THE SCENARIO OF METABOLIC SYNDROME IN INDIA: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

Background: Metabolic syndrome (MetS) is becoming major public health burden of any nation including India. It's interlinked people with various serious health related issues such as obesity, hypertension, type 2 diabetes mellitus, cardio vascular disease, dyslipidaemia (hypertriglyceridemia and low HDL) etc. **Objective:** Aim of this systematic review and meta-analysis is to estimate the overall Indian scenario of prevalence of MetS. **Methods:** Systematic e-database (ResearchGate, PubMed, Google Scholar, Science Direct, Medline) search was conducted at a time frame from January 2014 to June 2023. For this review, studies, reporting the prevalence of MetS among the adult population of India were included. Proportional Meta-analysis was performed and random effect model reported overall prevalence of MetS with 95% CI. Funnel plot and Egger's test was performed to see publication bias. **Result:** For this review 44 studies were included with overall participation 59100. Significant heterogeneity found among the selected studies ($p<0.0001$). There is no asymmetry in funnel plot which indicate absence of publication bias. The overall prevalence of MetS was 31.473% (95% CI: 26.788 - 36.354). Diagnostic criteria IDF was showed significantly higher prevalence of MetS (32.556%; 95% CI: 25.776 – 39.725) than NCEP ATP III (30.403%; 95% CI: 29.792 – 37.447), Female has significantly more prevalence of MetS (35.991%; 95% CI: 28.774 – 43.377) than their counterpart (22.6%; 95% CI: 16.701 – 29.105). In comparison of urban and rural, prevalence of MetS was also significantly higher among the urban (32.214%; 95% CI: 16.572 – 38.130) than rural (26.907%; 95% CI: 21.602 – 32.566). Central India had highest prevalence of MetS 36.362% (95% CI: 15.574 – 60.272). **Conclusion:** More than thirty per cent adult were suffering from MetS, indicating upcoming generation should not be safe from this complex disease. Everyone must need to focus on prevention and control this silent epidemic.

Key words: Metabolic syndrome, systematic review, silent epidemic, adult, India.

INTRODUCTION

In all over the world, there are various factors which are responsible for changing human health [1]. Those factors are directly or indirectly associated with rapid urbanization or globalization which leads people to invoke sedentary and unhealthy lifestyle such as baleful dietary habits and physical inactivity that's playing an important role to developing lifestyle related disorders which known as Non-Communicable Diseases (NCDs) [2]. NCDs comprising with central obesity, hypertension, type-2 diabetes mellites (T2DM), dyslipidaemia, cardio-vascular diseases (CVDs) etc. interlinked risk factors are known as the Metabolic Syndrome

[3,4]. Metabolic Syndrome also identified by various other health related issues such as non-alcoholic fatty liver, polycystic ovarian syndrome, breast cancer, prostate cancer, ovarian cancer, pancreas cancer, Alzheimer's disease, sleep and breathing disorder, cataract and glaucoma etc. [5].

Over the past few decades there is a rapid increase in Metabolic Syndrome globally leading to serious public health burden of any Nation. Being a developing nation India is also not lacking behind in increasing Metabolic Syndrome [6]. Rapidly absorption of modernized lifestyle the rate of Metabolic Syndrome in the Asians including the Indian is very high [7]. Combination of environmental and genetic factors, the prevalence of Metabolic Syndrome differs in different population [6], because of their geographical settings, gender, race, ethnicity [8,7]. Besides urban India, rural India is also suffering in Metabolic Syndrome due to remarkable mechanized socioeconomic progress, increased intake of fast food, sugars, high fat diet, low green vegetable and fruits consumption etc. [9]. The prevalence of Metabolic Syndrome among the urban women, aged ≥ 30 years, were very high in Mysore (57.54 %) [10] followed by West Bengal (45.95%) [11] respectively.

All over the world there are different guidelines for defining Metabolic Syndrome. Among those most popular definition has been proposed by World Health Organization (WHO), National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATP III) and International Diabetes Federation (IDF).

Although various studied has been conducted in all over the India, but there are very few systematic reviews and meta-analyses found which addressed the prevalence of metabolic syndrome. Result from our study would help to guide future researcher, policy maker to estimate the overall Indian scenario of prevalence of metabolic syndrome.

METHODS

Design

Systematic review and meta-analysis of cross-sectional studies. For this study PRISMA checklist was followed.

Eligibility criteria

Types of studies: For this review the studies were selected which reported the prevalence of metabolic syndrome in India. There was no restriction about study design (i.e., cross-sectional, longitudinal, cohort studies), state, communities (rural or urban), gender (male/female), age group. Only full text publications were included, and unpublished literatures, abstracts were excluded.

Types of Participants: For this review the studies were included which were conducted among adults aged 18 years and above and addressed the prevalence of metabolic syndrome.

Types of outcomes: For this review the studies were selected which reported the prevalence of metabolic syndromes and diagnosed criteria as per NCEP ATP III and/or IDF guidelines (Table 1) [12-15].

Table 1. Metabolic syndrome definition given by NCEP ATP III and IDF.

Risk Factor	***NCEP ATP III (2001)***	***NCEP ATP III (2005)***	***IDF (2005)***	***IDF "Harmonized" (2009)***
Central Obesity (WC)	Men >102 cm Women >88 cm	Men ≥90 cm Women ≥80 cm	South Asian Cut off Men ≥90 cm Women ≥80 cm	South Asian Cut off Men ≥90 cm Women ≥80 cm
Glucose	≥100 mg/dl	≥100 mg/dl	≥100 mg/dl	≥100 mg/dl
Triglyceride	≥150 mg/dl	≥150 mg/dl	≥150 mg/dl	≥150 mg/dl
Low HDL-Cholesterol	Men < 40 mg/dl Women < 50 mg/dl	Men < 40 mg/dl Women < 50 mg/dl	Men < 40 mg/dl Women < 50 mg/dl	Men < 40 mg/dl Women < 50 mg/dl
Blood Pressure	Systolic ≥130 mmHg **Or** Diastolic ≥85 mmHg	Systolic ≥130 mmHg **Or** Diastolic ≥85 mmHg	Systolic ≥130 mmHg **Or** Diastolic ≥85 mmHg	Systolic ≥130 mmHg **Or** Diastolic ≥85 mmHg
Diagnostic Criteria	**3/5 Risk Factors**	**3/5 Risk Factors**	**Must have abdominal obesity + 2 other risk factors**	**3/5 Risk Factors**

Search Strategy

For this study, literatures were searched in a systematic way in electronic data bases: ResearchGate, PubMed, Google Scholar, ScienceDirect, Medline etc. in Google and Yahoo search engines. For searching literatures various keywords and their related terms, corresponding subject heading, cross references etc. were used. A time frame from January 2014 to June 2023 with publication in English language was used for searching criteria.

Study Selection

For primary screening title, abstract and keywords of the literatures were identified for including in this review. In secondary screening after removing duplicates, reading full text of those articles selected which were fulfilling the eligibility criteria. After this in final screening was performing and selected the literatures which have valid outcomes.

Data Extraction

For data extraction predefined structured format was used. Manually, general information: author, publication year; Methodology: study design, study period, state, communities (rural or urban), gender (male/female), age group, sample size, sampling technique, diagnostic criteria; Result: Response rate and prevalence of metabolic syndrome were collected.

Statistical Analysis

All statistical analysis was performed in MedCalc® Statistical Software version 22.009 (MedCalc Software ltd, Ostend, Belgium). Proportional meta-analysis was performed to estimate geographical region wise, gender wise, community wise, diagnostic criteria wise and overall proportional prevalence of metabolic syndrome in random effect model. Forest plot was done to graphically represent study specific and pooled estimate proportional prevalence. To see existence of heterogeneity, Cochrane's Q test based on Chi-square and I^2 inconsistency was performed. To see the sub group variation Chi-square and odds ratio was performed. To assess the publication bias and to represent it graphically, funnel plot was performed and Egger's test was done to see asymmetry of the plot.

RESULTS

Study Selection

For this review a systematic search was conducted to find out literatures, reporting prevalence of metabolic syndromes in India from January 2014 to June 2023 time frame. After primary screening 100 literature were selected. After secondary screening 73 literature were selected. Then final screening conducted and 44 literatures selected for this study, which were found to be eligible and fulfilling the criteria of this review.

Characteristics of the selected studies

Table 2 shows the characteristics of the included studies on prevalence of metabolic syndromes among the adult population in India. Sample size varied from 114 [16] to 9886 [9]. The overall prevalence of metabolic syndrome was 31.473% (95% CI: 26.788 - 36.354) as calculated by random effect model (I^2 = 99.35%, p<0.0001).

Table 2. Prevalence of metabolic syndrome among the adult population in India.

Study	Sample size	Proportion (%)	95% CI	Weight (%)	
				Fixed	Random
Bandela et al. 2017	688	37.064	33.444 to 40.795	1.16	2.29
Bansal & Joshi 2015	406	75.123	70.621 to 79.255	0.69	2.27
Bansal et al. 2017	350	16.571	12.830 to 20.889	0.59	2.26
Barik et al. 2017	9886	15.628	14.918 to 16.359	16.72	2.31
Basha et al. 2018	802	32.419	29.187 to	1.36	2.29

			35.781		
Bhattacharya & Sinha 2016	114	42.105	32.919 to 51.712	0.19	2.16
Bhutia et al. 2017	361	33.518	28.663 to 38.646	0.61	2.26
Chakraborty et al. 2015	690	32.754	29.260 to 36.396	1.17	2.29
Chinawale et al. 2018	473	41.015	36.545 to 45.598	0.80	2.28
Das et al. 2017	397	4.534	2.709 to 7.071	0.67	2.27
Deedwania et al. 2014	6198	36.108	34.911 to 37.319	10.48	2.31
Dhabriya et al. 2015	1130	22.301	19.904 to 24.843	1.91	2.30
Gupta et al. 2023	942	6.263	4.802 to 8.005	1.59	2.30
Harikrishnan et al. 2018	5063	32.807	31.514 to 34.119	8.56	2.31
Jamkhandi et al. 2019	200	32.500	26.063 to 39.465	0.34	2.22
Jeyasheeela et al. 2018	154	64.286	56.175 to 71.835	0.26	2.20
Jones et al. 2016	6217	13.946	13.094 to 14.832	10.51	2.31
Kapil et al. 2018	979	28.601	25.787 to 31.544	1.66	2.30
Kaur 2014	351	17.379	13.562 to 21.756	0.60	2.26
Kaushal et al. 2016	127	37.008	28.613 to 46.024	0.22	2.17
Khan et al. 2018	420	40.952	36.209 to 45.824	0.71	2.27
Krupp et al. 2020	471	57.537	52.931 to 62.048	0.80	2.28

Krupp et al. 2023	607	41.516	37.563 to 45.551	1.03	2.29
Mahanta et al. 2017	3372	47.628	45.930 to 49.330	5.70	2.31
Manjunath et al. 2014	473	6.554	4.496 to 9.174	0.80	2.28
Mini et al. 2018	2287	27.022	25.211 to 28.893	3.87	2.31
Mittal et al. 2018	125	35.200	26.873 to 44.246	0.21	2.17
Pai & Meenakshi 2019	420	3.571	2.012 to 5.822	0.71	2.27
Patel et al. 2016	478	42.469	37.991 to 47.040	0.81	2.28
Pathak et al. 2018	1200	9.167	7.594 to 10.943	2.03	2.30
Rajput et al. 2014	3042	28.994	27.386 to 30.643	5.15	2.31
Selvaraj & Muthunarayanan 2019	360	16.667	12.966 to 20.926	0.61	2.26
Sharma et al. 2016	350	62.571	57.269 to 67.659	0.59	2.26
Sharma et al. 2016	210	11.905	7.854 to 17.071	0.36	2.23
Sharma et al. 2019	210	46.667	39.771 to 53.658	0.36	2.23
Singh et al. 2016	1700	26.647	24.558 to 28.817	2.88	2.31
Singh et al. 2017	2002	19.331	17.622 to 21.130	3.39	2.31
Srimani et al. 2017	222	45.946	39.258 to 52.743	0.38	2.23
Srimani et al. 2018	509	38.114	33.876 to 42.491	0.86	2.28
Srinivasan et al. 2016	432	60.880	56.100 to 65.509	0.73	2.27

Subramani et al. 2018	1190	72.689	70.062 to 75.204	2.01	2.30
Sundarakumar et al. 2022	2503	41.031	39.095 to 42.987	4.23	2.31
Venugopal et al. 2019	489	39.673	35.308 to 44.163	0.83	2.28
Wani & Bhat 2014	500	8.600	6.294 to 11.409	0.85	2.28
Total (fixed effects)	**59100**	**27.327**	**26.968 to 27.688**	**100.00**	**100.00**
Total (random effects)	**59100**	**31.473**	**26.788 to 36.354**	**100.00**	**100.00**

Figure 1 shows the forest plot which shows the proportional prevalence of metabolic syndrome among the adult population of India. In this plot every horizontal line indicates the selected study individually, box with line indicate the results and its 95% CI. At the bottom of this figure two diamond box shows the overall prevalence of metabolic syndrome calculated by fixed and random effects model respectively. This figure also shows the highest proportional prevalence 75.123% (95% CI: 70.621 - 79.255) reported at New Delhi [6] and the lowest proportional prevalence 3.571% (95% CI: 2.012 – 5.822) reported at Karnataka [33] of metabolic syndrome respectively.

Table 3. Prevalence of metabolic syndrome according to different sub group.

Characteristics	***No of Study***	***Sample Size***	***Prevalence of Metabolic Syndrome (%)*** #	***Chi-Square***	***OR (95% CI)***
			DIAGNOSTIC CRITERIA		
IDF	22	22502	32.56	83.966*	0.8447* (0.8146-0.8760)
NCEP ATP III	22	36598	30.40		
			GENDER		
Female	30	18004	35.91	734.372*	1.9190* (1.8300-2.0123)
Male	24	16550	22.60		
			COMMUNITIES		
Urban	17	24837	32.21	196.845*	1.2910* (1.2456-1.3381)
Rural	17	34074	26.91		

**p<0.0001* *#Proportional Prevalence according to Random Effects model.*

Table 3 shows the various sub group analysis. According to diagnostic criteria the prevalence of metabolic syndrome in IDF was significantly higher than NCEP ATP III (x^2= 83.966, p<0.0001) (OR: 0.8447, 95% CI: 0.8146-0.8760). In the case of female prevalence of metabolic syndrome was significantly 1.919 times higher than their counterpart (x^2= 734.372, p<0.0001) (OR: 1.9190, 95% CI: 1.8300-2.0123). In comparison of urban and rural, prevalence of metabolic syndrome was also significantly higher among the urban (x^2= 196.845, p<0.0001) (OR: 1.2910, 95% CI: 1.2456-1.3381).

Figure 2 shows the funnel plot, which is symmetric alliance indicating that there is no publication bias in this current review. Similarly Egger's test also confirmed that this review has free from publication bias (Co-efficient: 5.0921; 95% CI: -1.6969 to 11.8812; p=0.1376). p≥0.10 was considered as statistically no significant publication bias [49].

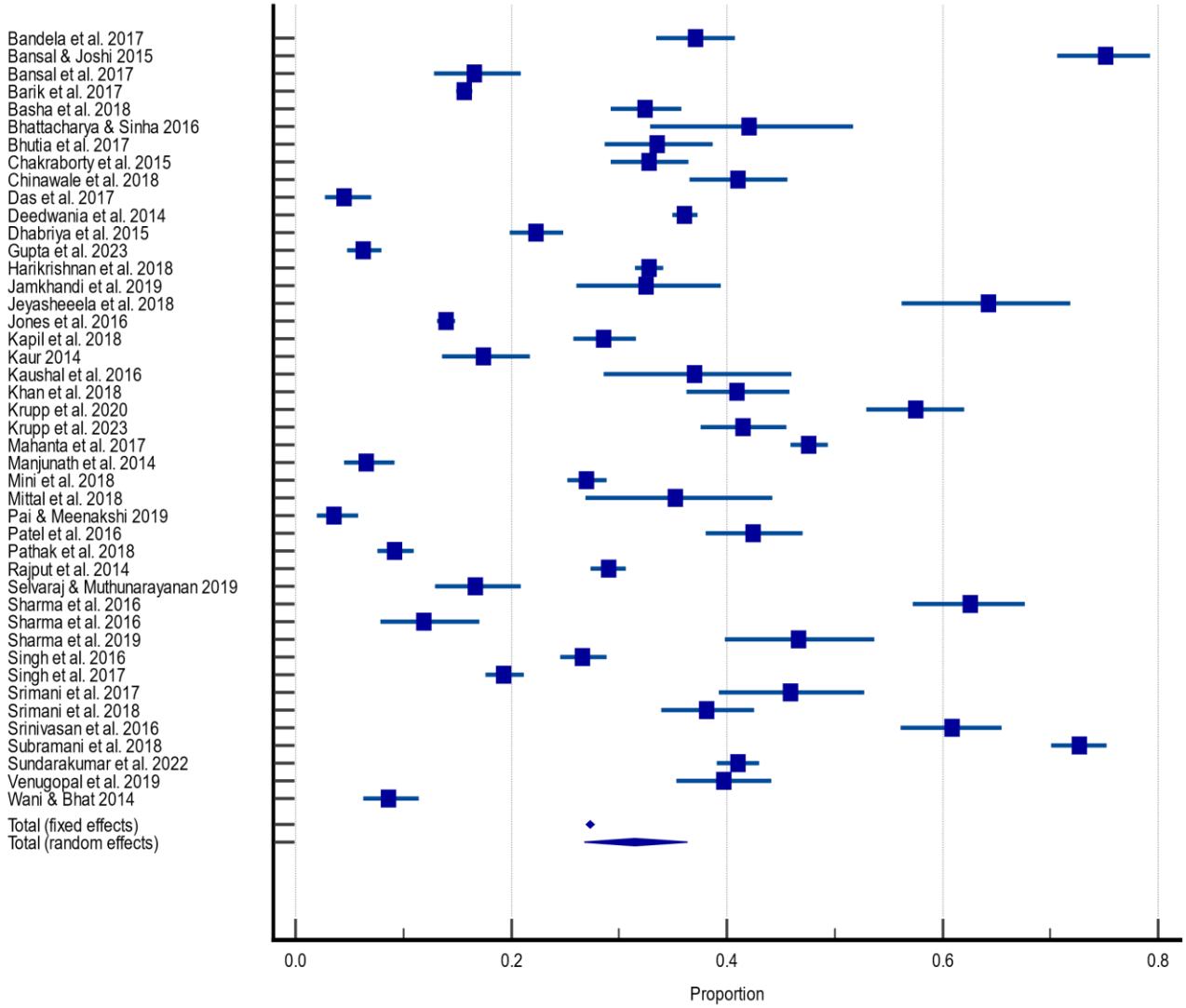

Figure 1. *Forest plot for proportion of metabolic syndrome among the adult population in India.*

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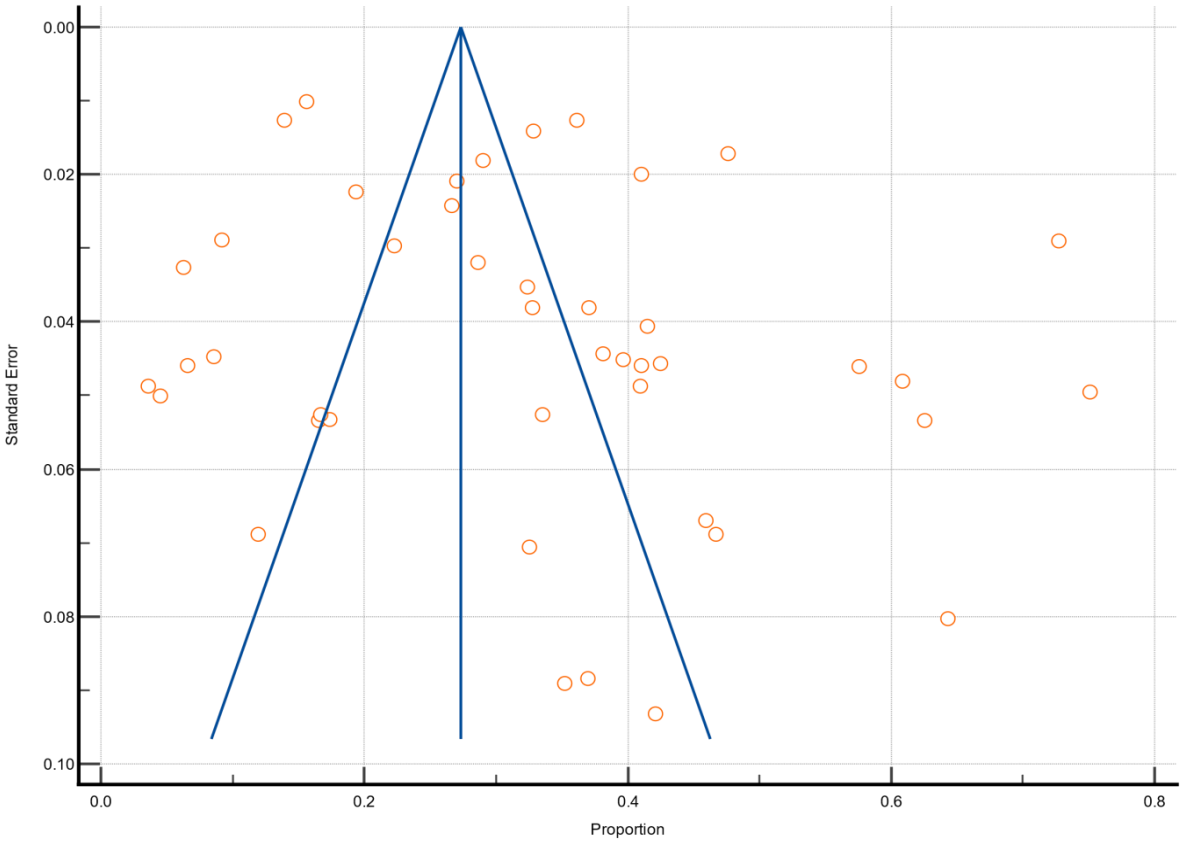

Figure 2. *Funnel plot for assessment the publication bias.*

DISCUSSION

Rapid urbanization vis-à-vis globalization, adoption of modernized technology, processed and packaged food played an important role in bringing people to change their life style. Multiple interlinked factors such as unhealthy dietary habits, physical inactivity, and sedentary lifestyle occurred due to those adoptions. These factors have developed various lifestyle related disorders such as central obesity, hypertension, T2DM, CVD, dyslipidaemia etc. which is characterized by Metabolic Syndrome. It plays an identical role to developed public health burden for a nation and it varies from different geographical area, gender, ethnicity, race, and individual to individual also.

The present review revealed overall prevalence of metabolic syndrome was 31.473% (95% CI: 26.788 - 36.354) among the Indian adult population. Figure 3 shows geographical region wise prevalence of metabolic syndrome. Central India had highest prevalence of metabolic syndrome 36.362% (95% CI: 15.574 – 60.272) which is greater than overall prevalence (present study), followed by South India 31.301% (95% CI:24.093 – 38.994), East India 29.54% (95% CI: 16.163 – 45.016) and North India 28.23% (95% CI: 18.669 – 38.905) respectively.

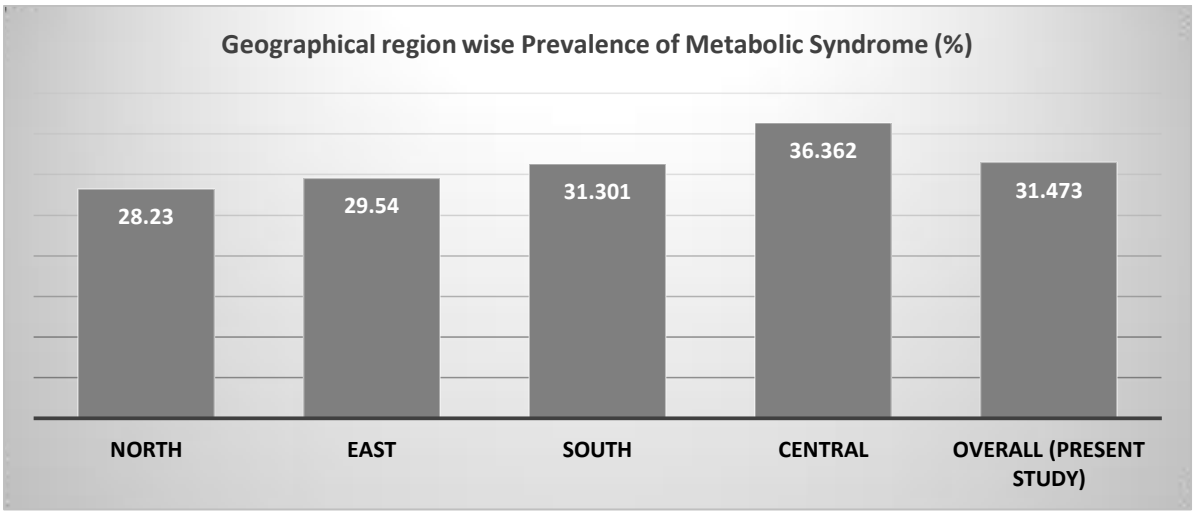

Figure 3. *Bar graph of Geographical region wise metabolic syndrome.*

A study reported that very high prevalence of MetS (75.12%) in urban Delhi people age group from 35-65 years [6], followed by Madhya Pradesh (72.69%) [45], Tamil Nadu (64.29%) [24], Chandigarh (62.57%) [38] respectively. At Andhra Pradesh urban adult [1] reported more than double prevalence of MetS than rural adult [25]. Another study reported that urban living slum-dwelling women in Mysore has lower prevalence of Mets (41.52%) [28] than rural living women (57.54%) in Mysore [10].

Peoples were more affected in metabolic syndrome due to their increased waist circumference and central obesity is also related more effectively in comparison to BMI of an individual [32]. Physical activity inversely related with MteS [1]. Another study also confirmed that moderate level physical activity had high risk of MetS than high level physical activity [23].

CONCLUSION

This systematic review and meta-analysis revealed that more than thirty percent adult were suffering from metabolic syndrome, indicating not only we but also our upcoming generation should not be safe from this complex disease. So, everyone must need to focus on prevention and control this silent epidemic.

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