Research Article

Obesity Phenotype among a Population of Market Traders in Fiji Islands

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Abstract

Background: Obesity continues to be a major health burden in South Pacific Islands countries are they account for the top 10 countries with the highest obesity rates globally. Currently Fiji Islands stands at 24th nation with highest obesity rate. High obesity rate is believed to be contributing to the rising chronic noncommunicable disease. However, obesity seems to differ by work types, especially those involving sedentary and stressful task as seen among market traders. Using a cross-sectional survey, this study investigated obesity profile among market traders in Suva, Fiji. **Methods:** One hundred and eighty-nine participants from Nasouri and Suva markets were assessed for general and abdominal obesity using body mass index (BMI), percent body fat (PBF), waist circumference (WC), waist-hip-ratio (WHR) and waist-height ratio (WHtR) using standard procedure. Obesity was defined as BMI (>30 kg/m^2); PBF (Male: >25%; Female: >35%); WC (Male: >102 cm; Female>88 cm); WHR (Male>1.0; Female >0.8) and WHtR (>0.5). **Results:** Prevalence of overweight and obesity using BMI were 32% and 45% respectively among study participants (Male: 48%). Mean systolic and diastolic blood pressures are 131.7(sd:17) mmHg and 82.3(sd:11) mmHg; mean anthropometric indices: BMI (29.8; 95% CI: 28.9, 30.8), WC (100.9 ± 15 cm), WHR (1.01 ± 0.83), WHtR (0.61 ± 0.09). Female traders had significantly higher PBF (38.3% *vs.* 27.7%) and WHtR (0.64 *vs.* 0.58); while males had significantly higher weight (82.9 *vs.* 81.6 kg). Obesity was associated with restrictive lung impairment (p=0.002) and hypertension (p=0.006). BMI was positively correlated with WC (r=0.75), WhtR (r=0.73), PBF (r=0.52); but inversely correlated with WHR (r=-0.07). 17% of the traders had normal BMI but also had abdominal obesity; and 27% had normal PBF and abdominal obesity. **Conclusion:** Prevalence of obesity among market traders (45%) is higher than that of general population (32%). Proportion of traders with normal BMI and abdominal obesity is also high. This highlights the need to incorporate indices of abdominal obesity in obesity assessment. This population could potentially benefit from targeted obesity education and prevention effort.

Keywords: Obesity; Abdominal obesity; Fiji Islands; Market traders; Non-communicable disease

Introduction

Obesity continues to be a public health problem globally, which disproportionately affects low-income countries. [1] Countries in the South Pacific region have the highest obesity rate worldwide, with nine of the top 10 countries with highest obesity burden. [2] Additionally, the Pacific region has the highest rates of obesity in the world. [3] STEP Survey (2011) estimated obesity rate to be 32.1% among Fijian adults; indicating an increase of 8.5% from 2002 data. [4] This trend has been accompanied by low physical activity levels and unhealthy diet. [5]

Obesity trend could be influenced by nature of work, especially those involving repetitive stress and sedentariness like market traders. [6] Coupled with unhealthy diet and increased access to food, market traders have been found to have high prevalence of undiagnosed hypertension. [7,8]

BMI is not the best marker for obesity, as it only indicates accumulation of excess weight without differentiating the composition and distribution of the excess weight. [9,10] The accuracy of BMI among certain population such as athletes, and across different race has been challenged. [11,12] Assessing obesity using BMI with its one-size fit all cut offs among Fijian population, which comprises a blend of multiple racial identities, presents inherent flaws. [13] While other more accurate measures are expensive and impracticable in routine clinical practice, the use of secondary indices that captures adiposity and its distribution have been recommended. [14,15] We described obesity phenotypes using different indices of general and abdominal adiposity in a population of market traders in Fiji.

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Materials and Methods

Study design and setting

A cross-sectional study design was conducted at the Suva City Central Market in conjunction with the Healthy Workplace Initiatives of the Ministry of Health and Medical Services, as part of ongoing community outreach.

Study population

Study participants were market traders from Suva and Nasouri markets, in Fiji.

Data collection

Detailed methods, previously described elsewhere. [8] Socio-demographic variables (age, gender, ethnicity); anthropometric indices (weight, height, waist circumference, hip circumference and percent body fat), lung function indices (forced expiratory capacity (FVC), forced expiratory volume in the first second (FEV1), and forced expiratory ratio was computed as ratio of forced expiratory volume in the first second and forced expiratory capacity (FEV1/FVC), and blood pressure were obtained using standard procedures.

Case definition

Normal blood pressure was defined as (SBP<120mmHg and DBP<80mmHg); while elevated (SBP: 120 – 129mmHg and DBP: <80mmHg), and blood pressure of systolic blood pressure of ≥130mmHg and or diastolic blood pressure of ≥ 80 (hypertension grade I, II and III according to the American Heart Association, 2017 guidelines) were classified as hypertension. Waist circumference of greater 88 cm (females) and 102 cm (males) were defined as excess abdominal adiposity. [16] Waist-hip ratio (WHR) of greater than 0.8 (females) and greater than 1.0 (males) were classified as abdominal obesity; while waist-height ratio (WHtR) above 0.5 was also classified as abdominal obesity. [17] Combination of reduced FEV1 and (FEV1/FVC) ratio were defined as obstructive lung impairment; while reduced FVC and normal FEV1 were classified as restrictive lung impairment. [18] Percent body fat greater than 35% and 25% were defined as obesity for women and men respectively. [19]

Data analysis

Categorical variables were summarized as frequency and percentages, while continuous variables as mean and standard deviation. Correlation between continuous variables and obesity indices were tested by Pearson Correlation Coefficient, while Spearman Correlation Coefficient. Independent t-test, Mann-Whitney U test and Fischer-exact test were used to test association between continuous and categorical covariables with obesity indices. Kruskal-Wallis was used to test for association between covariates and BMI categories.

Ethical considerations

Ethical approval was obtained from the College of Medicine Health Research Ethics Committee and appropriated permissions were also obtained. The nature and purpose of the study was explained to prospective participants and their questions answered. Data collection procedure was done in accordance with the Declaration of Helsinki. Participants were informed that their participation is voluntary and that they reserve the right to withdraw from continuing in the study at any point. No data collection instrument contained personal identifier. All participants were educated about the health implications of excess adiposity.

Results

On the average, participants 50 years old, with mean weight of 82 kg. Mean blood pressure (systolic and diastolic) were above normal cut-off (SBP= 131 mmHg; DBP=82 mmHg). On the average a third of body weight of participants was composed of fat (%BF of 33%), and all abdominal indices indicated excess abdominal obesity.

Comparison between gender shows males were significantly older than female participants (52.2 *vs.* 48.5 years; p=0.031). Female participants had significantly higher BMI (31.2 *vs.* 28.3; p=0.001); body fat (38. *vs.* 27.7; p=0.000); WHtR (0.64 *vs.* 0.58; p= 0.000). There was no significant difference in systolic and diastolic blood pressures, weight, WC and WHR. Meaning gender is not associated with blood pressure, weight, waist circumference or waist-hip-ratio among study participants. Men had more weight but less BMI compared to the women [Table 1].

Prevalence of healthy BMI among participants was 22%, underweight accounted for 1%, while 32% were overweight (BMI: 25 – 29.9 kg/m^2). Prevalence of obesity in this study was

Table 1: Participants' characteristics by gender.

Parameters	Total (N=189) Mean (95% CI)	Male (N=90) Mean (95% CI)	Female (N=99) Mean (95% CI)	p-value
Age	50.2 (48.5;51.9)	52.2 (49.6;54.8)	48.5 (46.2; 50.7)	0.031
SBP	131.7 (129.3; 134.2)	132.8 (129.2; 136.5)	130.8 (127.5; 134.1)	0.411
DBP	82.3 (80.6; 84.0)	83.1 (80.5; 85.7)	81.6 (79.4; 83.9)	0.388
Weight	82.2 (79.3; 7.2)	82.9 (78.4;87.5)	81.6 (77.7; 85.5)	0.658
BMI	29.8 (28.9; 30.8)	28.3 (27.0; 29.6)	31.2 (30.0; 32.5)	0.001
%BF	33.3 (31.7;34.8)	27.7 (25.7; 29.8)	38.3 (36.6; 40.0)	0.000
WC	100.9 (98.8; 103.1)	98.7 (95.7; 101.8)	103.0 (100.0; 106.0)	0.052
WHR	1.01 (0.88; 1.12)	0.96 (0.94; 0.98)	1.04 (0.89; 1.17)	0.490
WHtR	0.61 (0.59; 0.62)	0.58 (0.56; 0.59)	0.64 (0.62; 0.66)	0.000

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; BMI: Body Mass Index; % BF: Percent Body Fat; WC: Waist Circumference; WHR: Waist Hip Ratio; WHtR: Waist-Height Ratio; 95% CI: 95% Confidence Interval.

45% (obesity I (BMI: 30 – 34.9 kg/m^2): 26%; obesity II (BMI: 35 – 39.9 kg/m^2): 10%; and morbidly obese (BMI >40 kg/m^2): 8%. Prevalence of abdominal obesity was 67% and 92% using WHR and WHtR respectively.

Age, blood pressure (systolic and diastolic) and adiposity indices of weight, percent body fat, waist circumference and waist-height-ratio were significantly associated with BMI status. Post-hoc analysis showed significant differences in systolic and diastolic blood pressures between overweight (BMI: 25 – 29.9 kg/m^2) and obese II (BMI: 35 – 39.9 kg/m^2). Participants with healthy weight (BMI: 18.5 – 24.9 kg/m^2) and obese II (BMI: 35 – 39.9 kg/m^2), also had significant difference in diastolic blood pressure. Weight and waist-height-ratio were significantly different across BMI status, and between each pair of BMI categories. In addition, waist circumference was also significantly different across the BMI categories.

Prevalence of obesity among men is 34.4% and 54.5% among female. Prevalence rate ratio of obesity comparing participants with hypertension to this without was 2.71. Most (59%) of the participants had normal lung function indices, 10% had obstructive impairment, while 31% had restrictive lung impairment. Prevalence of obesity among participants with normal lung function is 36.9%; 40% among those with obstructive lung impairment; and 62.1% among participants with restrictive lung impairment [Table 2].

Table 2: Participants' characteristics by obesity status.

Parameters	Underwt (n=2) Mean (sd)	Normal (n=42) Mean (sd)	Overwt (n=60) Mean (sd)	Obese I (n=50) Mean (sd)	Obese II (n=20) Mean (sd)	Obese III (n=15) Mean (sd)	Total (n=189) Mean (sd)	p-value
Age	52.9 (13.8)	52.9 (13.8)	48.5 (12.6)	50.8 (10.2)	48.5 (9.3)	48.4 (17.6)	50.2 (11.9)	0.215
SBP	126 (2.8)	132.4 (17.8)	124 (17.1)	135.2 (14.9)	139 (14.9)	137.1 (16.6)	131.8 (17.0)	0.003a
DBP	77.5 (0.7)	80.7 (12.5)	79.5 (10.5)	83.4 (10.9)	91.2 (12.6)	83.7 (10.8)	82.3 (11.7)	0.004ab
Weight	44 (7.1)	61.7 (7.8)	75.3 (8.7)	89.9 (10.6)	101.3 (12.2)	121.4 (23.2)	82.2 (20.6)	0.000c
%BF	14.1 (6.0)	24.6 (9.5)	32.0 (9.1)	36.9 (7.8)	43.0 (7.0)	39.9 (8.4)	33.3 (10.5)	0.000
WC	75.0 (1.4)	87.4 (8.3)	95.9 (8.6)	106.6 (9.3)	116.3 (12.8)	123.4 (15.3)	101.0 (15.0)	0.000d
WHR	0.89 (0.02)	1.19 (0.75)	0.94 (0.09)	0.96 (0.11)	0.95 (0.11)	0.97 (0.08)	1.00 (0.83)	0.728
WHtR	0.47 (0.02)	0.53 (0.06)	0.58 (0.05)	0.64 (0.06)	0.71 (0.8)	0.75 (0.09)	0.61 (0.09)	0.000c
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
				Ethnicity				
iTaukei	2 (1%)	29 (15%)	32 (17%)	21 (11%)	6 (3%)	4 (2%)	94 (50%)	
IndoF	0 (0%)	13 (7%)	28 (15%)	29 (15%)	14 (7%)	11 (6%)	95 (50%)	0.005
				Gender				
Male	2 (1%)	26 (14%)	31 (16%)	23 (12%)	3 (1.6%0	5 (3%)	90 (48%)	
Female	0 (0%)	16 (8%)	29 (15%)	27 (14%)	17 (9%)	10 (5%)	99 (52%)	0.005
				HTN				
Yes	2 (1%)	32 (17%)	40 (21%)	45 (24%)	20 (10%)	13 (7%)	152 (80%)	
No	0 (0%)	10 (5%)	20 (11%)	5 (3%)	0 (0%)	2 (1%)	37 (20%)	0.006
				Lung Indices				
Normal	2 (1%)	28 (15%)	40 (21%)	25 (13%)	11 (6%)	5 (3%)	111 (59%)	
Obstructive	0 (0%)	2 (1%)	10 (5%)	5 (3%)	2 (1%)	1 (0.5%)	20 (10%)	
Restrictive	0 (0%)	12 (6%)	10 (5%)	20 (11%)	7 (4%)	9 (5%)	58 (31%)	0.022
				Abdominal Adiposity Indices				
				WC				
Normal	2 (1%)	37 (19%)	31 (16%)	6 (3%)	0 (0%)	4 (2%)	77 (41%)	
Obese	0 (0%)	5 (3%)	29 (15%)	44 (23%)	20 (11%)	14 (7%)	112 (59%)	0.000
WHR								
Normal	2 (1%)	23 (12%)	24 (13%)	13 (7%)	2 (0%)	4 (2%)	68 (36%)	
Obesity	0 (0%)	19 (10%)	36 (19%)	37 (20%)	18 (9.5%)	11 (6%)	121 (64%)	0.002
				WHtR				
Normal	2 (1%)	10 (5%)	3 (1.5%)	1 (0.5%)	0 (0%)	0 (0%)	16 (8%)	
Obesity	0 (0%)	32 (17%)	57 (30%)	49 (26%)	20 (11%)	15 (8%)	173 (92%)	0.089
				General Adiposity				
				%BF				
Normal	2 (1%)	31 (16%)	21 (11%)	6 (3%)	2 (1%)	3 (2%)	65 (34%)	
Obese	0 (0%)	11 (6%)	39 (21%)	44 (23%)	18 (10%)	12 (6%)	125 (66%)	0.000

a: Significant difference between overweight and Obese II (SBP: p=0.017) (DBP: 0.001)
b: Significant difference between normal weight and Obese II (DBP: p=0.013)
c: Significant difference between each pair
d: Significant difference between each pair (except obese II and obese III, and underweight vs. Normal weight)
SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; BMI: Body Mass Index; %BF: Percent Body Fat; WC: Waist Circumference; WHR: Waist Hip Ratio; WHtR: Waist-Height Ratio; 95% CI: 95% Confidence Interval. InfoF: Indian Fijian; HTN: Hypertension; n: Number; %: Percentages

Age is negatively associated with weight and BMI (r=-0.169); while weight was positively associated with BMI (r=0.884); WC (r=0.716); WHtR (r=0.522) and % BF (r=0.287). This indicates that the higher the weight, the higher the BMI, WC and PBF. Association between weight and BMI was the strongest among study population, which means weight can be used as a proxy for BMI. However, there is a weak positive association between weight and percent body fat; which means as weight increases fat also increases but to a much less degree.

Body fat was positively and moderately associated with BMI and WhtR; meaning increase in body fat moderately increases BMI and waist-height-ratio. This implies caution should be exercised when using BMI as obesity index, as there is moderate correlation between both in this population. BMI was positively associated with WC (r=0.753); WhtR (r=0.735); and % BF (r=0.522). WC was strongly and positively associated with WhtR (r=0.925) [Table 3].

Classification by whtr indicates 92% (173) of participants had abdominal obesity. WHtR, WHR and % BF identified 64% of study participants as having obesity; WC was slightly less (59%). Prevalence of general adiposity as measured by % BF was 66%; only 60% of these were identified by BMI as obese. Thirty-two (17%) had normal BMI, but have abdominal obesity. Prevalence of abdominal obesity across the BMI categories are as follows: normal BMI (72%), overweight (95%) and obese (99%). Forty-four percent of participants were obese by BMI (>29.9 kg/m^2) and also had abdominal obesity [Table 4].

Discussion

Prevalence of general obesity was high among study population: BMI (77%); percent body fat 66%. Prevalence of abdominal obesity was also high (WC: 59%, WHR: 64%; and WHtR: 92%). BMI wrongly classified more people as being obese than percent body fat: 11% with normal percent body fat as being overweight and additional 6% as obese [Table 1]. Some participants (17%) with normal BMI had also had excess abdominal fat; such individuals could be classified as having low risk by their BMI, despite having excess abdominal adiposity [Table 4]. Irrespective of the type of obesity measure prevalence of general and abdominal obesity is high among this population. Prolonged and consistent sedentariness and increase access to food might explain, in part, these high estimates. [6]

Ethnicity, gender, hypertension status and lung impairment were each associated with BMI. Prevalence of obesity among iTaukei is 32.9%, while among Indian-Fijian it was 28.6%, with iTaukei participants have 15% higher obesity rate compared to Indian-Fijian. This is not surprising as iTaukes are likely to be more heavily built compared to Indian-Fijians. Across gender, female traders had 58% higher prevalence of obesity compared to males. Traders with hypertension have 2.71 times higher risk of being obese (excess body mass) compared to those without hypertension. Increase in fat composition of the excess mass poses additional health risk, alluding to the association between obesity and hypertension. [20] Obesity is closely linked to high prevalence and pathophysiology of hypertension. [21-23]

There was a high rate of lung function impairment (41%) among participants. Compared to traders with normal lung function, those with restrictive lung impairment have 1.68 times the prevalence of obesity; indicating 68% higher obesity rate among those with restrictive lung impairment. This highlights

Table 3: Correlation among obesity phenotypes.

Variables	Age	Weight	BMI	WC	WHR	WHtR	%BF
Age	1.000						
Weight	-0.169	1.000					
BMI	-0.083	0.884	1.000				
WC	0.016	0.717	0.753	1.000			
WHR	0.034	-0.074	-0.069	0.095	1.000		
WHtR	0.099	0.522	0.735	0.925	0.109	1.000	
%BF	0.029	0.288	0.522	0.426	-0.213	0.5506	1.000

Table 4: Comparison among obesity phenotypes.

Indices	Waist-height ratio			p-value
BMI	Normal (n=16)	Obese (n=173)	Total (n=189)	
Normal	12 (6%)	32 (17%)	44 (23%)	
Overweight	3 (2%)	57 (30%)	60 (32%)	
Obese	1 (1%)	84 (44%)	85 (45%)	0.000
Waist Circ.				
Normal	16 (9%)	61 (32%)	77 (41%)	
Obese	0 (0%)	112 (59%)	112 (59%)	0.000
Waist-hip-ratio				
Normal	14 (7%)	54 (29%)	68 (36%)	
Obese	2 (1%)	119 (63%)	121 (64%)	0.000
% Body Fat				
Normal	13 (7%)	52 (27%)	65 (34%)	
Obese	3 (2%)	121 (64%)	124 (66%)	0.000

the link between obesity and restrictive lung impairment. When comparing traders with obstructive lung impairment to those with normal lung functions, prevalence of obesity only increased by 8%. This high rate of restrictive lung impairment among study participants could be due to the prevalent abdominal obesity in the population. It has been shown that increase abdominal fat restricts lung expansion, by wedging the diaphragm and preventing its full excursion during inspiration. [24,25] This could potentially lead to closure of peripheral alveoli and limit oxygen exchange during physical stress. [26,27]

Prevalence of obesity within a country could differs across different segment of the at society. For example, the Obesity Prevention in Communities (OPIC), estimated prevalence of obesity to be 26% and 17% amongst female and male adolescents respectively. The 2011 nationwide STEP Survey in Fiji estimated 67% (males: 59%; females: 75%). Obesity was estimated at 32.0% (males 22.4%; females 42%). [4] In this study we found a lower estimate of overweight (45%), but obesity rate was similar to national survey (32%). Mean BMI (mean: 29.8; 95% CI: 28.9; 30.8) of our study population was higher than that reported in the national survey (27.9). The mean BMI in our study was also higher by gender (male: 28.3 *vs.* 26.5; female: 31.2 *vs.* 29.3).

We observed a significant difference in both systolic and diastolic blood pressure across the BMI range (Table 2). The association between obesity and hypertension is well established. Linhart, et al. [28] found that BMI explained 45% of the age-adjusted increase in DBP over a 30-year period (1980–2011) among Fiji Indians of both sexes; while among the i-Taukei, BMI accounted for 16% increase in DBP among the men and 38% among women.

Estimates of overweight and obesity among market traders form other studies reported lower prevalence compared to our study (45% overweight; 32% obese). In a study among traders in Ijebu-Ode, Nigeria, overweight and obesity were reported as 25.3% and 26.7% respectively; [29] and 28% in Sokoto, Nigeria, Awofisan et al. [30] reported obesity prevalence of 28.1%.

Based on findings from different population, we used whtr as the reference in comparing other obesity indices. WHtR was were more sensitive in predicting risk for CVD, DM and MetabS in different population Iran, [31] China [32] and India. [33] Abdominal obesity estimates from this study was also higher compared to findings from other studies: this study recorded 665 based on PBF, 67% based on WHR and 92% when using WHtR. Previous studies reported lower estimates; 33.8% among adults in Ogbomoso, [34] 52.0% in Ijebu- Ode, [29] and 12.3% in Lagos in Nigeria. [35] This has been attributed in part to the increased body fat stores from puberty compared to males. [36]

Obesity has been classified as a disease in itself, which warrants prevention and seeking medical management. [37] Appropriate screening could help with early diagnosis and management, and potentially prevent associated morbidity such as hypertension, heart diseases and stroke, type 2 diabetes mellitus, kidney and liver, certain types of cancers; premature and all-cause mortality. [9,37,38]

Different obesity indices better predict risk of chronic diseases, which is also influenced by gender and race. For example, in China, BMI cut off of 24, WC (male; 85 cm, female 80 cm), WHR (male 0.88; women 0.85) has been suggested for optimal health. In the same population, WC was found to more sensitive in men in predicting CVD risk and MetabS; but WHtR is found to be more sensitive in women. [32] In India, WC and WhtR has been identified as the most appropriate obesity indices in screening for hypertension and diabetes among adults 20- 60 years. [33] There is need for concerted effort to generate robust data to identify which obesity indices that can better predict various chronic diseases among people of the South Pacific Island nations. This may help in reversing the trend of high NCD rates in the region [39].

Strengths and Weakness

This study is probably the first obesity study among this population, and the findings can be used as baseline for future studies. As a cross-sectional, there are issues with temporality and as such association should be interpreted with caution.

Conclusion and Recommendations

General and abdominal obesity is high among study participants irrespective of the indices used. Prevalence was high in women. Obesity using BMI could miss-classify individuals with high body fat and high abdominal adiposity as normal. About 2 in 10 participants who were classified as normal by BMI had abdominal obesity. There is need for obesity measure that can factor in peculiar racial diversity in predicting chronic diseases associated with obesity. Such a measure could play a significant role in reversing the trend of NCD in the region.

Competing Interests

The authors declare that they have no competing interests.

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