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COMPARATIVE PREVALENCE OF NON-COMMUNICABLE DISEASES IN THE ADULT POPULATION OF VADODARA AND GODHRA IN GUJARAT AND DETERMINANTS OF DIABETES MELLITUS IN THE POPULATION

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ABSTRACT: The present study was conducted for mapping the prevalence of non-communicable diseases in free living populations of Vadodara & Godhra. Multistage sampling (cluster and systematic random sampling) was used to draw a sample of 351 subjects. Anthropometric data, medical history, lifestyle and dietary practices were elicited using standard procedures. Overweight and obesity were comparable in both the cities (Overweight: 24% v/s 25%, Obesity: 48% and 42%). Diabetes and hypertension, were higher in Godhra (diabetes: 19%, Hypertension: 36%) as compared to Vadodara (diabetes: 12%, Hypertension: 24%). Predictor variables identified were family history of diabetes, high BMI, waist circumference, hypertension, physical inactivity, smoking, alcohol, tobacco abuse, low intake of fruits and vegetables and low intake of green leafy vegetables. Majority of the subjects (79%) had 2-5 risk factors. Thus, prevalence of multiple risk-factors calls for development of a surveillance system to monitor and reduce the risk of developing non-communicable diseases.

Key words: Risk factors, obesity, diabetes, hypertension,

INTRODUCTION

Humankind has faced major shifts in dietary and physical activity patterns and subsequent body composition since Paleolithic era. These changes are reflected in nutritional outcomes, such as changes in average stature and body composition. Furthermore, these dietary and activity pattern changes are paralleled by major demographic changes and changes in health status, which are reflected in the rising prevalence of non-communicable diseases[1]. WHO estimates that half of the adult disease burden in South Asia is attributable to non-communicable diseases and to add to it, India has the highest number of people with diabetes across the world[2]. Considering the ramifications on the economy, the share of health costs of this shift toward elevated chronic diseases represents a serious component of India's GDP[3]. In providing a context for policy planners and health education programs, it is important to quantify the proportion of the population at high risk for CVD. Such data provide an understanding of the size of the population in need of targeted interventions to lower the population burden of illness due to CVD. In this context, the present study was conducted with the broad objective of assessing the prevalence of risk factors of non-communicable diseases in two districts in Gujarat and to study the determinants of diabetes mellitus in the study population.

MATERIALS AND METHODS

Sampling, Study Design and Subjects: To get a representative sample from both the cities of Vadodara and Godhra, the samples were drawn using multi-stage sampling. At the first stage, cluster sampling was employed. For this, the list of the various administrative wards of both the cities was obtained and from each ward, one residential society was purposively selected based on the willingness of the subjects to participate in the study. At the second stage, using systematic random sampling, every 10^{th} household in each residential society was enrolled in the study. In all, 250 subjects from Vadodara and 101 subjects from Godhra were enrolled, giving a total of 351 subjects.

Methods: Using a structured pre-tested questionnaire, information on level of education of the subjects, their socio-economic status and medical history was obtained. Anthropometric measurements including weight; height; waist and hip girth were obtained using the established measurement protocols [2]. Nutrient intake, through 24 hour dietary recall, was calculated using food composition tables from "Nutritive Value of Indian Foods" [3]. The determinants considered for risk factor analysis are given in Table 1

Statistical Analyses: Analyses were carried out in Microsoft Excel. Various indices for assessing fatness namely: Body Mass Index (BMI), Waist to Hip Ratio (WHR) and Waist to Weight ratio (WC/Wt); were arrived at by using the following formulae: $BMI=Wt/(Ht)^2$, WHR=WC/HC. Asia Pacific Classification for South Asians was used for categorizing BMI, WHR and WC of the subjects into normal or overweight/obese. For quantifiable variables, descriptive statistics (means and standard deviation) were calculated. In case of categorical variables, frequency distribution was computed. Comparison of means was done using't' test and difference in proportions were compared by 'chi-square' test. ODD's ratio for each determinant was computed using EpiInfo package for studying the risk contribution of each determinant to the development of Diabetes Mellitus. A p value of 0.05 was considered as significant for all the statistics.

RESULTS

Background Information: The background information revealed that majority of the subjects were middle-aged as indicated by the mean age of 43.2 $\pm$ 15.8 yrs; and illiteracy was found in 4% of the subjects, the proportion of illiterate subjects being higher in Godhra (14%) as compared to Vadodara (2%). Occupation-wise, more than one-third (41%) of the subjects were professionals or were into business; remaining were either stay-at-home wives (38%), retired (12%), or still studying (9%). These figures were comparable for both Vadodara and Godhra. However, regarding ethnicity, it was found that significantly more number of subjects in Godhra followed Islam (50%), as compared to subjects in Vadodara (1.6%). The subjects had an average per capita income of Rs. 6130, and majority of them fell in middle or high income group.

Table 1 : Determinants Used for Risk Factor Analysis

Medical History	a. BP
	b. Presence of DM, CHD, HT
	c. Heredity factor
Anthropometry	a. BMI
	b. WC
	c. WHR
Diet	a. Distribution of macronutrients for energy, antioxidant vitamin C & β carotene
	b. Intake of Green leafy vegetables (GLVs)
	c. Intake of Fruits

Anthropometric Profile: Anthropometric parameters namely height, weight and BMI were comparable in the subjects in Vadodara and Godhra (159cm v/s 158cm, 64kg v/s 63kg, and 25.3kg/m^2 v/s 25kg/m^2 respectively). Mean Waist circumference, Waist to Hip Ratio and Conocity Index were marginally higher in males compared to females in both cities, though not significantly so (86.2cm v/s 82.4cm, 0.95 v/s 0.88, 1.22 v/s 1.21 respectively). Mean WC/Wt however was higher in females compared to males (1.38v/s1.26).

Prevalence of Overweight and Obesity: Prevalence of overweight and obesity (Table 2) was higher in males of Vadodara than those of Godhra (52.4% v/s 38.6%), whereas it was comparable in the females in both the cities (44.9% v/s 45.6%). Overall stated, 3/4th of the population studied was either underweight (5%), overweight (24.5%) or obese (46.3%), with only 23.9% subjects falling in the normal BMI category.

Table 2 : Prevalence of Overweight and Obesity in the Subjects

	Vadodara (%)			Godhra (%)			Total n= (%)		
	Males n=101	Females n=149	Total n=250	Males n=44	Females n=57	Total n=101	Males n=145	Females n=206	Total n=351
Ow	29.7	20.1	24	29.5	22.8	25.7	29.6	20.8	24.5
Ob	52.4	44.9	48	38.6	45.6	42.5	48.2	45.1	46.3
Under-nutrition	0.9	9.3	4	4.5	1.7	2.9	2	7.2	5.1
Normal	13.8	25.5	21	27.2	29.8	50.8	20	26.6	23.9

Prevalence of Abdominal Obesity: Central adiposity was assessed using WC/Wt, a measure for subcutaneous fat; WC, a surrogate measure for visceral fat. About 81.3% of the male subjects and 79.9% of females had higher WHR than the recommended Asia Pacific cut-offs for South Asians. In case of waist circumference, more than half of the female subjects had a WC>80cm, which was significantly higher than the 36.5% of males who had a waist girth >90cm. WC/Wt ratio was also skewed for more than half of the subjects, as can be seen in the table 3.

Diabetes and Hypertension: The prevalence of Diabetes (Table 4) was marginally higher in Godhra as compared to Vadodara, whereas, the prevalence of Hypertension was significantly higher in Godhra as indicated by Chi-square analysis (χ^2=4.91, p<0.05). Further, the prevalence was higher in male subjects as compared to females in both the cities.

Table 3 : Prevalence of Abdominal Obesity in the Subjects

Indicator	Males n=145 (%)	Females n=206 (%)
High WHR	81.30	79.9
High WC	36.54	57.27
High WC/Wt	55.82	84.41

Table 4 : Percent Prevalence of Diabetes and Hypertension

	Vadodara			Godhra			χ2
	Male n=101	Female n=149	Total n=250	Male n=44	Female n=57	Total n=101	
Diabetes	14.8	10	12	25	14	18.8	2.78
Hypertension	28.7	20.8	24	47.7	26.3	35.6	4.91*

**Significantly different between Vadodara and Godhra at p<0.05*

Risk Factors Analysis: The risk factors that were looked into include heredity, physical inactivity, smoking and low intake of GLVs & fruits (Table 5). While considering the heredity factor, all the subjects were categorized on the basis of either parent with diabetes (PDM), siblings with diabetes (SDM) or one parent diabetic and other from diabetic family (1PDM.2DF). All in all, 28.4% of the total population studied had heredity as one of the risk factor. Smoking was seen only in male subjects and was more in Godhra (13.6%) than in Vadodara (6.9%). Physical inactivity was as high as 45% and comparable in both the cities. Low consumption of fruits and vegetables emerged as one of the major risk factors in the study (61.2%) and was significantly higher in subjects of Vadodara as compared to Godhra (69.2% v/s 41.6%), as revealed by Chi-square analysis ($p<0.001$).

Since a number of risk factors were present, an attempt was made to look into presence of multiple risk factors and subjects were categorized on the basis of number of risk factors present (Table 6). It was observed that majority of the subjects had 2-5 risk factors (79%). Similar trends were seen in both the study groups. Almost 0.8% of the subjects had as high as 9 risk factors. Maximum number of subjects had 3 risk factors (31%). No significant gender wise variation was noted in any of the cities. The most common risk factors were low consumption of fruits and vegetables, physical inactivity, hypertension, overweight and/or obesity.

With respect to the working status of the subjects, it was found that the prevalence of certain risk factors namely, elevated BMI, WC and diabetes and hypertension was lower among students, as compared to working subjects, which in turn was lower when compared to those who were retired. Sample size could have role to play here (Table 7). Thus even across age, the prevalence of obesity and diabetes is high.

The risk factor scenario was also cross tabulated with the presence of heredity of diabetes in the subjects (Table 8). Twenty eight percent of the subjects had family history of diabetes while 72% did not have heredity as a risk factor. The prevalence of hypertension was higher in those who had heredity of diabetes than those who didn't (37% vs. 26.6). In the heredity group, 57% of subjects in Vadodara and 50% from Godhra were obese, whereas the figures were significantly lower (χ^2: 4.12, $p<0.05$), in the non-heredity group (Vadodara 44% and Godhra 40%). The prevalence of overweight, high waist circumference and hypertension were slightly lower in the non-heredity group. It is interesting to note that the prevalence of behavioral risk factors (low consumption of fruits and vegetables) was higher in the non-heredity group in both the cities, signifying their contributory role in the existing prevalence rates of overweight, obesity and hypertension in the non-heredity group. These results reveal that behavioral risk factors are as significant as heredity in precipitating non-communicable diseases.

Table 5 : Percent Prevalence of Various Risk Factors

	Vadodara			Godhra			Total			χ^2
	Male n=101	Female n=149	Total n=250	Male n=44	Female n=57	Total n=101	Male n=145	Female n=206	Total n=351	
SDM	5.9	10	8.4	9.09	7	7.9	6.8	9.2	8.26	0.02
PDM	20.7	22.8	22	27.3	26.3	26.7	22.7	23.7	23.3	0.9
1PDM.2DF	1.98	9.39	6.4	2.3	7	4.95	2.06	8.7	5.98	0.27
Physical Inactivity	37.6	48.3	44	61.4	43.9	51.5	44.8	47	46.1	1.62
Smoking	6.9	0	2.8	13.6	0	0	8.9	0	3.7	1.56
GLV	64.3	72.4	69.2	47.7	36.8	41.6	59.3	62.6	61.2	23.12 ***
Fruits	59.4	62.4	61.2	43.2	66.7	56.4	54.4	63.5	59.8	0.68

*** $p < 0.001$

Table 6 : Frequency of Risk Factors in the Subjects

Risk Factors	Vadodara			Godhra			Total		
	Male n=101	Female n=149	Total n=250	Male n=101	Female n=149	Total n=250	Male n=101	Female n=149	Total n=250
0	0.99	3.3	2.4	0	0	0	0.69	2.4	1.7
1	11.8	5.3	8	4.5	1.7	2.9	9.6	4.3	6.5
2	16.8	12.7	14.4	11.3	10.5	10.8	15.1	12.1	13.4
3	37.6	28.8	15.2	31.8	24.5	27.7	35.8	27.6	31
4	14.8	18.7	17.2	29.5	29.8	29.7	19.3	21.8	20.8
5	12.8	14.7	14	9.09	14.04	11.8	11.7	14.5	13.3
6	11.8	10.07	6.8	4.5	7.02	5.94	2.7	9.2	6.5
7	0.99	4.03	2.8	6.8	8.7	7.9	2.7	5.3	4.2
8	0	2.01	1.2	2.3	1.7	1.9	0.69	1.9	1.4
9	0	1.3	0.8	0	1.7	0.99	0	1.4	0.85

Table 7 : Prevalence of Risk Factors Across Age-Groups, Depending Upon Working Status

	Students (n=31)			Working (n=276)			Retired (n=43)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
BMI	0	22.2	19.3	48.5	47.3	47.8	52.9	70	58.1
WC	0	7.4	6.4	5.6	34.9	23.5	5.8	40	13.9
DM	0	3.7	3.2	11.2	10.6	10.8	29.4	30	30.2
HT	0	0	0	26.1	25.4	25.7	73.5	80	76.7

Table 8 : Risk Factor Scenario Based on Heredity of Diabetes among the Subjects

Risk Factors	Heredity		Non-Heredity	
	Vadodara (n=72)	Godhra (n=28)	Vadodara (n=178)	Godhra (n=73)
OW	27.7	21.4	16.8	27.3
OB	56.9	50	44	39.7
WHR	45.8	89	53	78
WC	51.3	50	42.1	61.6
HT	36.1	39	23	36
Physical inactivity	44.4	43	44	55
Low Fruits Consumption	58.3	71	63	71
Low GLV Consumption	63.8	54	71	58
Smoking	2.7	4	2	7

Nutrient Intake: The nutrient intake of the subjects indicated comparable intakes between both the cities. Percentage of calories coming from proteins was slightly higher in subjects from Godhra than Vadodara, which could be attributed to higher consumption of non-vegetarian foods in Godhra. This difference was not statistically significant. The percent calories coming from fat were around 25% for both the study groups, 13% coming from proteins and rest (60%) from carbohydrates. Consumption of iron in the diet was also very low and could meet only 38% of the RDA for iron (21mg/day) in case of females and only 56% in case of males. The diet of the subjects met 76-78% of the RDA for calories and was particularly poor in β-carotene and iron, which could be due to meager intake of GLVs. This observation was reflected in risk factor analysis too.

Determinants of Diabetes Mellitus: As 14% of the subjects were diabetics, an attempt was made to estimate the odds ratio for various risk factors between diabetics and non-diabetics (Table 9). Out of the nine variables, seven (family history, overweight/Obesity, hypertension, smoking, tobacco use and low intake of GLVs) were found to be significant.

Table 9: Odds Ratios of Getting Diabetes for Various Risk Factors

Variable	Odds Ratio	Range (95% CI)	P value
Heredity			
Family History	2.58***	1.33<OR<5.01>	0.002
Anthropometric Measurements			
BMI≥23	3.98***	1.45<OR<11.80>	0.002
WC>80cm (Females) >90cm (Males)	3.39***	1.70<OR<6.84>	0.0001
Biophysical Parameters			
BP	12.1***	5.6<OR<26.7>	0.0001
Lifestyle Factors			
Physical Activity	0.92	0.48<OR<1.75>	0.776
Smoking	3.32*	0.94<OR<11.23>	0.027
Tobacco	4.13***	1.76<OR<9.63>	0.0001
Dietary Factors			
Low Fruit Intake	1.05	0.53<OR<2.07>	0.885
Low GLV Intake	0.49*	0.25<OR<0.93>	0.018

DISCUSSION

Though considered as diseases associated with affluence, non-communicable diseases are becoming progressively prevalent in developing countries too. They have common lifestyle related risk factors namely unhealthy diets, obesity, smoking and physical inactivity. In South Asia, half of the total disease burden is attributed to non-communicable diseases [2].

Globally, there are more than 1 billion overweight adults, at least 300 million of them obese. India's neighboring countries report the prevalence to be 28% [4]. Nationally representative data [5], indicates that Gujarat state ranks 10th as regards prevalence of obesity in males with the figure of 15.4% and 7th in case of females (17.7%). However, the present study found obesity to be as high as 46% and overweight 24%, drawing attention to the fact that regional figures may not be adequately represented in the national average.

Hypertension appears to be the most important risk factor for the development of Coronary Artery Disease (CAD) throughout India. There is sufficient clinical and epidemiological evidence that hypertension is increasing in India and the prevalence has quadrupled in urban as well as rural populations over a 50-year period from early 1950s to late 1990s [6]. National Cardio-vascular Database [7] reports the prevalence of hypertension in India to be 28% (criteria: =JNC VI) from 10 regions of the country in the age group 20-69 years; while studies by Chennai Diabetes Research Foundation indicated a prevalence of 22% in selected South Indian population [8]. A study conducted in industrial population of Vadodara itself [9] has reported a prevalence of 14.2%. The current study found a prevalence of 24% in Vadodara and further 35% in Godhra, which certainly indicate a continuous increase in the hypertension figures in India.

The impending diabetic epidemic has already reached us, with India having the highest contribution to the Diabetes burden in the world [2]. The Jaipur Heart Watch study[10] looked into the prevalence three successive times in 1994, 2001 and 2003; and found a rising trend in the prevalence which was 1% to begin with but increased to 13% and then to 18%. Studies in Vadodara itself have reported prevalence of 6.4 % in 2007 [9]. Again, in the present study, the prevalence has increased to 12% in Vadodara and 18% in Godhra, re-enforcing the pattern found in earlier studies.

Looking into the causative risk factors; the WHO-ICMR study [11] on NCDs risk factor surveillance showed that the major risk factors indentified were low consumption of fruits and vegetables, high blood pressure, physical inactivity and obesity. These are also precisely the risk factors identified in the present study. Studies in population in Vadodara [12] have also reported low consumption of fruits and vegetables being prevalent in as high as 76% of the subjects. The present study however found the prevalence to be 61% in case of low consumption of GLVs and 59% low consumption of fruits; the difference can be attributed to difference in sample sizes and sampling methods in both the studies. The determinants of Diabetes Mellitus and the risk factor scenario highlight the role of life style factors in precipitating the condition.

CONCLUSIONS

The above results draw attention to the boom in the NCD prevalence that is being faced by cities in the Gujarat region and consequently, is a cause of grave concern. The take home point here is that our population requires a paradigm shift in its dietary and behavioral pattern, which contributes greatly to the prevalence; to revert the current risk situation. Utilization of this information especially by the stake holders and policy makers in the regional health sector can avert adverse health situations on a massive scale.

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