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Original Research Article

Lipid profile in school children: study from a District of Uttar Pradesh, India

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ABSTRACT

Background: Lipid imbalance when diagnosed in childhood, can forecast the development of atherosclerosis in adulthood and its complications. Therefore, early detection of dyslipidemia should begin in childhood and it should lead to long-term prevention of atherosclerosis by controlling the risk factors. The Objectives of the study were to study lipid profile of children in the age group of 10-19 years and the prevalence of dyslipidemia among them.
Methods: This is a cross-sectional study, which was conducted in 300 children aged 10 to 19 years, of either sex, from schools of Barabanki. After getting consent from school authorities, children and their parents, a detailed history was taken with a pre-designed pro forma and fasting blood samples were analyzed for lipid profile.
Results: Mean total cholesterol (TC) for boys and girls were 161.06±33.14 mg/dl and 164.68±33.53 mg/dl, LDL-C 99.35±27.41 mg/dl and 101.71±26.44 mg/dl, HDL-C 42.76±5.78 mg/dl and 43.93±5.68 mg/dl, VLDL-C 18.94±4.47 mg/dl and 19.04±4.97 mg/dl and triglycerides (TG) 94.69±22.34 mg/dl and 95.20±24.83 mg/dl respectively. Serum TC, TG, LDL-C, VLDL-C and HDL-C levels were higher in girls than in boys for all age groups. 26.55% boys and 25.20% girls had TC levels above 190 mg/dl. The overall results revealed that 26.0% of children had hypercholesterolemia.
Conclusions: The study presents age- and sex-related findings about the dynamics of changes in serum lipid levels in children. Significant number of children had hypercholesterolemia.

Keywords: Atherosclerosis, Dyslipidemia, Lipid profile

INTRODUCTION

Coronary artery disease (CAD) has been delineated as the greatest epidemic humanity has ever faced.[1] It takes a tremendous toll in premature sickness, disease, and death, which have a major economic impact on the person and upon the health care delivery system. Accounting nearly 80% of all cardiac morbidity, CAD is now the major cause of morbidity and mortality throughout the world. In most countries, it accounts for 30% of all deaths.[2]

Many studies demonstrate that atherosclerotic process has its silent beginning during childhood.[3,4] The earliest grossly visible arterial lesions of the atherosclerotic process are Fatty streaks. Autopsy studies demonstrated that these fatty streaks are the precursors of mature

atherosclerotic lesions.[5] Dyslipidemia, hypertension, poor eating habits, sedentary lifestyle, constitute ideal conditions for the development of CAD. It is known that the pathology of atherosclerosis starts from childhood and if risk factors identified early and corrective steps are taken, the process can be delayed.[6,7] For the primary prevention of coronary artery disease in adulthood, detection of dyslipidemia must begin early, followed by appropriate interventions to reduce it. Therefore, blood lipid profile in children should be screened as early as possible to detect dyslipidemia and management should involve the adoption of healthy lifestyles, reduction of total and saturated fat consumption and encouragement of physical activity. The present study would contribute to establish the norms of lipid profile in Indian children for which there are only a few studies from India.[8-12] In this context, the western norms may not be applicable for our setting in view of the divergent genetic, dietary, socio-cultural and lifestyle factors.[13]

The present study therefore was, designed to study lipid profile and prevalence of dyslipidemia among children in the age group of 10-19 years.

METHODS

It was a descriptive cross-sectional study, which was conducted in Barabanki district during March 2016 to August 2016. Barabanki district is divided into 6 Tehsils. A list of all the Government and Private schools was prepared Tehsil-wise. From this list, three government and three private schools were selected from each Tehsil of Barabanki by simple random sampling technique. By this method, 36 schools were selected out of the total schools listed. In next stage, from each Tehsil, one government and one private school were approached and the purpose of the study was explained to the concerned authority of the school and consent was asked for the study. If they denied giving consent, the next school was approached and by this method, one government and one private school were selected from each Tehsil and twelve schools were selected from the District.

In next stage, from each selected school, a list of students of the age group 10 to 19 years was obtained and 10% students were selected for study by simple random sampling technique. 1343 student were selected by this method. After applying the exclusion criteria, 962 students were selected. Parents of these selected students were approached through the school authorities to obtained consent for the study and for the collection of fasting blood sample. 725 parents gave consent for the study. These parents were told send their child an empty stomach on a fixed date scheduled for blood sample collection.

On the sample collection day, 332 students came in fasting state. The sample was collected and anthropometric parameters were recorded of these students. Samples were sent to the laboratory for lipid profile estimation. 32 samples were discarded because they were either inadequate or haemolysed and finally, 300 samples were analysed.

Inclusion criteria

Healthy children (10 to 19 years) resident of Barabanki, Uttar Pradesh, India.

Exclusion criteria

Subjects with chronic illness, having a history of hospital admission in last 6 months, having a history of weight loss in last 6 months, those who were on steroids, anticonvulsants, diuretics, having hypothyroidism or nephrotic syndrome were excluded from the study.

Pretesting was done before actual data collection and relevant modifications were made.

Detailed history, including dietary history, was taken with a systematically pre-designed pro forma. A complete physical examination was done to rule out any systemic disorder. Anthropometric measurements were done in these children and body mass index (BMI) was documented. The percentile charts based on gender, age and height provided by WHO growth charts were used for classification.[14]

Blood samples were drawn after a minimum of 12 hours of fasting from all the children. Serum was separated within 2 hours of sample collection and then was analysed.

Serum cholesterol estimation was done by an enzymatic endpoint method using cholesterol esterase, cholesterol oxidase and peroxidises (CHOD-PAP). Estimation of Total Cholesterol (TC) was done by Modified Roeschlau's method.[15] Estimation of Triglyceride (TG) was done by the method of Wako with modification of Fossati et al and McGowan et al.[16,17] Estimation of HDL-Cholesterol (HDL-C) was done by the methodology of Burstein et al.[18]

Determination of VLDL And LDL Cholesterol was done by following Fried Ewald's formula:[19]

VLDL Cholesterol (VLDL-C) = TG / 5

LDL Cholesterol (LDL-C) = TC - (HDL-C + VLDL-C)

In this study, to determine the prevalence of hypercholesterolemia, the cut-off point was taken as above 190 mg/dl of TC.[8] The Ethical Approval for the study was obtained from the Institute's Ethics Committee. The data collected was analyzed statistically with the help of SPSS software (version 17.0). Continuous variables are expressed as mean±SD and percentile. The comparison of the data was performed

using appropriate statistical test. p value</=0.05 were considered significant.

RESULTS

The study consisted of 300 school children, 59.0% were boys, 41.0% were girls, and their mean age was 13.24±2.50 years (177 boys and 123 girls). Most children belonged to Nuclear families (87.0%) than to Joint families (13.0%). This shows an upsurge of modernization and has an impact on the eating habits of the children. About 63.0% were vegetarian, 7.3% were eggetarian and 29.7% were non-vegetarian (Table 1).

Table 1: Demographic and biochemical characteristics of study population

Parameter	Boys (n = 177) mean±SD	Girls (n = 123) mean±SD	Total (n = 300) mean±SD
Age (in years)	12.90±2.35	13.69±2.65	13.24±2.5
Weight (kg) *	37.99±13.04	38.48±12.1	38.25±12.63
Height (cm) *	147.60±12.90	145.73±9.92	146.9±11.74
BMI (kg/m^2) *	17.03±3.93	17.81±4.27	17.36±4.08
TC (mg/dl) *	161.06±33.14	164.68±33.53	162.68±33.28
TG (mg/dl) *	94.69±22.34	95.2±24.83	95.03±23.3
VLDL-C (mg/dl) *	18.94±4.47	19.04±4.97	19.01±4.66
LDL-C (mg/dl) *	99.35±27.41	101.71±26.44	100.42±26.99
HDL-C (mg/dl) *	42.76±5.78	43.93±5.68	43.25±5.77
TC/HDL-C Ratio*	3.78±0.67	3.75±0.58	3.77±0.63
LDL-C/HDL-C Ratio*	2.34±0.61	2.32±0.5	2.33±0.57

*statistically not significant (p>0.05), BMI- Body Mass Index, TC: Total Cholesterol, TG Triglycerides, VLDL-C Very Low-density lipoprotein cholesterol, LDL-C Low-density lipoprotein cholesterol, HDL-C High-density lipoprotein cholesterol.

Table 2: Mean±SD of lipid levels by gender and age groups.

Sex	Age group (years)	TC (mg/dl)	TG (mg/dl)	VLDL-C (mg/dl)	LDL-C (mg/dl)	HDL-C (mg/dl)	TC/ HDL-C ratio	LDL-C/ HDL-C ratio
Boys* (n=177)	10-13* (n=123)	162.57 (30.67)	94.41 (23.96)	18.88 (4.79)	100.53 (24.13)	43.16 (5.58)	3.78 (0.58)	2.34 (0.50)
	14-16* (n=36)	171.08 (36.18)	98.22 (26.99)	19.64 (5.40)	105.74 (29.12)	45.69 (5.85)	3.75 (0.61)	2.32 (0.54)
	17-19* (n=18)	162.29 (36.48)	94.29 (23.77)	18.86 (4.75)	100.06 (28.35)	43.38 (5.45)	3.72 (0.50)	2.28 (0.45)
Girls* (n=123)	10-13* (n=63)	159.98 (31.54)	94.53 (21.51)	18.91 (4.30)	98.48 (26.27)	42.6 (5.77)	3.77 (0.63)	2.32 (0.58)
	14-16* (n=36)	165.0 (36.57)	96.56 (24.09)	19.31 (4.82)	102.8 (30.03)	42.89 (5.87)	3.86 (0.80)	2.41 (0.71)
	17-19* (n=24)	160.5 (37.95)	92.11 (25.25)	18.42 (5.05)	98.47 (30.61)	43.61 (5.90)	3.68 (0.69)	2.26 (0.62)

* statistically not significant (p>0.05) TC: Total Cholesterol, TG: Triglycerides, VLDL-C Very Low-density lipoprotein cholesterol, LDL-C Low-density lipoprotein cholesterol, HDLC: High-density lipoprotein cholesterol

Table 3: Children with hypercholesterolemia (TC>190 mg/dl)

Age group (years)	Boys	Girls	Total
10-13	28 (n=123)	13 (n=63)	41 (n=186)
14-16	9 (n=36)	10 (n=36)	19 (n=72)
17-19	10 (n=18)	8 (n=24)	18 (n=42)
Total	**47 (n=177)**	**31 (n=123)**	**78 (n=300)**

TC: Total Cholesterol

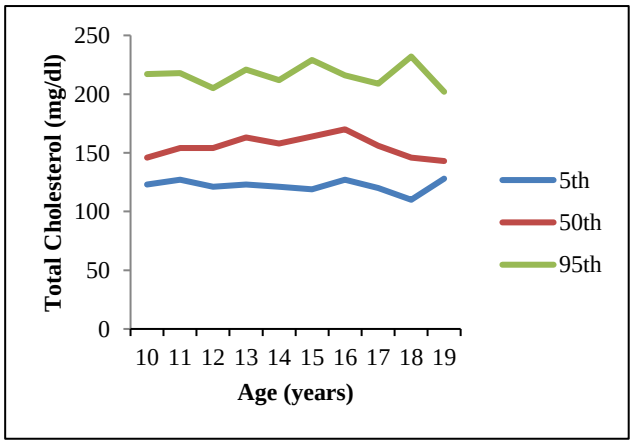
The mean weight for boys and girls were 37.99±13.04 kg and 38.48±12.10 kg, Height 147.60±12.90 cm and 145.73±9.92 cm, BMI 17.03±3.93 kg/m^2 and 17.81±4.27 kg/m^2. Mean total cholesterol (TC) for boys and girls were 161.06±33.14 mg/dl and 164.68±33.53 mg/dl, LDL-C 99.35±27.41 mg/dl and 101.71±26.44 mg/dl, HDL-C 42.76±5.78 mg/dl and 43.93±5.68 mg/dl, VLDL-C 18.94±4.47 mg/dl and 19.04±4.97 mg/dl and triglycerides

(TG) 94.69±22.34 mg/dl and 95.20±24.83 mg/dl respectively (not significant, p value>0.05) (Table 1). The children were grouped into three age groups: 10-13 years, 14-16 years and 17-19 years. All lipid parameters, in both boys and girls, peaked at 14-16 years and thereafter their levels decreased by about 5% among adolescents aged 17-19 years. Levels at 10-13 years age group were almost similar to the late adolescent age group levels (Not significant, p value>0.05) (Table 2).

Table 4: Mean and percentile (5th, 50th and 95th) values of serum lipid levels in study group.

Age (yr)	TC (mg/dl)				TG (mg/dl)				VLDL-C (mg/dl)				LDL-C (mg/dl)				HDL-C (mg/dl)			
	Mean (SD)	5	50	95	Mean (SD)	5	50	95	Mean (SD)	5	50	95	Mean (SD)	5	50	95	Mean (SD)	5	50	95
10	159.6 (31.2)	123	146	217	92.5 (21.7)	58	96	120	18.5 (4.3)	12	19	24	98.6 (27.1)	62	93	150	42.5 (5.9)	33	44	52
11	161.8 (31.1)	127	154	218	100.3 (20.7)	64	104	125	20.1 (4.1)	13	21	25	99.1 (24.8)	71	96	145	42.7 (6.2)	32	45	51
12	155.8 (27.9)	121	154	205	91.9 (21.1)	59	97	119	18.4 (4.2)	12	19	24	95.2 (22.8)	61	93	132	42.2 (5.4)	33	42	51
13	166.1 (34.0)	123	163	221	95.8 (24.5)	58	97	131	19.2 (4.9)	12	19	26	103.3 (27.0)	66	100	148	43.6 (5.6)	35	45	52
14	166.6 (31.9)	121	158	212	96.1 (24.9)	59	96	127	19.2 (5.0)	12	19	25	103 (25.8)	64	99	141	44.4 (5.3)	36	44	53
15	168.7 (43.7)	119	164	229	101.6 (22.4)	67	98	127	20.3 (4.5)	13	20	25	105.1 (36.0)	61	99	168	43.3 (8.3)	32	42	55
16	172.5 (38.4)	127	170	216	96.0 (31.7)	45	111	124	19.2 (6.3)	9	22	25	108 (30.5)	68	102	143	45.2 (4.7)	37	47	50
17	161.7 (32.6)	120	156	209	92.7 (20.4)	70	89	121	18.5 (4.1)	14	18	24	99.7 (26.6)	63	96	137	43.5 (4.4)	36	45	48
18	163.6 (44.4)	110	146	232	99.1 (26.0)	66	100	140	19.8 (5.2)	13	20	28	100 (34.5)	57	89	152	43.8 (7.0)	34	46	52
19	158.4 (31.1)	128	143	202	86.0 (24.9)	57	84	122	17.2 (5.0)	11	17	24	98.2 (25.0)	71	89	136	43 (4.8)	35	43	49

Data presented are Mean (Standard Deviation) for continuous variables. TC Total Cholesterol, TG Triglycerides, VLDL-C Very Low-density lipoprotein cholesterol, LDL-C Low-density lipoprotein cholesterol, HDL-C High-density lipoprotein cholesterol.



TC- Total Cholesterol

Figure 1: Percentile curves for the 5th, 50th and 95th percentiles of TC of study group.

It was seen that 26.55% boys and 25.20% girls had TC levels above 190 mg/dl. The overall results revealed that 26.0% of children had hypercholesterolemia (Table 4).

DISCUSSION

It is reported that the prevalence, morbidity and mortality due to CAD in Asian Indians is three to four times higher than Americans and Europeans, and even higher in comparison to all other Asians.[20] It has been confirmed that patients with diabetes have an increased risk of cardio-vascular disease and the insulin resistant phenotype is marked by high levels of plasma insulin, VLDL-C, triglycerides and free fatty acids. These early changes may be important because these risk factors for atherosclerosis track over time; so that children with elevated cholesterol levels or blood pressure may become an adult with CAD.[21] The balanced lipid profile is an important factor, in young age to maintain health and in the later life to avoid early morbidity. Thus blood lipid profiles in children should be screened as early as possible to detect imbalances; furthermore, there are limited data available on the characterization of profiles of lipids in children. The first Guideline for Atherosclerosis Prevention in Children and Adolescents recommended assessment of cholesterol levels for every child over 10 years old.[22]

In a cross-sectional study, in Delhi, 410 healthy children, in the age group of 3-12 years were screened for lipid profile; the mean value was found to be 134.5 mg/dl of cholesterol, 91.1 mg/dl of TG, 34.15 mg/dl of HDL-C and 80.1 mg/dl of LDL-C. In this study lipid profile norms and cut-off levels to define abnormalities for Indian children were recommended (Khalil et al).[8] Wajid Ali et al [23] studied 314 normal Kashmiri children in the age group of 5-14 years including 169 boys and 145 girls for their blood lipids and lipoprotein levels. Mean TC of 172.8 mg/dl, TG of 66.4 mg/dl, HDL-C of 71.2 mg/dl, LDL-C of 88.9 mg/dl and VLDL-C of 13.3 mg/dl was

obtained. Furthermore, yet in another study, it was observed that 5825 school children, aged 6-18 years, residing in Hisayama Japan, had a mean TC ranging from 155-172mg/dl for boys and 150-170 mg/dl for girls.[24] The study finds that there was no difference in the mean value of TC in both sexes. According to Dholpuria R et al who studied 200 healthy adolescents from upper and middle class of society, in Bikaner, Rajasthan, the mean TC for boys and girls were 166.6 mg/dl and 161.4 mg/dl, LDL-C 94.0 mg/dl and 90.0 mg/dl, HDL-C 43.49 mg/dl and 44.6 mg/dl and TG 95.62 mg/dl and 88.0 mg/dl respectively.[25]

In 2007, a cross-sectional study was done in Turkey involving 2896 children (1467 girls, 1429 boys) aged between 7-18 years, to evaluate the prevalence of dyslipidemia and also evaluate serum non-HDL-C levels according to gender difference, age groups and living areas.[26] The mean TC for boys and girls, respectively, were 159.2mg/dl and 169.1mg/dl, TG 86.7mg/dl and 89.7mg/dl, LDL-C 89.6 mg/dl and 97.6mg/dl, HDL-C 51.1 mg/dl and 53.3mg/dl, Non-HDL-C 106.7mg/dl and 115.5mg/dl. Nijaguna et al studied 440 school adolescents (220 boys and 220 girls) in Bangalore and found the mean TC for boys and girls were 123.02mg/dl and 136.18mg/dl, TG 91.94mg/dl and 102.75mg/dl, LDL-C 66.46mg/dl and 76.74mg/dl, HDL-C 38.11mg/dl and 38.83mg/dl, VLDL-C 18.47mg/dl and 20.64mg/dl, Non-HDL-C 84.91mg/dl and 97.34mg/dl.[27]

Mean serum TC level found in the present study compared well with those of Kashmiri, Japanese, Rajasthani and Turkish children and other lipid profile compared well with the Turkish study and the study by Dholpuria R et al.[23-26] The higher values of lipid profile than those observed by Khalil et al, can be explained by the rapid westernization of our society and changing food habits, especially high consumption of junk food in children these days.[8] Gupta et al had also reported the mean total TC of 166.6 mg/dl in the age group of 13-17 years, it is also well compared with the present study.[28] They reported that in adolescent borderline (170-199mg/dl) and definite (≥200mg/dl) hypercholesterolemia was present in 32.9% and 6.8% respectively. The Turkish study demonstrated hypercholesterolemia was present in 14.1% of girls and 9.5% of boys, respectively, with an overall prevalence of 11.8%.[26] While in Slovak study, about 19% of boys and 25% of girls had borderline elevated and 6% of boys and 15% of girls had elevated TC.[29]

In the present study, to determine the prevalence of hypercholesterolemia the cut-off point was taken as above 190 mg/dl of TC.[8] 26.55% boys and 25.20% girls had TC levels above 190mg/dl. The overall results revealed that 26.0% of children had hypercholesterolemia, which was lower than the study of Gupta et al, who had shown the prevalence of hypercholesterolemia as 39.7% in adolescents and Dholpuria R et al who reported it to be 50%.[22,25]

It may be due to the fact that the Indian studies included children only of upper and middle class of the society with no economic constraints and had an excess consumption of fat-rich food in their diets and the Turkish and Slovak children may have different genetic and nutritional factors such as intake of animal foods, carbohydrate, and high fiber consumption.[30]

The comparatively lower levels of lipid profile in the current study from NCEP standards are consistent with the observation that developing countries have generally lower values than the developed world.[13] This is well explained by the difference in genetic makeup, environment, lifestyle, dietary habits and by the use of different techniques for assessment and even by the same technique in different laboratories.

The most striking results were higher in girls within each of the lipid variables analyzed, though the difference was not significant statistically. This result is in accordance with findings in Turkish, Bangalore, Mexican, and Brazilian study.[26,27,31,32] In contrast, in the study by Dholapuria et al, all the lipid variables except HDL-C were marginally higher in boys than girls.[25] These inconsistent results may be due to genetic variations and different dietary habits in Turkey, Mexico, Bangalore, Brazil, Bikaner, and Barabanki. Different study designs may also contribute to the different results, as the influence of sex hormones becomes more obvious with increasing age. The gender-specific differences may be directly related to hormonal differences between the two sexes.

During puberty, an increase of both TC and TG levels are seen in children, which may be a result of the pubertal increased insulin resistance that makes an appearance during early puberty.[33] In Slovak study, both mean TC, and TG levels in boys and TG levels in girls were peaked at 11-14 years and thereafter decreased by 5%-15%.[29] In the present study, all lipid parameters, in both boys and girls, peaked at 14-16 years and thereafter their levels decreased by about 5% among adolescents aged 17-19 years. Levels at 10-13 years age group were almost similar to the late adolescent age group levels. In the study by Madhvan et al in Delhi on 680 boys and 521 girls aged 14-18 years aimed to develop sex- and age-specific percentile reference data for serum lipids, boys aged 14 to 16 years showed a minimal increase in mean serum TC followed by a rapid decline afterwards.[12] However, the serum TC in adolescent girls showed a relative minimum at 16-17 years. It is seen that at the age group of 14-16 years, the children in India are subjected to many important and strenuous examinations, defining their future. This often leads to a sedentary lifestyle and adversely changed dietary habits during this period, which could be the result of higher levels of TC and lower HDL-C levels seen in this age group.[12] At the age of 17-18 years, the average Indian children enter graduation when the physical activity and dietary habits are likely to become better which may be the reason of

lower TC and higher HDL-C levels observed in these adolescents.[34]

Among the lipoproteins, LDL-C is considered the major atherogenic fraction and thus both the primary prevention and the hypolipidemic therapy are directed to it.[35] The changes seen in levels of LDL-C during puberty are almost consistent with the dynamics in TC levels because approximately 50%-60% of the cholesterol in serum is transported by LDL-C during this age. In the present study, the changes in LDL-C levels were very closely related to TC levels in all subjects. The correlation between TC and LDL was almost linear in this study.

It is known that low HDL-C is an independent risk factor for CAD, not influenced by levels of LDL-C.[36] It is established that levels of HDL-C are noticeably lower in males than females.[37] In children, this gender-related difference is not necessarily this clear. In Istanbul[38] 420 children from the age group, 0-15 years were studied and no considerable difference was observed between the HDL-C levels in boys and girls. Interestingly, after the age of 1 year, the HDL-C levels remained relatively stable in both genders. Similarly, in Slovak children[29] aged 7-18 years, the mean HDL-C levels were the same for both sexes. In our study too we had similar results for both sexes.

In adults, the ratio of HDL-C to TC and HDL-C to LDL-C are considered even more predictive for CVD.[39] The TC/HDL-C ratio also called “atherogenic index” should ideally be around 5 and while the LDL-C/HDL-C ratio around 3.5. These have found a place as markers of coronary atherosclerosis.[40] But have received limited attention in pediatric practice and studies. In our study, the mean atherogenic index (TC/HDL-C) was 3.77±0.63 and LDL-C/HDL-C ratio was 2.33±0.57. These correlate well to the TC/HDL-C ratio of 4.3±1.4 and LDL-C/HDL-C ratio of 2.65±1.11 observed by Khalil et al.[8] These ratios may find a use for risk assessment of atherosclerosis in children in future.

CONCLUSION

The study presents age- and sex-related findings about the dynamics of changes in serum lipid levels. Significant number of student had hypercholesterolemia.

Recommendations

There is a need for further studies, using a larger sample size to be more representative of the society, to evaluate the lipid profile norms for different age groups and to determine the optimal timing and cut-off points for the screening of dyslipidemia in children and adolescents. It is recommended that children should have their lipid profiles checked at least by the age of 10 years, to detect imbalances early, so that necessary modifications in dietary consumption of fats, adoption of healthy lifestyles and encouragement of physical activity can be done.

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