Low prevalence of cardiovascular risk factors among primary school children in Tanzania: an opportunity for primordial prevention?

P Chillo[1], JLwakatare[2], MJanabi[1], W Matuja [2], G Greve[3]

Abstract

Background: Identification of obesity and other risk factors for cardiovascular disease in childhood is strongly recommended for prevention of the diseases in adulthood.
Objectives: To determine the prevalence of the conventional cardiovascular risk factors among primary school children aged 6-15 years in Urban Dar es Salaam and Rural Morogoro.
Methods: Anthropometric and blood pressure measurements were determined using standard techniques. Metabolic variables such as blood sugar, total cholesterol, low density lipoprotein (LDL) cholesterol, high density lipoprotein (HDL) cholesterol and triglycerides levels were assessed. A questionnaire was used to assess socio-demographic characteristics, involvement in physical activities and active and passive cigarette smoking.
Results: Among the 508 studied children systolic hypertension was found in 11.4%, diastolic hypertension in 8.1% and combined hypertension in 3.9%. Obesity was observed in 5.3%. Four percent of the subjects were found to have elevated levels of total cholesterol and 2% elevated levels of LDL-cholesterol. Passive smoking was reported from 35%, while only 1.2% had a history of active cigarette smoking. None had blood sugar levels that met the World Health Organisation's definition of diabetes mellitus. Subjects from affluent families were more likely to be hypertensive and obese. Most of the children were physically active.
Conclusions: The prevalence of the conventional cardiovascular risk factors is relatively low among children in this society. A significant difference was, however, observed between children from different socio-economic backgrounds.

Keywords: Cardiovascular risk factors, children, urban, rural

Introduction:

The prevention of cardiovascular diseases (CVD) has, in the last two decades been focused on detection and control of risk factors, whereas prevention and treatment of risk factors themselves has not received much attention(1) Prevention of the acquisition or augmentation of risk factors is distinct from risk factor detection and management; and the prior is the concept of primordial prevention coined by Strasser(2) in 1980, meaning preserving risk free societies from the penetration of risk factors epidemics.

In developing countries, already burdened by other diseases, the challenges of addressing CVD are serious. Primordial prevention should therefore feature prominently as part of the CVD prevention strategy. It is important to preserve healthy lifestyles in the rural areas and prevent introduction of changes that have the potential to accelerate the prevalence of CVD.

The World Health Organisation (WHO) urges the developing countries for a prompt address and prevention of the foreseen CVD epidemic(3) The target, the WHO stressed should be on primordial prevention of the diseases. This should start in children as it is well established that CVD have their roots in childhood. Furthermore, children with cardiovascular risk factors tend to track them into adulthood(4) and it is easier to instil healthy lifestyles in children before risky behaviours have developed.(50

With this background, we aimed at determining the prevalence of the conventional cardiovascular diseases risk factors in urban and rural settings and in addition to determine social factors associated with the presence of these risk factors among children aged 6 – 15 years in Tanzania.

Materials and methods

Subjects

We carried out a cross-sectional survey of healthy primary school pupils aged 6 to 15 years in urban Dar es Salaam and rural Morogoro from November 2001 to January 2002. Dar es Salaam is a cosmopolitan commercial city and the capital of Tanzania. It has a total population of approximately 3.5 million. The majority are migrants from different regions within Tanzania due to economical reasons. The city has a total of 199 primary schools located randomly within and at its outskirts. We used a multi-staged sampling technique. A list of all primary schools in Urban Dar es Salaam and Rural Morogoro was obtained from the office of the Director of Primary education in the Ministry of Education and Culture. Using tables of random numbers, two schools were selected from the following school settings: Urban Low Density (Bunge and Academic), Urban High Density (Mbagala Kuu and Miburani) and Rural (Lungo and Manyenga). Children who attended Urban Low Density schools were mainly from affluent families with a better socio-economic status, while those attending Urban High Density Schools were mainly from families with low income (vendors and peasants). Children from Rural Morogoro schools were typically from families that depend on small scale farming as their source of income.

Data collection

Using a sample size formula for prevalence studies, 464 subjects were estimated after substituting 5.1% as the population prevalence (for hypertension) and taking the margin of error to be 5%. Out of 900 eligible children who received consent forms, 692 (77%) agreed to participate, and 508 (73% of the consented children) had complete data and were analysed.

All participants completed a questionnaire about their lifestyle characteristics, including cigarette smoking and usual physical activities. Research assistants were trained to record weight to the nearest 0.1 kg using standard balance scale *(Momert Hungary)* with subjects barefoot and wearing light clothing. Height was recorded to the nearest 0.5 cm with a ruler attached to a wall. We calculated body mass index (BMI) as body weight (kg) divided by height (m) squared. After subjects rested for 5 minutes in a sitting position, we measured blood pressure (BP) on their right arm using a mercury

Correspondence to: Pilly Chillo, P. O. BOX 65000, Dar es Salaam
pchillo2000@yahoo.co.uk

[1]Muhimbili National Hospital, Department of Internal Medicine, [2]Muhimbili University of Health and Allied Sciences, [3]Department of Clinical Medicine, Section of Paediatrics, University of Bergen, Norway

sphygmomanometer and a standard paediatric cuff size[6]. Two readings, 5 minutes apart were done and the average was taken as the blood pressure of the individual. The first and fifth Korotkoff sounds were recorded as systolic and diastolic BP, respectively. Measurements were taken in the morning and during class hours. Children were coming in turns from class sessions in a calm situation. A 5 ml blood sample was collected from the antecubital vein. This was done in the morning before the children had their school snacks, but without an overnight fasting. Whole blood glucose level was determined on the spot by a Glucometer-4 (Amron, UK). Serum was separated from the remaining blood samples, stored at –20□C and thereafter shipped to Haukeland University Hospital, Bergen, Norway for lipid analyses.

Definition of terms

Systolic hypertension is defined as a systolic blood pressure greater than or equal to the 95th percentile for age, sex and height of the child[7].

Diastolic hypertension is defined as diastolic blood pressure greater than or equal to the 95th percentile for age, sex and height of the child[7].

Obesity is defined as BMI equal or above the 95th percentile for age and sex of the child.[8]

Hypercholesterolaemia; elevated total Cholesterol and low density lipoprotein (LDL) cholesterol is defined as total serum cholesterol > 5mmol/l, and serum LDL-cholesterol > 3mmol/l respectively.[9]

Diabetes Mellitus: In this study presence of diabetes mellitus was defined as a random blood glucose level ≥ 11.1mmol/l, or known diabetic on treatment.[10]

Data Analysis

Chi square test was used for categorical variables and the differences between two group means were analysed using the *student's t-test.* For groups more than two, one way *Analysis of Variance* (ANOVA) was used to compare group means. All results are given as mean values ±SD. Differences were considered significant if the *p*-value was < 0.05.

Results

A total of 508 primary school children from 6 schools constituted the study population. Of these, 228 (45%) were males. Sixty percent of the study population came from Dar es Salaam, representing two different school settings. The remaining 40% were from rural Morogoro region. It is estimated that more than 95% of children who are in school age are attending school. Our study population is therefore representative of the children in Tanzania.

The mean age of the study population was 11.5□2.4 years. Subjects from rural area were older (12.6□2.5 years), followed by UHD subjects (11.5□2.2 years) and ULD subjects (9.8□1.9 years). The difference in age is statistically significant, p <0.001. Parents of subjects from ULD schools were more educated (secondary school level and higher) compared to children in UHD and rural schools, p < 0.001 for both parents (Table 1).

Table 1. Demographic Characteristics of the Study Population by school setting

Demographic characteristics	Total N (%)	Urban Low Density N (%)	Urban High Density N (%)	Rural N (%)
Gender				
Males	228 (44.9)	61 (43.0)	69 (41.6)	98 (49.0)^{NS}
Females	280 (55.1)	81 (57.0)	97 (58.4)	102 (51.0)
Age group (yrs)				
6 – 11	233 (45.9)	95 (66.9)	79 (47.6)	59(29.5)**
12 – 15	275 (54.1)	47 (33.1)	87 (52.4)	141(70.5)
Father's education				
Secondary school or higher	228 (49.4)	124 (96.1)	60 (41.1)	44(23.5)**
Less than secondary school	234 (50.6)	5 (3.9)	86 (58.9)	143(76.5)**
Mother's education				
Secondary school or higher	165 (37.3)	110 (88.7)	28 (20.4)	27(14.9)**
Less than secondary school	277 (62.7)	14 (11.3)	109 (79.6)	154 (85.1)**

NS = Not Significant

** significant difference, p< 0.001

Cardiovascular risk factors

Obesity

The mean BMI of the total studied was 17.1□3.4 kg/m^2. There was no statistically significant difference between females 17.1□2.9 kg/m^2 and males 17.0 □3.9 kg/m^2, p = 0.9. Subjects from ULD had significantly higher mean BMI 18.4□4.9 kg/m^2) when compared to both UHD (16.64□4.92 kg/m^2), and rural schools 16.5□2.0 kg/m^2), p<0.001. Comparison between UHD and rural schools showed no significant difference, p = 0.7143 (Table 2). Twenty seven (5.3%) subjects were obese. Females had a slightly higher, but not significant proportion of individuals with obesity, being 5.7% as compared to 4.8% in males, p = 0.66. Examination of obesity from each school separately revealed a statistical difference among subjects. Children from ULD schools were more likely to be obese (16.9%) when compared to both UHD (1.8%) and rural schools (0.0%), p<0.001. Comparison between UHD and rural schools revealed non significant difference, p = 0.1845. Further analysis showed that obese individuals were more likely to be hypertensive when compared to non obese subjects, (41.4% vs 16.2%), p< 0.001

Hypertension:

Mean systolic and diastolic blood pressures of the total population were 108.2□11.9 mmHg and 66.4□8.7mmHg, respectively. Both systolic and diastolic blood pressures increased with age. There was no sex difference between females and males in systolic blood pressure, 108.5□11.2mmHg and 108.0□11.9mmHg respectively and diastolic blood pressure, 66.8□8.1mmHg and 65.8□8.8mmHg respectively. (Figure 1a and b).

Subjects from ULD schools had significantly higher mean levels for both systolic and diastolic blood pressure, compared to their counterparts (Table 2). In total, 58 (11.4%) subjects of the studied population had systolic hypertension. Systolic hypertension was significantly higher in subjects from ULD schools (29.6%) when compared to both UHD (4.8%) and rural (4.0%) schools, p<0.001. No significant difference was found when UHD and rural schools were compared, p = 0.7027. Diastolic hypertension was found in 8.1% of the total studied population. It was more prevalent among subjects from ULD schools (20.4%) when compared to those from UHD (3.0%) and rural (3.5%), p < 0.001. There was no difference between UHD and rural schools, p = 0.7941. Only 20 (3.9%) subjects had combined systolic and diastolic hypertension. Of these, 16 were from ULD schools and two from each of UHD and rural schools. The prevalence of combined hypertension was therefore 11.3%, 1.2% and 1.0% in the ULD, UHD and rural schools respectively. The difference is significant when ULD schools are compared to both ULD and rural schools (p < 0.001), but an insignificant difference is found between UHD and rural schools, p= 0.7510

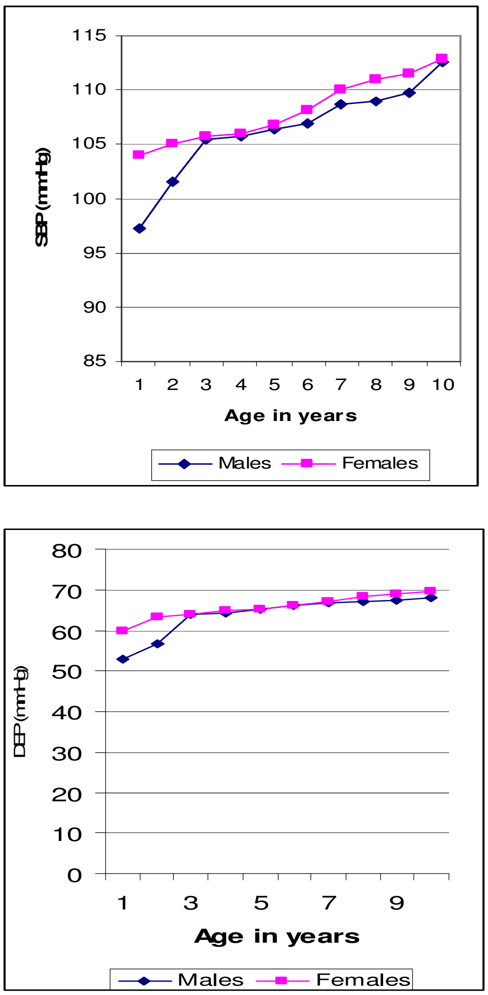

Figure 1: Blood pressure by age and sex. a: Systolic blood pressure (SBP). b: Diastolic blood pressure (DBP).

Diabetes

The mean blood glucose level among the study population was 4.9±0.7 mmol/l. There was no difference between males (4.8±0.6 mmol/l) and females (5.0±0.6 mmol/l), p = 0.1. Subjects from ULD schools had a significantly higher mean level of blood glucose (5.1±0.5 mmol/l) when compared to UHD schools (4.9±0.54 mmol/l) and rural (4.7±0.8mmol/l), p<0.001.There was no significant difference between UHD and rural schools, p= 0.1356. In this study none of the subjects had blood glucose level meeting the WHO's definition for diabetes[10].

Dyslipidaemia

Mean total serum cholesterol, LDL-cholesterol, high density lipoprotein (HDL) cholesterol and triglyceride levels were 3.6±0.9 mmol/l, 2.0±0.7 mmol/l, 0.9±0.3 mmol/l and 1.0±0.4 mmol/l, respectively. There was no sex difference. The mean levels of total and LDL-cholesterol were significantly higher in subjects from ULD schools (Table 2). Twenty one (4.1%) subjects had high levels of total cholesterol and 10 (2%) elevated LDL-cholesterol out of the 483 subjects whose blood samples were analysed. Subjects from ULD schools were more likely to have a high total cholesterol levels (12.1%) than those from UHD schools (3.1%), while none of the subjects from rural schools had elevated total serum cholesterol. Similar pattern was observed for LDL-cholesterol. ULD subjects had an elevation in 5.3%, while elevated LDL-cholesterol was found in only 0.6% and 1.1% of the subjects among UHD and rural schools, respectively. No subjects had elevated triglycerides levels (Table 2). Subjects from rural schools had significantly lower HDL cholesterol (0.63±0.33mmol/l) when compared to both ULD (1.3±0.36mmol/l) and UHD (1.05±0.30mmol/l) schools, p<0.001. The difference between ULD and UHD was also significant, p < 0.001. Further assessment showed that children from the rural schools had significantly higher ratios of both total cholesterol/HDL-C and LDL-C/HDL-C (Table 2).

Smoking

In total, 35% of the study population reported living in the same household with a person who smoked, leading them to passive smoking. In comparison, children from the UHD schools had the highest proportion of passive smokers (42.8%). Only six (1.2%) subjects were active smokers. No difference was found between schools (Table 2). Awareness of the hazards of smoking was high among all children (97.2%).

Table 2. Cardiovascular risk factors by school setting

	Total *N = 508	ULD N = 142	UHD N = 166	Rural N = 200	Significance test
BP (mmHg)					
Systolic BP	108.2±11.9	112.9±9.7	109.8±9.3	103.6±13.0	ULD>>UHD>>R
Diastolic BP	66.4±8.7	69.2±8.7	66.0±7.0	64.7±8.9	ULD>>UHD=R
Hypertension (%)					
Systolic	11.4	29.6	4.8	4.0	ULD>>UHD=R
Diastolic	8.1	20.4	3.0	3.5	ULD>>UHD=R
Combined	3.9	11.3	1.2	1.0	ULD>>UHD=R
Cholesterol (mmol/l)					
Total	3.56±0.88	4.19±0.82	3.74±0.73	2.98±0.64	ULD>>UHD>>R
LDL	1.99±0.66	2.26±0.63	1.96±0.59	1.83±0.68	ULD>>UHD=R
HDL	0.88±0.38	1.3±0.36	1.05±0.30	0.63±0.33	ULD>>UHD>>R
	0.98±0.42	1.02±0.45	0.91±0.42	1.02±0.38	ULD=R>UHD
Tryglycerides (mmol/l)					
Total/HDL	4.05	3.22	3.56	4.73	ULD=UHD<R
LDL/HDL	2.26	1.74	1.87	2.90	ULD<UHD<<R
Hypercholesterolemia (%)					
Total-C > 5mmol/l	4.1	12.1	3.1	0.0	ULD>>UHD>R
LDL-C > 3mmol/l	2.0	5.3	0.6	1.1	ULD>UHD=R
Blood glucose (mmol/l)	4.88±0.74	5.07±0.47	4.84±0.54	4.73±0.81	ULD>>UHD=R
BMI (kg/m^2)	17.07±3.35	18.38±4.93	16.64±4.92	16.50±2.04	ULD>>UHD=R
Obesity (%)	5.3	16.9	1.8	0.0	ULD>>UHD=R
Smoking (%)					
Active	1.2	0.0	1.2	2.0	ULD=UHD=R
Passive	35	26.1	42.8	34.5	ULD<UHD=R

*N = 483 for blood lipid analyses, ULD= Urban Low Density, UHD= Urban High Density, R= Rural
>> significant difference, p<0.001 > significant difference, p<0.05 = no significant difference

Physical inactivity

The level of physical activity was assessed using two criteria: (1) means of going to school, (2) spare time activities. In addition, the subject's attitudes towards sports were interrogated. About two thirds (68.9%) of the children were going to school by foot, 29.1% by motor vehicles and 2% by bicycles (Table 3).

Table 3. Most frequently used transportation to school

	Urban low density n (%)	Urban high density n (%)	Rural n (%)
Walking	13 (9)	150 (90)	187 (94)
Bicycle	0 (0)	0 (0)	10 (5)
Public transport	35 (25)	15 (9)	3 (2)
School bus	30 (21)	0 (0)	0 (0)
Private transport	64 (45)	1 (1)	0 (0)
Total	**142 (100)**	**166 (100)**	**200 (100)**

The majority (>90%) of children from the ULD schools were using a form of motor vehicles for transport. On the contrary, children from the UHD and rural schools were walking. Sixty one percent of the population was active during their spare time, playing football and other games. Only 12% were leading a sedentary life style (watching TV or just staying at home). Four percent of the subjects engaged themselves in farm work after school hours. On the response on their attitude towards sports, majority (88%) responded by acknowledging that physical activity was good for health. Fifty three (11%) subjects regarded sports as bad for health and 10 (2%) subjects were not certain whether sport was good or bad for health.

Discussion

In this study both systolic and diastolic blood pressures were found to rise with age. This is consistent with earlier reports.(11) These results are similar to those found by Hamidu et al in a study from Nigeria.(12) Children aged 5–16 years had mean systolic and diastolic blood pressures of 102 mmHg and 65 mmHg respectively. We found the prevalence of systolic, diastolic and combined hypertension to be 11.4%, 8.1% and 3.9% respectively. This is different from the prevalence found earlier within Tanzanian adolescents aged 15 – 19 years.(13) The prevalence of hypertension in this study was found to be only 0.4%. This difference could be due to the fact that they used a fixed cut off point for hypertension of □ 140/90 mmHg, regardless of age, height and sex. Our results are however similar to those found by Chadha et al in India.(14) Areas of residence are claimed to influence the mean blood pressure levels of the inhabitants.(15) In this study, subjects from the urban areas had higher mean systolic and diastolic blood pressures. Furthermore, within the urban area, there was a significant difference in mean blood pressure between those from ULD and from UHD areas. These differences are more likely to be even larger because children from ULD were in average younger than children from UHD and rural areas. These results are similar to those found in previous African studies.(15) Affluence and socio-economic status of the individual families determine the areas of settlement, and are directly influencing the children's lifestyle.

We found a striking finding in our study regarding the differences in prevalence of obesity in the three school settings, i.e. 16.9%, 1.8% and 0.0% in ULD, UHD and rural schools, respectively. The increase in obesity during childhood is multifactorial. Several studies have concluded that the sedentary lifestyle of today's children and adolescents is a major determinant.[16] Also causally related to obesity is the availability of food rich in energy ``fast foods´´ around school premises, as well as familial obesity and socio-economic status of parents, which makes children have enough money to buy food rich in energy and soft drinks. Difference in socio-economic status of the parents and the lifestyle in these school settings might explain the differences.

The health problems brought about by cigarette smoking can not be overemphasised. Most studies have shown a strong dose-response relation of cigarettes smoked to deaths from CVD. In addition, smoking increases the risk of peripheral arterial occlusive disease, and various forms of cancer.[17] In this study, cigarette smoking was found in only 1.2% of the subjects. These results are similar to earlier findings by Kitange et al in which the prevalence of cigarette smoking was found in only 1.1% of the adolescents aged 15 years.[13] The results are however different from those found in most European and American children.[18,19] The low prevalence of active cigarette smoking in these children can be explained by the fact that at this young age parents still are controlling their children's behaviour, and culturally parents discourage smoking at young age. However, this trend may change because of the increasing level of cigarette advertisement in the country. Surprisingly was the finding in this study of high prevalence (35%) of passive smoking in these young children. The current findings suggest that even if the young children do not smoke by themselves, they cannot escape the smoke that is coming from their own parents and close relatives. So, with the high prevalence of smoking in the adult population the problem of passive smoking will still be there in these children.

Related to the prevention of CVD, daily physical activity in children has become a field of interest. Epidemiological studies have shown that physical activities appear to offer some degree of protection against CVD, hence a fundamental approach for prevention should begin at childhood[20]. This study found most of the children (61%) to be active, engaging themselves in sports, doing farm and other house activities (8%), and most of them were going to school on foot as part of their daily activities. There was however a difference in the level of activities with regard to the different school settings. The subjects from ULD schools were more likely to go to schools using motor vehicles as compared to those from the UHD and rural schools, thus lacking walking as part of physical activity. However this study did not look on the actual levels of physical activities since this would have involved direct observation of the level of activities of the children. We can therefore not be able to conclude on the influence of different intensities of physical activities from these finding. Some activities like water fetching from distances, assisting in food harvest or collecting firewood are common in the rural areas and in some less well off families in Dar es Salaam. This may contribute to these children being more active than those from affluent urban families.

Type 2 diabetes in children is an increasing problem world-wide, being more marked in the developed world. The problem goes hand in hand with the world-wide increase in the prevalence of obesity in children, coupled with today's sedentary lifestyle. In this study the mean level of blood glucose was found to be 4.88±0.74 mmol/l. This figure is similar to that found by other researchers among Tanzanian adolescents, aged 15 –19 years in which the mean level was 4.2 mmol/l.[13] The most prosperous school setting, ULD had the highest mean level of blood glucose. This trend has also been observed by previous researchers.[21] The differences in the mean blood glucose levels in this study population can be explained by the differences in the levels of type 2 diabetes precursors in the different school settings. As reported earlier, the most prosperous subjects (those from ULD schools) were more likely to be obese and to have a sedentary lifestyle as compared to those from the UHD and the rural subjects. The two (i.e. obesity and physical inactivity) are major determinants of glycaemic level.

In the present study we have shown the mean serum total cholesterol to be 3.52 mmol/l in males and 3.61 mmol/l in females. These results are in keeping with those found by others among Tanzanian adolescents in which the values were 3.46 mmol/l in males and 3.74 mmol/l in females.[13] This still reflects a low risk profile from hypercholesterolemia. In the present study, the mean values of total serum cholesterol were found to be significantly higher in the most affluent school children, than in children from UHD and rural areas. Whether this difference in serum cholesterol levels is protective to the under privileged children (rural) against atherosclerosis or whether the affluent children have a higher risk of atherosclerosis in adult life is a question that need to be part of a long term follow up study. Another striking finding is the low HDL-cholesterol level in children from the rural areas. It is a general consensus that low levels of HDL-cholesterol are harmful even if the total cholesterol level is only borderline elevated.[22] The clinical importance of low HDL-cholesterol in individuals with particularly low total and LDL-cholesterol level is however unclear.[23] This study also found the ratios of LDL-cholesterol/HDL-cholesterol and Total/HDL-cholesterol to be higher in the underprivileged rural children. The ratios have been considered to be important markers of the risk of atherogenesis, i.e. an increased ratio is a risk for atherosclerosis.[24] The paradox finding in our study can be explained as follows; the ``westernization´´ of developing countries gives increased values of all cholesterol fractions, i.e. total, LDL-cholesterol and HDL-cholesterol. With low total cholesterol levels there is only a small fraction of HDL cholesterol. With increasing intake of fat especially saturated fat and increasing levels of total cholesterol it is beneficial when HDL-cholesterol increases more than the LDL-cholesterol and thereby constitutes a fraction total cholesterol/HDL-cholesterol and LDL-cholesterol/HDL-cholesterol decrease. That is what one observes when the individuals are of normal weight. With obesity, HDL-cholesterol decreases both in absolute number and its fraction (metabolic Syndrome). These results therefore represent a spectrum of progression towards the metabolic syndrome. In our study the children in all three groups are still far from the state of metabolic syndrome, ie even the most affluent children are not yet there.

Conclusion

The prevalence of the conventional cardiovascular risk factors is generally low among children in this society. There is a marked difference in the prevalence of cardiovascular risk factors among children from different socio-economic background, being very low in those from the rural and low-income background and considerably high in those from the affluent socio-economic background.

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