ORIGINAL ARTICLE

Diet, nutrition and cardiac risk factor profile of tribal migrant population in an urban slum in India

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Abstract

Migration of tribal population to urban areas may increase the risk of non-communicable chronic diseases. In this study an attempt was made to explore the risk factors influencing cardio vascular disease, hypertension and Type 2 diabetes among the tribal migrants living in urban areas. A population based cross sectional study was carried out on tribal migrants (n=138 men, n=137 women aged ≥30 years) of low economic status, living in an urban slum (Kondapur) of Hyderabad, Telangana, India. Blood lipids, glucose, homocysteine, glycated Haemoglobin, blood pressure and nutritional biochemical markers such as serum albumin, serum protein, Vitamin-D and haemoglobin were examined in a subsample of tribal migrants. The prevalence of overweight in men and women was 35.3% and 32.4% while general obesity was 14.3% and 24.3% respectively. In addition, high concentration of total cholesterol, low density lipo proteins (LDL), triglycerides, homocysteine and glycosylated haemoglobin in the study population was also observed. Duration of stay had no significant association with overweight and obesity. Majority of tribal migrants did not meet at least 50% of RDI of micro-nutrients such as iron (80-84%), vitamin A (81-83%) and riboflavin (67-84%). Similar finding was observed with food groups such as leafy vegetables (84-91%), milk and milk products. However, the consumption of fat and protein was found to be ≥70% of RDA indicating transition in diet pattern. The present study shows urban life style and diets may predispose to higher incidence of diabetes, hypertension and atherosclerotic cardiovascular disease among tribal migrants living in urban areas.

Key Words

Tribal migration; Diet; Urban life style; Cardiovascular Risk Factors

Introduction

In India, migration of rural communities to urban areas is on the rise due to rural impoverishment, lack of employment opportunities, attraction for urban lifestyle, rapid industrialization and urbanization. In Andhra Pradesh urban population growth rate has increased from 1% during the period of 1991-2001 to 3% during 2001-2011 and a substantial increase is attributed to rural to urban migration (1). The rural migrants adapted to urban lifestyle, food consumption patterns, leading to demographic,

epidemiological and nutrition transitions among the migrant population (2). Various studies carried out in India documented that the migrant populations living in urban slums are more prone to develop chronic non-communicable diseases (NCDs) such as obesity, hypertension, dyslipidaemia, diabetes mellitus, and coronary artery disease (3, 4). The tribal population constitute 8.6 % of the total population of India (5). These tribal groups reside in varying ecological and geo-climatic conditions, with different socio economic and occupational back ground which can influence their health and nutritional status (6).In a recent survey carried out by National Nutrition Monitoring Bureau in tribal areas, the prevalence of overweight and obesity among tribal men and women was 2.6% and 3.2% respectively and the prevalence of hypertension (Systolic Blood Pressure140 mm of Hg and/or Diastolic Blood Pressure 90 mm of Hg) was about 25% among men, and 23% among women (7).

Only few studies were carried out on the prevalence of obesity, diabetes and other NCD's among the tribal populations in India and the information on these chronic diseases especially with tribal migrants in urban areas in India is limited.

Aims & Objectives

Hence, this study was conducted to understand if tribal migrants living in urban slums are more likely to develop NCDs, because of urban life style and environment

Material and Methods

Study design and participants: A population-based cross-sectional study was carried out in an urban slum (Kondapur) of Hyderabad, in the state of Andhra Pradesh in India where most of the state's migrant tribal population resides. Assuming the prevalence of hypertension 25% with 95% CI and 20% relative precision, a sample size of 288 was required. As per the Municipal health records a total of 942 households were enlisted. Among them, 87 households belong to local population and the remaining 855 households belong to migrant tribal population. A total of 275 participants, 138 men and 137 women subjects of ≥30 years belonging to low socio economic group tribal migrants were recruited. Migrant status was attributed to those who have migrated from tribal villages to urban areas, both within state of Andhra Pradesh and from other states of India, to Hyderabad.

Ethical clearance and consent: The study was approved by the Scientific Advisory Committee (SAC) of the Indian Council of Medical Research (ICMR).The research protocol was approved by the institutional ethical review board. All participants were informed about the study and written informed consent was obtained before initiation of the study.

Measures: Participant's information on socioeconomic and demographic particulars such as place of origin, social status, and linguistic origin, duration of stay, literacy and type of house was collected using pre-tested questionnaires. Clinical examination was performed to detect nutritional deficiency signs and blood pressure (BP) was recorded using mercury sphygmomanometer (8). Anthropometric measurements were recorded according to the standard guidelines. Body weight was measured to the nearest 0.1Kg on lever type SECA balance (Hamburg, Germany) and height was measured to the nearest 0.1 cm with Stadiometer (SECA, UK) by adopting standard procedures. Waist and hip circumference were measured with chasmors metallic tape. Skin fold thickness at triceps, biceps, supra iliac and sub scapular regions were measured with Harpenden skin fold calipers. Density of the body fat was obtained from four skin folds using Durnin and Womersley equation (9). Body fat and percent of body fat from Density was estimated by using Siri's equation which was validated in Asian Indians (10).

Estimation of Dietary intakes: In a sub sample of population 24-hr recall method diet survey was carried out to assess dietary intake of the individuals (11).Dietary intakes were calculated by using the published values of nutritive values of the Indian foods (12). The intake of different foods by recommended dietary allowances (RDA) were calculated according to their age, sex using recommended dietary allowances for Indians (13).

Laboratory assays: An overnight fasting blood sample was drawn for estimation of serum total cholesterol (14), triglycerides(15), high density lipoprotein (HDL), low density lipoprotein (LDL) (16), glycosylated hemoglobin (17) and homocysteine (18,19) and were analyzed based on published guidelines. The estimation of nutritional biochemical markers such as serum albumin (20), serum protein, Vitamin-D (HPLC Method) and haemoglobin (21) parameters were also carried out using standard procedures in a sub sample of population.

Measurements of cardiovascular risk factors: General obesity, abdominal and central obesity were measured based on body mass index (BMI), waist circumference, waist hip ratio using WHO recommended Asian cut off values., BMI of ≥27.5 was defined as obese (22), The cut-off level for waist circumference (WC) ≥90cms for men and ≥80cm for women was used to define abdominal obesity. While, men with WHR as >0.90 and women with >0.80 were identified as centrally obese (22).

Prevalence of hypertension was assessed by measuring systolic and diastolic blood pressure based on JNC Criteria, 2007 (23). Subjects with systolic pressure (≥ 140 mmHg) and diastolic pressure (≥ 90 mm Hg) were defined as hypertensive. In addition, those who were on medication for high blood pressure were also considered to have Hypertension. Homocysteine and glycosylated haemoglobin estimations were also carried out and individuals with homocysteine level >15µmol/L were considered to have hyperhomocysteinemia (24), and those with glycosylated haemoglobin ≥6.7% were considered to have diabetes respectively.

Statistical analysis: The data were analysed using Statistical Package for Social Sciences; version 15.0 for Windows. Descriptive statistics of means were calculated for continuous variables. The participants were further pooled and grouped according to residence in the area of less than five years, 5-10 years, and more than 10 years and the data was analysed according to the duration of stay. Mean values of anthropometric and blood pressure measurements were compared in relation to duration of stay in years by one way ANOVA with post hoc test of least significance difference (LSD) method for both males and females. For categorical variables, Proportion test was done to see significant differences. Correlation analysis was done to see the association of biochemical parameters and anthropometric indices. Logistic regression was performed to identify the risk factors of hypertension with obesity and lipid profiles. Level of significance was considered as 0.05.

Results

A total of 275 participants (138 men and 137 women) were covered in the study. About 65% had migrated from the other states of Karnataka, Maharashtra, Chhattisgarh, Orissa and Bihar. Average household size was 4.6, and majority (85%) of the families were nuclear families. Most of the subjects were construction workers (35%), followed by housekeepers (25%), vegetable vendors and domestic helpers (20% each). Mean age of subjects was 41 years and men were little older than women. The average height of men and women was similar to other studies reported from India. Women had higher body fat percent than in men but were not significant. Mean diastolic and systolic blood pressure was 80 and 121 respectively and no significant difference was observed between men and women (Table 1). Similarly, no significant difference was observed with duration of stay and overweight as well as with obesity indicators (Table 2). Majority of migrants subsisted on inadequate diets (<70% of RDI) and the proportion of migrants not meeting even 50% of RDI was highest for leafy vegetables (84-91%) followed by other vegetables, milk and milk products, pulses, sugar and jaggery. The consumption of milk and milk products, sugar and jaggery was significantly ($p<0.000$) higher in women than in men. Inadequacy of cereals consumption was significantly ($p<0.05$) higher in males than in females (Table 3). Nearly 96-100% people consumed adequate (≥70% of RDA) amounts of total fat , 64-98% energy , 61-82% protein and 69% consumed folic acid, while majority did not meet at least 50% of RDI of micro-nutrients such as iron (80-84%), vitamin A (81-83%) and riboflavin (67-84%).The deficit (<50% RDA) of nutrient intakes were significantly ($p<0.05$) higher among men than women with respect to protein, energy, thiamine, riboflavin and niacin (Table 4).However 49.6% men and 56.6% women were overweight and 47% men had more than 25% fat (Table 5).

Men (39.1%) had significantly ($p<0.010$) higher levels of glycosylated haemoglobin than women (18.3%). The prevalence of anaemia was significantly ($p<0.000$) higher in women (69%) compared to men (10.9%). About 39% of men had higher (≥15) concentrations of homocysteine ($p<0.001$), while none of the women had the same. The prevalence of obesity in terms of BMI was higher in women (24.3%) compared to men (14.3%), while the prevalence of abdominal obesity and hypertension was comparable between both genders (Table 6).

Correlation with anthropometric and biochemical parameters: The correlation coefficients are given in the Table 7. In men BMI was significantly positively correlated (r= 0.577) with triglycerides and in the women, BMI was significantly correlated with total cholesterol (r= 0.283), LDL (r= 0.223), triglycerides (r=

0.258) and with glycosylated hemoglobin (r= 0.350). In men, waist circumference was significantly correlated with triglycerides (r= 0.551) and in women it significantly correlated with total cholesterol (r= 0.3411), triglycerides (r= 0.295) and glycosylated hemoglobin (r=0.395). In men waist hip ratio significantly correlated with triglycerides (r=0.450), glycosylated hemoglobin (r=0.334) and in women it significantly correlated with total cholesterol (r=0.341), triglyceride (r= 0.258), and glycosylated hemoglobin (r= 0.395). No relation was observed among obesity and biochemical nutritional variables except Hb (Table 7). Hypertension in both men and women was significantly associated with total cholesterol (OR= 4.0 95% CI 1.8-10.8), waist circumference (OR =1.9, CI: 1.02-3.06), WHR (OR= 3.5, CI: 1.3-9.3) and BMI (OR=2.5, CI: 1.2- 4.4).

Discussion

This is the first study in India to assess the prevalence of risk factors for cardiovascular diseases in tribal migrant population. This study Provides important information on indicators of under nutrition (chronic energy deficiency and anaemia), obesity, and risk factors for cardiovascular disease in this population. The prevalence of obesity in India from the national family health survey (NFHS-3) (>25kg/m^2) was 20% in urban areas and 6% in rural areas (25). In our study, the prevalence of overweight in men and women (BMI 23.5-27.5) was 35.3% and 32.4% respectively, and obesity (≥27.5 BMI) was 14.3% of men and 24.3% of women. Our study adds further evidence to the existing knowledge that migration from rural to urban areas is associated with obesity; probably due to decreased physical activity and consumption of unhealthy diets. However unlike earlier studies (3) we found no impact of duration of stay in urban area on obesity and other cardiovascular risk factors. One probable reason for this difference may be due to smaller sample size of our study. Studies on Asian Indian migrants have shown that there is a dual burden of disease in this population i.e. both under and over nutrition (26). In our study, 16.5% of men and 11.0% of women were suffering from chronic energy deficiency, while 14.3% of men and 24.5% of women were suffering from obesity followed by abdominal obesity (men: 35.1% & women: 47.1%) and central obesity (men: 72.25% & women: 75.6%) and the percentages were found to higher compared to the earlier studies from India on urban slum dwellers (4). About 69% of women had anaemia. Our study reveals high concentrations of total cholesterol, low density lipo proteins (LDL), triglycerides, homocysteine, and glycosylated hemoglobin in both men and women, and these concentrations were observed to be higher compared to the values among tribal Indian population. These findings indicate that tribal migrant populations are more likely to develop insulin resistance (27) and metabolic syndrome (28). There is little data on prevalence of Hyperlipidemia in tribal population. Our study show that more than 20% of men and women suffer from Hyperlipidemia. Various studies show that reduced intake of fibre and increased consumption of animal fats and carbohydrate are responsible for diabetes (29,30). The prevalence of diabetes in urban India is around 15 % (31,32). In our study, 39.1%of males and 18.3% of females were suffering from Diabetes estimated from serum glycosylated Hemoglobin. This increased prevalence of diabetes in these populations is similar to a previous study in India (4). The total fat consumption in this study is more than 35grams which is nearly 75% higher than the average consumption (21grams) in rural India (7).The high fat consumption in both men and women, contribute to increase in body fat content, both linearly and inversely, related to the insulin resistance (33), which may be the cause of high glycosylated hemoglobin levels in our study. Interestingly, in spite of adequate consumption (RDA) of folic acid rich foods, only males (39.1%) had higher concentrations of tHcy, thus confirming earlier study (34) from south India. These findings show that migrant men were more prone to coronary artery disease (CAD) (35) than women.

Conclusion

Our study concludes that the tribal populations migrating to cities are more prone to obesity and also are more on the verge of metabolic syndrome than those living in their natural habitats and this may be attributed to rural to urban migration. These migrant populations need screening for NCDs, health education on balanced diet, and physical activity. The study results indicate that national and state campaigns are urgently needed to create awareness about lifestyle modifications in relation to diet, physical activity, and providing screening for non-communicable diseases which is crucial to prevent the onset of NCDs.

Recommendation

The tribal migrant populations in urban settings need screening for NCDs, health education on balanced diet, and physical activity. The study results indicate that national and state campaigns are urgently needed to create awareness about lifestyle modifications in relation to diet, physical activity, and providing screening for non-communicable diseases which is crucial to prevent the onset of NCDs.

Limitation of the study

This tribal migrant study is the first of its kind in the country. This study should have been designed as a case control study, with age and sex matched controls from the same tribal background with required sample size. Instead a cross-sectional study was carried out due to limited resources and financial constraints.

Relevance of the study

Our study concludes that the tribal populations migrating to cities are more prone to obesity and also are more on the verge of metabolic syndrome than those living in their natural habitats and this may be attributed to rural to urban migration. The increasing NCD trend among the tribal migrant population is became evident with this study.

Authors Contribution

JJBG: Study design, execution of field work & supervision, data analysis, interpretation of results and writing of manuscript. SBK: Contributed to manuscript preparation, corresponding author
BN: Statistical analysis and interpretation of the data. AD: Subjects recruitment and liaison between community, hospital and field staff. RV: Data interpretation, analysis. NR, GV: Anthropometry and Field work and quality control. AKP: Conducted the bio chemical assays. CD: Conducted 24 hrs. Diet survey and diet data analysis SU: Homocysteine estimation, interpretations.

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Tables

TABLE 1 PHYSICAL AND ANTHROPOMETRIC VARIABLES OF MIGRANT POPULATION

	MALE			FEMALE			ALL		
	N	Mean	SD	N	Mean	SD	N	Mean	
Age	138	42.9	10.7	137	39.7	9.9	275	41.3	10.4
Height	133	162.9	7.0	136	150.0	5.8	269	156.3	9.1
Weight	133	61.1	12.8	136	54.4	11.4	269	57.7	12.6
BMI	133	22.9	4.1	136	24.2	5.0	269	23.6	4.6
MUAC	135	27.5	3.7	136	26.8	3.8	271	27.1	3.8
Waist circumference	134	85.4	11.5	136	78.2	12.2	270	81.7	12.4
Head Circumference	133	90.7	7.8	135	92.4	10.5	268	91.6	9.3
Biceps (mm)	135	5.6	2.6	135	6.9	3.1	270	6.2	2.9
Triceps (mm)	134	10.9	4.9	136	14.4	4.5	270	12.6	5.0

Subscapular (mm)	135	15.9	7.3	136	14.5	5.1	271	15.2	6.3
Suprailliac (mm)	135	9.9	4.6	135	11.5	5.0	270	10.7	4.8
Lean body mass	134	42.7	9.5	135	43.7	7.8	269	43.2	8.7
Fat(%)	134	24.1	7.0	135	24.8	6.5	269	24.5	6.8
DBP	136	81.3	7.6	137	79.4	8.5	273	80.4	8.1
SBP	136	124.1	12.7	137	118.3	17.2	273	121.2	15.4

TABLE 2 MEAN± SD PHYSICAL AND ANTHROPOMETRIC VARIABLES OF MIGRANT POPULATION BY DURATION OF STAY

	Males				Females			
	1-5 Years	5-10 Years	10-15 years	P value	1-5 years	5-10 years	10-15 years	P value
Age (years)	39.4±8.3 (27)	40.36± 7.7 (44)	45.85±12.74(67)	<0.005	36.9±8.4 (31)	38.3±7.9(34)	41.5±11.1(72)	0.62
Height (cms)	163.75±5.2(24)	161.97±6.8(42)	163.1±7.44(67)	0.570	152.96±5.2(31)	150.4±7.0(33)	148.5±4.9((72)	0.001
Weight (kgs)	60.5±10.56(24)	61.5±12.8(42)	61.0±13.7(67)	0.956	57.9± 10.9(31)	54.38±12.9(33)	52.87±10.7(72)	0.123
BMI(kg/m²)	22.59±3.8(24)	23.37±4.22(42)	22.8±4.2(67)	0.701	24.8±4.7(31)	24.1±5.92(33)	23.35±4.6(72)	0.733
Mid Upper Arm circumference (cms)	27.49±3.48(25)	27.57±3.1(43)	27.42±4.22(67)	0.981	27.99±3.43(31)	26.04±4.68(33)	26.5±3.48(72)	0.101
Waist circumference (cms)	85.1±10.67(25)	85.8±11.58(43)	85.2±11.9(66)	0.955	79.9±12.5(31)	78.6±14.1(33)	77.22±11.1(72)	0.576
Hip circumference (cms)	89.7±6.2(25)	92.2±8.4(43)	90.0±8.0(65)	0.289	94.3±9.0(30)	93.1±11.98(33)	91.34±10.3(72)	0.931
Triceps circumference (mm)	10.4± .87(25)	10.48±4.21(42)	11.21±5.3(67)	0.612	15.68±4.31(26)	14.67± 4.6(29)	13.7±4.4(74)	0.114
Biceps(mm)	5.413±2.55(23)	5.4±2.16(39)	5.681±2.74(69)	0.826	7.03±3.19(26)	6.55±2.24(28)	6.418±2.92(74)	0.636
Sub scapular (mm)	14.88±6.39(25)	16.3±7.5(43)	15.97±7.4(67)	0.739	15.3± 4.6(31)	15.0± 6.0(33)	13.9±4.7(72)	0.362
Supra Iliac(mm)	9.0 ± (3.5) (25)	9.96 ± 4.5(43)	10.2 ± 5.0(67)	0.573	11.3±5.03(31)	12.1± 5.63(32)	11.03±4.6(72)	0.54
Fat (%)	25.7±6.5(25)	23.9±7.7(42)	23.6±6.7(67)	0.442	23.6±7.2(31)	24.9±6.5(32)	25.3±6.3(67)	0.48
Fat free mass (kgs)	42.4±6.7(25)	43.2±10.8(42)	42.4± 9.7(67)	0.917	44.6±7.59(31)	44.6±7.6(32)	42.6±7.9(72)	0.233
SBP(mm hg)	122.57±9.2(25)	123.6±11.66(44)	125.4±14.45(67)	0.526	115.7±18.8(31)	118.4±19.1(34)	119.3±15.53(72)	0.619
BP(mm hg)	81.5±5.0(25)	81.2±8.5(44)	81.3±7.8(67)	.986	77.9±8.5(31)	80.1±7.8(34)	79.7±8.8(72)	0.555

TABLE 3 MEAN (±SD) INTAKE OF DIFFERENT FOODS AND DISTRIBUTION (%) OF FOOD GROUPS ACCORDING TORD IN MALES (N=100) AND FEMALES (N=96)

		Mean ±SD	P value	<50 (%)	50-70(%)	>70(%)	"P" value
Cereals	Males	315.3 ±113.6	0.753	24.0	28.0	48.0	0.012
	Females	301.1±88.8		9.4	40.6	50.0	
Pulses	males	22.3±26.8	0.763	55.0	13.0	32.0	0.796
	Females	20.87±25.8		54.2	10.4	35.4	
Leafy -vegetables	Males	9.85±22.8	0.365	84.0	2.0	14.0	0.28
	Females	10.49±20.9		90.6	5.2	4.2	
Vegetables	Males	28.3±58.2	0.727	70.0	3.0	27.0	0.092
	Females	30.1±55.1		66.7	0	33.3	
Roots and tubers	Males	36.8±50.1	0.712	52.0	16.0	32.0	0.449
	Females	34.0±35.6		45.8	22.9	31.3	
Milk and milk products	Males	42.2±67.5	0.602	70.0	20.0	10.0	0.000
	Females	44.9±64.6		64.6	4.2	31.3	
Fats and oils	Males	22.2±18.9	0.761	17.0	19.0	64.0	0.882
	Females	22.79±16.3		16.7	21.9	61.5	
Sugar and jaggery	Males	11.7±8.8	0.065	73.0	11.0	16.0	0.000
	Females	14.3±12.2		37.5	17.7	44.8	

TABLE 4 MEDIAN [95% CI] INTAKE OF NUTRIENTS AND DISTRIBUTION ACCORDING PERCENT OF RDA IN MALES (N=100) AND FEMALES (N=96)

Nutrients		Median, range	"P" value	<50	50-70	>70	P value
Protein	Males	45.30 [34.88,63.92]	0.931	18.0	21.0	61.0	<0.004
	Females	45.20[37.65,56.30]		8.3	9.4	82.3	
Energy	Males	1861.30[1514.85,2224.53]	0.905	13.0	23	64.0	0.000
	Females	1871.15[1562.30,2146.10]		2.1	9.4	88.5	
Calcium	Males	270.55[163.75,403.10]	0.521	34.0	19.0	47.0	0.252
	Females	273.35[193.73,409.45]		25.0	27.10	47.9	
Iron	Males	9.85[718,13.48]	0.769	80.0	13.0	7.0	0.631
	Females	9.70[7.23,13.08]		84.4	11.5	4.2	
Vitamin A	males	110.40[68.73,182.20]	0.801	83.0	4.0	13.0	0.587
	Females	112.95[77.53,177.65]		81.3	2.1	16.7	
Thiamine	males	0.60[0.40,0.88]	0.697	54.0	21.0	25.0	0.002
	females	0.60[0.40,0.80]		29.2	28.1	42.7	
Riboflavin	males	0.50[0.30,0.68]	0.474	84.0	11.0	5.0	0.017
	females	0.50[0.30,0.60]		66.7	21.9	11.5	
Niacin	Males	9.45[7.53,12.73]	0.606	32.0	35.0	33.0	0.000
	Females	9.30 [7.00,12.68]		13.5	26.0	60.4	
Vitamin C	Males	27.65 [17.00,44.55]	0.849	32.0	18.0	50.0	0.876
	Females	27.15[18.88,45.55]		30.2	20.8	49.0	
Folic acid	Males	93.05[60.08,132.93]	0.986	19.0	12.0	69.0	0.673
	females	93.50[63.28,132.90]		15.6	15.6	68.8	
Total fat	Males	35.15 [24.80,46.98]	0.362	1.0	3.0	96.0	0.065
	Female	39.40 [26.78,50.70]		0	0	100	

TABLE 5 PREVALENCE OF OVERWEIGHT AND OBESITY INDICATORS BY DURATION OF STAY BY GENDER

	MALES					FEMALES				
Variables	1-5Years	5-10Years	10-15Years	Total	P value	1-5 Years	5-10Years	10-15Years	Total	P Value
BMI (≥ 23.0)	50.0	52.4	47.8	49.6	0.895	67.7	51.5	54.2	56.6	0.352
WC (≥0.9/0.8	44.0	32.6	33.3	35.1	0.582	58.1	48.5	41.7	47.1	0.305
Fat % (>25/>30)	56.0	42.9	47.8	47.8	0.581	22.6	28.1	20.8	23.0	0.716
Hypertension (>140-- >90)	16.0	13.6	22.4	18.4	0.479	9.7	17.6	19.4	16.8	0.472

TABLE 6 PREVALENCE (%) OF BIO-CHEMICAL AND NUTRITION PROFILE OFMIGRANT POPULATION

Variables	Males No =46	Females No = 83	P value
Total Cholesterol (≥220mgs/dl)	32.6	27.7	0.559
LDL mgs/dl (≥175)	23.9	14.5	0.179
HDLmgs/dl (≥30)	89.1	96.8	0.102
Triglycerides mgs/dl (>165 M)(≥134F)	23.9	22.9	0.895
Glycosylated hemoglobin (≥6.7%)	39.1	18.3	0.010
Hb (g/dl) (<12g/dl)	10.9	69.1	0.000
Protein (gms/dl) (≥6gms/dl)	97.8	97.6	0.932
Albumin (gms/dl) (≥3.5)	6.5	93.5	0.036
Vitamin D (≥15ngs/ml)	82.6	86.4	0.563
Homocysteine (≥15 umol)	39.1(N=23)	0.09 (N=23)	0.001
BMI (Kg/m²) (≥27.5)	14.3	24.3	0.160
Fat percentage (≥25, M) (≥30F)	52.2	23.0	0.000
Abdominal Waist circumference (cms) (≥90cm, M) (≥80 cm, F)	35.1	47.1	0.045
Waist hip ratio (≥0.9,M, ≥0.8,F)	72.2	75.6	0.053
Hypertension ≥140& or 90mm	18.4	16.8	0.729
( ) Cut off values, M = Males. F = Female			

TABLE 7 CORRELATION COEFFICIENTS OF OBESITY INDICATORS WITH BIOCHEMICAL PARAMETERS

	Total Cholesterol	LDL	HDL	TG	Glycosylated Hb	Homo cysteine	Hb	Protein	Albumin	Vitamin D
Males										
BMI	0.108	0.068	0.111	0.577**	0.242	- 0.062	0.198	0.218	0.135	0.280(T)
Waist circumference	0.174	0.067	0.040	0.551**	0.240	0.004	0.222	0.176	0.205	0.177
Waist hip ratio	0.242	0.061	0.040	0.450**	0.334*	0.047	0.147	0.162	0.150	0.109
Fat %	0.142	0.147	0.005	0.177	0.146	-0.230	0.033	0.270(T)	-0.073	0.033
Females										
BMI	0.283**	0.223*	0.087	0.258*	0.350**	-0.245	0.252*	0.030	-0.039	-0.144
Waist Circumference	0.341**	0.201	0.013	0.295**	0.395**	-0.55	0.289**	0.025	-0.046	-0.079
Waist hip ratio	0.360**	0.177	0.048	0.328**	0.318**	0.109	0.146	0.011	-0.105	-0.018
Fat %	0.203	0.178	0.116	0.198	0.139	0.038	0.048	0.110	-0.014	0.00

** P< 0.05, ** p< 0.01, T – Trend (p<0.010)*