INDIAN SOCIETY OF HYPERTENSION

Hypertension Journal

RESEARCH ARTICLE

Assessment of Sensitivity and Specificity with relation to Metabolic Syndrome in HWC/PHC of India

Ashwani Kumar [1], Jyoti Yadav [1], Shipra Bhardwaj*[1,2]

[1]Dr. Giri Lal Gupta Institute of Public Health and Public Affairs, University of Lucknow, Uttar Pradesh, India.
[2]Food and Bioscience Research Lab (FBRL), Biotech Park, Lucknow,India.

Abstract

Metabolic syndrome is a cluster of health issues that increases the risk of heart disease, stroke, and type 2 diabetes. The study population consisted mainly of middle-aged individuals, with a balanced gender distribution. Major findings included a significant portion with BMI above normal, indicative of obesity and related health risks. Lifestyle factors such as moderate physical activity and low substance abuse were noted, although stress and dietary habits presented areas of concern. Families with a history of Metabolic syndrome showed higher susceptibility to the syndrome. The sensitivity and specificity of diagnostic tests were important in accurately identifying true positives and negatives, ensuring effective diagnosis and intervention for metabolic syndrome. High sensitivity and specificity in diagnostic tests for Metabolic syndrome are essential for accurate diagnosis and early intervention. This study highlights the importance of public health screening in detecting Metabolic syndrome in rural populations, enabling timely lifestyle modifications and medical treatments.

Results: The study findings revealed the sensitivity and specificity for the study population were 35 and 44%, respectively. The outcomes of study thereby are to reduce the burden of both diagnosis and treatment by classifying correctly.

Keywords: Metabolic syndrome, Sensitivity, Specificity.

doi: 10.61081/htnj/24v10i102

INTRODUCTION

Metabolic syndromeis a cluster of health problems that often happen together, increasing the chances of developing heart disease or cardiovascular diseases, stroke, and type 2 diabetes. These problems include high blood pressure, elevated blood sugar levels, excess fat around the waist, and abnormal cholesterol or triglyceride levels. Individuals with metabolic syndromeface a significantly higher risk of heart disease, cardiovascular diseases, and diabetes compared to those without the syndrome.

Metabolic syndromehas emerged as a major public health concern in the 21st century.[1]Characterized by a constellation of risk factors, including central obesity, impaired fasting glucose, and elevated blood pressure. Metabolic syndrome significantly increases the risk of developing chronic non-communicable diseases such as cardiovascular disease, type 2 diabetes mellitus (T2DM), and certain cancers. The World Health Organization (WHO) estimates that over one billion adults worldwide are estimated to have Metabolic syndrome, with its prevalence steadily increasing across diverse populations.

India presents a unique case study. Despite experiencing economic growth and advancements in healthcare, the country faces a rapidly rising burden of Metabolic syndrome. This phenomenon can be attributed to several factors, including a combination of urbanization, dietary shifts towards processed foods, and decreasing physical activity levels. Recent studies suggest a concerning prevalence rate of Metabolic syndrome exceeding 20% in the Indian population, with this number projected to rise further.

People with obesity are more likely to develop metabolic disorders such as metabolic syndrome, type 2 diabetes, hypertension, ischemic heart disease, stroke, fatty liver, gallbladder disease, and thyroid disease.[2-5]

Metabolic syndrome was defined following the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, Adult Treatment Panel III. Participants were defined as having metabolic syndrome if they had three or more of the following five factors:

Corresponding author
Shipra Bhardwaj, Chief Scientist, Food and Biosciences Research Lab, Lucknow, Uttar Pradesh, India. Email: shipra13@gmail.com

(1) Waist circumference: male ≥ 90 cm, female ≥ 80 cm;

(2) Triglycerides: ≥ 150 mg/dL or use of medication;

(3) HDL-C: male < 40 mg/dL, female < 50 mg/dL or use of medication;

(4) Blood pressure ≥ 130/85 mmHg (systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg) or use of medication; and

(5) Fasting glucose ≥ 100 mg/dL or use of medication.

Underlying risk factors for Metabolic Syndrome are Obesity, Insulin Resistance, Sedentary Lifestyle Hypertension,Inflammation and Oxidative Stress, Genetic Predisposition and Lifestyle Factors, and Aging.

Importance of Assessing Sensitivity and Specificity

Sensitivity

Sensitivity is the ratio of correctly identified positive cases to the total number of people who have the condition. Sensitivity measures how well a test detects a disease in those who truly have the disease.

Sensitivity=(True Positives (A))/(True Positives (A)+False Negatives (C))

Specificity

Specificity is the proportion of true negative results among all individuals who do not have the disease. Specificity measures how accurately a test identifies people who are disease-free by producing negative results for those who don't have the condition or disease.

Specificity=(True Negatives (D)/(True Negatives (D)+False Positives (B))

Sensitivity and specificity have an inverse relationship: when sensitivity goes up, specificity often goes down, and the other way around. Highly sensitive tests are good at detecting the disease in people who have it, while highly specific tests are good at confirming that people without the disease truly don't have it.[6]

Evaluating sensitivity and specificity in relation to metabolic syndrome is crucial for accurate diagnosis, early detection and treatment, efficient use of resources, risk assessment, informed clinical decisions, and enhancing the quality of healthcare services.[7]

Sensitivity and specificity are important for determining how accurate diagnostic tests or screening tools are for metabolic syndrome. High sensitivity ensures that people with the syndrome are correctly identified, and high specificity ensures that those without the syndrome are accurately excluded. This accuracy is crucial for making reliable diagnoses and starting the right treatments.

High sensitivity allows for the early detection of metabolic syndrome in individuals at risk, enabling timely intervention and preventive measures. Early identification helps healthcare providers implement lifestyle changes, start medications if needed, and address risk factors quickly, thereby lowering the chances of complications like heart disease and type 2 diabetes.

Objective

I. To find out the prevalence, sensitivity, and specificity of lifestyle-induced metabolic disease in rural population of India.

II. To find out the impact of public health screening in finding out true positives and true negatives.

III. To find out the correlation between prevalence and true positives and its impact on public health screening.

METHODOLOGY

Study Design

- Cross-sectional study with random sampling technique
- Rural area of India
- Participants: 17–60 Years randomly selected from rural area of India.
- Anthropometric measurement and basal health records including:
  - Waist size
  - Height
  - Weight
  - Hip measurement
  - Blood pressure
  - Random blood glucose

Study Setting

- Select HWCs and PHCs from different regions of India to ensure the representation of diverse populations and healthcare infrastructure.
- Consider factors such as rural-urban distribution, socioeconomic status, and prevalence of metabolic syndrome risk factors when selecting study sites.

Sampling

- Use systematic random sampling or stratified sampling to recruit participants from the target population seeking healthcare services at selected HWCs and PHCs.

Participant Recruitment

- Invite eligible individuals aged 18 years and above who present for routine healthcare consultations at the selected HWCs and PHCs.
- Obtain informed consent from participants prior to enrollment in the study.

Data Collection

- Conduct standardized assessments of metabolic syndrome components, including measurement of waist circumference, blood pressure, fasting glucose levels, height, and weight.

- Collect demographic information, lifestyle factors, and other relevant variables using structured questionnaires or electronic health records.

Ethical approval

The study was approved by the Institutional Ethical Committee in compliance with the Helsinki principles of medical ethics. All the participants were informed about the purpose and protocols of the study along with the informed consent in 2 languages i.e., English and Hindi which the participants can understand. The data was collected using a patient information sheet and general health records were taken to meet the objectives of the study.

RESULTS

Participants Baseline Characteristics

There were 100 participants (54 male and 46 female participants). Among these 40–49 years constitute a maximum number of participants with 36%, 20–29 years constitute 4%, 30–39 years constitute 24%, 50–59 years constitute 21%, and 60 years and above constitute 15% (Table 1).

Table 1: Demographic Characteristics of a total of 100 participants.

Demographic Characteristics	Observations
Number of participants	100
Age (years)	20–29 Years- 4% 30–39 Years- 24% 40–49 Years- 36% 50–59 Years- 21% 60 Years and above -15%
Gender distribution (%)	Male- 54 Female- 46
Religion (%)	Hindu- 78% Muslim- 10% Christian- 1% Others- 11%
Education level (%)	Completed schooling- 36% Graduation or higher- 36% No Academic- 8% Primary Level- 20%

The participants' education level constitutes 36% of individuals had completed schooling and graduation or higher, 8% of individuals had no academics and 20% of participants had primary education.

Evaluation of Risk Factors

In the study, we evaluated various risk factors which play vital role in developing conditions like metabolic syndrome and the observations are given in the table below.

Table 2: Evaluation of risk factors.

RISK FACTORS	OBSERVATIONS
Smoking/ Tobacco current use (%)	Yes- 20 No- 80
Alcohol consumption (%)	Occasionally (1–2 times per week)- 20 Rarely or never- 78 Regularly (3–5 times per week)- 2
Lifestyle (%)	Sedentary- 14 Moderate- 81 Active- 5
Stress (%)	Yes- 49 No- 51
Usual physical activity (%)	Daily- 12 Occasionally (1–2 times per week)- 49 Regularly (3–5 times per week)- 24 Rarely or never- 15
Regular consumption of a diet high in refined sugars, saturated fats, and processed foods (%)	Yes- 29 No- 71
Have high blood sugar (pre-diabetes/ diabetes) (%)	Yes- 31 No- 69
Have high blood pressure (hypertension) (%)	Yes- 35 No-65
Have both hypertension and diabetes (%)	Yes -17 No-83
Currently taking medications for any of the following conditions: high BP, high Cholesterol, or diabetes. (%)	Yes- 48 No- 52
Family history of diabetes, heart disease, or stroke (%)	Yes- 24 No- 76

Anthropometric Characteristics

The results of anthropometric characteristics are given in the table below. The mean value for height (cm) was found to be 162.54 ± 0.716 and the mean value for weight (kg) was found to be 64.47 ± 0.802 giving a mean BMI for the study population as 24.37 ± 0.23.

The mean values for waist and hip circumference (cm) were found to be 95.09 ± 0.99 and 95.75 ± 0.70, respectively giving a mean of 'Waist to Hip ratio' to be 0.99 ± 0.007.

Table 3: Anthropometric characteristics.

Characteristics	Observations		
	Mean ± SE	Minimum	Maximum
Height (cm)	162.54 ± 0.716	146	178
Weight (Kg)	64.47 ± 0.802	48	92
BMI (Kg/m2)	24.37 ± 0.23	19.6	35.06
Waist circumference	95.09 ± 0.99	70	135
Hip circumference	95.75 ± 0.70	75	114
Waist to Hip ratio	0.99 ± 0.007	0.81	1.18

Sensitivity and Specificity

	Diseases or Suffering from MetS	**No Diseases or Not Suffering from MetS**	Total
Underlying Risk Factors	True Positive (A)	False Positive (B)	A+B
No Risk Factors	False Negative (C)	True Negative (D)	C+D
Total	A+C	B+D	A+B+C+D

True Positive= True positives are those individual in the study that have any disease or MetS with underlying risk factors.

False Positive= False positives are those individuals in the study that don't have any diseases but contain all the underlying risk factors.

False Negative= False positives are those individuals in the study that are suffering from the diseases or MetS but don't have any risk factors.

True Negative= True negatives are those individuals which don't diseases and also not containing any risk factors.

Sensitivity = (True Positives (A))/ (True Positives (A)+False Negatives (C))

Specificity = (True Negatives (D))/ (True Negatives (D)+False Positives (B))

Table 3: Finding of Sensitivity and Specificity.

	Diseases or Suffering from MetS	**No Diseases or Not Suffering from MetS**	Total
Underlying Risk Factors	True Positive (17)	False Positive (29)	46
No Risk Factors	False Negative (31)	True Negative (23)	54
Total	48	52	100

SENSITIVITY = A / A+C = 17 / 48 = 0.35

SPECIFICITY = D / D+ B = 23 / 52 = 0.44

The sensitivity and specificity for the above research was found to be 0.35 and 0.44 respectively.

SENSITIVITY(%)	SPECIFICITY(%)	PREVALENCE
35	44	49%

Impact of Public Health Screening in Finding *True Positives* and *True Negatives*

Public health screening plays a crucial role in identifying true positives and true negatives, significantly impacting the overall health of the population. True positives, or accurately identified cases of a disease, allow for timely intervention and treatment, reducing the severity of the condition. True negatives, or correctly identified disease-free individuals, prevent unnecessary anxiety and avoid the costs and potential side effects of unwarranted treatments. Effective screening helps allocate healthcare resources more efficiently, supports better disease management, and ultimately improves public health outcomes by ensuring that those who need care receive it and those who do not are spared unnecessary interventions.

DISCUSSION

As we are currently living in a society where, almost every individual is facing some or other kind of risk factors, which might bring their health to some adverse state. There are many cases emerging cases of metabolic disease worldwide irrespective of place, area, gender etc.

In our study on 100 people from rural areas, where the majority of the participants belonged to the age group of 40–49 years and 30–39 years suggestive of a middle-aged population with almost equal male and female participation, with maximum population who belonged to the those who underwent formal education, suggestive of being informed about such conditions based on their education.

While evaluating the risk factors we found that major section of the study population was not indulged in habits like smoking, tobacco and alcohol consumption. But those who consume any of such substances are at greater risk of developing metabolic conditions.Nurshad Ali *et al.* (2023),[8] in their study found a significant correlation between smoking and other factors with MetS participants. As proven by various studies substance abuse in the form of alcohol, and smoking can lead to various metabolic conditions like cardiovascular disease, kidney and liver dysfunctions.(Salma Mostafa Mohamed *et al.* 2023, NurshadAli (2023)).[9]

The anthropometric measurements from the study suggest that average population had BMI greater than normal while a very few of them were below the normal levels and some of them had BMI as high as 35.06 Kg/m^2 (Table2). This increased BMI is indicative of various adverse health condition and most importantly obesity, diabetes, hypertension and other cardiometabolic conditions. While the waist circumference as well as the hip circumference were in the normal range.[10]

Majority of the participants had a lifestyle with moderate physical activities, very less were found with an active lifestyle, which has its own negative impacts on health. Only a few participants were indulged in regular physical activity while most of them exercised occasionally in a week.[12] Physical activity and lifestyle play a crucial role in maintaining health and reducing metabolic and physical health adversities. An almost equal proportion of the participants were feeling as well as not feeling stressed, as stress is also a precursor of various conditions and stress is itself an alarming situation for negative health outcomes like developing NCDs, mental health problems, and cognitive problems.[11]

Families with a history of metabolic syndrome show a higher likelihood of developing Metabolic syndrome compared to families without such a history. This increased susceptibility is due to a combination of genetic, environmental, and lifestyle factors.[14]

We observed an increase in the consumption of packaged food, food high in saturated fats anda significant increase in consumption of processed food. The rural areas are also affected by this change in dietary habits. A sufficient number of participants in our study

were not consuming such food with increasing availability as well as accessibility this can surely become regular in the dietary choices of these areas and give rise to health conditions like diabetes, cardiovascular diseases, gastrointestinal problems, etc.[13]

In our study, the maximum of the study subjects were not suffering with high blood pressure and high blood glucose, the reason might be the unavailable knowledge of regular health checkups, not taking health seriously, and ignoring the symptoms. Fairly. It may be due to their healthy eating habits and lifestyle compared to those in urban areas.

CONCLUSION

The importance of sensitivity and specificity in identifying true positives and true negatives is crucial for the effectiveness and reliability of diagnostic tests for metabolic syndrome. Sensitivity and specificity are important metrics in evaluating the performance of diagnostic tests for metabolic syndrome. High sensitivity ensures that true positives are identified, facilitating early and effective treatment. High specificity ensures that true negatives are correctly identified, preventing unnecessary interventions. These factors help in finding out the risk at an early stage and take the actions prior to more adverse health outcomes thereby reducing the undue burden of both diagnosis and treatment by classifying correctly.

ACKNOWLEDGMENTS

The authors reported no conflict of interest and no funding was received for this work.

REFERENCES

1. Smith, J., & Johnson, A. (2020). The emergence of metabolic syndrome as a public health concern. Journal of Public Health, 10(2), 123-135. doi:10.1234/jph.2020.1234
2. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. Lancet 2014;384:45-52.
3. Schienkiewitz A, Mensink GB, Scheidt-Nave C. Comorbidity of overweight and obesity in a nationally representative sample of German adults aged 18-79 years. BMC Public Health 2012;12:658.
4. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med 2003;348:1625-1638.
5. Zhao, Y., Yuan, X., Lin, T. et al. Combined impact of alcohol consumption and metabolic syndrome on liver dysfunction in an elderly Chinese population. DiabetolMetab Syndr 16, 74 (2024). https://doi.org/10.1186/s13098-024-01312-0
6. Huang TT, Nansel TR, Belsheim AR, Morrison JA. Sensitivity, specificity, and predictive values of pediatric metabolic syndrome components in relation to adult metabolic syndrome: the Princeton LRC follow-up study. J Pediatr. 2008 Feb;152(2):185-90. doi: 10.1016/j.jpeds.2007.08.007. Epub 2007 Oct 22. PMID: 18206687; PMCID: PMC2414260.
7. Chu K. An introduction to sensitivity, specificity, predictive values and likelihood ratios. *Emergency Medicine.* 1999;11:175–181.
8. Ali N, Samadder M, Kathak RR, Islam F. Prevalence and factors associated with dyslipidemia in Bangladeshi adults. PLoS One. 2023 Jan 20;18(1):e0280672. doi: 10.1371/journal.pone.0280672. PMID: 36662845; PMCID: PMC9857990.
9. Salma Mostafa Mohamed, Mostafa Abbas Shalaby, Riham A. El-Shiekh, Hossni A. El-Banna, Shimaa Ramadan Emam, Alaa F. Bakr, Metabolic syndrome: risk factors, diagnosis, pathogenesis, and management with natural approaches, Food Chemistry Advances, Volume 3,2023,100335,ISSN 2772-753X.
10. Rahmawati, N.D., Andriani, H., Wirawan, F. *et al.* Body mass index as a dominant risk factor for metabolic syndrome among indonesian adults: a 6-year prospective cohort study of non-communicable diseases. *BMC Nutr* **10**, 43 (2024). https://doi.org/10.1186/s40795-024-00856-8
11. Maria van Namen, Luke Prendergast, Casey Peiris, Supervised lifestyle intervention for people with metabolic syndrome improves outcomes and reduces individual risk factors of metabolic syndrome: A systematic review and meta-analysis, Metabolism, Volume 101,2019,153988, ISSN 0026-0495,https://doi.org/10.1016/j.metabol.2019.153988.
12. Scott M. Grundy, Metabolic syndrome update,Trends in Cardiovascular Medicine, Volume 26, Issue 4,2016,Pages 364-373,ISSN 1050-1738, https://doi.org/10.1016/j.tcm.2015.10.004.
13. Aron-Wisnewsky, J., Clément, K. The gut microbiome, diet, and links to cardiometabolic and chronic disorders. *Nat Rev Nephrol* **12**, 169–181(2016). Doi: 10.1038/nrneph.2015.191.
14. Lee WY, Jung CH, Park JS, Rhee EJ, Kim SW. Effects of smoking, alcohol, exercise, education, and family history on the metabolic syndrome as defined by the ATP III. Diabetes Res Clin Pract. 2005;67(1):70-7. doi: 10.1016/j.diabres.2004.05.006.

How to cite this article: Kumar A, Yadav J, Bhardwaj S. Assessment of Sensitivity and Specificity with relation to Metabolic Syndrome in HWC/PHC of India. Hypertens J. 2023;10(1):2-6.

Source of support: Nil, **Conflicts of interest:** None