INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH
ISSN: 2395-6429, Impact Factor: 4.656
Available Online at www.journalcmpr.com
Volume 7; Issue 04(A); April 2021; Page No.5702-5707
DOI: http://dx.doi.org/10.24327/23956429.ijcmpr202104994

Case Report

PREVALENCE OF HYPERTENSION, PREDIABETES, LIPID ABNORMALITY AND VITAMIN D DEFICIENCY AMONG AHMEDABAD POPULATION

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ARTICLE INFO

Article History:
Received 06th January, 2021
Received in revised form 14th February, 2021
Accepted 23rd March, 2021
Published online 28th April, 2021

Key words:
Obesity, prediabetes, lipid abnormalities, vitamin D, Ahmedabad

ABSTRACT

Countries like India is undergoing a rapid epidemiological transition with increased urbanization and socio-economic development which has led to increased incidence of lifestyle diseases like hypertension, type 2 diabetes mellitus, dyslipidemia, obesity and ischemic heart diseases Obesity, prediabetes are of the most common diseases worldwide and the prevalence in young aged group appears to be increasing. Thus, the present study was planned to study the prevalence of prediabetes, obesity, abnormal lipid profile and vitamin D deficiency in apparently healthy school and college-going students and in adult population. Materials and Methods: A population based cross sectional study was conducted on subjects of Ahmedabad of aged 12 to 55 years. Using stratified random sampling method, 2412 participants were selected. Body Mass Index status, blood pressure were estimated using standard protocol. Questionnaire was filled to collect data on stress level, food habit and socioeconomic status. Lab investigations were carried out by trained lab technician. Result: Prevalence of overweight, obesity, hypertension, prediabetes, lipid abnormality and vitamin D deficiency was found to be high in 36-55 years age group, followed by 18-35 year and low in 12-17 years age group. Conclusion: The prevalence of lifestyle disorders has increased at an alarming rate globally. Obesity, hypertension, prediabetes, lipid abnormalities and vitamin D deficiency were found to be common in the city of Ahmedabad which suggest the need for greater public awareness programs on these morbidities.

INTRODUCTION

Prediabetes is a state of hyperglycemia with a blood sugar level higher than normal but not high enough to be diagnosed as diabetes type 2. People with prediabetes are at an increased risk of type 2 diabetes. According to the American Diabetes Association (ADA), prediabetes is diagnosed as an elevated fasting plasma glucose level (100 mg/dL-125 mg/ dL), a glycated hemoglobin (HbA1c) value of 5.7% to 6.4%, or an elevated plasma glucose level after an oral glucose tolerance test (OGTT) (140-199 mg/dL)[1]. The diagnostic criteria for prediabetes and diabetes are shown in Table 1.

Table 1 American Diabetic Association diagnostic criteria for normal glucose, prediabetes and diabetes [1]

Diabetes Test	Normal	Prediabetes	Diabetes
Hemoglobin A1c, %	< 5.7	5.7-6.4	≥ 6.5
Fasting blood glucose, mg/dL	< 100	100-125	> 125
Oral glucose tolerance, mg/dL	< 140	140-199	> 199

The American Diabetes Association recommends that diabetes testing is necessary for all adults who are overweight (body mass index [BMI] > 25 kg/m^2) and have any of the additional risk factors such as; physical inactivity, hypertension or history of cardiovascular disease, low levels of high-density lipoprotein cholesterol and high triglycerides, first-degree relative with diabetes, history of previously elevated blood glucose level or HbA1c measurement, women with polycystic ovarian syndrome, history of gestational diabetes or giving birth to a baby weighing more than 4.082 kg or member of an ethnic or minority racial group.

According to an ADA expert panel, up to 70% of individuals with prediabetes will eventually develop diabetes [2]. The occurrence of diabetes in Indians is almost a decade earlier than in the western population [3]. The data on the prevalence of prediabetes in school and college students as well as in adults is scanty. There are hardly any studies providing the prevalence of prediabetes among school, college students, and adults in our country. Insufficient studies on pre-diabetes in central India and the high projected prevalence and high conversion rate of prediabetes to diabetes (70%) generate the rationale behind the research.

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METHODOLOGY

This cross-sectional, observational study was conducted amongst the 2412 subjects of both genders in the age group of ≥12 years to 55 years, residing in the urban community in Ahmedabad to find out the prevalence of prediabetes, lipid abnormalities, and vitamin D deficiency from December 2013 to December 2016. The subjects were further divided into three groups, i.e. school going children (12 years to 17 years), young aged (18 years to 35 years), and adult aged (36 years to 55 years).Subjects from different zones in the city were included to avoid bias and to get an equal distribution of subjects by socio–economic state, ethnic variability, and gender.

The study included only those subjects of age 12 to 55 years, whose legal guardian or parents signed consent form or who had given his/her voluntary consent for participation in the study. The study excluded subjects with any chronic ailments such as diabetes, hypertension, COPD, asthma, cancer, hyperparathyroidism, hypocalcemia, sarcoidosis, chronic kidney disease, a significant chronic medical condition that would interfere with study participation, pregnant or lactating women or subjects who are under any drug therapy.

This predesigned and pretested questionnaire contained questions relating to the information on family characteristics such as residence, type of family, family history of diabetes mellitus, and family history of chronic disease; income and personal characteristics such as age, sex, education, occupation, and dietary habit including salt intake physical activity and addiction.

The study was approved by Institutional Ethics Committee and informed consent was obtained from all participants. The families were informed and motivated to participate in the study along with the scope of future intervention, if necessary. All the participants were explained about the purpose of the study and were ensured strict confidentiality, and then informed consent was taken from each of them before the total procedure. The participants were given the option not to participate in the study if they wanted. Data regarding family and personal characteristics were recorded by face-to-face personal interview. Anthropometric data like height and weight were measured with a stadiometer and a digital weighing scale respectively. Then, body weight (kg) was divided by height (m^2) to obtain body mass index. Clinical examination of the subjects was carried out by taking their BP measurements. BP was recorded in sitting position in the right arm by an auscultatory method using a standard mercury sphygmomanometer with the subject seated and the arm extended over the table at the level of the heart. Subjects with chronic ailments such as diabetes, hypertension, asthma, and thyroid disorder as well as pregnant or lactating women and subjects under any drug therapy were excluded from the study. Those involved in regular smoking of a tobacco product once or more times per day or at any time in the past 30 days were defined as the smokers in this research. We have referred to the seventh report of the joint national committee on prevention, detection, and treatment of high blood pressure (JNC 7) criteria for prehypertension and hypertension. A systolic blood pressure of 120–139 mm Hg and/or diastolic blood pressure of 80–89 mm Hg was/were determined as a prehypertension case while systolic blood pressure ⩾140 mm Hg and/or diastolic blood pressure of ⩾90 mm Hg was considered as hypertension[4]. For serum lipids, we referred NCEP - ATP III (National Cholesterol Education Program) Guidelines. According to these standard guidelines; hypercholesterolemia is defined as total cholesterol more than 200mg/dl, hypertriglyceridemia as triglycerides more than 150mg/dl, and HDL-C less than 40mg/dl in men and less than 50mg/dl in women. Dyslipidemia is defined by the presence of hypercholesterolemia and low HDL-C levels[5].

Sample Size Calculation

Sample size is calculated based on BMI and Blood Pressure (Systolic) using formula: Z'=0.5*ln((1+r)/(1-r)) and found 1099~1100. Due to long duration of study and collection of blood sample, 30% considered drop out or not allowed blood sample. Hence final sample size is 1570.

Statistical Analysis

The collected data were thoroughly cleaned and entered into MS Excel spreadsheets for analysis. The statistical analyses were done using SPSS 20. In this study, we have calculated frequencies and percentage for qualitative data.

RESULT

A total number of 2,412 students with age group between 12-55 years from different zones of Ahmedabad were screened for their height, weight, and body mass index. Out of 2,412 subjects, 456 (18.91%) participants were school-going children, and the age of these school-going children were between 12 years to 17 years, 1,010 (41.87%) participants were of 18 years to 35 years age group and 946 (39.22%) participants were of 36 years to 55 years age group.

In our study, we have found that the prevalence of obesity is higher in 12-17 years age group (5.48 %) followed by 36-55 years age group (5.39%) and 18-35 years age group (21.71%). Whereas percentage of overweight participants was higher in 36-55 years age group (26.22%) followed by 18-35 years age group (18.51%) and 12-17 years age group (16.23%). The percentage of normal weight was higher in 18-35 years age group (69.50%) compare to the other two age groups. It has also been observed that percentage of the underweight participant was higher in school going children (17.11%) compare to adults (Table 2).

Table 2 Anthropometric data

	12-17 Years (N = 456)	18-35 Years (N = 1,010)	36-55 Years (N = 946)	Total (N = 2,412)
BMI Classification				
Underweight	78 (17.11%)	69 (6.83%)	45 (4.76%)	51 (5.39%)
Healthy weight	279 (61.18%)	702 (69.50%)	602 (63.64%)	1,583 (65.63%)
Overweight	74 (16.23%)	187 (18.51%)	248 (26.22%)	509 (21.10%)
Obese	25 (5.48%)	52 (5.15%)	51 (5.39%)	128 (5.31%)
Blood pressure				
Pre-hypertension	56 (12.28%)	279 (27.62%)	277 (29.28%)	612 (25.37%)
Hypertension	23 (5.04%)	231 (22.87%)	302 (31.92%)	556 (23.05%)
Normal	377 (82.68%)	500 (49.50%)	367 (38.79%)	1,244 (51.57%)
Participation in exercise				
Yes	304 (66.67%)	328 (32.48%)	210 (22.20%)	842 (34.91%)
No	152 (33.33%)	682 (67.52%)	736 (77.80%)	1,570 (65.09%)
Dietary type				
Vegetarian	379 (83.11%)	585 (57.92%)	671 (70.93%)	1,635 (67.79%)
Non-vegetarian	25 (5.48%)	73 (7.23%)	56 (5.92%)	154 (6.38%)
Eggetarian	52 (11.40%)	352 (34.85%)	219 (23.15%)	623 (25.83%)
Frequency of junk food eating habit				
Everyday	63 (13.82%)	139 (17.76%)	102 (10.78%)	304 (12.60%)
Once in a week	230 (50.44%)	628 (62.18%)	493 (52.11%)	1,351 (56.01%)
Once in 15 days	89 (19.52%)	186 (18.42%)	213 (22.52%)	488 (20.23%)
Once in a month	74 (16.23%)	57 (5.64%)	138 (14.59%)	269 (11.15%)
Frequency of sweet eating habit				

Everyday	103 (22.59%)	265 (26.24%)	229 (24.21%)	597 (24.75%)
Once in a week	216 (47.37%)	537 (53.17%)	459 (48.52%)	1,212 (50.24%)
Once in 15 days	78 (17.11%)	139 (13.76%)	186 (19.66%)	403 (16.70%)
Once in a month	59 (12.94%)	69 (6.83%)	72 (7.61%)	200 (8.29%)
Stress level				
No stress	387 (84.87%)	749 (74.15%)	547 (57.82%)	1,683 (69.77%)
Less level	54 (11.84%)	194 (19.21%)	368 (38.90%)	616 (25.53%)
Medium level	15 (3.29%)	67 (6.63%)	31 (3.28%)	113 (4.68%)
High level	0	0	0	

This study found that the prevalence of prehypertension and hypertension was higher in adults compared to school-going children. The prevalence of hypertension was 5.04% and prehypertension was 12.28% among 12-17 years, old age group. The prevalence of prehypertension in 18 to 35-year age group was 27.62% whereas in 36 to 55-year age group was 29.28%. Similarly, the prevalence of hypertension in 18 to 35-year age group was 22.87% whereas in 36 to 55-year age group was 31.92% (Table 2).

It has been seen that compared to adults, school-going children have more participation in exercise. We have found that 66.67% school-going children were participating in exercise followed by 18-35 years age group (32.48%) and 36-55 years age group subjects (22.20%). In this study, majority of the participants were found to be vegetarian in all age group (83.11%, 57.92%, and 67.79% respectively) compare to non-vegetarian (5.48%, 7.23% and 5.92%) (Table 3)

In the current study, among all the frequencies of junk food habit, once in a week was found the highest in all age groups (56.01%). Once in a week frequency of eating junk food amongthe age group 12-17, 18-35 and 36-55 year was found to be 50.44%, 62.18% and 52.11% respectively (Table 2).

The sweet eating habit once in a week was found highest among all frequencies in all three age groups (50.25%). In the age group of 12-17, 18-35 and 36-55 year we found 47.37%, 53.17% and 48.52% participants have once in a week sweet eating habits respectively (Table 2).

In this study, we found the majority of participants had no stress in all age groups. In 12-17-year age group, 84.87% of participants have no stress whereas in 18-35-year age group no stress level was found in 74.15% participants, and in 36-55-year age group no stress level was found in 57.82% participants. It has been also concluded that stress level increases as age increases. Furthermore, the current study did not find any participants with high-stress levels (Table 2).

Table 3 shown prevalence of the different medical conditions in all age groups. The prevalence of prediabetes in school-going children was 5.09% followed by 28.81% and 33.19% in 18-35-year age group and 36-55-year age group, respectively. Diabetes was found in 11.78% 18-35-year age group participants and 17.44% in 36-55-year age group participants. Prevalence of Vitamin D deficiency was found the highest in 36-55 year adults compare to school-going children, i.e. 73.15%. We have not found any lipid abnormalities as well as increased insulin level in school-going 12-17-year age group children. However, lipid abnormalities, vitamin D deficiency and hyperinsulinemia were found to be high in the 36-55-year age group compared to the 18-35-year age group.

Table 3 Biochemical parameters

Parameter	Age Group		
	12-17 Years (N=456)	**18-35 Years (N=1,010)**	**36-55 Years (N=946)**
Prediabetes (FBS >100)	23 (5.09%)	291 (28.81%)	314 (33.19%)
Diabetes (FBS >125)	0 (0.00%)	119 (11.78%)	165 (17.44%)
Hypercholesterolemia (Total Cholesterol >189)	0 (0.00%)	164 (16.23%)	277 (29.28%)
Hypertriglyceridemia (Triglyceride >149)	0 (0.00%)	163 (16.14%)	312 (32.98%)
Low HDL-C (less than 40 in men, Less than 50 in women)	0 (0.00%)	274 (27.13%)	386 (40.80%)
Dyslipidemia (High total cholesterol and low HDL)	0 (0.00%)	131 (12.97%)	252 (26.64%)
Vitamin D deficiency (<20ng/dL)	252 (55.26%)	683 (67.62%)	692 (73.15%)
Hyperinsulinemia (>37.5)	0 (0.00%)	169 (16.73%)	295 (31.18%)

DISCUSSION

It has been well demonstrated that the burden of disease increases as age increases. There are widespread reports regarding the trend of the increasing prevalence of overweight, obesity, prediabetes, and lipid abnormalities among young aged subjects. In the present study, we found positive interaction between increased age and prediabetes, lipid abnormalities as well as vitamin D deficiency. The risk of chronic diseases increases with increased age.

We found the prevalence of overweight and obesity in 12-17-year group subjects was 16.23% and 5.48% respectively. Gamit *et al*. reported prevalence of overweight 10.2% and obesity 6%, in Surat city [6]. Prasad *et al.* conducted a study on 10 to 18 years' subjects of Pondicherry and reported 9.7% and 4.3% of overweight and obesity[7]. In both the studies the prevalence of overweight and obesity was found to be high compared to our result. The prevalence of overweight and obesity according to Masoodi *et al* in North Indian subjects was 16.3% and 5.1%, respectively[8]. Primary factors associated with overweight and obesity excess calorie intake or insufficient physical activity or both. Developing countries like India have a unique problem of 'double burden' where we found overweight and obesity in children and adolescents simultaneously. We also found a high prevalence of malnutrition and underweight subjects.

Prehypertension is associated with cardiovascular risk factors such as obesity, diabetes mellitus, and dyslipidemia. The relationship between prehypertension and cardiovascular disease awakens widespread concern. JNC-7 suggested lifestyle modification help subjects with prehypertensionto lower blood pressure and prevent progression to hypertension as well as cardiovascular events. The study conducted by Narayanappa *et al*. in Mysore on 10-16 years' subjects found 2.8% and 2.4% prevalence of prehypertension and hypertension, respectively[9], which was found less in comparison to the current study. A study on military adults of age 18-50 years of Southern India conducted by Ray[10] *et al* has reported a very high prevalence of prehypertension (79.8%), whereas S Srinivas *et al* [11] conducted a study on 18-35 years old subjects of Andhra Pradesh and reported 30.1% of prevalence of prehypertension which is likely to be similar with the current study. Another study by Reddy *et al*[12]on subjects above the age of 18 years reported a very less prevalence of hypertension (7.1%) compared to the finding of the current study.

Participation in any kind of physical activity or exercise is found to be greater in the 12-17 years age group (66.67%) followed by the 18-35 years (32.48%) and the lowest in the 36-55 years age group (22.20%). Exercise such as aerobic and resistance types of exercise are associated with a decreased risk of type 2 diabetes[13]. According to a study conducted by Helmrich *et al* [14], each increase of 500 kcal (2100 kJ) in energy expenditure per week was associated with a decreased incidence of type 2 diabetes of 6%. It was reported that exercise has a positive role in maintaining the glycemic level, increasing insulin sensitivity, and improving cardiovascular risk factors with regard to type 2 diabetes mellitus [15,16,17,18,19]. Food can be powerful in preventing and reversing diabetes. Newer treatment programs drastically reduce meats, high-fat dairy products, and oils [20]. At the same time, they increase grains, legumes, fruits, and vegetables. In the present study, we found a high prevalence of subjects with a vegetarian diet compared to non-vegetarian and eggetariandiets.

Junk food simply means an empty calorie food which is considered as a high calorie or calorie-rich food which lacks micronutrients such as vitamins, minerals, or amino acids, and fiber but has high energy. The high levels of sugar in junk food put metabolism under stress; when refined sugar is taken, the pancreas secretes high amounts of insulin to prevent a dangerous spike in blood sugar levels. As adequate amounts of protein and good carbohydrates are not present in fast food and junk food, the blood sugar levels suddenly drop after eating it, resulting in a grumpy, fatigued feeling and a craving for sugar [21].In the present study, we found the almost equal prevalence of everyday junk food eating habits irrespective of age group. Whereas once in a week frequency of junk food eating habit is found to be high in 18-35 years of age group compared to other two groups.

Sweetened foods are responsible for an elevation of blood glucose. Excess glucose is deposited as fat in adipose tissues causing overweight or obesity [22]. Therefore, the limitation of sweetened foods or drinks consumption is a key step in the guidelines for the control of diabetes. In the current study, irrespective of the age group we found a high prevalence of once-in-a-week frequency of sweet eating habits compared to an everyday habit of eating sweets.

According to the ADA, stress triggers an increase in the body's fight-or-flight hormone levels, as if the body were under attack. In response, the body releases extra energy in the form of glucose and fat. In non-diabetic subjects, stress causes a temporary rise in blood sugar, but their body can adjust, while in diabetes patients, the blood sugar level stays high. In our study, we have found a high prevalence of subjects in no stress level group, followed by less level of stress and a medium level of stress. None of the subjects were found to have a high level of stress. The reason for the same we can consider is we have followed American guidelines for the preparation of the questionnaire for the evaluation of the stress category. The questions mainly included in the questionnaire were related to the family issues and career failure.

In the current study, the prevalence of prediabetes was found to be 5.09% in 12-17 years old subjects. Taranikanti *et al* [23] conducted a study on South Indian rural adolescent school students in 2014 and reported a high prevalence of prediabetes compared to our result (7.1%). Whereas Narayanappa *et al*[24] has conducted a similar study on 5 to 10 years old students of Mysore and reported a 3.7% prevalence of prediabetes which is found to be similar as compared to our report. In our study, the prevalence of prediabetes and diabetes among subjects of 18-35 years old was 28.81% and 11.78%, respectively. While the prevalence of prediabetes and diabetes among 36 to 55 years old subjects was found to be 33.19% and 17.44%, respectively. Muthunarayanan, *et al*.[25] conducted a study on rural adults of Tamil Nadu above the age of 20 years and found 8.5% of prediabetes and 10.1% of diabetes. Dasappa *et al*.[26]conducted a study on urban slums of Bangalore above the age of 35 years and reported 11.5% of prediabetes prevalence and 12.3% of diabetes prevalence. Gupta *et al* [27] conducted a study on adult population in 2016 and reported 17.8% prevalence of prediabetes and 15.7% prevalence of diabetes.

In the present study, we found none of the subjects of age group 12-17 years have lipid abnormalities. Lipid abnormalities were found to be high in 36-55 years age group compared to 18 to 35 years' age group subjects. Thomas *et al*[28]reported 14% prevalence of hypercholesterolemia, 7.25% prevalence of hypertriglyceridemia and 33% prevalence of low HDL-C level among the young adults of Chennai. Comparing these results with our study, we found the prevalence of hypercholesterolemia and low HDL-C levels were found to be similar compared to our data whereas the prevalence of hypertriglyceridemia was found to be low compared to our study. Joshi *et al*[29] conducted a similar kind of study and reported 18.3% and 4.9% prevalence of hypercholesterolemia as well as 68.9% and 76.8% prevalence of low HDL-C level in subjects aged more than 20 years of Tamilnadu and Jharkhand respectively. They have conducted a study on subjects of Chandigarh and Maharashtra and reported 38.6% and 22.8% prevalence of hypertriglyceridemia respectively.

We found a high prevalence of vitamin D deficiency among subjects of 36-55 years, followed by 18-35 years and lowest among 12-17 years. Sahu *et al*[30] reported 88.6% prevalence of vitamin D deficiency among 10-20 years old girls and 32% prevalence among pregnant women. International Osteoporosis Foundation[31]has also reported 91%, 78%, and 84% prevalence of vitamin D deficiency among healthy school girls, healthy hospital staff, and pregnant women respectively. Comparing these results with our study we found an almost similar prevalence of vitamin D deficiency.

Strengths of the study

To the horizon of our knowledge, no related publication on school children, young aged and middle aged group's lifestyle has been reported so far in Ahmedabad.

Future direction of study

Any short-term solution may not help us to reach the goal of control of diseases like prediabetes, lipid abnormalities and vitamin D deficiency in a multicultural country like India. Alone health professionals are unable to care of enormous task. Strategic interventions to be made by considering responsibility of professionals, health services, governments, and teaching institutions. To overcome this burden, unique strategies to prevent such diseases need to be clearly formulated and tested. Life style modification and early detection of disease can prevent further complications.

CONCLUSION

In conclusion, the crisis of obesity, elevated blood pressure, prediabetes, abnormal lipid profile and vitamin D deficiency is global and is steadily affecting many low and middle-income

countries, particularly in urban settings. The prevalence has increased at an alarming rate globally. Current lifestyle methods like physical inactivity, unhealthy eating habits like junk food are the major causative factors for this increasing trend in urban area. These trends are disturbing and call for concerted efforts targeted at improving lifestyles of children and adolescents.

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How to cite this article:

Bhoomi Arora (2021) 'Prevalence of Hypertension, Prediabetes, Lipid Abnormality and Vitamin D Deficiency among Ahmedabad Population', *International Journal of Current Medical and Pharmaceutical Research,* 07(04), pp 5702-5707.

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