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Comparative Investigation of Body Mass Index of Tertiary Students of the South Pacific Origin

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Abstract

The body mass index (BMI) trends in the South Pacific Island Countries (PICs) have been analysed. Five South Pacific countries, namely; Fiji, Tonga, Nauru, Kiribati and Solomon Islands have been analysed based on the population that have stayed in Fiji at some point (mean age 25.20±5.27). Standard BMI threshold defined as underweight (<18.5 kg/m^2), normal weight (18.5 - 24.9 kg/m^2) overweight (25 - 30 kg/m^2) and obese (≥30 kg/m^2) was used to study the BMI trends. The data collection was carried out by randomly selecting the subject of study and manually recording their heights (in meters) and weight (in kg). These measurements were done during the period of 2014-2015. The data showed that only Fiji had an average BMI with normal weight of 23.74±4.63 kg/m^2 while other countries' population were either overweight (Solomon Islands) or obese (Nauru) in the range of 25.29±4.37 kg/m^2 to 37.24±12 kg/m^2. Cohen's d and eta square test were performed to see differences in height and weight where large differences were found primarily in the male population compared to female. The average BMI for gender within a country did not show variation (p>0.001) but variation was seen among the PICs (p<0.001) as significant difference.

Keywords: *BMI trends, Pacific Islands Countries, South Pacific, Obese, Underweight, Community Health, Public Health*

1. Introduction

The increasing rate of obesity in children and adults is a global health concern (Pei *et al.*, 2017). The body mass index (BMI), a simple measure of weight divided by squared height (kg/m^2), is the most widely used screening tool for overweight and obesity (Mei *et al*., 2002). The World Health Organization (WHO) has also recommended BMI as the most useful population level measure for both sexes and in all age groups (WHO, 2012). Thus, to facilitate clinical decision-making and public health interventions, standard BMI thresholds have been established to define overweight (BMI 25-29.99) and obesity (BMI ≥30) (WHO, 2000). However, these limits have been derived from studies performed in Western countries, primarily in Caucasian subjects, which may not be appropriate for other racial/ethnic groups (James *et al*., 2002; WHO, 2000) such as the Pacific region due to different diet and activities practiced.

In institutes and work force, the health education programs focus mainly on alcohol, tobacco, drugs, sexual related diseases and mental health but there has been inadequate focus on weight issues. Recent studies have shown that differences in rates of overweight and obesity have been identified among different ethnicities and also between genders as well (Finucane *et al*., 2011). National Health and Nutrition Examination Survey (NHANES) study of the United States of America (USA) showed that 53% of African American and 51% of Mexican American women aged 40-59 years were obese compared to 39% White/Caucasian women of the same age group (Ogden, 2007). Over the past two decades the number of overweight and obese people in most developed and developing countries have been increasing (Dyer *et al*., 2017; Malekzadeh *et al*., 2005).

It has been estimated that the USA spent $92.6 billion annually for obesity and overweight related medical expenditure (Finkelstein, 2009). One of the substantial psychosocial consequences of obesity is the decreased quality of life (Fontaine *et al*., 1996; Hill and Williams, 1998; Orzano and Scott, 2004). A study by O'Dea has explored the associations between obesity, weight perceptions and gender, ethnicity, culture and social class of Australian school children and reported the prevalence of obesity 6.4% of males and 5.6% of females in primary school students (O'Dea, 2008). Most recently, Dyer *et al*. (2017) has reported a systematic review on the prevalence and characteristics of overweight and obesity in indigenous Australian children. They concluded that the prevalence of obesity is higher in girls, increases as children age, and that children living in remote areas are likely to have lower

prevalence than urban living children, but studies still needed confirmation. A review by Kolahdooz *et al.* (2017) on the prevalence of overweight and obesity shows that Canada is facing a challenge of increase in overweight and obesity among indigenous populations. Current statistics has estimated 70% of Canadian adults in general aged 40 years and older will be overweight or obese by 2040. This review has highlighted the need for nutritional intervention programs for obesity prevention among indigenous populations in Canada.

The studies conducted by National Fiji Nutrition Centre (NFNC) have shown that Fiji as well as other Pacific Island Countries (PICs) has unfortunately been following the unhealthy trends seen in developed countries, notably with weight gained and high blood pressure (Ogden *et al*., 2007). It has also been reported that the heavyweight people are having high blood pressure and heart diseases (Bell *et al*., 2001; Jee *et al*., 2005). The Ministry of Health, Fijian Government annual report documents that diseases associated with lifestyle are one of the leading causes of morbidity and mortality in Fiji (Ogden *et al*., 2007). Thus, it was worthwhile to obtain BMI related data from South Pacific Countries to do cross-country comparative analyses and to evaluate BMI trends in the South Pacific region and is presented in this paper.

2. Materials and Method

BMI data across five South Pacific Island Countries, namely; Fiji, Tonga, Nauru, Kiribati and Solomon Islands were collected and analysed based on the population (mostly tertiary students) that live in Fiji for varied periods of time. The study was granted ethical approval from the Ethics Committee of the University of the South Pacific. The age group selected in this study was between 18 to 55 years (mean age 25.20 ± 5.27 years). The data was collected between 2014 and 2015. The students were randomly selected and were either $1^{st}/2^{nd}$ or 3^{rd} year students. The respondents were mostly approached via the University of the South Pacific Student Association (USPSA) and also through advertisement and flyers that were placed on notice boards. The students were informed to come at a location (Biology Laboratory) where their height, weight, ethnicity, sex as well as age were recorded at the same time. The sample size was n=867(405 male and 462 female) with the mean age 25.20±5.27 years. The number of people who were in each group of the 5 countries was as follows: Fiji – 447, Tonga – 57, Kiribati – 96, Solomon Islands – 237, Nauru – 30. The population was calculated by counting the number of completed questionnaires. The participants were only students who were based in at The University of the South Pacific, Laucala Campus, Suva, Fiji. The populaces were also informed that they could withdraw at any point of time during the study. Weight in light clothing without shoes was measured to the nearest 0.1 kg on a digital scale (Model Seca 770, Hamburg, Germany). The BMI was thus calculated for each body mass measured.

The standard BMI thresholds defined as underweight (BMI<18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2) overweight (BMI 25-29.99 kg/m^2) and obese (BMI ≥30 kg/m^2) were used to study the BMI trends (WHO, 2000). All information taken was kept confidential where height, weight, ethnicity and country was recorded in an excel sheet. Using the same excel sheet (windows 2010), graphs were plotted to compare BMI trends for the different PICs populaces.

2.1. Statistical Analysis

The range of effect sizes in terms of the Cohen's d for differences between genders and across countries for weight and height and eta-square test were analysed. ANOVA single factor was performed for BMI to see the differences between genders of the same country and also to see the difference among the PICs for the whole sample population. A Tukey Honest Significant Difference (HSD) Post Hoc Analysis was also conducted using SPSS Software.

3. Results and Discussion

The descriptive statistics from the collected data for age, height, weight and BMI are shown in Table 1. For the countries studied, differences in height and weight were more pronounced in male than in female. The eta-square among male was 0.36 for height and 0.28 for weight while in case female it was 0.03 for height and 0.17 for weight. The Cohen's effect sizes are like *Z* score where its denominator is a standard deviation (SD). In terms of the Cohen's effect size, pair wise differences (d) in height and weight among different PICs countries were studied. The Cohen's effect for female height was d>0.2 for Nauru:Solomon Islands. On the other hand, the Cohen's effect for female for Tonga:Fiji, Kiribati:Nauru, Solomon Islands:Fiji, Solomon Islands:Tonga was d>0.5 while for the rest of the combinations it was d>0.8. The Cohen's effect for male, Nauru:Solomon Islands, Kiribati:Solomon Islands pairs was d<0.2 which was followed by Nauru: Kiribati d>0.2, Tonga: Fiji d>0.5 while the rest of the combinations showed d>0.8.

Females were the shorter gender in Fiji and Tonga whereas males were shorter in comparison to the female counterparts in Nauru, Kiribati and Solomon Islands (Table 1). Similarly, there were also differences with respect to weight amongst the PICs for both; male and female populations. The Cohen's effect for female weight had d>0.2 for Tonga:Solomon Islands, Nauru:Kiribati and Solomon Islands:Fiji while Nauru:Tonga and Kiribati:Tonga showed d>0.5 and for

the rest of the combinations the Cohen's effect was d>0.8. For male, Nauru:Tonga had d<0.2 while for Kiribati:Fiji and Kiribati:Solomon Islands it was d>0.2. All other male combinations had d>0.8. When comparing the Cohen's effect for both height and weight amongst the five PICs, there were larger differences in male as compared to female population.

Figure 1 shows the comparison of average BMI for male and female population for the studied PICs. Among the five PICs studied, Nauru had the highest average BMI for both; male and female population (Figure 1). According to Figure 1, the combinations of Tonga and Kiribati as well as Fiji and Solomon Islands had similar average BMI values. Statistical data (ANOVA – single factor) showed that there was some variation in average BMI among the different PICs studied ($p<0.001$). The test also confirmed that for all the five countries studied, there were no variation for BMI values between the male and female population within a country ($p>0.001$). BMI depends on the amount of physical activities as well as physiological factors since actual weight may be influenced by food habits and environments, nutritional knowledge, cultural norms and expectations and mass media depictions. The expected economic development and growing western influence may also lead to lifestyle changes.

Table 1. Descriptive statistics of age, height, weight and body mass index (BMI) in different South Pacific Islands Countries.

Parameters	**Fiji** (n = 447)	**Tonga** (n = 57)	**Nauru** (n = 30)	**Kiribati** (n = 96)	**Solomon Islands** (n = 237)
	Mean±SD	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Males					
Age (year)	20.7±2.8	23.9±6.2	35.0±9.6	22.3±2.1	24.2±6.1
[a*]Height (m)	1.8±0.1	1.8±0.03	1.6±0.04	1.6±0.04	1.6±0.1
[a**]Weight (Kg)	76.1±13.7	98.5±16.9	101.5±19.3	71.0±17.6	64.9±11.9
BMI (kg/m^2)	24.1±4.0	29.7±5.0	39.9±6.0	27.8±5.6	25.4±3.9
Females					
Age (year)	21.1±2.3	23.6±4.9	33.0±12.7	21.7±3.9	25.6±4.2
[b*]Height (m)	1.6±0.1	1.7±0.02	1.7±0.1	1.7±0.04	1.7±0.1
[b**]Weight (Kg)	64.1±16.8	78.1±16.5	97.4±42.1	86.9±12.7	72.3±16.5
BMI (kg/m^2)	23.5±5.1	28.2±5.9	33.3±14.7	28.7±4.5	25.2±5.0
Overall					
Age (year)	20.9±2.5	23.8±5.6	34.2±11	22.1±3.4	25.0±5.4
Height (m)	1.7±0.1	1.8±0.1	1.6±0.1	1.6±0.1	1.7±0.1
Weight (Kg)	68.8±16.4	90.7±19.2	99.8±33.3	75.5±15.7	69.1±14.4
BMI (kg/m^2)	23.7±4.6	29.1±5.2	37.2±12.0	28.1±4.7	25.3±4.4

[a]The Cohen's effect for male height, Nauru:Solomon Islands, Kiribati:Solomon Islands was d<0.2 followed by Nauru:Kiribati d>0.2 and Tonga:Fiji d>0.5 while the rest of the combinations showed d>0.8.*

*[a**]The Cohen's effect for male weight, Nauru:Tonga had d<0.2, Kiribati:Fiji and Kiribati:Solomon Islands was d>0.2 while all other male combinations had d>0.8.*

[b]The Cohen's effect for female height was d>0.2 for Nauru:Solomon Islands followed by d>0.5 for Tonga:Fiji, Kiribati:Nauru, Solomon Islands:Fiji, Solomon Islands:Tonga while the rest of the combinations it was d>0.8.*

*[b**]The Cohen's effect for female weight, Tonga:Solomon Islands, Nauru:Kiribati and Solomon Islands:Fiji was d>0.2 followed by Nauru:Tonga, Kiribati:Tonga d>0.5 while for the rest of the combinations showed d>0.8.*

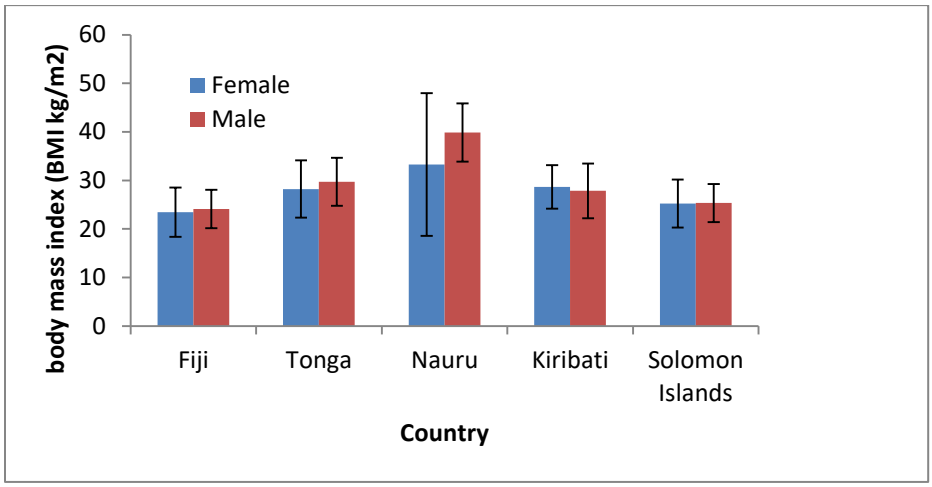

Figure 1. Plot of average BMI (kg/m^2) for the male and the female population in the studied Pacific Island Countries.

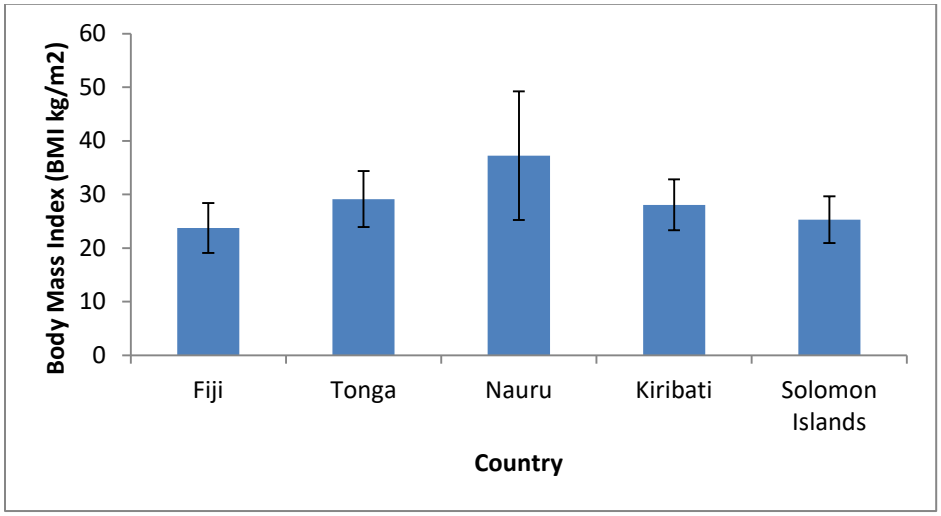

Figure 2. Plot of average BMI (kg/m^2) for the whole population for the studied Pacific Island Countries.

Figure 2 shows the comparison of average BMI for the overall population (male and female) for the studied PICs. Among the five PICs studied, as compared to the male and female population BMI shown in Figure 1, the overall population also has the highest BMI for Nauru (Figure 2). Nauru is the world's smallest republic island country in the South Pacific but today they are the most obese and have the greatest prevalence of high blood pressure of all people in the Pacific (Diamond, 2003; Marks, 2010). Although mining of 1000 years' worth of fossilized bird droppings has been lucrative, Nauru relies on imports for nearly everything from food, water to fuel. Apart from some foods which are readily available from the natural sources, the population depends on imported food. It has been reported that "in Nauru a popular snack is a whole fried chicken, washed down with a bucket–sized beaker of coke". It has also been reported that in Nauru 97% of male and 93% of female population is overweight and obese (Marks, 2010). The Nauruan population continue with fast foods with high protein and carbohydrate diet and thus fall in the extremes of obese and overweight. Table 2 shows the distribution of standard body mass index thresholds in the populations of the studied Pacific Islands Countries.

Table 2. Distribution of standard body mass index thresholds in the populations of the studied Pacific Islands Countries.

Population in each category (%)					Average BMI (kg/m^2)		
*Country	UW	NW	OW	OB	**Female	**Male	Average ± SD (male and female)
Fiji	12.4	51.7	24.8	11.0	23.5	24.1	23.7±4.6
Tonga	0.0	28.6	33.3	38.1	28.2	29.7	29.1±5.2
Nauru	0.0	0.0	20.0	80.0	33.3	39.9	37.2±12.0
Kiribati	0.0	25.0	53.1	21.9	28.7	27.8	28.1±4.7
Solomon Islands	1.3	50.6	32.9	15.2	25.2	25.4	25.3±4.4

*Significant difference in BMI in between the countries ($p<0.001$)
** No significant difference in BMI between the male and female population ($p>0.001$)
UW: Underweight; NW: Normal weight; OW: Overweight; OB: Obese

Table 3. Multiple comparisons through Tukey HSD Post-Hoc Test for overall scores for BMI.

(I) Countries	(J) Countries	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Fiji	Kiribati	-4.2725*	.5629	.000	-5.811	-2.734
	Nauru	-13.4407*	.9437	.000	-16.020	-10.861
	Solomon Islands	-1.4918*	.4021	.002	-2.591	-.393
	Tonga	-5.4217*	.7037	.000	-7.345	-3.498
Kiribati	Fiji	4.2725*	.5629	.000	2.734	5.811
	Nauru	-9.1681*	1.0466	.000	-12.029	-6.307
	Solomon Islands	2.7807*	.6053	.000	1.126	4.435
	Tonga	-1.1492	.8367	.645	-3.436	1.138
Nauru	Fiji	13.4407*	.9437	.000	10.861	16.020
	Kiribati	9.1681*	1.0466	.000	6.307	12.029
	Solomon Islands	11.9489*	.9696	.000	9.298	14.599
	Tonga	8.0189*	1.1286	.000	4.934	11.104
Solomon Islands	Fiji	1.4918*	.4021	.002	.393	2.591
	Kiribati	-2.7807*	.6053	.000	-4.435	-1.126
	Nauru	-11.9489*	.9696	.000	-14.599	-9.298
	Tonga	-3.9299*	.7382	.000	-5.948	-1.912
Tonga	Fiji	5.4217*	.7037	.000	3.498	7.345
	Kiribati	1.1492	.8367	.645	-1.138	3.436
	Nauru	-8.0189*	1.1286	.000	-11.104	-4.934
	Solomon Islands	3.9299*	.7382	.000	1.912	5.948

*The mean difference is significant at the 0.05 level.

The data presented in Table 2 shows that the participants of normal weight (NW) category are 51.7% from Fiji and 0% in Nauru. The underweight (UW) category comprised of participants only from Fiji (12.4%) and Solomon Islands (1.3%) while the participants from Nauru were either in the overweight (OW, 20%) or obese (OB, 80%) category only. The mean prevalence for the obesity was in the range of 11-80% for the five PICs studied. When compared with the mean prevalence for the countries like Indonesia 4.6% (Hill and Williams, 1998), England 15% (Prescott-Clarke and Primatesta, 1998) and Netherlands 8% (Diamond, 2003), the values obtained for the five PICs studied are high.

Table 3 shows the multiple comparisons through Tukey HSD Post-Hoc Test for overall scores for BMI. A Tukey HSD post hoc test revealed that there was significant difference in BMI for most of the PICs studied. The only country which was similar was Tonga and Kiribati with s significant difference of 0.645. This suggested that the mean score of BMI between Fiji vs Kiribati/Nauru/Solomon Islands/Tonga, Kiribati vs Fiji/Nauru/Solomon Islands, Nauru vs Fiji/Kiribati/Solomon Islands/Tonga, Solomon Islands vs Fiji/Kiribati/Nauru/Tonga and Tonga vs Fiji/Solomon Islands/Nauru significantly differ at the 5% level of significance. Details of the multiple comparisons through the Tukey HSD post-hoc test for scores of the pre-test and post-test for BMI are presented in Table 3.

Hughes has reported that the obesity in the South Pacific Island Countries has some of the highest rates in the world ranging from 43% among Fijian males to nearly 88% among the Samoan females (Hughes, 2003). In PICs, the commercial ventures stock the high-fat and energy-dense foods on which many Pacific Islanders depend on. These imported foods have now become a sign of social status in the communities, and has decreased the consumption of traditional foods contributes to obesity in the Pacific population (Curtis, 2004).

A study conducted by WHO (2002) has also indicated that increase in modern technology and shift from agriculture-based occupations to civil servant office work has led to a sharp reduction in the day-to-day physical activity of many Pacific Islanders (Curtis, 2004; WHO, 2002). Polynesian countries like Tonga also suffer from high rates of diabetes, high blood pressure and heart diseases (Curtis, 2004). The most recent study conducted by WHO has also recommended PICs populations to have a diet free of fat, sugar and salt while increased intake of fruits and vegetables in order to protect against the development of obesity (WHO, 2012). There still lies an issue which complicates the task of health officials. The general body structure of Pacific Islanders is a larger frame and more muscles if equated to Asians and Europeans (Curtis, 2004). Thus, this becomes a challenge that the Pacific is being big as a consequence of hereditary factors versus as a result of overeating (Curtis, 2004).

4. Conclusion

BMI data across five South Pacific Island Countries, namely; Fiji, Tonga, Nauru, Kiribati and Solomon Islands were collected and analysed based on the population (mostly tertiary students) that live in Fiji for varied periods of time. On the basis of the age-group studied, analyses for BMI showed that there was a significant variation ($p<0.001$) amongst the population of the five PICs studied. The highest BMI recorded was for the students from Nauru whereby the average BMI was 39.88 kg/m^2 for males and 33 kg/m^2 female falls in the obese category. The Cohen's test also disclosed that for all the five PICs studied, there were no variation for BMI values between the male and female population within a country ($p>0.001$). Among the many reasons, BMI depends on the amount of physical activities as well as physiological factors where actual weight is influenced by food habits, nutritional knowledge, cultural norms and mass media depictions. The present study was conducted with only those participants who stayed in Fiji at some point in time and the results and conclusions made are reflective of only a defined group of people and does not cover the entire demography. It is thus imperative to do cross-country comparative analyses on a larger scale and investigate BMI trends in whole Pacific region to help change lifestyle and to decrease unhealthy weight.

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