Descriptive Data and Unpaired (t) test for Differences Between Boys and Girls. Age Groups (7-9 years)

	Boys ($n_1 = 13$)		Girls ($n_2 = 19$)			
	(X_1)	(SE_1)	(X_2)	(SE_2)	t	p
Age	7.91	0.228	8.10	0.169	-0.6678	N.S
Max W.L.	62.5	10.879	63.15	4.82	0.0546	N.S
Max. H.R.	126.91	5.030	128.68	1.72	0.3328	N.S
% degree of fitness	69.4	2.39	65.32	1.57	1.3596	N.S
Q.1	1.45	0.050	1.5	0.027	0.8658	N.S
Tricpes S.F	8.41	0.752	9.05	0.61	1.0252	N.S
Subscapular S.F.	8.16	0.86	8.57	0.698	0.4233	N.S
Suprailiac S.F	10.25	1.168	11.26	0.851	2.4097	P < 0.05*
Thigh	11.66	1.321	14.42	1.175	-3.5075	P < 0.01**
Summated peripheral S.F.	20.08	1.959	23.47	1.573	1.3489	N.S
Summated central S.F	18.25	2.023	19.84	1.54	0.6249	N.S
Systolic B.P.	105.83	2.875	106.31	2.882	0.1277	N.S
Diastolic B.P.	70.41	2.496	69.73	2.948	0.17599	N.S
Cholesterol	193.3	9.049	203.4	8.624	0.8079	N.S
T.G	96.58	14.51	136.3	9.278	-2.3056	P < 0.05*
HDL-C	44.9	4.28	44.7	2.98	0.01648	N.S
LDL-C	127.1	11.61	133.8	8.74	0.6880	N.S
VLDL-C	18.8	2.82	26.5	1.85	-2.2786	P < 0.05*

N.S: Not significant *: Significant *: Highly significant ***: Very highly significant
H.R: heart rate

Table (2): Descriptive Data and Unpaired (t) test for Differences Between Boys and Girls. Age Group (9 - 11 years)

	Boys (n_1 = 12)		Girls (n_2 = 12)			
	(X_1)	(SE_1)	(X_2)	(SE_2)	t	p
Age	9.5	0.194	9.95	0.188	- 1.476	N.S
Max W.L.	77.38	7.182	60.41	6.194	2.043	p < 0.05*
Max. H.R.	114.25	9.901	135.7	4.081	- 2.072	p < 0.05*
% degree of fitness	80.42	6.38	65.43	4.58	1.979	p < 0.05*
Q.1	1.49	0.02	1.59	0.052	- 1.715	N.S
Tricpes S.F	8.83	0.561	11.09	0.585	- 2.819	P < 0.01**
Subscapular S.F.	8.33	0.284	10.71	0.552	- 3.9009	P < 0.001***
Suprailiac S.F	10.33	0.721	13.95	1.029	- 1.1472	N.S
Thigh S.F	13	0.717	16.38	1.565	1.965	N.S
Summated peripheral S.F	21.83	1.127	28.09	2.15	- 2.586	p < 0.05*
Summated control S.F.	18.75	0.888	24.66	1.434	- 3.5178	p < 0.001***
Systolic B.P.	107.9	3.664	110.47	3.465	- 0.5096	N.S
Diastolic B.P.	68.33	2.071	72.14	3.019	- 1.057	N.S
Cholesterol	169.6	8.27	204.3	14.5	- 2.089	P < 0.05*
T.G	98.6	10.42	99.9	10.5	0.11627	N.S
HDL-C	44.25	3.238	41.38	2.127	0.7473	N.S
LDL-C	107.7	9.14	143.9	12.22	- 2.3706	P < 0.05*
VLDL-C	20.6	2.09	20.3	2.142	0.1003	N.S

Table (3): Descriptive Data and Unpaired (*t*) test for Differences Between Boys and Girls. Age Group (11-13 years)

	Boys (n_1 = 13)		Girls (n_2 = 22)			
	(X'_1)	(SE_1)	(X_2)	(SE_2)	*t*	*p*
Age	12.69	0.174	12.6	0.139	0.4023	N.S
Max W.L.	92.3	8.196	65.9	6.889	2.4655	P < 0.05*
Max. H.R.	148.15	3.312	137.13	1.808	2.92307	P < 0.001***
% degree of fitness	84.62	2.88	73.9	1.3	3.687	P < 0.001***
Q.1	1.99	0.109	1.88	0.0799	-1.31609	N.S
Tricpes S.F	11.46	0.851	12.68	0.485	-1.2443	N.S
Subscapular S.F.	11.53	0.666	11.45	0.069	0.0886	N.S
Suprailiac S.F	14.07	0.771	14.72	6.736	-0.6094	N.S
Thigh S.F	17.53	1.308	20.54	1.253	-1.60213	N.S
Summated central S.F	29.07	2.098	33.22	1.618	-1.56615	N.S
Summated peripheral S.F	25.61	1.375	28.18	1.166	-2.31619	P < 0.05*
Systolic B.P.	116.15	2.412	112.04	4.195	2.49345	P < 0.05*
Diastolic B.P.	76.15	2.129	73.6	2.871	0.71328	N.S
Cholesterol	160.3	7.66	216.2	8.55	-1.56715	P < 0.05*
T.G	113	13.37	110.09	9.712	0.0867	N.S
HDL-C	39.15	2.247	42.2	1.878	-0.8531	N.S
LDL-C	117.04	8.73	76.7	8.51	3.3499	P < 0.001****
VLDL-C	23.3	2.73	23.04	2.2014	0.08135	N.S

Table (4): Correlations Between B.P. and Indices of Aerobic Fitness, Body Composition and Fatness (Age group 7-9 years).

	Diastolic B.P.		Systolic B.P.	
	Boys n= 13	Girls n=19	Boys n= 12	Girls n=19
% degree of fitness	-0.1220-	+ 0.0135-	-0.7178**	- 0.6089**
BMI (Q.I)	+ 0.7096*	+ 0.5682	+ 0.7832*	+ 0.4623*
Triceps S.F	+ 0.8813***	+ 0.6013**	+ 0.6576*	+ 0.6453**
Subscapular S.F	+ 0.9141***	+ 0.8672***	+ 0.6686*	+ 0.7607***
Suprailiac S.F	+ 0.8146**	0.7938***	+ 0.6819*	+ 0.7251***
Thigh S.F	+ 0.7727**	+ 0.8727***	+ 0.2258	+0.7243***
Summated central S.F	+ 0.8604 ***	+ 0.8058***	+ 0.7450**	+ 0.7499***
Summated peripheral S.F	+ 0.8593***	+ 0.11314-	+ 0.3954-	+ 0.7949***
Cholesterol	-0.0.2788-	+ 0.1244	-0.1232-	+ 0.239-
Triglycerides	+ 0.083003	-0.0425-	+ 0.3244-	+ 0.0013-
HDL-C	-0.52044-	-0.0136-	0.2721-	0.0.0323-
LDL-C	- 0.10733-	+0.1654-	- 0.335-	+0.2751-
VLDL-C	+ 0.03308-	-0.0574-	+ 0.05744-	+0.0.0271-

- = Insignificant

* = Significant ($p < 0.05$)

**- = Highly Significant ($p < 0.01$)

*** = Very highly significant ($p < 0.01$)

Table (5): Correlations Between B.P. and Indices of Aerobic Fitness, Body Composition and Fatness (Age group 9-11 years).

	Diastolic B.P.		Systolic B.P.	
	Boys n= 12	Girls n=21	Boys n= 12	Girls n=21
% degree of fitness	+ 0.1172^{-}	+ 0.0389^{-}	- 0.7471**	- 0.5423**
BMI (Q.I)	+ 0.5842*	+ 0.1887^{-}	40.6189*	+ 0.4429*
Triceps S.F	+ 0.1410^{-}	+ 0.3176^{-}	+ 0.22.38^{-}	+ 0.3452^{-}
Subscapular S.F	+ 0.5893*	+ 0.5326*	+ 0.5962*	+ 0.4821*
Suprailiac S.F	+ 0.2619^{-}	-+ 0.1492^{-}	- 0.0477^{-}	+ 0.2706^{-}
Thigh S.F	+ 0.0509^{-}	+ 0.2684^{-}	+ 0.0576^{-}	+ 0.3011^{-}
Summated central S.F	+ 0.6037*	+ 0.2638	+ 0.7132**	+ 0.4769*
Summated peripheral S.F	+ 0.1027^{-}	+ 0.2955^{-}	+ 0.1482^{-}	+ 0.2856
Cholesterol	+ 0.31422^{-}	- 0.0345^{-}	+ 0.1337^{-}	- 0.10808^{-}
Triglycerides	+ 0.5789*	+ 0.5136*	+ 0.7271**	+ 0.5011*
HDL-C	- 0.6021*	- 0.4965*	- 0.8013**	- 0.4441*
LDL-C	+ 0.2625^{-}	- 16619^{-}	+ 0.1264^{-}	- 0.3115^{-}
VLDL-C	+ 0.3457^{-}	+ 0.2206^{-}	+ 0.1889^{-}	+ 0.0854^{-}

Table (6): Correlations Between B.P. and Indices of Aerobic Fitness, Body Composition and Fatness (Age group 9-11 years).

	Diastolic B.P.		Systolic B.P.	
	Boys n= 13	Girls n=22	Boys n= 13	Girls n=22
% degree of fitness	+ 0.1800^{-}	+ 0.0389^{-}	- 0.7471**	- 0.5423**
BMI (Q.I)	+ 0.5519*	+ 0.1887^{-}	40.6189*	+ 0.4429*
Triceps S.F	+ 0.3464^{-}	+ 0.3176^{-}	+ 0.22.38^{-}	+ 0.3452^{-}
Subscapular S.F	+ 0.7631**	+ 0.5326*	+ 0.5962*	+ 0.4821*
Suprailiac S.F	+ 0.15148^{-}	+ 0.1492^{-}	- 0.0477^{-}	+ 0.2706^{-}
Thigh S.F	+ 0.1653^{-}	+ 0.2684^{-}	+ 0.0576^{-}	+ 0.3011^{-}
Summated central S.F	+ 0.6739*	+ 0.2638	+ 0.7132**	+ 0.4769*
Summated peripheral S.F	+ 0.2636^{-}	+ 0.2955^{-}	+ 0.1482^{-}	+ 0.2856
Cholesterol	- 0.1594^{-}	- 0.0345^{-}	+ 0.1337^{-}	- 0.10808^{-}
Triglycerides	+ 0.5538*	+ 0.5136*	+ 0.7271**	+ 0.5011*
HDL-C	- 0.6503*	- 0.4965*	- 0.8013**	- 0.4441*
LDL-C	- 0.0717	- 16619^{-}	+ 0.1264^{-}	- 0.3115^{-}
VLDL-C	- 0.4509	+ 0.2206^{-}	+ 0.1889^{-}	+ 0.0854^{-}

Table (7): Correlations Between Fitness and Fatness (Age group 7-9 years).

	% Degree of Fitness	
	Boys (n = 13)	Girls (n = 19)
Q.I	- 0.6760*	- 0.5326*
Cholesterol	- 0.2207	- 0.3201
Triglycerides	- 0.5723*	- 0.0.4557*
HDL-C	+ 0.5941*	+ 0.5002*
LDL-C	- 0.2231	- 0.2194
VLDL-C	+ 0.11009	+ 0.0721
	(Age group 9-11 years)	
	Boys (n = 12)	Girls (n = 21)
Q.I	- 0.5821*	- 0.5129*
Cholesterol	- 0.2121	- 0.1009
Triglycerides	- 0.6254*	- 0.4432*
HDL-C	+ 0.59201*	+ 0.4798*
LDL-C	- 0.3201	- 0.2209
VLDL-C	+ 0.4372	+ 0..3220
	(Age group 11-13 years)	
	Boys (n = 13)	Girls (n = 22)
Q.I	- 0.5729*	- 0.4821*
Cholesterol	- 0.2119	- 0.3079
Triglycerides	- 0.59102*	- 0.4347*
HDL-C	+ 0.6221*	+ 0.5021*
LDL-C	- 0.4202	- 0.2073
VLDL-C	- 0.0102	+ 0.1101

Table (8): Correlations Between Index of Q.1 & Lipids (Age group 7-9 years).

	Q.1	
	Boys (n = 13)	Girls (n = 19)
Cholesterol	+ 0.4073	+ 0.2027
Triglycerides	- 0.0179	- 0.4023
HDL-C	+ 0.1216	+ 0.1079
LDL-C	+ 0.2022	- 0.1325
VLDL-C	- 0.2196	- 0.3372

	(Age group 9-11 years)	
	Boys (n = 12)	Girls (n = 21)
Cholesterol	+ 0.3131	+ 0.2076
Triglycerides	- 0.2023	- 0.0321
HDL-C	+ 0.0213	+ 0.3111
LDL-C	+ 0.2222	- 0.1132
VLDL-C	- 0.4376	+ 0.2135

	(Age group 11-13 years)	
	Boys (n = 13)	Girls (n = 22)
Cholesterol	+ 0.0027	0.03278
Triglycerides	+ 0.5732*	+ 0.5121*
HDL-C	- 0.60021*	- 0.4202*
LDL-C	+ 0.4076	+ 0.1128
VLDL-C	- 0.2021	+ 0.09822

These data confirm that sex hormones may have a different effect on LDL-C and HDL-C in the preadolescent [22]. Males in early adult life therefore develop lipid and lipoprotein levels that render them more at risk for coronary artery disease than females. BPs is higher in preadolescent boys than girls. Schieken [23], suggested that in young adolescents, boys genetic paths shared with the BMI appear to influence BPs but not BPd, in girls the genetic control of BP may be a consequence of the more advanced sexual maturation. Previous results are consistent with the presence of an inverse relationship between physical activity and BP [24, 25], and in general physical activity is now recognized as one of the measures that can be used to lower BP in adults. In our data BPs is strongly related to physical fitness, while BPd is unrelated. This may be explained by the larger variability of BPd at this age of life [7]. The altered haemodynamic, associated with exercise could reset the controls determining vascular resistance and affect BP levels. Alternatively, cardiac output (CO) at rest could be decreased in physically fit people [26]. Pavilk et al. [27] showed that highly trained adult athelets have lower resting CO and higher resting peripheral resistance than non athelets. However, less trained athelets have lower resting peripheral resistance and higher resting CO than non athelets, consequently, mechanisms whereby fitness may affect BP are not well known. Sex difference in the correlation between BPs and fitness was detected in our study in preadolescent age where we found highly significant -ve correlation in males while it is insignificant in females. This can be explained by the lower ratio of muscle to total body weight in females at that age. Our sample clearly exhibited significant +ve correlation between fatness as expressed by QI and BPd acheived significance for boys and non for girls. These results are similar to those of Shear et al. [28]. There was a tendency for the central skin folds to show significantly higher +ve correlations with BP except for girls in older ages. Shear et al. [28], also, found that controlling for peripheral fatness resulted in clearer +ve correlation between central deposition and BP for boys than girls. So, total body fat appears to be less important indicator of health than the pattern of fat distribution. There is no significant correlation between BP and HDL-C in young ages while older males and females have -ve correlation between BP and HDL-C and +ve one between BP and TG. We can explain this by the fact that a child with high normal BP always has a high BMI [29]. Such child has a reduced catabolism of TG rich lipoprotein due to reduced level of lipoprotein lipase enzyme [30]. Hence, relative increase in BMI may be associated with reduced HDL-C and high levels of TG. So, it is advisable for children to start physical training early, aiming to decrease the BMI and hence decrease in BP and help to maximize the levels of potentially antiatherogenic HDL-C. For both sexes, an inverse relationship was found between fitness and fatness. This relationship becomes stronger as the children grow due to its cyclic nature i.e. less fit child becomes less active and tends to become fatter, which leads to less physical activity and fitness and so on [31]. There were +ve correlation between % degree of fitness and HDL-C in both sexes and -ve correlation with TG. Physical exercise has been shown to increase the activity of lipoprotein lipase of skeletal muscles and possibly of adipose tissues [30]. In both males and females above 11yr, QI was negatively associated with HDL-C levels and positively with TG levels. This relation was not present in younger children. This coincided with Fredriches et al. [32]. The surface constituents of TG rich lipoproteins contribute to the HDL-C molecule in which relative increase of BMI is associated with reduced catabolism of TG rich lipoprotein due to reduced levels of lipoprotein lipase and hence reduced HDL-C [33].

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