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ORIGINAL ARTICLE

Cumulative prevalence of risk factors for atherosclerotic cardiovascular diseases in Iranian adolescents: IHHP-HHPC

A prevalência cumulativa de fatores de risco para doença cardiovascular em adolescentes iranianos – IHHP-HHPC

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Abstract

Objective: To evaluate the cumulative prevalence of atherosclerotic cardiovascular disease risk factors in a representative sample of Iranian adolescents.

Methods: The subjects of this cross-sectional study were 1,000 girls and 1,000 boys, ages 11-18 years, selected by multi stage-random cluster sampling from urban and rural areas of three cities in Iran.

Results: The prevalence of physical inactivity, dyslipidemia, smoking, high blood pressure and obesity (body mass index >95th percentile) were 66.6, 23.7, 8.7, 5.7 and 2.2%, respectively. Of subjects studied, 79.1% had at least one and 24.6% had two cardiovascular disease risk factors. The prevalence of physical inactivity was significantly lower in boys than girls [53.9 vs. 79.3%, respectively, OR 95%CI, 0.44 (0.39-0.51)]. The prevalence of smoking was higher in boys than girls [13.1 vs. 4.2%, respectively, OR 95%CI, 3.4 (2.4-4.9)].

Conclusion: Considering the high prevalence of cardiovascular disease risk factors in adolescents, age-appropriate and culturally sensitive interventions for lifestyle change are warranted, so that preventive measures can be taken in a timely manner.

J Pediatr (Rio J). 2005;81(6):447-53: Cardiovascular disease, risk factors, adolescent, prevalence.

Resumo

Objetivo: Avaliar a prevalência cumulativa de fatores de risco para doenças cardiovasculares ateroscleróticas em uma amostra representativa de adolescentes iranianos.

Métodos: Os sujeitos incluídos neste estudo transversal foram 1.000 meninas e 1.000 meninos com idades entre 11 e 18 anos, selecionados em amostragem aleatória de residentes em áreas urbanas e rurais em três cidades do Irã.

Resultados: As prevalências de sedentarismo, dislipidemia, tabagismo, hipertensão e obesidade (índice de massa corporal > 95º percentil) foram de 66,6, 23,7, 8,7, 5,7 e 2,2%, respectivamente. Dentre os sujeitos avaliados, 79,1% apresentavam pelo menos um fator de risco e 24,6% apresentavam dois fatores de risco para doença cardiovascular. A prevalência de sedentarismo foi significativamente mais baixa nos meninos do que nas meninas [53,9 *versus* 79,3%, respectivamente, RC de 95%IC, 0,44 (0,39-0,51)]. A prevalência do tabagismo foi mais alta nos meninos do que nas meninas [13,1 *versus* 4,2%, respectivamente, RC 95%IC, 3,4 (2,4-4,9)].

Conclusão: Considerando a alta prevalência de fatores de risco para doenças cardiovasculares em adolescentes, são justificadas intervenções adequadas à idade e cultura dos sujeitos, com o objetivo de promover mudanças de estilo de vida necessárias para que medidas preventivas possam ser tomadas oportunamente.

J Pediatr (Rio J). 2005;81(6):447-53: Doença cardiovascular, fatores de risco, adolescente, prevalência.

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Introduction

There are multiple lines of evidence with regard to the strong association between the presence and extent of atherosclerotic cardiovascular disease (CVD) and the presence of their risk factors from early life. Thus, it is suggested that the emerging epidemic of atherosclerotic CVD can have its roots in early life. Findings from the Bogalusa study showed that as the number of CVD risk factors increases, so does the pathological evidence for atherosclerosis from early childhood.[1]

It is known that biological risk factors tend to occur more frequently together than expected by chance. This clustering in childhood and adolescence was shown in developed countries many years ago.[2] In developing countries, the extent of the problem remains unknown.

The prevalence of atherosclerotic CVD risk factors is high in the Iranian population with an escalating trend even in children and adolescents.[3] Considering the positive interaction between the biological CVD risk factors, which lead to higher risk for the development of CVD than just the sum of the risk of the separate risk factors, the present study aimed to determine the cumulative prevalence of these risk factors in a representative sample of Iranian adolescents.

Subjects and methods

This cross-sectional study was performed in 2001 as the baseline survey of a longitudinal interventional project named Heart Health Promotion from Childhood (HHPC), part of a national community-based program called Isfahan Healthy Heart Program.[4]

HHPC is evaluating the outcome of different interventions in two counties in a given province (Isfahan and Najaf-Abad in Isfahan province) in comparison to a reference area (Arak). During the second phase, interventions are being carried out only in Isfahan province based on the results of the first phase. In addition to process, and annual evaluation in the three counties, the post-intervention outcomes will be evaluated and compared.

The behavior, attitude, skills and knowledge (BASK) of 2,000 students (1,000 girls, 1,000 boys) ages 11-18 years, one of their parent (2,000 samples), 500 members of the school staff (the principal, the superintendent, the students' counselor, the health care professional, the exercise instructor, and four randomly selected biology teachers in each school) and 2,000 parents of preschool and elementary school children were evaluated. The atherosclerotic CVD risk factors were assessed in 2,000 students ages 11-18 years old, selected by multistage random cluster sampling from 56 middle and high schools of urban and rural areas according to CINDI protocol e.g. 250 subjects in each sex and age group.[5] These areas were defined concerning the national population census in 1999.

Considering the population distribution in the three counties, the urban/rural ratios of the subjects studied were 90/10, 60/40 and 66/34 in Isfahan, Najaf-Abad and Arak, respectively. Schools were stratified according to location (urban, rural), and the socioeconomic character of its uptake area, taking into considering the proportion of the different types of schools (government/private) to avoid socioeconomic bias. From each stratum, a proportional, two stage cluster sample of children was selected. The primary units (clusters) were the schools. The secondary units were the students within the schools, and equal numbers of students were sampled from each school. Students were allocated with code numbers and randomly selected using random number tables. The Ethics Committee of Isfahan Cardiovascular Research Center (ICRC, a WHO collaborating center) approved the study. Parental informed consent and student assent were obtained from all participants. When the response rates in the intervention and reference areas were 92 and 90%, respectively, sampling was continued to reach the stated number of subjects. A team of expert nurses, especially trained for this survey for one week, carried out the field examinations of the survey. All instruments were standardized; the scales and sphygmomanometers were zero-calibrated. Structured questionnaires were prepared for students, parents and school staff; their content validity was affirmed based on observations by a panel of experts from Isfahan University of Medical Sciences. Item analysis and reliability measures were assessed based on the response of 100 students, 50 parents and 50 school staff. The Cronbach alpha reliability coefficients for their questionnaires were 0.71, 0.72 and 0.75, respectively.

Subjects were instructed to fast for 12 hours before the screening, and compliance with fasting was determined by interview on the morning of examination. Blood samples were taken from the antecubital vein between 8:00 to 9:30 am during school days. After collecting blood samples, the participants were served a healthy snack and then continued with other measurements. The students' questionnaires were filled out confidentially under the supervision of trained nurses. The age and birth date were recorded. Height and weight were measured twice to ±0.2 cm and to ±0.2 kg, respectively with subjects being barefoot and lightly dressed; the averages were recorded. As a measure of obesity, body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters.

Blood pressure (BP) was measured using mercury sphygmomanometers (Richter, Germany) after 5-minutes of rest in the sitting position. The subjects were seated with the heart, cuff, and zero-indicator on the manometer at the observer's eye level. All reading was taken in duplicate in the right arm. Appropriate size cuffs were used with cuff-width 40% of mid-arm circumference, and cuff bladders covering 80 to 100% of the arm circumference and approximately two thirds of the length of the upper arm without overlapping.

The procedure was explained to the students, the cuff inflated and deflated once, the first BP measured was not used in the analysis of this study. The reading at the first and the fifth Korotkoff phase were taken as systolic and diastolic BP (SBP and DBP), respectively. The average of the two time measurements was recorded and analyzed.

The blood samples were centrifuged for 10 minutes at 3,000 rpm by portable centrifuge in schools and within 30 minutes of venipuncture. The blood serum was frozen (-20 °C), and was transported from all three counties to the central laboratory at ICRC, which meets the standards of the national reference laboratory of the Ministry of Health – a WHO collaborating center – and is also under the quality control of the Department of Epidemiology, St. Rafael University, Leuven, Belgium. Serum total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-C) and triglycerides (TG) were measured by an enzymatic method using an Elan 2000 autoanalyzer (Eppendorf, Germany). Low-density lipoprotein-cholesterol (LDL-C) was calculated (in serum samples with TG $\leq$ 400 mg/dl) according to the Friedewald equation.[6]

Definition of risk factors

Subjects with a BMI greater than the 95th percentile for age and sex were considered obese.[7] Dyslipidemia was defined as a TC, LDL-C or TG higher than the level corresponding to the standard age- and gender-specific 95th percentile.[8] Elevated BP was defined as the mean SBP or DBP above the 95th percentile for that age and gender after adjusting for weight and height.[7]

Those students who reported to smoke at least one cigarette per day were defined as smokers. Subjects were considered to be physically inactive if they reported watching TV more than 3 hours a day and not participating in regular exercise activities at least for three 20-minute sessions per week.

Statistical analysis

Data were collected and stored on a computer database. A trained team checked recorded information for missing values and data entry errors. Missing or doubtful data were rechecked by returning the questionnaires to the respective school. After tidying up the data, statistical analysis was done with the SPSS 11 (SPSS, Inc. Chicago, IL). The data are presented as frequencies, percentages, and 95% confidence intervals. The prevalence of different risk factors was compared using the χ^2 test. A p value < 0.05 was considered to be statistically significant.

Results

In this cross-sectional study, 1,000 girls and 1,000 boys with a mean age of 14.3±1.2 years were studied. Overall, 65% (n = 1,299) of subjects lived in urban and 35% (n = 701) in rural areas.

As shown in Table 1, the two most prevalent CVD risk factors were physical inactivity and dyslipidemia, with a prevalence of 66.6 and 23.7%, respectively. Of subjects studied, 79.1% (n = 1581) had at least one, and 24.6% (n = 491) had two risk factors (Table 2).

Table 1 - Prevalence of cardiovascular disease risk factors

	Physical inactivity* n (%)	Obesity (BMI > 95%) n (%)	Smoking† n (%)	Dyslipidemia‡ n (%)	High blood pressure§ n (%)
Total	1,332 (66.6)	43 (2.2)	173 (8.7)	473 (23.7)	114 (5.7)
Gender					
Girls	793 (79.3)	20 (2)	42 (4.2)	240 (24)	40 (4)
Boys	539 (53.9)	23 (2.3)	131 (13.1)	233 (23.3)	74 (7.4)
OR boys/girls	0.44 (0.39-0.51)	1.1 (0.6-2.1)	3.4 (2.4-4.9)	0.9 (0.9-1)	1.9 (1.2-2.8)
Age groups (school level)					
11-14 yrs (Middle school)	660 (66)	24 (2.4)	56 (5.6)	271 (27.1)	64 (6.4)
15-18 yrs (High school)	672 (67.2)	19 (1.9)	117 (11.7)	202 (20.2)	50 (5)
OR high school/ middle school	1.03 (0.91-1.1)	0.7 (0.4-1.4)	2.2 (1.6-3.3)	0.9 (0.8-0.9)	0.7 (0.5-1.1)
Living area					
Urban	874 (67.3)	28 (2.2)	112 (8.6)	302 (23.3)	82 (6.3)
Rural	458 (65.3)	15 (1.2)	61 (8.7)	171 (24.4)	32 (4.6)
OR urban/rural	1.091 (0.89-1.3)	1.007 (0.5-1.8)	0.99 (0.72-1. 3)	0.93 (0.7-1.1)	1.8 (0.8-2)
County of residence					
Isfahan	465 (66.2)	20 (2.8)	49 (7)	134 (19.1)	48 (6.8)
Najaf-Abad	191 (64.1)	8 (2.7)	30 (10.1)	59 (19.8)	51 (17.1)
Arak	676 (67.6)	15 (1.5)	94 (9.4)	280 (28)	15 (1.5)
p value	0.51	0.13	0.13	< 0.0001	< 0.0001

* Regular exercise < 3 sessions of 20 minutes each/week.
† Smoking of at least one cigarette/day.
‡ Total cholesterol or LDL-C or triglyceride > 95th percentile or HDL-C < 5th percentile.
§ Systolic and or diastolic blood pressure > 95th percentile.

Table 2 - Number of cardiovascular disease risk factors* in adolescents

	No risk factors n (%)	One risk factors n (%)	Two risk factors n (%)	Three risk factors n (%)	Four risk factors n (%)	Five risk factors n (%)	At least one risk factor n (%)
Total	419 (20.9)	1.9 (54.5)	428 (21.3)	59 (3)	3 (0.2)	1 (0.1)	1,581 (79.1)
Gender							
Girls	136 (13.6)	619 (61.9)	219 (21.8)	24 (2.4)	1 (0.1)	1 (0.1)	864 (86.4)
Boys	283 (28.3)	471 (47.1)	209 (20.9)	35 (3.5)	2 (0.2)	0 (0)	717 (71.7)
OR boys/girls	0.48 (0.39-0.57)	0.54 (0.45-0.65)	1 (0.9-1.3)	1.01 (0.99-1.02)	1 (0.99-1)	0.99 (0.99-1)	0.48 (0.3-0.5)
Age groups (school level)							
11-14 yrs (Middle school)	220 (22)	512 (51.2)	241 (24.1)	27 (2.7)	0 (0)	0 (0)	780 (78)
15-18 yrs (High school)	199 (19.9)	578 (57.8)	188 (18.7)	32 (3.2)	3 (0.3)	1 (0.1)	801 (80.1)
OR of high school/ middle school	0.8 (0.7-1.1)	1.3 (1.09-1.5)	0.85 (0.76-0.96)	1.005 (0.9-1.02)	1.003 (1-1.006)	1.001 (0.9-1.003)	1.1 (0.9-1.3)
Living area							
Urban	267 (20.6)	708 (54.5)	282 (21.7)	38 (2.9)	3 (0.2)	1 (0.1)	1,032 (79.4)
Rural	152 (21.7)	382 (54.5)	146 (20.8)	21 (3)	0 (0)	0 (0)	549 (78.3)
OR Urban/Rural	1.07 (0.8-1.3)	1 (0.83-1.2)	1.06 (0.8-1.3)	0.97 (0.5-1.6)	0.99 (0.9-1)	0.99 (0.9-1)	1.07 (0.8-1.3)
County of residence							
Isfahan	162 (23.1)	393 (56)	118 (16.8)	25 (3.6)	3 (0.4)	1 (0.1)	540 (76.9)
Najaf-Abad	66 (22.1)	143 (48)	71 (23.9)	18 (6)	0 (0)	0 (0)	232 (77.9)
Arak	191 (19.1)	554 (55.4)	239 (23.9)	16 (1.6)	0 (0)	0 (0)	809 (80.9)
p value	0.12	0.049	0.003	< 0.0001	0.062	0.39	0.12

* Risk factors: physical inactivity, dyslipidemia, smoking, high blood pressure, obesity.

The mean (±SD) of biological and biochemical variables is presented in Table 3. The mean serum total and LDL-cholesterol were significantly higher in girls than boys and the mean HDL-C was lower in boys than girls. The mean systolic and diastolic blood pressure was significantly higher in boys than girls.

The most prevalent situation of co-existing risk factors was for physical inactivity and dyslipidemia, present in 15.6% (n = 311) of subjects with a significantly lower prevalence in boys than in girls (12.5 vs. 18.6%, respectively, OR, 95%CI = 0.93, 0.89-0.96). The co-existence of smoking and physical inactivity was found in 5.1% of subjects, with a significantly higher prevalence in boys than in girls (6.9 vs. 3.2%, respectively, OR, 95%CI = 1.04, 1.01-1.06).The co-existence of smoking, hypertension and physical inactivity was significantly higher in boys than in girls (1.2 vs. 0.1%, respectively, OR, 95%CI = 1.01, 1.004-1.018).

Discussion

In the present study, the cumulative prevalence of atherosclerotic CVD risk factors was assessed in a representative sample of Iranian adolescents living in three cities in the central part of Iran. Most of the subjects studied (66.6%) were physically inactive, especially girls, and dyslipidemia was found in 23.7% of adolescents. 79.1% of adolescents had at least one and 24.6% had two CVD risk factors. The differences between the mean values of the risk factors between the two sexes are consistent with the existing physiologic differences during adolescence.

Many previous studies have assessed such clustering in Western countries. Because of the differences between the risk factors and age groups evaluated in various studies, different clustering rates are reported, but overall a high prevalence of risk factors contributing to development of atherosclerotic CVD is found in youth. The results of the European Youth Heart Study showed that in Danish children, more participants than expected had four or five CVD risk factors.[9] In a study performed in Norway, about 30% of the students presented no factors negatively related to development of CVD.[10] The Cardiovascular Risk in Young Finns Study revealed a high prevalence of risk factors in children and adolescents aged 3-18 years.[11] A survey in Sweden showed a CVD risk indicators clusters in adolescents, being more pronounced

Table 3 - Mean (±SD) of biologic and homodynamic cardiovascular disease risk factors in adolescents

	Total	Girls	Boys	p
TC (mg/dl)	162.2±33	166.8±±32.9	158.8±33.3	< 0.0001
LDL-C (mg/dl)	90.35±31	94.2±29.6	86.4±32.19	< 0.0001
HDL-C (mg/dl)	49.52±14.1	50.3±13.3	48.6±14.8	0.006
TG (mg/dl)	119.7±50.25	116.9±47.7	122.4±52.5	0.03
SBP (mmHg)	105.5±14	100.8±13.1	110.25±13.28	< 0.0001
DBP (mmHg)	63.7±10.5	59.6±10.5	67.9±8.7	< 0.0001
BMI (kg/m^2)	19.6±3.77	19.7±3.77	19.47±3.77	0.19

TC = cholesterol; LDL-C = low density lipoprotein cholesterol; HDL-C = high density lipoprotein cholesterol; TG = triglyceride; SBP = systolic blood pressure; DBP = diastolic blood pressure; BMI = body mass index.

in girls from a low socio-economic status.[12] Consistent with that survey, the findings of the present study revealed a higher prevalence of physical inactivity and obesity in girls; in the present paper, but the prevalence of overweight (85th percentile < BMI < 95th percentile) was also higher in girls than in boys (data not shown).[13]

The results of longitudinal studies support the CVD risk factors cluster in children and adolescents found in cross-sectional surveys. Longitudinal studies such as the Bogalusa Heart study in the USA and the study of Twisk et al. in the Netherlands have shown a high prevalence of atherosclerotic CVD risk factors in children and adolescents influenced by the age-related changes in obesity and the attendant insulin resistance; in addition they have demonstrated relationships between lifestyle parameters and a clustering of biological CVD risk factors.[14,15]

Data about the extent of CVD risk factors in children and adolescents living in developing countries is very limited; however, the rapid changes in dietary patterns and lifestyles occurring in many developing countries warrant close monitoring of CVD risk factors clustering in school-age children so that preventive measures can be taken in a timely manner.[16] The analysis of 160 nationally representative surveys from 94 developing countries showed an increasing prevalence of overweight and obesity from childhood to adulthood, although rates of early childhood malnutrition remained relatively high.[17]

A study performed in Turkey – a neighbor country to Iran – revealed that 47.7% of school children, ages 7-18 had at least one risk factor and 11.7% of them exhibited two or more risk factors.[18] Although the age of subjects studied was different from the present study, the high prevalence of risk factors in both studies are comparable.

Studies performed in developing countries located in the Eastern Mediterranean region (EMRO) are limited in this regard, but show a high prevalence of atherosclerotic CVD risk factors in children and adolescents. In Tunisia, as one of these countries with a rapid epidemiological transition, a high prevalence of CVD risk factors is demonstrated in urban population of school children.[19] Hakeem et al. have evaluated the prevalence of certain CVD risk factors in 10-12 year old school children living at different levels of urbanization and compared the Pakistani, British Pakistani, British Indian and British Caucasian children. Those authors found that the proportion of children at high CVD risk increased with urbanization rank. They have suggested that in addition to genetic predisposition, environmental factors such as undernourishment in early life, adoption of urbanized lifestyle or a combination of both could be the major determinants of this high CVD rate.[20] The study of Badruddin et al. in Pakistan found a high prevalence of CVD risk factors among school children from low and middle-income families.[21]

As the Middle East has the highest dietary energy surplus of the developing countries, and considering the rapid changes in the demographic characteristics of the region and the large shifts in dietary and physical activity patterns, a rapid rise in CVD risk factors is not unlikely.[22] Most of the surveys in this part of EMRO are performed in adult populations; however, the few studies evaluating CVD risk factors among youth living in this region have been in line with the finding of studies of other developing countries. As the prevalence of adult obesity in Kuwait is among the highest in the Arab Peninsula, and CVD is the leading cause of mortality in that country, Moussa et al. have evaluated the risk factors of such diseases among 6 to 13-year-old school-children and found a high prevalence of these risk factors particularly in obese subjects.[23]

Iran has undergone a rapidly occurring nutrition transition. This is suggested to be secondary to the rapid change in fertility and mortality patterns and to urbanization, which have led to increased consumption of low nutrient density foods, with over-consumption evident among more than a third of households.[24] Our previous studies showed an increase trend in the prevalence of CVD risk factors, especially dyslipidemia and overweight among Iranian children and adolescents.[3] Findings of recent survey in Tehran, the capital city of Iran, are in agreement with the present study showing a high prevalence of CVD risk factors among Iranian adolescents.[25]

Analyzing environmental factors associated with dyslipidemia among adolescents studied in the present study showed that rapid change in lifestyle, especially the mass consumption of hydrogenated solid fats, deep fried food, fat/salty snacks, and carbohydrate intake higher than the recommended daily allowance (RDA) accompanied by lack of sufficient physical activity, have contributed to lipid profiles that signal risk for atherosclerotic CVD.[26] The birth weight of subjects with dyslipidemia was significantly lower than in other adolescents.[27]

Although there are some variations in the risk factors evaluated in different studies, overall it can be assumed that as in many other developing countries, the prevalence of atherosclerotic CVD risk factors is high in Iranian adolescents. People living in developing countries are not homogeneous, but they are undergoing rapid lifestyle changes leading to such high prevalence of CVD risk factors. In addition, intrauterine growth retardation leading to low birth weight is prevalent in these populations, predisposing them to insulin resistance later in life, and can partly contribute to this high prevalence of CVD risk factors in youth living in these countries.[28]

Considering tracking of CVD risk factors from childhood into adult life, the acquisition of behaviors associated with these risk factors, and finally the safety and success of interventions to reduce them in childhood, and considering the extent of these risk factors in Iranian adolescents, it is assumed that community-based intervention toward healthy living should start at a young age in order to prevent or delay the appearance of atherosclerotic CVD.

The second phase of the survey is now taking place in Isfahan province, aiming to provide age-appropriate and culturally sensitive instructions to help children, adolescents, their parents and school staff develop the BASK to adopt, maintain and enjoy healthy eating habits and a physical active lifestyle. The other province (Arak) remains as the reference area and is under usual national health care system; the annual and outcome evaluation by comparison of the two provinces will provide information about the extent of the efficacy of interventions.

Limitations of the study

Clustering of CVD risk factors cannot be precisely assessed in such cross-sectional study, but the repetition of the present study (for its annual and outcome evaluation) will give more information in this regard. Another limitation is that serum lipids were checked only once, however the results are consistent with other mentioned studies performed in Iran. In addition, our data on serum lipids are compared with standard percentiles of Western references, which are not necessarily universally healthful standards, and can underestimate the prevalence of dyslipidemia.

The other limitation is the use of a self-administered questionnaire to identify smoker students, which can increase the possibility of underreporting. However, the prevalence of smoking is in line with a previous survey based on serum cotinine level in the same community.[29]

Physical activity was assessed using a self-reported questionnaire which could not precisely determine the duration and intensity of physical activity, but overall, according to the available evidence from previous studies in the same community,[30] it appears that most Iranian children and adolescents do not meet the minimal requirement of moderate to vigorous physical activity necessary for an effectively functioning cardiorespiratory system. If the recommended physical activity level for adolescents (vigorous activity of 30-60 min duration for at least 5 days a week) and recommended TV watching time to a maximum of 2 hours had been considered in the present study,[1,7] the prevalence of sedentary lifestyle would be much higher than that reported .

Conclusion

Considering the high prevalence of CVD risk factors in adolescents, age-appropriate and culturally sensitive interventions for lifestyle change are warranted, so that preventive measures can be taken in a timely manner.

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