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The epidemiological profile of metabolic syndrome in Indian population: A comparative study between men and women

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ABSTRACT

Background: Metabolic syndrome is one of the most important risk factors that increase the likelihood of developing chronic diseases. Therefore, the aim of this study is to determine the prevalence of metabolic syndrome and its component as well as to find out the predictors in India. It has also tried to see the coexistence of metabolic syndrome and other morbid conditions.

Methods: This study has utilized the secondary data collected in fourth round of National Family Health Survey (NFHS-4), which was conducted during 2015–2016 in India. Since this study is concentrated on metabolic syndrome among women and men, so various information regarding biomarker measurements and various socio-economic, demographic and lifestyle characteristics have been used. Appropriate bivariate and multivariate analysis have been done to carry out the results.

Results: In this representative sample of Indian men, about 1.1% have met the International Diabetes Federation (IDF) criteria for metabolic syndrome whereas almost 1.5% women aged 15–49 have met this criteria. The results of multivariate analysis revealed that the risk of metabolic syndrome increase steadily with age and the risk is quite high among people belonging to higher wealth quintiles and postmenopausal period.

Conclusion: Though this study has shown a comparatively lower prevalence of metabolic syndrome but at the same time it has highlighted some high prevalence for the components of metabolic syndrome. So emphasis should be focused on prevention, early detection of metabolic risk factors and treatment of its components that will have a significant impact on future adult health.

1. Introduction

Over the last fifty years, severe changes have been observed in the human environment, behaviours and life style. These changes have not only helped in improving the living condition of the societies but at the same time they have also posed numerous threats to health of the people and metabolic syndrome is one of them. Metabolic syndrome is a cluster of at least three out of the five interrelated metabolic risk factors such as hypertension, central obesity, impaired glucose tolerance, low serum high density lipoprotein (HDL) and high serum triglycerides.[1] Several institutions and expert groups have proposed different criteria for the definition of metabolic syndrome. It has been proposed by WHO in 1999,[2] National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) in 2002[3] and International Diabetes Federation (IDF) in 2005.[4] Those criteria are given in Table 1. Despite the lack of agreement on the definition of metabolic syndrome, the criterion given by IDF is widely used in most part of the world.

As metabolic syndrome is a combination of individual metabolic risk factors, therefore its prevalence is highly dependent on the cut-off points used for the definition of each single component of this syndrome. A large variation has been found in the global prevalence of metabolic syndrome ranging from 7.1% to 41.6% across studies.[5,6] The prevalence of metabolic syndrome is quite high worldwide - 35% in USA,[7] 24.9% in Latin America[8] and 20.7%–37.2% in the gulf countries[9] as per ATP III criteria. According to a study of meta-analysis based on 21 cohort studies from United States and Europe, the prevalence of metabolic syndrome ranges from 23% to 46% according to WHO or NCEP criteria.[10] Furthermore, according to a systematic review the prevalence of metabolic syndrome in South Asia was 26.1% and 29.8% as per ATP III and IDF criteria.[11]

Though national representative studies on metabolic syndrome are not available in India, there are some studies based on clinical data and small sample surveys. Available data indicate that the prevalence of metabolic syndrome in India varies according to socioeconomic and cultural factors, lifestyle pattern, extend of urbanization.[12] The main reason why the metabolic syndrome is attracting scientific and

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Table 1
Definitions of metabolic syndrome.

Criteria	WHO	NCEP ATP III	IDF
Essential	Diabetes mellitus or IFG or IGT or insulin resistance (assessed by clamp studies) and at least two of the following:	Three or more of the following five risk factors:	Central obesity plus any two of the following four factors:
Central obesity	Waist-to-hip ratio > 0.90 in man and > 0.85 in women or BMI > 30 kg/m^2	Waist circumference > 102 cm in men and > 88 cm in women	Waist circumference (Europid) ≥ 94 cm in men and ≥80 cm in women (ethnic specific values for other population groups as applicable)
Impaired glucose tolerance	Diabetes mellitus or IFG or IGT or insulin resistance by clamp studies	FPG ≥ 100 mg/dl (5.6 mmol/L)	FPG ≥ 100 mg/dl (5.6 mmol/L) or previously diagnosed diabetes
Lipid profile	Serum triglycerides ≥ 1.7 mmol/L and/or HDL-C < 0.9 mmol/L (35 mg/dl) in men and < 1.0 mmol/L (39 mg/dl) in women	Triglyceride ≥ 150 mg/dl (1.7 mmol/L). HDL-C < 40 mg/dl (1.03 mmol/L) in men and < 50 mg/dl (1.29 mmol/L) in women	Triglyceride ≥150 mg/dl (1.7 mmol/L) or specific treatment for this lipid abnormality HDL-C < 40 mg/dl (1.03 mmol/L) in men and < 50 mg/dl (1.29 mmol/L) in women or specific treatment for this lipid abnormality
Hypertension	Blood pressure ≥ 140/90 mmHg	Systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg	Systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg or treatment of previously diagnosed hypertension
Others	Urinary albumin excretion rate > 20 μg/min or albumin to creatinine ratio ≥ 30 mg/g		Additional metabolic criteria supportive of but not essential for diagnosis

Sources: WHO (1999); NCEP ATP III (2002); IDF (2005).
Note: According to IDF criteria if BMI is > 30 kg/m2, central obesity can be assumed and waist circumference does not need to be measured.

Table 2
Percentage of components of metabolic syndrome with their confidence interval among women aged 15–49 and men aged 15–54 by states/UTs in India, NFHS-4.

State	Obesity		Hypertension		Impaired glucose tolerance (IGT)	
	Women	Men	Women	Men	Women	Men
North	4.4 (4.241–4.463)	2.2 (2.030–2.404)	32.9 (32.628–33.128)	49.7 (49.113–50.382)	52.1 (51.830–52.359)	56.1 (55.457–56.719)
Chandigarh	11.1 (8.660–13.524)	1.1 (0.824–2.435)	28.0 (24.612–31.452)	40.9 (31.952–49.960)	40.7 (36.912–44.444)	47.8 (38.497–56.867)
Delhi	7.8 (7.076–8.631)	2.6 (1.239–3.991)	23.5 (22.249–24.670)	30.4 (26.374–34.376)	52.2 (50.776–53.657)	54.5 (50.155–58.862)
Haryana	3.6 (3.310–3.824)	1.8 (1.341–2.214)	36.1 (35.475–36.764)	57.2 (55.545–58.813)	58.6 (57.894–59.216)	62.0 (60.400–63.608)
Himachal Pradesh	5.0 (4.560–5.444)	2.3 (1.688–2.906)	34.7 (33.773–35.665)	56.8 (54.837–58.857)	50.3 (49.356–51.348)	51.1 (49.046–53.110)
Jammu & Kashmir	5.3 (4.968–5.554)	2.4 (2.042–2.833)	38.9 (38.267–39.515)	48.1 (46.817–49.380)	49.5 (48.872–50.153)	53.2 (51.909–54.471)
Punjab	7.1 (6.685–7.424)	3.7 (3.089–4.407)	41.2 (40.555–41.945)	60.9 (59.163–62.546)	58.3 (57.557–58.949)	61.7 (60.065–63.437)
Rajasthan	2.5 (2.336–2.645)	1.5 (1.231–1.844)	29.3 (28.818–29.693)	44.8 (43.526–45.998)	46.9 (46.399–47.359)	52.4 (51.195–53.680)
Uttarakhand	3.5 (3.253–3.822)	2.2 (1.566–2.822)	31.2 (30.529–31.922)	51.7 (49.532–53.814)	56.4 (55.677–57.170)	59.6 (57.471–61.685)
Central	**2.6 (2.479–2.628)**	**1.2 (1.039–1.294)**	**29.2 (29.033–29.449)**	**39.5 (38.903–40.060)**	**49.2 (48.951–49.409)**	**53.1 (52.558–53.741)**
Chhattisgarh	1.7 (1.535–1.866)	1.0 (0.715–1.365)	31.5 (30.948–32.101)	45.8 (44.196–47.385)	50.3 (49.695–50.936)	55.6 (54.038–57.222)
Madhya Pradesh	2.2 (2.090–2.329)	1.2 (0.978–1.401)	29.3 (28.910–29.627)	39.7 (38.737–40.651)	48.7 (48.265–49.053)	50.7 (49.721–51.680)
Uttar Pradesh	2.8 (2.723–2.940)	1.2 (03995–1.358)	28.9 (28.586–29.157)	38.3 (37.503–39.137)	49.2 (48.902–49.533)	53.9 (53.023–54.700)
East	**2.0 (1.958–2.120)**	**1.1 (0.929–1.243)**	**29.8 (29.543–30.051)**	**40.8 (40.055–41.543)**	**48.6 (48.334–48.890)**	**52.9 (52.161–53.676)**
Bihar	1.5 (1.386–1.620)	0.9 (0.663–1.153)	24.6 (24.249–25.043)	37.0 (35.706–38.194)	45.3 (44.854–45.771)	50.6 (49.344–51.922)
Jharkhand	1.5 (1.394–1.688)	0.9 (0.568–1.144)	29.7 (29.206–30.265)	43.0 (41.462–44.552)	52.8 (52.251–53.411)	60.1(58.533–61.595)
Odisha	2.5 (2.294–2.635)	1.5 (1.152–1.867)	29.7 (29.231–30.214)	42.0 (40.520–43.412)	49.6 (49.065–50.142)	53.9 (52.381–55.313)
West Bengal	2.5 (2.287–2.766)	1.1 (0.725–1.548)	35.1 (34.412–35.838)	43.0 (41.087–44.932)	50.2 (49.494–50.964)	52.4 (50.399–54.294)
Northeast	**1.6 (1.538–1.701)**	**1.0 (0.840–1.169)**	**42.2 (41.921–42.543)**	**55.2 (54.329–55.974)**	**53.7 (53.403–54.033)**	**58.0 (57.219–58.858)**
Arunachal Pradesh	2.0 (1.768–2.250)	1.2 (1.005–2.079)	39.4 (38.587–40.212)	55.3 (53.370–57.704)	51.0 (50.198–51.863)	57.1 (54.992–59.313)
Assam	1.4 (1.292–1.578)	0.8 (0.504–1.043)	44.6 (43.977–45.145)	56.6 (55.080–58.137)	52.5 (51.869–53.047)	57.5 (55.936–59.005)
Manipur	3.5 (3.173–3.811)	1.9 (1.161–2.359)	34.8 (33.996–35.601)	55.8 (53.600–58.114	54.6 (53.786–55.464)	54.3 (52.257–56.787)
Meghalaya	1.2 (0.939–1.403)	1.0 (0.442–1.574)	31.7 (30.700–32.621)	39.4 (36.758–42.296)	56.0 (54.963–57.026)	59.5 (56.731–62.340)
Mizoram	2.6 (2.268–2.843)	3.8 (2.604–4.337)	30.7 (29.832–31.473)	48.7 (46.586–51.319)	60.5 (59.584–61.323)	62.8 (60.708–65.278)
Nagaland	1.6 (1.365–1.861)	1.0 (0.534–1.576)	40.9 (39.944–41.829)	57.4 (54.714–59.771)	54.8 (53.879–55.794)	57.0 (54.339–59.445)
Sikkim	3.9 (3.280–4.335)	4.1 (2.619–5.189)	44.7 (43.415–46.101)	66.7 (63.057–69.338)	71.6 (70.433–72.870)	69.4 (66.699–72.801)
Tripura	1.7 (1.286–2.029)	1.3 (0.454–1.905)	39.7 (38.309–41.103)	53.1 (49.613–56.325)	57.4 (55.967–58.812)	60.3 (57.047–63.696)
South	**6.1 (5.921–6.240)**	**3.3 (3.052–2.638)**	**28.2 (27.884–28.472)**	**43.8 (43.030–44.621)**	**50.8 (50.430–51.086)**	**54.1 (53.252–54.855)**
Andaman & Nicobar	5.8 (4.787–6.525)	6.1 (4.241–8.881)	25.2 (23.732–26.960)	48.5 (43.794–53.149)	52.6 (50.711–54.416)	52.9 (48.868–58.203)
Andhra Pradesh	7.8 (7.276–8.364)	5.6 (4.407–6.793)	28.1 (27.234–29.019)	44.7 (42.109–47.265)	45.3 (44.291–46.289)	45.6 (42.964–48.168)
Karnataka	4.9 (4.617–5.156)	3.0 (2.439–3.505)	29.9 (29.337–30.457)	44.2 (42.658–45.775)	51.7 (51.122–52.348)	54.7 (53.138–56.270)
Kerala	4.3 (3.912–4.685)	2.6 (1.920–3.296)	24.6 (23.746–25.357)	38.8 (36.732–40.938)	60.4 (59.464–61.307)	71.5 (69.524–73.453)
Lakshadweep	9.8 (8.747–12.553)	0 (0.000–0.000)	34.9 (31.278–36.988)	42.9 (36.339–51.646)	69.8 (66.948–72.481)	66.7 (55.703–70.624)
Puducherry	8.0 (7.223–8.954)	3.6 (2.224–5.041)	30.6 (29.130–31.987)	54.7 (50.908–58.405)	51.0 (49.463–52.567)	52.6 (48.808–56.328)
Tamil Nadu	6.3 (6.032–6.607)	2.9 (2.480–3.398)	29.2 (28.712–29.768)	46.6 (45.258–47.968)	52.0 (51.386–52.545)	56.3 (54.912–57.607)
Telangana	6.6 (6.055–7.238)	2.8 (1.772–3.763)	26.0 (25.004–27.049)	38.9 (35.951–41.864)	44.4 (43.225–45.555)	38.5 (35.565–41.502)
West	**4.9 (4.707–5.076)**	**3.2 (2.911–3.550)**	**28.7 (28.352–29.109)**	**44.3 (43.402–45.196)**	**46.5 (46.090–46.927)**	**49.1 (48.163–49.972)**
Dadra & Nagar Haveli	3.6 (2.454–5.230)	4.3 (0.938–6.063)	27.5 (24.378–30.652)	46.8 (39.580–53.454)	39.9 (36.302–43.186)	46.8 (38.836–52.694)
Daman & Diu	6.0 (4.639–7.213)	5.3 (2.304–6.222)	32.9 (30.288–35.359)	40.5 (36.443–46.001)	53.0 (50.129–55.587)	64.9 (59.786–69.114)
Goa	7.0 (5.797–8.270)	6.9 (5.099–8.500)	29.3 (27.203–31.551)	47.0 (43.588–50.332)	55.9 (53.623–58.367)	60.7 (57.492–64.104)
Gujarat	5.6 (5.312–5.930)	3.2 (2.738–3.645)	32.4 (31.74332.969)	45.7 (44.380–46.952)	47.5 (46.794–48.107)	51.2 (49.875–52.461)
Maharashtra	4.5 (4.262–4.754)	3.1 (2.609–3.618)	26.9 (26.432–27.459)	43.1 (41.648–44.525)	45.9 (45.357–46.511)	46.9 (45.402–48.306)
India	**3.8 (3.747–3.840)**	**2.2 (2.096–2.270)**	**30 (29.891–30.108)**	**43.6 (43.295–43.885)**	**49.6 (49.462–49.699)**	**53.2 (52.858–53.452)**

Note: Obesity- BMI > 30kg/m2; Hypertension- Systolic BP≥130 or diastolic BP≥85 mmHg or treatment of previously diagnosed hypertension; IGT- Blood glucose≥100 mg/dl or previously diagnosed diabetes.

Table 3
Percentage of metabolic syndrome with confidence interval (CI) among women aged 15–49 and men aged 15–54 in India.

State	Women			Men		
	Percentage	Confidence Interval (CI)	N	Percentage	Confidence Interval (CI)	N
North	1.8	(1.740–1.885)	86452	1.3	(1.112–1.403)	14979
Chandigarh	3.9	(2.330–5.319)	488	0.0	(0.000–0.000)	91
Delhi	2.3	(1.866–2.754)	7884	1.6	(0.493–2.694)	1244
Haryana	1.7	(1.552–1.915)	14296	1.1	(0.709–1.383)	2469
Himachal Pradesh	2.5	(2.204–2.842)	3595	1.2	(0.764–1.655)	933
Jammu & Kashmir	2.3	(2.129–2.526)	6346	1.2	(0.933–1.497)	1685
Punjab	3.2	(2.981–3.493)	14398	2.4	(1.841–2.898)	2508
Rajasthan	1.0	(0.859–1.052)	33947	0.8	(0.536–0.966)	5267
Uttarakhand	1.6	(1.435–1.826)	5498	1.5	(1.059–2.138)	779
Central	**1.0**	**(0.987–1.083)**	**152395**	**0.6**	**(0.487–0.666)**	**23454**
Chhattisgarh	0.7	(0.563–0.772)	15353	0.7	(0.417–0.945)	2427
Madhya Pradesh	0.9	(0.833–0.989)	40356	0.5	(0.355–0.629)	6652
Uttar Pradesh	1.1	(1.076–1.215)	96686	0.6	(0.468–0.728)	14376
East	**0.8**	**(0.774–0.878)**	**141453**	**0.6**	**(0.463–0.693)**	**20116**
Bihar	0.6	(0.494–0.639)	50497	0.5	(0.283–0.631)	6804
Jharkhand	0.6	(0.482–0.663)	16206	0.4	(0.194–0.584)	2390
Odisha	0.9	(0.837–1.050)	23381	0.7	(0.481–0.983)	3195
West Bengal	1.1	(0.0947–1.067)	51369	0.7	(0.359–1.000)	7727
Northeast	**0.7**	**(0.689–0.801)**	**22567**	**0.5**	**(0.4345–0.683)**	**3488**
Arunachal Pradesh	0.9	(0.745–1.071)	549	1.2	(0.310–1.222)	85
Assam	0.7	(0.556–0.751)	15879	0.4	(0.202–0.593)	2435
Manipur	1.7	(1.404–1.843)	1144	1.2	(0.541–1.444)	162
Meghalaya	0.5	(0.333–0.635)	1415	0.5	(0.109–0.931)	199
Mizoram	1.3	(1.072–1.483)	541	1.3	(1.258–2.555)	77
Nagaland	0.6	(0.441–0.745)	724	1.0	(0.217–1.029)	100
Sikkim	2.3	(1.930–2.763)	306	2.1	(1.639–3.800)	48
Tripura	0.7	(0.510–1.022)	2009	0.8	(0.215–1.454)	382
South	**2.2**	**(2.135–2.333)**	**146631**	**1.5**	**(1.270–1.657)**	**25347**
Andaman & Nicobar	2.2	(1.652–2.758)	225	3.0	(1.941–5.484)	33
Andhra Pradesh	3.2	(2.867–3.592)	26677	2.8	(1.917–3.636)	4278
Karnataka	1.9	(1.761–2.107)	32521	1.3	(0.946–1.661)	5235
Kerala	1.4	(1.137–1.583)	18238	1.3	(0.793–1.774)	3481
Lakshadweep	4.9	(3.688–6.389)	41	0.0	(0.000–0.000)	6
Puducherry	2.8	(2.251–3.291)	758	2.2	(0.950–3.060)	138
Tamil Nadu	2.2	(2.023–2.370)	49134	1.1	(0.850–1.428)	9110
Telangana	2.3	(1.903–2.615)	19037	1.0	(0.410–1.640)	3066
West	**1.7**	**(1.607–1.830)**	**92404**	**1.6**	**(1.378–1.834)**	**19276**
Dadra & Nagar Haveli	1.2	(0.312–1.790)	168	0.0	(0.000–0.000)	46
Daman & Diu	2.5	(1.527–3.216)	80	2.7	(0.624–3.360)	38
Goa	1.8	(1.176–2.471)	836	1.9	(0.929–2.750)	419
Gujarat	2.0	(1.801–2.178)	29837	1.6	(1.315–1.974)	8396
Maharashtra	1.6	(1.438–1.734)	61483	1.6	(1.206–1.930)	10377
India	**1.5**	**(1.427–1.585)**	**641902**	**1.1**	**(1.008–1.131)**	**106660**

commercial interest is that, the factors defining the syndrome are associated with an increased morbidity and mortality. In fact, metabolic syndrome is considered to be a great risk factor for cardiovascular diseases and type 2 diabetes,[13,14] two of the most common chronic diseases of the recent time and also it elevate the risk of several cancers.[15] Some studies have also found a significant association of metabolic syndrome with colorectal, pancreatic, prostatic and breast cancer.[16,17]

The unavailability of national representative estimates and factors attributing on metabolic syndrome has obstructed the development of strategies to reduce it. Therefore, the purpose of present study is to estimate the prevalence of metabolic syndrome as well as its components and to explore the predictors of metabolic syndrome in Indian population. Besides, the study has also tried to explore the coexistence of metabolic syndrome and other morbid conditions which is important for targeting the high risk groups.

2. Data & methods

This study has utilized the secondary data collected in fourth round of National Family Health Survey (NFHS-4), which was conducted during 2015–2016 under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India and coordinated by the International Institute of Population Sciences (IIPS), Mumbai. National Family Health Survey is a large-scale multi-round survey conducted in a nationally representative sample of households. The survey provided national and state level data for India on infant and child mortality, fertility, reproductive health, maternal and child health, nutrition, anaemia, family planning services. It also provides data on biomarker measurements such as blood pressure, blood glucose level etc. The survey collected information from the nationally representative sample of 601,509 households; with 699,686 women aged 15–49 and 112,122 men aged 15–54 Since this study is concentrated on metabolic syndrome among women and men, so various information regarding biomarker measurements and various socio-economic, demographic and lifestyle characteristics based on men and women have been used. The NFHS-4 provides individual data files which helped us to do micro level analysis on the present study.

Bivariate analysis has been performed to determine the prevalence of metabolic syndrome and its components in various states and regions of India. Apart from that, chi-square test has been done to see the coexistence of metabolic syndrome and other morbid conditions. Multivariate analysis in the form of binary logistic regression has been carried out to determine the effect of various predictors on metabolic syndrome as well as to see which variables have more influence on metabolic syndrome. In this situation as the dependent variable is

Table 4
Adjusted odds ratio with 95% confidence interval (CI) by background characteristics.

Background Characteristics	Women		Men	
	OR	95% CI	OR	95% CI
Age				
15-29 ®				
30–39	3.829***	(3.51–4.177)	1.849***	(1.464–2.335)
40-49/40-54	6.924***	(6.341–7.562)	2.609***	(2.072–3.285)
Place of residence				
Urban ®				
Rural	0.691***	(0.656–0.728)	0.833*	(0.721–0.963)
Region				
North ®				
Central	0.937	(0.874–1.004)	0.84	(0.674–1.048)
Northeast	0.961	(0.863–1.071)	1.29	(0.970–1.715)
East	0.870**	(0.795–0.953)	1.033	(0.790–1.351)
West	0.908*	(0.832–0.991)	1.442***	(1.166–1.783)
South	1.250***	(1.162–1.344)	1.588***	(1.290–1.954)
Religion				
Hindu ®				
Muslim	1.546***	(1.446–1.652)	1.114	(0.895–1.387)
Christian	0.899	(0.792–1.020)	1.086	(0.802–1.471)
Others	1.497***	(1.370–1.637)	1.833***	(1.446–2.324)
Caste				
SC ®				
ST	0.775***	(0.693–0.867)	0.925	(0.687–1.245)
OBC	0.991	(0.922–1.065)	0.959	(0.776–1.185)
Others	1.246***	(1.157–1.343)	1.464***	(1.184–1.812)
Education				
No education ®				
Primary	1.199***	(1.109–1.296)	1.193	(0.864–1.647)
Secondary	1.174***	(1.100–1.254)	1.297	(0.987–1.703)
Higher	0.964*	(0.879–1.059)	1.284	(0.947–1.742)
Wealth Index				
Poorest ®				
Poorer	1.987***	(1.698–2.326)	1.666*	(1.027–2.703)
Middle	3.762***	(3.245–4.362)	3.205***	(2.041–5.031)
Richer	6.452***	(5.570–7.474)	6.291***	(4.035–9.809)
Richest	9.065***	(7.788–10.552)	9.179***	(5.816–14.488
Marital Status				
Never married ®				
Currently married	2.287***	(2.019–2.590)	2.214***	(1.719–2.850)
Widowed, divorced, separated	2.245***	(1.925–2.619)	1.746	(0.935–3.259)
Using tobacco				
No ®				
Yes	0.84	(0.767–0.920)	0.797	(0.687–0.924)
Drinks alcohol				
No ®				
Yes	1.151	(0.961–1.379	1.146	(0.988–1.329)
Menopause				
No ®				
Yes	1.295***	(1.216–1.379)	NA	NA

Note: ®: reference category; *, **, *** refers to < 0.05, < 0.01 and < 0.001 level of significance; NA: Not Applicable.

dichotomous in nature with mutually exclusive and exhaustive categories and the independent variables are categorical in nature so performance of binary logistic regression technique is the most appropriate one. For the analyses IBM SPSS (version 20) has been used.

3. Results

3.1. Components of metabolic syndrome in India

Table 2 illustrates the prevalence of all three components of metabolic syndrome (i.e., Obesity, hypertension and Impaired glucose tolerance) among women aged 15–49 and men aged 15–54 in various states, Union Territories and regions of India. As per the results, about 3.8% women and 2.2% men were obese. Andhra Pradesh showed the highest prevalence of obesity among women (7.8%) whereas, Goa (6.9%) reported the highest prevalence of obesity among men. Further, among women, the lowest prevalence of obesity was found in Meghalaya (1.2%) while among men the prevalence was found to be lowest in Assam (0.8%).

The prevalence of hypertension was 30% among women and 43.6% among men in India. Out of all six regions of India, North-eastern region showed the highest prevalence in case of both men (55.2%) and women (42.2%) but the lowest prevalence of hypertension was shown by Southern region (28.2%) among women and Central region (39.5%) among men. In case of both women as well as men, the highest prevalence of hypertension was shown by Sikkim whereas Delhi showed the lowest prevalence.

The overall prevalence of impaired glucose tolerance (IGT) among Indian women was 49.6% and among men its prevalence was 53.2%. Sikkim had shown the highest prevalence i.e. 71.6% in case of women, followed by Mizoram whereas in case of men, the highest prevalence was shown by Kerala (71.5%) followed by Sikkim (69.4%). Telangana had the lowest prevalence of IGT in case of both men (38.5%) and women (44.4%). Out of all six regions, North-eastern region had the highest prevalence and Western region had the lowest prevalence of impaired glucose tolerance.

3.2. Prevalence of metabolic syndrome in India

Table 3 illustrates the prevalence of metabolic syndrome among women and men in various states, UTs and regions of India. The overall prevalence of metabolic syndrome was 1.5% among women and 1.1% among men. According to NFHS-4, out of all states, the prevalence was found to be highest in Punjab and Andhra Pradesh (3.2%) in case of women where as in case of men also the highest prevalence was shown by Andhra Pradesh (2.8%). On the other hand, Meghalaya (0.5%) has shown the lowest prevalence of metabolic syndrome in case of women and the states like Jharkhand and Assam (0.4%) have shown the lowest prevalence in case of men. As per the result, Southern region (2.2%) of India had the highest prevalence of metabolic syndrome in case of women but in case of men, it is the western region that showed a comparatively greater prevalence. On the other hand North-eastern region had the lowest prevalence of metabolic syndrome among both male and female population.

3.3. Determinants of metabolic syndrome in India

To find out the possible determinants of metabolic syndrome in India, binary logistic regression analysis was carried out and the results were presented in Table 4. In this table the odds ratio are showing the association of background variables with metabolic syndrome. It was evident from the analyses that age has a positive significant effect on metabolic syndrome. The odds of metabolic syndrome were increasing with the increasing age. Rural women were 31% (OR = 0.691; CI: 0.656–0.728) and rural men were 17% (OR = 0.833; CI: 0.721–0.963) less likely to have metabolic syndrome than their urban counterparts. According to the result, higher educated women were at a lower risk of having metabolic syndrome than the uneducated women. This multivariate result had clearly shown the increase in the odds ratio with each increment in the wealth quintile; that means people belong to higher wealth index were at greater risk of metabolic syndrome than the people belong to lower wealth index. With regard to marital status, currently married women and women belong to widowed, divorced and separated category were 2.29 times and 2.24 time respectively more likely to have this syndrome as compared to the never married group whereas in case of men, currently married group were 2.214 times more likely to have this syndrome as compared to its never married men. Menopausal women were 1.295 times more likely to have metabolic syndrome (OR = 1.295; CI: 1.216–1.379) than the menstruating women.

Table 5
Percentage of metabolic syndrome by various morbid conditions.

Morbid Conditions	Women			Men		
	Percentage	N	P-value (Chi-square)	Percentage	N	P-value (Chi-square)
Asthma						
No	1.4	628951	p < 0.000	1.1	105082	p = 0.078
Yes	2.9	12951		1.5	1577	
Thyroid disorders						
No	1.3	627587	p < 0.000	1.1	106094	p < 0.000
Yes	6.4	14315		2.7	565	
Heart diseases						
No	1.4	632879	p < 0.000	0.9	105385	p = 0.043
Yes	3.4	9024		1.2	1275	
Cancer						
No	1.5		p = 0.644	1.1	106363	p = 0.221
Yes	1.6	1110		0.3	296	
Anaemia						
No	1.7	300707	p < 0.000	1.1	94781	p = 0.005
Yes	1.2	341195		0.8	11873	
Hysterectomy						
No	2.2	62368	p < 0.000	NA	NA	NA
Yes	4.3	21351		NA	NA	

Note: NA- Not Applicable.

3.4. Coexistence of metabolic syndrome and various morbid conditions

Table 5 presents the percentage of metabolic syndrome by various morbid conditions among both men and women. In case of women a significant association was found between metabolic syndrome and other diseases/disorders except cancer whereas in case of men, only thyroid disorders, heart diseases and anaemia had shown significant association with metabolic syndrome. This result was showing a greater percentage of metabolic syndrome among those who were already suffering from other morbid conditions like asthma, thyroid disorders and heart diseases. Again from this table we can observed that among women those who have undergone hysterectomy were more likely to have metabolic syndrome.

4. Discussion & conclusion

This study was forefront to determine the prevalence of metabolic syndrome and its component as well as to find out their socio-economic, demographic and lifestyle risk factors. Further this study attempted to see the coexistence of metabolic syndrome and other morbid conditions. In this representative sample of Indian men, only 1.1% met the IDF criteria for metabolic syndrome whereas almost 1.5% Indian women aged 15–49 met this criterion. From this result it is quite clear that metabolic syndrome is more prevalent among women than men. Similar results were reported in several other studies.[18,19] It suggests that more attention should be given to women in prevention and control of metabolic syndrome. This study revealed that the risk of metabolic syndrome increase steadily with age. It also showed that both men and women aged 40 and above are at greater risk as compared to the people of comparatively younger age groups. This finding is consistent with studies in China, Qatar and Nepal[20–22] whereas, it contradicts the finding from a study in Uttarakhand, India.[23] It is evident from the current study that there is significant association between metabolic syndrome and place of residence. People of rural residence are less likely to have metabolic syndrome as compared to the urban dwellers who are at a greater risk of metabolic syndrome. This result is in line with other studies.[22]

This study has also observed a higher risk of metabolic syndrome among people belong to higher wealth quintiles. This may be because of their sedentary lifestyle. Many studies in India have also given a similar kind of result.[24,25] Our study has shown a positive association of metabolic syndrome with marital status and currently married, widowed, divorced and separated women are at greater risk of metabolic syndrome. This result is consistent with the finding from a study in Northeast China.[20] While reviewing the relationship between alcohol consumption and metabolic syndrome, this study has not found any significant relationship between these two. But there are some studies that have shown a positive association between metabolic syndrome and alcohol consumption[26] whereas some have found a negative association.[27] Current study has also shown a comparatively higher risk of metabolic syndrome among postmenopausal women than menstruating women. Various research conducted in United States, Iran, India have also given similar result.[28,29]

This study has some strengths and limitations. As this study is based on the data from a large scale health survey in India, so one of the major strengths of this study is the wider relevance of its results. The limitations of this study are as follows; first limitation of this study is its cross-sectional design that does not permit assessment of the temporal and thus potential causal relation of variables. Second, because of the restriction of the secondary database two important components of metabolic syndrome, cholesterol and triglycerides are not available. Third, this study is also suffer from recall bias. Fourth one is self-reported data on smoking, alcohol consumption, taking medicines for diabetes and hypertension etc. Fifth, there is no data on physical activities. So we could not analyse the association between physical activity and metabolic syndrome. However several studies have reported that physical activities help in reducing the risk of metabolic syndrome.

A number of studies have shown relatively high prevalence of metabolic syndrome in various parts of India and also highlighted metabolic syndrome as a major public health issue. Burden of metabolic syndrome along with its individual risk factors is also evident throughout various studies. But the present study has documented a comparatively lower prevalence of metabolic syndrome in India. This lower prevalence could be because only three components of metabolic syndrome, obesity, blood glucose and blood pressure have been taken into consideration. Though this study has shown a comparatively lower prevalence of metabolic syndrome but at the same time it has highlighted some high prevalence for the components of metabolic syndrome. So emphasis should be focused on prevention, early detection of metabolic risk factors and treatment of its components that will have a significant impact on future adult health. Promotion of healthy living and knowledge about the risks associated with sedentary lifestyle should be part of any management strategy for people with or at risk of metabolic syndrome and its components.

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Declaration of competing interest

The authors declare that they have no conflict of interest.

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