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Prevalence of prediabetes and metabolic syndrome among the indigenous people of Purulia District, West Bengal, India: Another burden of malnutrition

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Abstract
Background: For many years the indigenous communities in Purulia district, West Bengal have been facing undernutrition. However, nutritional transition has simultaneously increased risk of overweight, prediabetes, and Metabolic Syndrome. This coexistence could be understood better as multiple burden of malnutrition.
Materials and Methods: A cross-sectional study was conducted among 436 adult males and 525 females aged 18 years and above, including eight tribal communities of Purulia district. Frequencies and percentages were used to describe categorical variables. Binary logistic regression analysis was performed to study the association between Metabolic Syndrome and lifestyle behaviours.
Results: The prevalence of prediabetes and MetS was found to be 40.6% and 26.3% respectively. Low physical activity (AOR 12.346, p <0.001), intake of junk food (AOR 1.818, p<0.001) and alcohol consumption (AOR 1.934, p<0.001) were found to be significantly associated with MetS.
Conclusion: Prevalence of prediabetes and Metabolic Syndrome was very high among the studied population. Low physical activity, regular intake of junk food and alcohol were found to be important modifiable lifestyle behaviour associated with Metabolic Syndrome. Therefore, the public health burden of malnutrition requires to be treated as multiple burden of malnutrition for better policy implementation.

Keywords: Prediabetes, metabolic syndrome, malnutrition, lifestyle behaviour

Introduction
People of mostly developing countries are experiencing a nutrition shift or transition where persistent undernutrition is accompanied by overweight, obesity, diabetes, hypertension, and Metabolic Syndrome (MetS). This causes malnutrition which according to World Health Organization means either deficiency, excess, or imbalances in energy or nutrient intake, causing undernutrition, micronutrient-related malnutrition, overweight, obesity, and diet-related NCDs [1]. Rising rates of prediabetes and MetS is further complicating the burden of malnutrition.
Prediabetes is a state of intermediate glucose levels that are higher than normal but not yet high enough to be diagnosed as diabetes. Depending upon the test it commonly includes impaired fasting glucose, impaired glucose tolerance, or elevated glycosylated haemoglobin [2]. MetS is a clustering of several risk factors which include higher central obesity, elevated triglycerides, elevated blood pressure, low high-density lipoprotein cholesterol, and elevated fasting blood glucose. A person having any three or more of these are known as MetS. Individual with MetS have double the chances of developing cardiovascular disease and five-fold the chances of experiencing diabetes [3]. This leads to multiple burdens where undernutrition, overweight and abdominal obesity, rising prediabetes or MetS, and micronutrient deficiencies may occur within the same ethnic group, household, or even at the individual level across the life course.
Several studies have found higher rates of undernutrition in different indigenous population of Purulia district in West Bengal [4, 5, 6] as well as double and triple burden of malnutrition [7, 8]. However, in best of our knowledge, the growing rates of prediabetes and MetS were arguably not studied earlier in this part or world. The present study was therefore undertaken to study the prevalence of prediabetes and MetS among the indigenous people of Purulia and its association with different lifestyle behaviours which include PAL, substance use, intake of extra salt and junk food.

Materials and Methods
Study Participants: Total 961 people of different indigenous communities participated in the study which includes 436 males and 525 females aged 18 years and above.

Sampling Method: Purposive random sampling was performed to select participants for the study.
Physical activity level (PAL): PAL was categorized as high, moderate, or low on the basis of whether they exercise regularly and how much physically demanding were their work. To differentiating participants into different PAL, individuals with physically demanding occupation and performed regular exercise were grouped as High PAL; individuals who had physically demanding occupation or performed regular exercise were grouped as Moderate PAL and individuals who neither had physically demanding occupation nor did they performed regular exercise were grouped as Low PAL [9].

Junk food intake and Substance-Use Behaviours: Information on junk food intake, extra salt intake, tobacco chewing, and alcohol consumption was collected using a pre-structured schedule.

Blood pressures: Systolic (SBP) and diastolic (DBP) blood pressure were measured twice in sitting posture using

sphygmomanometer and stethoscope and were averaged for analyses. Prior medical records for blood pressure were also taken into consideration.

Metabolic profiles: Fasting blood samples were collected from each subject for the determination of lipid profile and fasting blood glucose. All subjects maintained an overnight fast of ~12 h prior to blood collection. Total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDLc) and fasting blood glucose (FBG) was carried out on LipidoCare and glucometer (SD Biosensor, Korea). All biochemical analyses were measured in mg/dl unit.

MetS (MetS): Individuals with three or more of the five conditions were considered as MetS as per NCEP ATP-III [10]. Higher waist circumference male > 90 cm; female > 80 cm; higher triglycerides > 150 mg/dl; lower high-density lipoprotein cholesterol: male < 40mg/dl; female < 50mg/dl; high blood pressures (mmHg): SBP >130 and /or DBP >85 and higher fasting blood glucose (mg/dl): > 100. Prediabetes was considered as fasting blood glucose between 100 to 125 mg/dl.

Statistical Analysis: Frequencies and percentages of prediabetes and MetS were calculated to describe the distribution of categorical variables. Difference in frequency between males and females were analyzed by chi-square test. Binary logistic regression analysis was performed to examine the associations between lifestyle behaviour factors and MetS. Exp(B), was considered as the adjusted odds ratio (AOR) representing the odds ratio for a one-unit increase in the predictor. Gender was considered as an adjustment variable in the model to account for potential differences between males and females. Analyses were performed on IBM SPSS (version 25). Statistical significance was considered at p-value of less than 0.05.

Results

The prevalence of prediabetes and MetS are illustrated in figure 1. The prevalence of prediabetes was 40.6% and MetS 26.3%. Prevalence of prediabetes was higher among males (44.3%) than females (37.5%). In contrast, the prevalence of MetS was found to be higher among females (29.1%) than males (22.9). It indicates a high burden of metabolic dysregulation among the study participants.

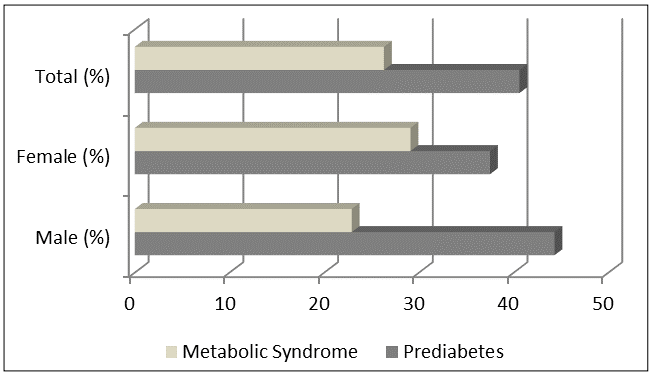


Fig 1: Prevalence (%) of Prediabetes and Metabolic Syndrome

Table 1 presents the differences in lifestyle-related behaviour between males and females. It was found that there were no significant differences in PAL (p =0.898) and intake of extra salt (0.198) among males and females. Prevalence of junk food intake and tobacco chewing was found to be significantly higher among females (p<0.001) than males. On the other hand, the prevalence of alcohol intake was found to significantly higher among males (p<0.00/) than females.

Table 2 presents the binary logistic regression analysis of selected lifestyle variables associated with MetS with gender as control variable in the adjusted model. The adjusted odds ratios (AORs) represent the odds of MetS after controlling for gender differences. Physical activity showed a significant association with MetS. Considering high physical activity as the reference category, participants with moderate physical activity had approximately 3.26-fold higher odds of MetS (AOR = 3.265, 95% CI: 2.057- 5.182, p < 0.001). On the other hand, participants with low physical activity had approximately 12.35-fold higher odds of MetS than those with high physical activity (AOR = 12.346, 95% CI: 7.658–19.903, p < 0.001). Junk food intake showed a statistically significant association with MetS. Participants consuming junk food had ~ 2-fold higher odds of MetS than their counterparts (AOR = 1.818, 95% CI: 1.323–2.497, p < 0.001). Regular alcohol consumption also showed a significant association with MetS. Alcohol drinkers had approximately 2-fold higher odds of MetS than non-drinkers (AOR = 1.934, 95% CI: 1.371–2.727, p < 0.001). Tobacco consumption was not statistically significantly associated MetS (AOR = 0.830, 95% CI: 0.586–1.174, p = 0.393). Extra salt intake was also not significantly associated with MetS (AOR = 1.150, 95% CI: 0.858–1.543, p = 0.350). Hence, low physical activity, intake of junk food and alcohol consumption were found to be statistically significantly associated with higher odds of MetS in the gender adjusted model, whereas tobacco chewing and intake of extra salt were not statistically significantly associated with MetS.

Table 1: Differences in lifestyle-related behavior

Lifestyle behavior	Category	Male (n= 436)	Female (n=525)	P
PAL	Low	107 (24.5%)	132 (25.1%)	
	Moderate	195 (44.7%)	227 (43.2%)	0.898^
	High	134 (30.7%)	166 (31.65%)	
Junk Food Intake	No	198 (45.4%)	164 (31.2%)	
	Yes	238 (54.6%)	361 (68.8%)	<0.001
Alcohol Intake	No	220 (50.5%)	456 (86.9%)	
	Yes	216 (49.5%)	69 (13.1%)	<0.001
Tobacco Chewing	No	93 (21.3%)	272 (51.8%)	
	Yes	134 (30.7%)	174 (33.1%)	<0.001
Extra Salt Intake	No	194 (44.5%)	212 (40.4%)	
	Yes	242 (55.55)	313 (51.6%)	0.198
Chi-square test with df - degree of freedom 1, ^ df 2				

Table 2: Logistic Regression of lifestyle behaviour associated with MetS, adjusted for gender (n=961)

Lifestyle behaviour	Sig.	AOR	95% C.I.	
			Lower	Upper
PAL (High)	(reference)			
Low	<0.001	12.346	7.658	19.903
Moderate	<0.001	3.265	2.057	5.182
Junk Food (No)	(reference)			
Yes	<0.001	1.818	1.323	2.497
Alcohol Intake (No)	(reference)			
Yes	<0.001	1.934	1.371	2.727
Tobacco Chewing (No)	(reference)			
Yes	0.393	0.830	0.586	1.174
Extra Salt (No)	(reference)			
Yes	0.350	1.150	0.858	1.543

Sig. = p-value; AOR = adjusted odds ratio; 95% CI = 95% confidence interval for AOR

Discussion

Malnutrition both underweight and obesity, could contribute to prediabetes through several interconnected factors. It includes: i) chronic undernutrition and micronutrient deficiency may lead to impaired glucose regulation. A recent study found that indicators of undernutrition were highly associated with impaired glycaemic regulation, higher complication burden, and increased mortality risk [11]; ii) an early-life exposure to undernutrition may lead to metabolic dysregulation in later course of life. *In utero* or early childhood exposure to poor nourishment when followed by surplus of food availability, change in dietary habit later in life could increase the susceptibility to overweight, impaired glucose tolerance, hypertension, and type 2 diabetes [12]. It seems that the life-course of contrasting nutritional insult is highly relevant to the indigenous communities under study. The adult participants might have experienced childhood food insecurity but now with reduced physical activity and poor dietary habits making them more susceptible to multiple burden of malnutrition; iii) Increased reliance on inexpensive, energy-dense, nutrient-poor foods by the indigenous communities due poor socioeconomic status, high cost of seasonal fruits and vegetables, food access constraints, and decrease in traditional foods habit could lead to unhealthy dietary patterns. Such diets may provide sufficient calories for weight gain while failing to supply adequate protein and other essential micronutrients [13]; and iv) malnutrition and inflammation reinforce each other. Both undernutrition and overweight are associated with inflammatory activity, creating a complex challenge to metabolic health and thereby increasing the risk of non-communicable diseases. In the present study area, where infection, anaemia, and other disease burdens coexist with poor nutrition, these interconnected factors could accelerate the normal glucose metabolism towards prediabetes and eventually leading to impaired glucose intolerance followed by type 2 diabetes.

MetS which is associated with excess adiposity and metabolic dysregulation, but its growing prevalence among the indigenous people of Purulia might follow more complex interconnected factors. First of all, low body mass index does not necessarily mean lower cardio-metabolic risk since if fat is deposited centrally instead of distributed evenly across the body. People apparently looking lean may develop MetS [14], and experience metabolic dysregulation depending upon of the body fat composition and distribution. Diet rich in refined carbohydrates, fried foods, salt, and processed items can raise triglycerides, blood pressure, and fasting glucose even when overall body weight remains low. Evidence from Indigenous communities elsewhere shows that higher intake of meat and fried foods was associated with higher waist-to-hip ratio, BMI, and odds of overweight or obesity, while processed-food intake was associated with higher odds of self-reported type 2 diabetes [13]. At the same time, protein-energy malnutrition may reduce lean body mass. Lower muscle mass reduces the body's capacity to dispose of glucose efficiently, thereby favouring insulin resistance. Thus, an adult with chronic energy deficiency may have low BMI but relatively high waist circumference, elevated triglycerides, low HDL cholesterol, or raised blood pressure—meeting MetS criteria despite appearing undernourished.

The coexistence of undernutrition and cardio-metabolic risk is therefore not contradictory. It reflects a nutrition transition in which inadequate food quality, episodic food scarcity, infection, reduced physical activity, stress, and changing diets act together. In India, underweight has been found to be especially high among the indigenous communities while overweight and obesity are also on rise [15, 16], so does the prevalence of prediabetes and metabolic syndrome further exacerbate the situation leading to multiple burden of malnutrition.

Conclusion

Undernutrition among the indigenous people of Purulia still persist along with emergence of overweight, prediabetes, and metabolic syndrome resulting into multiple burden of malnutrition. Metabolic syndrome was found to be significantly associated with low physical activity, alcohol consumption, and regular intake of junk food and extra salt. It highlights the importance of community-level intervention on modifiable lifestyle factors that are associated with metabolic syndrome prevention and thereby, withstand against public health burden of malnutrition among the indigenous communities of Purulia.

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Ethical Clearance

The study was approved by the Institutional Ethics Committee of Sidho-Kanho-Birsha University, Purulia vide ref no. IEC/465/01/B/22 dated 12.04.2022. Informed written consent was obtained from all participants prior to data collection.

Conflict of Interest

The authors declare no conflicts of interest.

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