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Full Length Research Paper

Emerging health threats among a primitive tribal group of Central India

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A cross-sectional study was conducted among adult Saharia, a primitive tribal group (PTG) of Madhya Pradesh. A total of 364 subjects (168 males and 196 females) ranging in age group 18 - 60 years were divided into two groups based on their random blood sugar level. Stature, weight, waist circumference, hip circumference, skin fold thicknesses, fat percent, blood pressure and blood sugar level were measured for all the subjects. 8.9% males and 7.1% females were found to be having more than 140 mg/dl random sugar level. All the skin fold thicknesses, body circumference, indices of adiposity, fat percentage and blood pressure were found to be significantly higher among the 'pre-diabetic males'. The picture was not so clear among females. Saharia is a socio-economically weaker population with very low literacy level but the clustering of higher blood sugar level, higher blood pressure and higher fat percentage is an indicator of a beginning of metabolic syndrome among this primitive tribal group showing a paradoxical situation.

Key words: Adiposity, subcutaneous fat, blood sugar, primitive tribal group, India.

INTRODUCTION

The rural and tribal populations in India face considerable disparity as compared to urban populations in terms of health facilities, education and economic pursuits. Naidu and Rao (1994) reported low BMI values among lowest monthly per capita income group as compared to those having better occupations. The relationship of mortality and BMI is U or J shaped (Shetty and James 1994; Allison et al., 2003) indicating that both the ends show higher morbidity and mortality. Developing countries are facing dual problem –over nutrition being reflected in obesity and associated cardiovascular and renal diseases, and under nutrition being reflected in a battery of associated health problems. Prevalence of hypertension has been found to increase in traditional populations undergoing modernization. The risks of cardio vascular disease (CVD) have been found to increase with the increasing blood pressure JNC 7th report (2003) and also with increasing blood sugar levels (Nathan et al., 2007). Among a total of 46 identified scheduled tribes according to Schedule Tribe Order, Government of India, 7 groups have been declared as primitive tribes in Madhya Pradesh. Saharia is a primitive tribal group in Madhya Pradesh. Total population of Saharia tribe in Madhya Pradesh in districts Shivpuri and Gwalior is 139124 and 33,239 respectively. Census of India (2001).

The primitive tribal group (PTG) status of Saharia is based on their lower level of literacy, primitive form of agricultural practices, declining or stagnant population, small population and economic backwardness (Government of India,2002). Although traditionally Saharias practiced shifting cultivation, hunting gathering etc, due to lack of cultivated land, scarcity of rain, most of the Saharias have become daily wage earners. The Saharia in the study population were mostly laborers with an income less than Rs. 2500 per month and with lower literacy level. 6.5% males and 4.6% females were chronic

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Abbreviations: PTG, primitive tribal group; **CED,** chronic energy deficient; **CVD,** cardio vascular disease; **BMI,** body mass index; **GMT,** grand mean thickness; **WHR,** waist hip ratio; **WSR,** weight stature ratio; **SBP,** systolic blood pressure; **DBP,** diastolic blood pressure.

Table 1. Distribution of subjects according to random blood sugar level.

Subjectsw	Prevalence			
	Random blood sugar			
	>140mg/dl		<=140 mg/dl	
	n	%	n	%
Males	15	8.9	153	91.1
Females	14	7.1	182	92.9

energy deficient III (CED III), 8.9% males and 10.7% females were chronic energy deficient II (CED II), 33.3% males and 21.4% females were CED I using BMI (communicated elsewhere). Tribal population is particularly vulnerable to malnutrition due to their traditional socio-cultural practices and low literacy level. The low socio-economic status of Saharia is quite apparent from their income and educational level. Kapoor et al.,(2009) found that among adult Raji, primarily a food hunting and gathering tribe of Indian Himalayas, almost 90% were chronic energy deficient (CED) as per BMI classification. Among Desia Kondh, a tribal population of Orissa, 16.2% males and 26.1% females were chronic energy deficient (CED III), Ghosh and Bala (2006). Socio-cultural profile of the Saharia have been studied elaborately by Biswas and Kapoor (2003a, b; 2004). However no study regarding their diabetic predisposition, cardio - vascular health and nutritional profile have been carried out by others so far. With this backdrop the authors conceptualized the present study.

MATERIALS AND METHOD

The present study has been conducted among Saharia in Shivpuri and Gwalior districts of Madhya Pradesh. A total of 364 males and females ranging in age 18-60 years were studied (males, n = 168 and females, n =196). Both the males and females were mostly working in brick kilns, road side construction, as agricultural laborers on daily wage basis. Only those subjects were studied who volunteered for it after the procedure and purpose was explained to them. Informed consent was obtained from each subject. All the subjects were apparently healthy with no visible deformity.

All experiments were performed in accordance with relevant guidelines and regulations. Ethical clearance was obtained as per rules. Anthropometric measurements like stature, weight, waist circumference, hip circumference, skin fold thickness at various sites were taken. Body mass index (BMI), Waist hip ratio (WHR) and Weight stature ratio (WSR) were computed. To assess an overall picture of subcutaneous fat the mean of skin fold thicknesses was taken as Grand mean thickness (GMT). All anthropometric measurements were taken by trained anthropologists using standard techniques (and Lourie, 1981). Blood pressure both systolic (SBP) and diastolic blood pressure (DBP) was measured with the help of sphygmomanometer and stethoscope. The percent body fat was recorded using a body composition analyzer employing bioelectric impedance technique. Random blood sugar was measured with single prick using glucometer. During data tabulation it was observed that a sizable fraction of subjects both males and females, had more than 140 mg/dl random sugar level. To cross check the values, their random blood sugar level was tested on two consecutive days. The level remained above 140 mg/dl. None of these subjects were aware of their being having high blood sugar. In order to evaluate the structural and functional variations, if any, the data on Saharia males and females was divided in two groups, one with random sugar level more than 140 mg/dl referred to as 'pre-diabetic' simply for the sake of convenience in the present study, and the other with less than 140 mg/dl (American Diabetic Association, 2009). The group with less than 140 mg/dl was taken as having normal blood sugar. The blood pressure, body mass index and fat percent and body measurements were averaged accordingly.

RESULTS

The prevalence of 'pre diabetics' was more among the Saharia males (Table 1). A relatively higher percent of males (8.9%) than females (7.1%) were found to belong to pre-diabetic category. But the range of blood sugar among females (78 - 240 mg/dl) was more than males (74 -172 mg/dl). The mean value of sugar among males (105.2 ± 23.2 mg/dl) was lower than that among females (112.7 ± 27.23 mg/dl). The stature of males and females in two groups were comparable with their respective counterparts. The 'pre-diabetic' males were significantly heavier than the normal blood sugar group males whereas normal blood sugar level females were heavier than 'pre-diabetic' females. The waist and hip circumferences of 'pre-diabetic' males were significantly more than the males with normal sugar level, whereas among females hip circumference among the normal blood sugar group was significantly more (Table 2).

The skin fold thickness taken at different sites over the bodies were significantly more among 'pre-diabetic males' (Table 2). Among females however the differences were not that marked between the two groups to reach statistically significant level. The skin fold thickness at different sites was more among 'pre-diabetic' males as compared to 'pre diabetic' females. But in normal sugar level category female showed more subcutaneous fat at each skin fold sites as compared to their counterpart males. Systolic blood pressure, waist hip ratio and fat percentage among both males and females were found to be higher among 'pre-diabetic' Saharia males and females with the exception of body mass index and diastolic blood pressure among females (Table 3). The mean

Table 2. Basic characteristics of Saharia males and females.

Characteristics	Males			Females		
	Normal sugar level (<=140mg/dl) (n=153; 91.08%) Mean ± SD	High sugar level (>140 mg/dl) (n=15; 8.92%) Mean ± SD	't'	Normal sugar level (<=140mg/dl) (n=182; 92.9%) Mean ± SD	High sugar level (>140mg/dl) (n=14; 7.1%) Mean ± SD	't'
Stature (cm)	165.1 ± 6.37	164.2 ±3.55	0.81	152.3 ± 5.75	153.3 ± 6.85	0.57
Weight (kg)	51.1 ± 6.80	61.2 ± 8.20	4.62***	44.4 ± 5.19	42.5 ± 3.83	1.73
Waist circumference (cm)	68.9 ± 5.77	75.3 ± 4.85	4.72 ***	65.0 ± 4.78	66.0 ± 5.61	0.62
Hip circumference (cm)	81.9 ±5.16	85.7±5.33	2.76 *	83.5 ± 4.76	81.8 ± 1.82	2.82*
Biceps SF	3.3 ±1.48	4.6± 0.84	5.21***	3.8 ± 1.64	3.4±0.70	1.74
Triceps SF	6.4 ±2.75	8.9 ± 2.07	4.32***	8.3 ± 3.14	8.7±2.17	0.62
Subscapular SF	9.5 ± 3.60	13.6 ± 3.65	4.13***	11.0 ±3.46	10.9± 3.17	0.14
Suprailiac SF	7.7 ± 3.47	12.4 ± 4.18	4.23***	8.6 ±3.52	9.5±1.74	1.77
Abdomen SF	12.8 ± 5.91	18.1 ± 6.87	2.92*	13.6 ± 5.15	15.3±3.11	1.82
Calf post. SF	8.3 ± 4.13	10.1 ± 2.33	2.53*	9.6 ± 3.53	9.0±2.14	0.98
Calf medial SF	6.1 ± 3.03	7.6 ± 0.97	4.27***	7.4 ± 2.8	7.1± 1.56	0.83

*p<0.05, ** p<0.01, *** p <0.001, SF- Skin fold thickness.

Table 3. Physical and physiological characteristics of Saharia according to random blood sugar level.

Variables	Males			Females		
	Normal sugar level (<=140mg/dl) (n=153; 91.08%) Mean ± SD	High sugar level (>140 mg/dl) (n=15; 8.92%) Mean ± SD	't'	Normal sugar level (<=140mg/dl) (n=182; 92.9%) Mean ± SD	High sugar level (>140 mg/dl) (n=14; 7.1%) Mean ± SD	't'
BMI (kg/m^2)	18.7 ± 2.18	22.7 ± 3.34	4.55***	19.1 ± 1.87	18.1 ± 1.19	3.03**
GMT (mm)	7.8 ± 3.06	10.8 ± 2.33	4.60***	8.9 ± 2.75	9.1 ± 1.65	0.40
WSR	0.42 ± 0.03	0.46 ± 0.03	4.01***	0.43 ± 0.03	0.43 ± 0.03	0.33
Fat percent (%)	10.4 ± 5.53	17.3 ± 7.08	3.60***	22.2 ± 5.68	23.2 ± 0.74	1.53
WHR	0.84 ± 0.04	0.89 ± 0.05	3.36**	0.78 ± 0.05	0.81 ± 0.06	1.57
Systolic blood pressure (mmHg)	119.9 ± 11.85	124.7 ± 6.78	2.39*	114.7 ± 10.23	119.1 ± 12.7	1.29
Diastolic blood pressure(mmHg)	79.4 ± 8.68	82.1 ± 6.56	1.47	73.2 ± 6.61	72.9 ± 7.67	0.18
Blood sugar (mg/dl)	99.9 ± 16.3	159.3 ± 10.45	19.77***	107.5 ± 17.49	179.7 ± 39.74	6.7***

*p<0.05, ** p<0.01, *** p <0.001.

(Table 3). The mean value of blood sugar among females was more in both the groups as compared to males. Both males and females in higher blood sugar level category were found to have relatively more upper body fat predominance. The Saharia females in 'pre-diabetic' category had the largest fat percentage followed by normal sugar level females, 'pre-diabetic' males and normal sugar level males.

Table 4 presents the association between blood sugar level and various indices of adiposity among Saharia males and females. Body mass index was significantly but positively correlated with blood sugar level among males but regional obesity indices, waist hip ratio and waist stature ratio, were significantly correlated with blood sugar level among females. To assess the subcutaneous fat distribution pattern among Saharia males and females in two groups with different blood sugar levels, the skin fold sites in the normal blood sugar group were arranged in ascending order of their thickness (Satwanti et al., 1980). The skin fold sites in 'pre-diabetic' group were arranged accordingly in Figure 1 for males and Figure 2 for females. The fat deposited at suprailiac, abdomen and

Table 4. Association between blood sugar level and various indices of adiposity among Saharia males and females.

Adiposity Indices	Correlation coefficient (r)	
	Males	Females
Body mass index (BMI)	0.19*	-0.11
Waist hip ratio (WHR)	0.00	0.29**
Grand mean thickness (GMT)	0.13	-0.06
Waist stature ratio (WSR)	0.02	0.26**

*p < 0.05 (2-tailed). **p < 0.01 level (2-tailed).

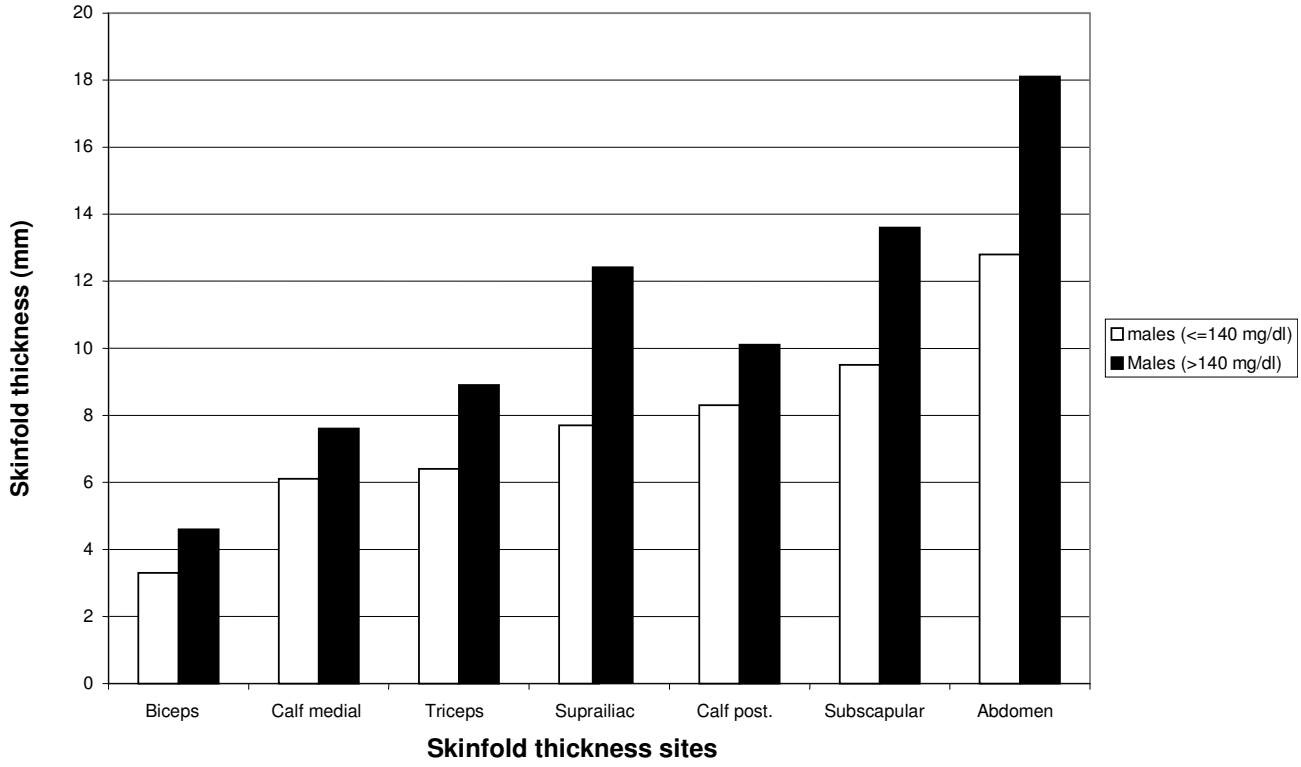

Figure 1. Subcutaneous fat distribution pattern among Saharia males according to their sugar level.

subscapular sites among 'pre-diabetic' males were markedly more as compared to the normal blood sugar group. At all the sites, 'pre-diabetic' males had large fat deposition but among females in two groups the skin fold at different sites were not much different with the exception of abdomen site where 'pre-diabetic' females had larger fat deposition. The 'pre-diabetic' males showed highest value of skin fold thickness at all the sites as compared to males in normal blood sugar level as well as Saharia females in both the categories.

DISCUSSION

A noticeable proportion of the adult Saharia were found to be 'pre-diabetic'. The term 'pre diabetic' used in the present study is merely for the sake of convenience, it is not based on IGT (Impaired Glucose Tolerance).The subject having higher blood sugar were also found to have significantly higher body weight, body mass index, waist hip ratio, higher fat percentage and higher blood pressure, both systolic and diastolic which is clearly evident among males. The presence of significantly higher body mass index among females in normal sugar level category as compared to 'pre diabetic' females but comparable grand mean thickness and fat percentage reflects relatively more muscle mass in the former group. The females in both the categories were fattest as per the bioelectric impedance technique. However, the presence of highest value of grand mean thickness (GMT) among

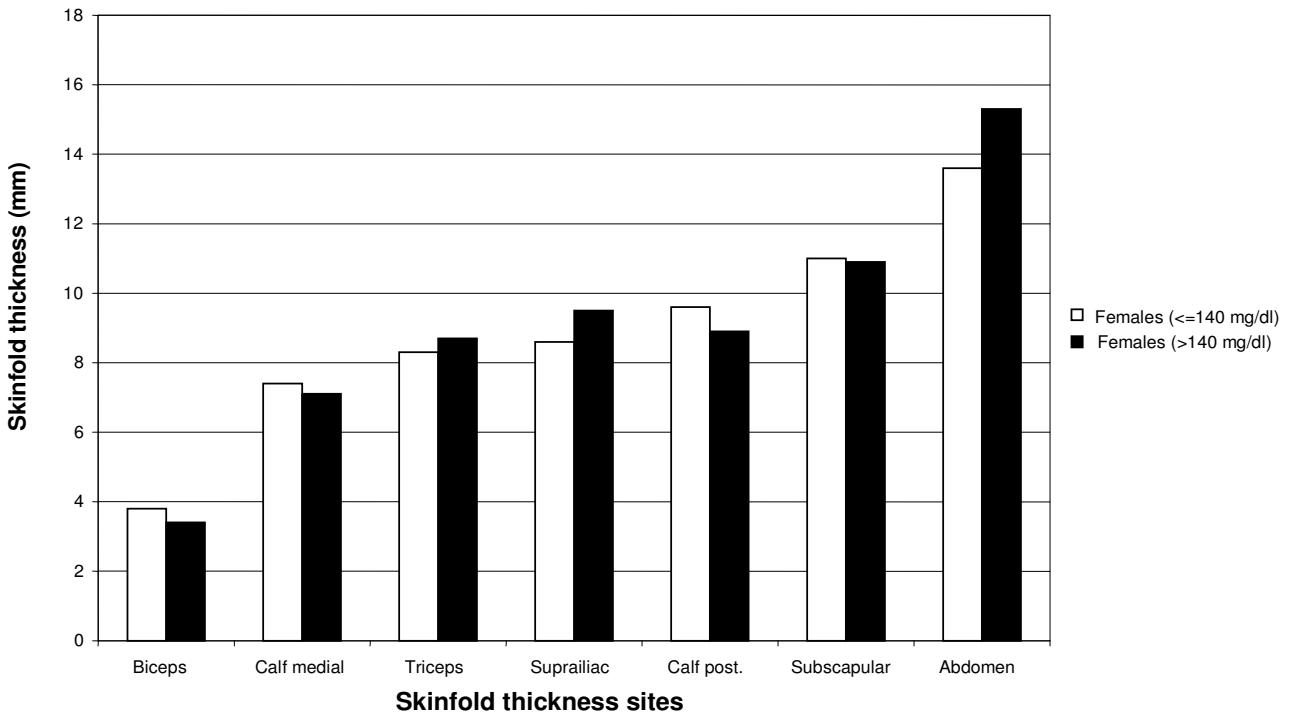

Figure 2. Subcutaneous fat distribution pattern among Saharia females according to their sugar level.

high blood sugar males indicated males to be having more subcutaneous fat while the females having more internal fat. The 'pre-diabetic' subjects were fattest in both the sexes. The preponderance of trunkal fat among high blood sugar category was evident by waist hip ratio, waist stature ratio and subcutaneous fat profile. The general adiposity among males and regional adiposity among females were found to be determinants of blood sugar level. Another health problem faced by human population in the present day scenario is hypertension especially among the overweight and obese. Saharias are no exception to it as with an increase in body mass index, blood pressure also increased among both males (BMI vs. SBP $r = 0.170$, $p<0.05$) and females (BMI vs. SBP $r = 0.197$, $p<0.01$; BMI vs. DBP $r = 0.199$, $p<0.01$). Both males and females worked as labourers with more rigorous physical activity noticed among females as evident by prolonged working hours involving both outdoor and household chores. This may account for differential distribution of high random blood sugar and adiposity among males and females. Males often migrate to nearing towns for work, thereby getting exposed to modern means of life and food items which might explain partially the present scenario. The latest WHO (2008) figure for the number of people with diabetes worldwide in 2000 was 171 million which is projected to increase at least 366 million by 2030. The situation in developing countries is of concern due to population growth, ageing, unhealthy diet, obesity, sedentary lifestyle and occurrence of type 2 diabetes at an early age. Diabetes has become the major cause of premature illness and death mainly through an increase in cardio-vascular diseases. Sadikot et al (2004). Found the prevalence rate for diabetes mellitus to be 4.3% in total Indian population, 5.9% in urban population and 2.7% in rural population respectively. The authors reported type 2 diabetes to be a major health problem in India. There are ethnic differences in insulin resistance, adiposity, and cardio-vascular risk profile. Higher levels of insulin resistance is found to be associated with ethnicity, McKeigue et al. (1991) which further increases the risk of developing type 2 diabetes and coronary heart disease in these populations. Insulin resistance in South Asians is manifested at an early age (Whinchup et al., 2002). Yajnik et al. (2002) have reported that even among newborn infants of non-diabetic mothers, Indian children born in India had higher insulin levels compared to white children born in London. While genetic factors probably play a part in these differences, the expression of insulin resistance differs between environmental settings (Whinchup et al., 2002).

The diversity in past and present ecological conditions

may lead to genetic differences in populations. The `thrifty' genotype, wherein certain populations may have genes that determine increased fat storage, which in times of famine represent a survival advantage, but in a modern environment result in obesity and type 2 diabetes. Transition from cyclic seasonal food shortages to stabilized food availability over the years probably has a significant effect on the metabolic processes involved in glucose-insulin interdependence (Khamaisi and Raz, 2002). Neel argued that such cycles would have favored individuals having a "thrifty gene ", responsible for storing fat when plasma glucose levels were highest during food abundance, thereby the accumulated fat to be utilized during the next food shortage According to the hypothesis, this special genetic characteristic was an asset to the tribal, hunter-gatherer ancestors with their intermittent feast or famine alimentation (Neel,1962).With change from nomadic to settled agriculture, high-calorie diet, sedentary lifestyle and influence of urbanisation, thrifty genotype promotes rapid weight gain, abdominal fat accumulation and predisposes to chronic hyperglycemia, insulin resistance, obesity, and type 2 diabetes (Neel ,1999). Among north-Indian adolescents girls the general and abdominal obesity was found to be positively associated with hypertension (Suman and Kapoor, 2000). The present study highlights that socio-economic transition along with lifestyle modifications can result in urgent health problems even in a primitive tribal group like Saharia. This socio-economically deprived population represents co-occurrence of high blood sugar level, high blood pressure and high fat percentage pointing towards beginning of metabolic syndrome which is very distinct and recent phenomenon among primitive tribal group. This may be explained by Neel's Thrifty gene hypothesis indicating that change in overall environment triggers the thrifty genes, hence predisposing this group to such lifestyle disorders. Co- existence of under nutrition and over nutrition has been found among adult Saharia (Kapoor et al. 2009). On one hand the Saharias are fighting with hunger and infectious diseases due to poor basic health amenities and on the other hand they may also be burdened with the costly treatment of diabetes and hypertension considered to be disease relegated among the affluent societies so far.

There is a drastic socio-cultural and economic shift among Saharia from agriculture to daily wage earning especially in urban sector, adopting unhealthy diet which could have resulted in early appearance of obesity related health problems among this primitive tribal group. In a population with nature based economy and consistent rainfall shortage leading to wage earning and migration, this phenomenon is quite alarming.Changes in economic status, eating habits, food selection and physical activity of this population indicate the importance of environment, nutrition and metabolism in early mortality. The occurrence of 'pre diabetic' conditions in adult male and female Saharias who were within normal range of body mass index but belonged to low socio-economic status, had poor dietary pattern with negligible intake of vegetables and fruits, is a pointer of greater health threat. The study also validates the use of simple anthropometric variables, fat percentage and its distribution as markers of health problems. A wider coverage of the Saharia could have given a comprehensive profile of the status of pre diabetics among this primitive tribal group, however, time framework and scope of the study was an important constraint. Carefully conducted prospective studies are needed to further our understanding and to determine whether a genetic predisposition among them is a contributing factor in the pathogenesis of type 2 diabetes. Adult diabetes is a health problem which requires constant monitoring and regular medication which would be very difficult in these socio-economically deprived populations with very limited health care facilities. More studies on this population with major focus on cardiovascular and metabolic disorder are required for making preventive strategies.

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