Rapid Increase of Female but not Male Obesity: Analysis of the 2023 Vanuatu Health Transition Project Survey on Aneityum

Matthew Christian  
*Binghamton University*, mchris18@binghamton.edu

Olivia LaSalle  
*Binghamton University*, olasall1@binghamton.edu

Zhiqiao Huang  
*Binghamton University*, zhuan102@binghamton.edu

Hannah Chen  
*Binghamton University*, hchen193@binghamton.edu

Ricky Chen  
*Binghamton University*, rchen141@binghamton.edu

*See next page for additional authors*

Follow this and additional works at: [https://orb.binghamton.edu/alpenglowjournal](https://orb.binghamton.edu/alpenglowjournal)

Part of the Biological and Physical Anthropology Commons, Cardiovascular Diseases Commons, Disorders of Environmental Origin Commons, Melanesian Studies Commons, and the Nutritional and Metabolic Diseases Commons

**Recommended Citation**


This Academic Paper is brought to you for free and open access by The Open Repository @ Binghamton (The ORB). It has been accepted for inclusion in Binghamton University Undergraduate Journal by an authorized editor of The Open Repository @ Binghamton (The ORB). For more information, please contact ORB@binghamton.edu.
Rapid Increase of Female but not Male Obesity: Analysis of the 2023 Vanuatu Health Transition Project Survey on Aneityum

Cover Page Footnote
The authors would like to thank the staff of the Republic of Vanuatu Ministry of Health and the welcoming people of Aneityum, especially Nelson Tom and Rennie Nakau who made this research possible. This research was funded by the Binghamton University Office of the Provost, Office of International Education and Global Initiatives, and the Center for Civic Engagement. The Provost’s International Internship Fellowship funded research expenses for 3 undergraduate students (Matthew Christian, Zhiqiao Huang, and Olivia LaSalle).

Authors
Matthew Christian, Olivia LaSalle, Zhiqiao Huang, Hannah Chen, Ricky Chen, and J. Koji Lum

This academic paper is available in Binghamton University Undergraduate Journal: https://orb.binghamton.edu/alpenglowjournal/vol9/iss1/9
Rapid Increase of Female but not Male Obesity: Analysis of the 2023 Vanuatu Health Transition Project Survey on Aneityum

Abstract

Globally, obesity rates are continuing to increase and countries in the midst of modernization are most vulnerable. Developing nations are undergoing a health transition alongside rapid economic modernization. The nation of Vanuatu, like other Pacific Island countries, is experiencing such a transition marked by decreased cases of infectious disease and increased incidence of chronic and non-communicable diseases. Aneityum is a small and sparsely populated island in Vanuatu and is behind more developed islands in its transition. This present study is the latest in a multi-year project examining health in Vanuatu as it undergoes a health transition with an increased prevalence of chronic disease, namely cardiovascular diseases, and type 2 diabetes. In this study, we sought to continue tracking the population health on Aneityum, to analyze health differences between men and women, and to compare findings to previous data in Vanuatu. In July and August of 2023, adult males [n=41] and females [n=62] were surveyed and had their anthropometric measurements taken on Aneityum in Vanuatu. Mean anthropometric measurements (body mass index, body fat percentage, waist circumference) continued to be significantly greater among women than men (P-value < 0.05). Women exhibited higher rates of obesity in all metrics than in previous studies while men remained relatively unchanged. While men still have lower obesity rates compared to those from Efate in 2011, the women of Aneityum have reached similar levels as their counterparts from a decade ago. There is debate whether Ni-Vanuatu populations are more accurately measured by WHO or Asian-Pacific BMI cutoffs. When Asian-Pacific BMI guidelines are applied, male obesity rate rises 4.87% and the female obesity rate rises 17.74%, indicating drastically worse population health than previously thought. Potential explanations for the disparity in obesity rates between males and females include sex-associated fat distribution patterns, social inequality, and cultural habits. This paper provides valuable insights into the state of Vanuatu's health in its transitional period and a greater understanding of the interplay between sex and health.

Keywords: health transition, Vanuatu, non-communicable disease, population health, body mass index, body fat percentage, waist circumference, obesity
Introduction

The worldwide obesity crisis continues to rise in urgency as developing countries continue their integration into global markets. The obesity epidemic and its associated non-communicable diseases (NCDs) have rapidly increased in prevalence specifically in developing countries, with obesity nearly tripling in the past 30 years (Prentice, 2006). Pacific Island nations, due to rapid market integration and accompanying health transition, are some of the most obese nations in the world.

Image 1. Map of Vanuatu, with study islands (Efate and Aneityum) indicated. (1)

The Republic of Vanuatu is an archipelago in the South Pacific with an estimated population of over 300,000 people. Among the archipelago’s 63 inhabited islands, urban residents largely depend on wage labor, with the majority of supermarket stock being Western foods (Olszowy et al., 2015). Rural residents, on the other hand, live a life of subsistence horticulture (~74%), with a diet dominated by traditional food from their gardens (World Bank, 2022). There are similarities in food growth capabilities, diet patterns, and economic trends that have caused these patterns to change at differing rates (Boutayeb & Boutayeb, 2005). Additionally, Ni-Vanuatu may face an
increased risk of disease factors due to different genetic histories in the Pacific (Olszowy et al., 2015). As a lower middle-income country, Vanuatu is characterized as undergoing a health transition of “double-burden” with increased prevalence of chronic diseases and persistent prevalence of infectious diseases.

Past research conducted to eradicate mosquito-borne malaria on Aneityum was another precursor to the health transition, as once it was eradicated in 1991, the tourism industry flourished in the form of cruise ships with ~110 cruise ship visits/year pre-pandemic (Kaneko et al., 2000; Sun et al., 2016). Though the COVID-19 pandemic temporarily slowed the tourism industry, it is proceeding to rise to pre-pandemic levels of activity (Wood, 2021). This decrease in malaria and increase in tourism has led to a shift from an infectious disease crisis to a chronic disease one. Health transitions similar to the one occurring in Vanuatu have been routinely linked to an increase in the risk of NCDs, most prominently obesity and cardiovascular disease (Prentice, 2006). This is especially true due to modernization replacing traditional practices in Vanuatu, with the increased consumption of processed food and use of technology leading to a decline in physical activity levels and increased risk of chronic diseases.

There are relevant discussions concerning whether to use the WHO or Asia-Pacific BMI cut-off points for Ni-Vanuatu. The correlation between C-reactive protein levels and BMI in NiVanuatu women is in line with the corresponding data in East Asian populations (Mann, 2021). Data collected from Aneityum, Vanuatu in the summer of 2023 aims to explain the trend of increasing non-communicable diseases (NCDs) in local populations due to biological and cultural changes caused by the integration of Vanuatu into the global economy. In addition to trends of increased disease risk, analysis of a possible discrepancy between NCD risk in males and females
has been undertaken. We aim to analyze male and female anthropometrics of the recent data compared with the previous research and how they correlate to an increased risk of NCDs.

**Participants and Methods**

This present study is the latest in a multi-year project examining health in Vanuatu as it undergoes a health transition with an increased prevalence of chronic disease, namely cardiovascular diseases and type 2 diabetes. The study protocol has been evaluated and approved by the Binghamton University Institutional Review Board (Protocol number 00004397), the Vanuatu Ministry of Health, and the Aneityum Island Health Council. Field surveys were conducted in July and August of 2023 on the island of Aneityum, with the research team seeking participants from previous surveys by working with local medical personnel.

We surveyed 103 adult residents of Aneityum aged 18-85 with an average participant age of 43.3. There were 41 male participants and 62 female participants. Average male age was 44.4 and average female age was 42.5. All participants identified as ethnically Ni-Vanuatu. The religious makeup of our sample was 62 Presbyterians, 29 Seventh-day Adventists, 5 Catholics, 2 Bahá’ís, 1 Pentecostal, 1 Jehovah’s Witness, 1 other, and 2 did not answer. The participants on average estimated that 69% of their diet consisted of food grown in their garden. Participants were administered questionnaires to collect information regarding their health and dietary habits, as well as having several anthropometric measurements taken such as weight, height, and waist circumference. Our scale utilized bioelectric impedance analysis (BIA) to calculate each subject’s body mass index (BMI) and body fat percentage (%BF) when given age, sex, and height.
Student’s t-testing was used to analyze means of anthropometric measurements for significant differences between males and females. Two-proportion z-testing was used to analyze differences between rates of inferred obesity (BMI and %BF) and central obesity (WC) in males and females. Z-tests were also used to compare rates of obesity and central obesity on Aneityum in 2023 to previous data from Aneityum and Efate. P-values are included for some results to indicate statistical significance in our findings, meaning the differences found are unlikely to be explained by random chance. When applicable, tests were performed under the hypothesis that female measurements of adiposity were greater than those of males. This was due to previous findings in various papers on the Vanuatu health transition (Dancause et al., 2011; Dancause et al., 2013; Olszowy et al., 2015; Sun et al., 2017). These previous studies demonstrated the trend of higher obesity rates among female populations in Vanuatu. Despite this hypothesis, sampling and surveying methods were identical for men and women.
Results

Table 1 shows the mean anthropometric measurements (BMI, BF%, WC) of both males and females, as well as standard deviations of the data. It was found that females exhibit significantly greater means in all metrics ($P$-value < .05).

Table 1: Mean ± SE anthropometric measurements of chronic disease risk by sex

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²)</td>
<td>25.4 ± 3.76</td>
<td>27.6 ± 4.85</td>
<td>0.014</td>
</tr>
<tr>
<td>%BF</td>
<td>20.8 ± 6.34</td>
<td>38.8 ± 7.01</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>85.2 ± 9.93</td>
<td>92.2 ± 11.48</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Figure 1: Comparison of mean BMI of males and females on Aneityum. Lines mark cut-off points of overweight and obese BMI defined by the WHO.
Figure 2: Comparison of mean BMI of males and females on Aneityum. Lines mark cut-off points of overweight and obese BMI set for Asian-Pacific populations.

Statistical analysis was performed to test our hypotheses that Aneityum women would exhibit higher overweight, obesity, and central obesity rates compared to men. Females exhibit significantly higher rates of obesity (BMI, BF%) and central obesity (WC) according to both WHO and Asian-Pacific guidelines (Table 2). Interestingly, males had a higher overweight rate according to the Asian-Pacific guidelines. This is due to a high proportion of overweight females by WHO standards being reclassified as obese under the Asian-Pacific standards.

Table 2: Overweight, obesity, and central obesity rates of adults based on multiple measures of adiposity

<table>
<thead>
<tr>
<th></th>
<th>Adult males</th>
<th>Adult females</th>
<th>Z</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overweight</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (WHO)</td>
<td>31.71%</td>
<td>38.71%</td>
<td>-0.725</td>
<td>0.234</td>
</tr>
<tr>
<td>BMI (A-P)</td>
<td>60.98%</td>
<td>37.10%</td>
<td>2.450</td>
<td>0.007</td>
</tr>
<tr>
<td><strong>Obesity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (WHO)</td>
<td>12.20%</td>
<td>27.42%</td>
<td>-1.845</td>
<td>0.033</td>
</tr>
<tr>
<td>BMI (A-P)</td>
<td>17.07%</td>
<td>45.16%</td>
<td>-3.011</td>
<td>0.001</td>
</tr>
<tr>
<td>%BF</td>
<td>21.95%</td>
<td>68.33%</td>
<td>-4.578</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>WC (central obesity)</td>
<td>9.76%</td>
<td>61.67%</td>
<td>-5.217</td>
<td>&lt;0.000</td>
</tr>
</tbody>
</table>

Statistical analysis was performed to test the hypotheses that the 2023 Aneityum adults would exhibit higher overweight, obesity, and central obesity rates than the adults of 2011 Efate and 2017 Aneityum. The only statistically significant finding was lower obesity (as defined by BMI) in 2023 Aneityum women than in 2011 Efate women (Tables 3-6). Rates of obesity in Aneityum women have reached those of 2007 and 2011 Efate in the other metrics.
Figure 3: Comparison of mean male BMI on Aneityum and Efate over time with overweight and obese cut-off points defined by the WHO.

Figure 4: Comparison of mean female BMI on Aneityum and Efate over time with overweight and obese cut-off points defined by the WHO.

Figure 5: Comparison of mean male BMI on Aneityum and Efate over time with overweight and obese cut-off points set for Asian-Pacific populations.
Figure 6: Comparison of mean female BMI on Aneityum and Efate over time with overweight and obese cut-off points set for Asian-Pacific populations.

Figure 7: Comparison of mean male BF% on Aneityum and Efate over time with the obese cut-off point defined by the WHO.

Figure 8: Comparison of mean female body fat percentage on Aneityum and Efate over time with the obese cut-off point defined by the WHO.
Figures 3-10 compare 2023 Aneityum adults to the 2011 Efate adults to illustrate the ~10-year delay in modernization and population health trends. Evident is the fact that males approximately match the men of 2011 Efate while female obesity is growing rapidly and surpassing their 2011 Efate counterparts.
Discussion

Our results showed that women had a greater propensity for obesity and chronic disease risk as opposed to men, which supported our stated hypothesis. Table 1 shows significant $P$-values (.014, <0.001, .002 respectively) for women, exhibiting higher BMI, BF%, as well as waist circumference when compared to men, meaning that the chances of our results being caused by random chance are minuscule. This large disparity may be explained by natural differences between males and females in energetics and differing biological mechanisms that lead to sex-associated fat distribution patterns with unique influences on the risk for chronic diseases and metabolism dysfunction diseases (Prentice, 2006). Females in Vanuatu also have different societal standards with many having substantially less autonomy than their male counterparts, especially in matters of societal standing, political control, and sexual freedom (Wood, 2021).

A possible explanation for males showing a less drastic increase in obesity is the prevalence of kava drinking on Aneityum. Kava is a root-derived drink commonly drunk in Vanuatu and other Pacific Island nations for its psychoactive effects. It is much more commonly consumed by men for long standing cultural reasons (Wood, 2021). Kava’s tendency to induce nausea and its increased potency when drunk on an empty stomach have led to frequent drinkers adapting their eating habits to best accommodate nightly kava drinking. In our sample, 76.9% of men drink kava while only 33.9% of women do, a statistically significant difference ($P$-value < .05). In addition, male kava drinkers drink 4.56 times per week, while female kava drinkers consume 3.98 times per week. Disadvantages in societal status and cultural habits may explain the large disparity between men and women as the lower societal status may lead to overeating as a form of control. Religion also plays a part in kava drinking on Aneityum. Drinking kava is only forbidden by Seventh-day Adventists (SDAs), who make up 28.1% of our sample. Due to its prominent cultural role, kava is
still consumed by some SDAs. We found that 80.6% of non-SDA men drank kava but only 66.7% of SDA men did. A similar trend is found in women, as 44.7% of non-SDA women drank kava but only 12.5% of SDA women did. There is not a statistically significant difference between SDA and non-SDA males in kava drinking rates, but there is in the female population (P-value < .05). We propose that the higher rate of religious compliance in women is related to their general lack of agency in Aneityum society.

In 2011, women in Aneityum had trailed the women in Efate in terms of BMI, but currently, our data shows that those on Aneityum have caught up to those in Efate, despite them having less developed infrastructure (Olszowy, 2015). The higher level of development on Efate and corresponding dietary habits have been the cause for higher obesity rates on the island compared to elsewhere in Vanuatu. The observed rapid changes in body composition are due to food and behavior, more specifically, the changes that come as a result of a society that has begun consuming an abundance of processed food and living a more sedentary life. A clear pattern has emerged, that rapid modernization and an increased consumption of processed foods are continuing to increase the obesity rate of the people in Vanuatu, specifically on Aneityum. Identifying how to classify Pacific Islanders in terms of BMI is crucial as it would give us the most accurate information and statistics for health correlation. Ninety-four percent of the people in Vanuatu are Melanesians, whose closest genetic descendants outside of the Pacific are Asians, thus this research has applied Asian-Pacific (A-P) scale cut-off points for overweight and obesity for Ni-Vanuatu. According to the WHO, Asians have a lower specific anthropometric cutoff point for overweight, 22-25 kg/m² as compared to ≥ 25 kg/m², and as a result are at a considerably higher risk of cardiovascular and other diseases associated with obesity at lower BMIs (WHO Expert Consultation, 2004). Figure 3 uses WHO standards and shows that few men are considered overweight, while none are
considered obese. Figure 4 shows women following a similar trend, where none of them were obese, however, a considerable amount of them were overweight. If the Asian-Pacific BMI scale was used instead, it becomes evident that both males and females are not particularly healthy. In Figures 5 and 6, both men and women appear to be overweight, with many being obese. A clear trend of increasing obesity emerged in Aneityum as there were few people with obesity in 2007 and the rates have ballooned since then. With this information, it becomes imperative that the Ni-Vanuatu understand how their behaviors, choices, and dietary changes in their rapidly modernizing society affect their health. Regardless of the BMI scale used for Ni-Vanuatu, a clear pattern has emerged; rapid modernization and increased consumption of processed foods have increased the BMI of the people in Vanuatu, specifically those in Efate and Aneityum.

Conclusion

This research project has provided valuable insights into Ni-Vanuatu's health and lifestyle patterns during a critical period of transition, through the analysis of field surveys and the use of biometric measurements. Various statistical tests were used to reveal significant differences and associations among different demographic groups, which revealed the interplay between sex and health metrics such as BMI, body fat percentage, and waist circumference. Though we found females have a much higher incidence of obesity when compared to men, both sexes have an average BMI well above the Asian-Pacific overweight cutoff points. When using the more appropriate Asian-Pacific cut-off points, it becomes apparent that neither males nor females on Aneityum are especially healthy.

As the global landscape continues to evolve, and localities like Aneityum experience shifts in economic structures and lifestyle patterns, this research serves as an important platform for
ongoing investigations. Future studies may explore longitudinal changes to examine the relationships between socioeconomic factors and health outcomes or intervention strategies to better improve health. In doing so, we can contribute to the development of public health initiatives aimed at promoting well-being in communities experiencing similar changes.
References


Image 1. Map constructed using files provided at DIVA-GIS.org.

Image 2. Photos of surveying and anthropometric measurements taken on Aneityum

Appendix

Table 3: Male obesity and central obesity rates of adults across several years on Aneityum (P-value describing the difference between 2023 and the most recent prior year)

<table>
<thead>
<tr>
<th></th>
<th>Aneityum 2007</th>
<th>Aneityum 2011</th>
<th>Aneityum 2017</th>
<th>Aneityum 2023</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>6.20%</td>
<td>2.50%</td>
<td>11.70%</td>
<td>12.20%</td>
<td>0.468</td>
</tr>
<tr>
<td>BF%</td>
<td>13.00%</td>
<td>11.00%</td>
<td>31.20%</td>
<td>22.00%</td>
<td>0.145</td>
</tr>
<tr>
<td>WC</td>
<td>6.80%</td>
<td>2.50%</td>
<td>N/A</td>
<td>9.80%</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 4: Male obesity and central obesity rates of adults across several years on both Efate and Aneityum (P-value describing the difference between 2023 and the most recent prior year)

<table>
<thead>
<tr>
<th></th>
<th>Efate 2007</th>
<th>Efate 2011</th>
<th>Aneityum 2023</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>13.20%</td>
<td>21.70%</td>
<td>12.20%</td>
<td>0.092</td>
</tr>
<tr>
<td>BF%</td>
<td>22.10%</td>
<td>33.30%</td>
<td>22.00%</td>
<td>0.088</td>
</tr>
<tr>
<td>WC</td>
<td>8.70%</td>
<td>17.50%</td>
<td>9.80%</td>
<td>0.121</td>
</tr>
</tbody>
</table>

Table 5: Female obesity and central obesity rates of adults across several years on Aneityum (P-value describing the difference between 2023 and the most recent prior year)

<table>
<thead>
<tr>
<th></th>
<th>Aneityum 2007</th>
<th>Aneityum 2011</th>
<th>Aneityum 2017</th>
<th>Aneityum 2023</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>11.80%</td>
<td>9.80%</td>
<td>26.70%</td>
<td>27.40%</td>
<td>0.464</td>
</tr>
<tr>
<td>BF%</td>
<td>19.90%</td>
<td>23.00%</td>
<td>65.30%</td>
<td>68.30%</td>
<td>0.357</td>
</tr>
</tbody>
</table>
Table 6: Female obesity and central obesity rates of adults across several years on both Efate and Aneityum (P-value describing the difference between 2023 and the most recent prior year)

<table>
<thead>
<tr>
<th></th>
<th>Efate 2007</th>
<th>Efate 2011</th>
<th>Aneityum 2023</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>21.70%</td>
<td>42.90%</td>
<td>27.40%</td>
<td>0.029</td>
</tr>
<tr>
<td>BF%</td>
<td>47.80%</td>
<td>55.80%</td>
<td>68.30%</td>
<td>0.068</td>
</tr>
<tr>
<td>WC</td>
<td>52.20%</td>
<td>55.30%</td>
<td>61.70%</td>
<td>0.225</td>
</tr>
</tbody>
</table>