Prevalence and Predictors of Metabolic Syndrome in Young Asymptomatic Gujarati Population

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Received 23 June 2015; Revised 14 July 2015; Accepted 14 July 2015

Background. Metabolic syndrome is a cluster of risk factors leading to the development of atherosclerotic cardiovascular diseases. We aimed to evaluate the prevalence of metabolic syndrome (MS) and its predictors in young and apparently healthy Gujarati individuals. Methods. This population based cross-sectional study involved a total of 1500 healthy adults of 20–40 years of age. Demographic details and clinical data such as body mass index (BMI), waist circumference (WC), and blood pressure were measured along with the estimations of lipoprotein (a), total cholesterol (TC), triglyceride (TG), total lipid, LDL/HDL ratio, TC/HDL ratio, and fasting blood glucose (FBS). Results. Overall in young Gujarati population (20–40 years) prevalence rates of MS were 16.0% (male: 21.5%; female: 10.8%) where the metabolic abnormalities increased with advanced age as 9.56% of the young population (20–30 years) had MS, in contrast to the 24.57% in the old (31–40 years). Odds ratio analysis had indicated BMI (1.120; 95% CI: 1.077–1.163; \( P < 0.0001 \)) as the strongest risk factor for MS closely followed by advancing age (1.100; 95% CI: 1.061–1.139; \( P < 0.0001 \)) levels. Conclusion. Prevalence of metabolic syndrome in young Gujarati population reinforces the need for early life style intervention and awareness programs in this ethnic group.

1. Introduction

The metabolic syndrome (MS) is a cluster of metabolic abnormalities possessing complex pathogenesis. The most widely documented metabolic risk factors are atherogenic dyslipidemia, hypertension, and diabetes. Atherogenic dyslipidemia is a combination of lipoprotein abnormalities including a reduced level of high-density lipoprotein cholesterol (HDL-C) and increased level of serum triglyceride (TG), apolipoprotein B, and low-density lipoprotein cholesterol (LDL-C). These characteristic abnormalities provide evidence of a prothrombotic and a proinflammatory state of an individual. Recently it was documented that about one-third of the urban Indians are suffering from MS clearly indicating the role of urbanization and mechanization in the disease onset. The overall prevalence of MS in Indian population is 31.4% where females (48.2%) are more affected than their male counterparts (16.3%) [1, 2]. The age-wise MS prevalence had increased from 2.9% in those aged 18–30 years to 31.0% in those aged 60–69 years in Asians [3].

The metabolic factors causative of MS are highly associated with cardiovascular diseases (CVD) and diabetes. These factors often lead to a 2-fold elevation in CVD risk and a 5-fold elevation in risk of diabetes (if not already present) within 5 years, with an even higher long-term risk. In urban India, nearly 77.2% of the diabetic patients had MS which was significantly higher in women (87.71%) as compared to men (69.33%), whereas in coronary artery disease (CAD) patients, the prevalence of MS was reported to be 60.06%. However, the epidemiological assessment of MS prevalence and the individual components contributing to its development in young and apparently healthy Indians is less studied [4].

In this state of affairs, the aim of the study was to assess the prevalence of MS in young and apparently healthy Gujarati...
Asian Indians and look for its predictors in this ethnic group of population [5].

2. Material and Method

2.1. Study Design. This observational and randomized screening study was conducted by U. N. Mehta Institute of Cardiology and Research Center. The protocol was approved and cleared by Institutional Ethics Committee. Total 1500 individuals of both genders (729 males and 1006 females), who were apparently healthy, asymptomatic, disease-free, and ranging in age from 20 to 40 years, were included in the study. The subjects taking any medications and with abnormal stress test were excluded from the investigation. The details of demographic data, ethnicity, family history of CAD, and smoking were collected for each individual.

2.2. Metabolic Syndrome Risk Factors Assessment. Laboratory assessments included obtaining venous blood samples in a fasted state for the determination of lipid components (total cholesterol (TC), HDL-C, LDL-C and TG, and total lipid) and blood glucose. Serum glucose and lipids were measured by International Federation of Clinical Chemistry (IFCC) approved enzymatic methods using commercially available kit on autoanalyzer (ARCHITECH PLUS ci4100, Germany). Blood pressure was measured using a sphygmomanometer kit on autoanalyzer (ARCHITECH PLUS ci4100, Germany). The MS was assessed in the last rib.

2.3. Definition and Preferred Cutoff Values. The MS was defined according to the NCEP-ATPIII guidelines with an anthropometric modification of WC value that is specifically applicable to South Asians [5]. Patients were defined as having the MS when they met at least 3 of 5 criteria: (1) elevated WC > 90 cm in men and > 80 cm in women, (2) elevated blood pressure (SBP > 130 mmHg and/or DBP > 85 mmHg), (3) reduced HDL-C < 40 mg/dL in men and < 50 mg/dL in women, (4) elevated fasting glucose > 110 mg/dL or drug treatment for elevated glucose, and (5) elevated TG > 150 mg/dL or drug treatment for elevated TG.

2.4. Statistical Analysis. Statistical analysis was performed using SPSS, Version 20.0 (Chicago, IL, USA). Qualitative data were expressed as proportions whereas the quantitative data was expressed as mean ± SD. As the data follows non-Gaussian distribution the variables were compared using Mann-Whitney U test. The level of significance was accepted at P < 0.05. Binary logistic regression test was used to assess the predictors contributing to the development of MS in this population.

3. Result

The demographic characteristics of the study population are presented in Table 1. Out of 1500 healthy young subjects, 771 were females (51.4%) and 729 were males (48.6%) showing the overall mean age of 29.88 ± 5.97 years. According to modified NCEP-ATPIII criteria, 240 (16.0%) individuals were suffering from MS. The lipid profile of the overall population showed mean value of Lp. (a), TC, TG, HDL-C, LDL-C, VLDL, and total lipid as 28.16 ± 25.81, 80.39 ± 14.24, 43.82 ± 9.93, 106.91 ± 29.28, 20.74 ± 12.36, and 619.02 ± 84.13 mg/dL, respectively. The levels of other risk factors such as blood sugar, SBP, DBP, BMI, and WC were 80.39 ± 14.24 mg/dL, 124.09 ± 16.23 mm/Hg, 79.50 ± 7.97, 23.12 ± 4.82, and 86.80 ± 25.16 cm correspondingly. Among study participants, 155 (10.3%) had family history of premature CAD and 123 (8.2%) had addiction.

Comparison of various risk factors according to the presence or absence of MS is shown in Table 2. The population affected with MS was mostly male (65.4% versus 45.4%) and older (33.00 ± 5.33 versus 29.29 ± 5.91 years). The levels of blood sugar (89.00 ± 20.30 versus 78.75 ± 12.00), blood pressure (SBP: 137.96 ± 16.91 versus 121.45 ± 14.69, DBP: 86.60 ± 9.18 versus 78.15 ± 9.18), TC (192.75 ± 40.00 versus 167.42 ± 32.11), TG (157.37 ± 99.30 versus 93.50 ± 45.04), LDL-C (120.49 ± 32.77 versus 104.32 ± 27.85), BMI (2598 ± 3.80 versus 22.66 ± 4.82), and WC (95.63 ± 10.92 versus 85.09 ± 26.78) were significantly (<0.0001) higher in the population having MS as compared to the population not having MS. The low HDL-C (40.80 ± 9.40) level was highly prevalent in individuals detected with MS. However,
we found that 16.0% of the young Gujaratis who are below healthy and young Gujarati Asian Indians has been reported.

The process of MS may start in very early stage of life which continues to progress during childhood and adolescence, reaching almost 50% in prevalence in severely obese youngsters [6–10]. However, this process is subjected to variation according to the region, urbanization, lifestyle patterns, and socioeconomic and cultural factors in Asian Indian community. The prevalence of metabolic syndrome is increasing exponentially in India, in both the urban and rural areas showing the prevalence range from 11% to 41% [11]. In the current study for the first time the prevalence of MS was the highest in individuals having diabetes (51.6%) followed by TG (48.9%). These patients were further categorized according to age and gender and the results are shown in Table 5. The strength of various risk factors in the development of MS was assessed using multivariate logistic regression analysis and the results are presented in Table 6. We have found that BMI (odds ratio: 1.120; 95% CI: 1.077 to 1.163; *P* < 0.0001) and age (odds ratio: 1.100; 95% CI: 1.061 to 1.139; *P* < 0.0001) are two prime contributors of MS in this ethnic group.

### 4. Discussion

The process of MS may start in very early stage of life which continues to progress during childhood and adolescence, reaching almost 50% in prevalence in severely obese younger [6–10]. However, this process is subjected to variation according to the region, urbanization, lifestyle patterns, and socioeconomic and cultural factors in Asian Indian community. The prevalence of metabolic syndrome is increasing exponentially in India, in both the urban and rural areas showing the prevalence range from 11% to 41% [11]. In the current study for the first time the prevalence of MS in healthy and young Gujarati Asian Indians has been reported. We found that 16.0% of the young Gujaratis who are below

### Table 2: Profile comparison of population with and without metabolic syndrome.

| Variable                   | With MS, *N* = 240 | Without MS, *N* = 1260 | *P* value |
|----------------------------|--------------------|------------------------|-----------|
| Gender                     |                    |                        |           |
| Male                       | 157 (65.4%)        | 572 (45.4%)            | <0.0001   |
| Female                     | 83 (34.6%)         | 688 (54.6%)            | <0.0001   |
| Age (year)                 | 33.00 ± 5.33       | 28.40 ± 6.83           | 0.3970    |
| Lp. (a) (mg/dL)            | 26.86 ± 24.45      | 78.75 ± 12.10          | <0.0001   |
| Blood sugar (mg/dL)        | 89.00 ± 20.30      | 167.42 ± 32.11         | <0.0001   |
| TC (mg/dL)                 | 192.75 ± 40.00     | 173.56 ± 111.99        | <0.0001   |
| TG (mg/dL)                 | 157.37 ± 99.30     | 93.50 ± 45.06          | <0.0001   |
| HDL-C (mg/dL)              | 40.80 ± 9.40       | 44.39 ± 9.92           | <0.0001   |
| LDL-C (mg/dL)              | 120.49 ± 32.77     | 104.32 ± 27.85         | <0.0001   |
| VLDL (mg/dL)               | 31.46 ± 19.88      | 18.71 ± 9.00           | <0.0001   |
| Total lipid (mg/dL)        | 690.92 ± 123.13    | 605.32 ± 66.16         | <0.0001   |
| LDL-C/HDL-C                | 3.10 ± 1.05        | 2.50 ± 1.17            | <0.0001   |
| TC/HDL-C                   | 4.93 ± 1.37        | 3.96 ± 1.49            | <0.0001   |
| Premature CAD              | 32 (13.3%)         | 123 (9.8%)             | 0.1211    |
| Addiction                  | 25 (10.4%)         | 98 (78%)               | 0.2160    |
| SBP (mm/hg)                | 137.96 ± 16.91     | 121.45 ± 14.69         | <0.0001   |
| DBP (mm/hg)                | 86.60 ± 9.81       | 78.15 ± 9.18           | <0.0001   |
| BMI (kg/m²)                | 25.98 ± 3.80       | 22.66 ± 4.74           | <0.0001   |
| WC (cm)                    | 95.63 ± 10.92      | 85.09 ± 26.78          | <0.0001   |

MS: metabolic syndrome; Lp. (a): lipoprotein; TC: total cholesterol; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; VLDL: very low-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; WC: waist circumference.
| Variable                  | Males having MS | Females having MS | P value |
|---------------------------|-----------------|-------------------|---------|
| Age (year)                | 32.78 ± 5.27    | 33.40 ± 5.45      | 0.3925  |
| Lp. (a) (mg/dL)           | 22.92 ± 21.56   | 34.30 ± 27.78     | 0.0005  |
| Blood sugar (mg/dL)       | 91.10 ± 20.27   | 85.02 ± 19.89     | 0.0271  |
| TC (mg/dL)                | 195.59 ± 42.56  | 187.40 ± 34.54    | 0.1325  |
| TG (mg/dL)                | 177.20 ± 108.34 | 119.84 ± 65.06    | <0.0001 |
| HDL-C (mg/dL)             | 55 (3.6%)       | 44 (4.3%)         |         |
| LDL-C (mg/dL)             | 37.45 ± 7.04    | 47.13 ± 10.07     | <0.0001 |
| VLDL (mg/dL)              | 122.69 ± 34.43  | 116.34 ± 29.10    | 0.1537  |
| Total lipid (mg/dL)       | 710.24 ± 135.24 | 654.37 ± 85.57    | 0.0007  |
| LDL-C/HDL-C               | 3.32 ± 1.39     | 2.44 ± 1.21       | <0.0001 |
| TC/HDL-C                  | 5.33 ± 1.27     | 4.17 ± 1.23       | <0.0001 |
| Premature CAD             | 21 (13.4%)      | 11 (13.3%)        | 0.011   |
| Addiction                 | 18 (11.5%)      | 7 (8.4%)          | 0.032   |
| SBP (mm/hg)               | 139.9 ± 16.46   | 134.29 ± 17.26    | 0.0142  |
| DBP (mm/hg)               | 86.92 ± 10.69   | 85.99 ± 7.94      | 0.4864  |
| BMI (kg/m²)               | 26.15 ± 3.52    | 25.66 ± 4.28      | 0.3429  |
| WC (cm)                   | 96.73 ± 10.03   | 91.83 ± 11.84     | 0.0009  |

MS: metabolic syndrome; Lp. (a): lipoprotein; TC: total cholesterol; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; VLDL: very low-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; WC: waist circumference.

| Variable                  | Age group (20–30) | Age group (31–40) | P value |
|---------------------------|-------------------|-------------------|---------|
| Gender                    | 56 (66.4%)        | 104 (65.8%)       | 0.0026  |
| Lp. (a) (mg/dL)           | 26.89 ± 22.99     | 26.84 ± 25.24     | 0.9880  |
| Blood sugar (mg/dL)       | 83.04 ± 13.16     | 92.09 ± 22.59     | 0.0010  |
| TC (mg/dL)                | 181.96 ± 33.66    | 198.35 ± 42.06    | 0.0025  |
| TG (mg/dL)                | 126.17 ± 57.34    | 173.56 ± 111.99   | 0.0004  |
| HDL-C (mg/dL)             | 41.33 ± 10.04     | 40.53 ± 9.07      | 0.5329  |
| LDL-C (mg/dL)             | 115.39 ± 28.01    | 123.14 ± 34.77    | 0.0822  |
| VLDL (mg/dL)              | 25.24 ± 11.49     | 34.69 ± 22.42     | 0.0004  |
| Total lipid (mg/dL)       | 649.46 ± 80.85    | 712.44 ± 135.43   | 0.0001  |
| LDL-C/HDL-C               | 2.95 ± 1.06       | 3.17 ± 1.04       | 0.1239  |
| TC/HDL-C                  | 4.62 ± 1.29       | 5.09 ± 1.39       | 0.0116  |
| Premature CAD             | 7 (8.5%)          | 25 (15.5%)        | 0.0884  |
| Addiction                 | 9 (11.0%)         | 16 (10.1%)        | 0.0012  |
| SBP (mm/hg)               | 137.18 ± 15.57    | 138.37 ± 17.61    | 0.6063  |
| DBP (mm/hg)               | 84.88 ± 11.38     | 87.49 ± 8.80      | 0.0505  |
| BMI (kg/m²)               | 25.93 ± 4.15      | 26.01 ± 3.62      | 0.8775  |
| WC (cm)                   | 94.28 ± 9.27      | 95.42 ± 11.69     | 0.4441  |

Lp. (a): lipoprotein; TC: total cholesterol; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; VLDL: very low-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body mass index; WC: waist circumference.
We found that the prevalence of MS is highly associated with advancing age in both genders. It is noteworthy that the frequency of MS increases from 9.56% in 20–30-year individuals to 24.57% in 30–40-year individuals. Hildrum et al. [17] found increase in prevalence of metabolic syndrome with increasing age that 6.7% of subjects in the age group of 20–29 years are increased to 29.3% of subjects in the age group of 30–39 years. Hildrum et al. [17] findings were almost similar to this study on Norwegian population. Total cholesterol, TG, VLDL, total lipid, and TC/HDL-C had significantly higher prevalence in comparatively older group of 31–40 years compared to age group of 20–30 years.

Though the factors of MS are multifactorial, distribution of these risk factors is subjected to ethnic and racial variations. Asian Indians have higher rates of diabetes and hence are more prone to develop MS as compared to their Caucasian counterparts [18]. Diabetes mellitus is characterized by disorders of insulin action or insulin secretion, either of which may be a predominant feature. Hyperinsulinemia appears to be a compensatory mechanism that responds to increased levels of circulating glucose and hence development of MS. People who develop diabetes usually pass through the phases of excessive adipogenesis (obesity), insulin resistance, hyperinsulinemia, pancreatic beta cells stress, and damage leading

### Table 5: Prevalence of metabolic syndrome in population having diabetes, blood pressure, dyslipidemia, and abnormal waist circumference.

| Variable | Total affected population | MS present | MS present in males & females | P value | MS present in different age groups | P value |
|----------|--------------------------|------------|-------------------------------|---------|-----------------------------------|---------|
| DM (mg/dL) | 95 (6.3%) | 49 (51.6%) | M = 38 (77.6%) | F = 11 (22.4%) | <0.0001 | 20–30 = 5 (10.2%) | 31–40 = 44 (89.8%) | <0.0001 |
| SBP (mm/hg) | 546 (36.4%) | 188 (34.3%) | M = 128 (68.1%) | F = 60 (31.9%) | <0.0001 | 20–30 = 67 (35.6%) | 31–40 = 121 (64.4%) | <0.0001 |
| DBP (mm/hg) | 373 (24.86%) | 146 (39.5%) | M = 97 (66.4%) | F = 49 (33.6%) | <0.0001 | 20–30 = 43 (29.5%) | 31–40 = 103 (70.5%) | <0.0001 |
| TG (mg/dL) | 229 (15.3%) | 112 (48.9%) | M = 88 (78.6%) | F = 24 (21.4%) | <0.0001 | 20–30 = 29 (25.9%) | 31–40 = 83 (74.1%) | <0.0001 |
| HDL-C (mg/dL) | 847 (56.5%) | 145 (17.1%) | M = 100 (69.0%) | F = 45 (31.0%) | <0.0001 | 20–30 = 51 (35.2%) | 31–40 = 94 (64.8%) | <0.0001 |
| WC (cm) | 712 (47.5%) | 216 (30.3%) | M = 135 (62.5%) | F = 81 (37.5%) | <0.0001 | 20–30 = 75 (34.7%) | 31–40 = 141 (65.3%) | <0.0001 |
| Premature CAD | 155 (10.3%) | 32 (20.6%) | M = 21 (65.6%) | F = 11 (34.4%) | 0.024 | 20–30 = 7 (21.9%) | 31–40 = 25 (78.1%) | <0.0001 |

MS: metabolic syndrome; DM: diabetes mellitus; SBP: systolic blood pressure; DBP: diastolic blood pressure; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol; WC: waist circumference; CAD: coronary artery disease.

### Table 6: Multiple logistic regression analysis using metabolic syndrome as dependent variable.

| Variables | B     | Wald | Sig. | Adjusted odds ratio | 95% CI for EXP(B) |
|-----------|-------|------|------|---------------------|-------------------|
| Male gender | 0.6853 | 18.9230 | 0.0000 | 1.9844 | 1.4572–2.7022 |
| Age | 0.0809 | 35.7508 | 0.0000 | 1.0842 | 1.0559–1.1134 |
| Lp. (a) | −0.0017 | 0.3256 | 0.5683 | 0.9983 | 0.9924–1.0042 |
| Premature CAD | 0.0679 | 0.9091 | 0.7640 | 1.1070 | 0.6869–1.6677 |
| Addiction | −0.0172 | 0.0047 | 0.9452 | 0.9830 | 0.6024–1.6040 |
| BMI | 0.1145 | 49.9796 | 0.0000 | 1.1213 | 1.0863–1.1575 |
| Constant | −7.2995 | 169.9954 | 0.0000 | 0.0007 | |

CI: confidence interval; CAD: coronary artery disease; BMI: body mass index.
to progressive decrease of insulin secretion, impaired glucose postprandial, and fasting levels [19, 20]. The second key contributor of MS development in Gujarati Asians was TG (48.9% and odds) which has long been identified as “obesity epidemic” contributing to the rising prevalence of MS in Indians. This phenomenon refers to the fact that despite the relatively lower prevalence rates of generalized obesity, Indians tend to have a greater degree of central body obesity and increased body fat, particularly increased visceral fat, and have lower cutoffs for BMI in comparison to their Caucasian counterparts [21]. Obesity contributes significantly to the development of MS, especially in presence of increased WC, as it induces insulin resistance and exerts highly deleterious impact on metabolism [22]. Collectively, diabetes and obesity are risk predictors of both venous thrombosis and an occlusive arterial disease most likely due to existence of an atherothrombotic syndrome secondary to insulin resistance and defective fibrinolysis. Patients with MS were found to have significantly more atherosclerosis compared with the patients without MS, independent of their diabetes status [23].

5. Conclusion

In conclusion, prevalence of metabolic syndrome in young Gujarati Asian Indian population reinforces the need for a comprehensive noncommunicable disease prevention and control program. This study has shown the unacceptably high prevalence rate of MS in males (65.4%) compared to females (34.6%) showing an accelerating trend with ageing. Increasing awareness and early identification of these clusters of risk factors should be emphasized in designing population-wide prevention strategies for Gujarati Asian Indians, in particular.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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