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Female obesity and socioeconomic gradients in small Island developing states

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Abstract

Purpose – Rapid changes in diet, physical activity and food systems have contributed to rising obesity in developing countries. As national incomes increase, obesity often shifts from higher to lower socioeconomic groups, a process known as the obesity transition. Small Island Developing States (SIDSs) face particular risks because of limited health system capacity, geographic isolation and dependence on imported foods. This study aims to examine female obesity patterns across six SIDSs to identify their position within the obesity transition.

Design/methodology/approach – The analysis uses nationally representative data from Demographic and Health Surveys and Multiple Indicator Cluster Surveys for Fiji, Haiti, the Maldives, Samoa, Timor Leste and Vanuatu. Female obesity prevalence was assessed across age and wealth groups. Predicted margins were estimated to examine socioeconomic gradients in obesity and to classify each country's stage of the obesity transition.

Findings – Substantial heterogeneity exists across countries. Haiti, Samoa, Timor Leste and Vanuatu exhibit early transition patterns, with obesity concentrated among women of higher socioeconomic status. Fiji shows a weakening positive gradient, suggesting movement between Stages 2 and 3. The Maldives demonstrates characteristics of a later transition stage, where obesity is increasing more rapidly among lower socioeconomic groups, indicating emerging health inequalities.

Originality/value – To the best of the authors' knowledge, this study offers one of the first cross-country assessments of obesity transition stages in SIDSs using harmonized survey data, providing evidence to support stage-specific and equity-focused obesity prevention strategies.

Keywords Small Island states, Female obesity, Obesity transition, Socioeconomic status (SES) gradient, Urbanization (urban–rural disparities)

Paper type Research paper

1. Introduction

Obesity has emerged as a significant global health challenge in recent decades, affecting individuals across social groups and geographic locations. While traditionally considered a problem of developed nations, the rapid changes in lifestyles, urbanization, increased accessibility to highly processed and calorie-dense foods, and sedentary behaviors have

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collectively contributed to the growing prevalence of overweight and obesity also in many developing countries, sparking concerns about adverse health and negative economic and social consequences.

Studying the probability of female obesity is especially important, as women are more prone to being obese than men, with far-reaching implications for their health and reproductive health. Dietary habits and obesity among mothers and pregnant women affect their offspring (Godfrey *et al.*, 2017), thus affecting the health of younger generations. Female obesity is, therefore, a health concern that extends across generations.

1.1 The obesity transition

Obesity prevalence follows visible patterns over time, leading to the identification of an *obesity transition*, as overweight and obesity increase, while countries undergo economic development and urbanization (Jaacks *et al.*, 2019). Following Jaacks *et al.* (2019), the obesity transition can be described through several distinct stages. In Stage 1, a country has higher obesity prevalence among women than men, an overall obesity of 5%–20% for women and higher prevalence in individuals with higher socio-economic status (SES) compared to those with lower SES, with a larger SES-gap for women. Countries in Stage 2 see significant increases in the prevalence of obesity for adults (between 25% and 40% for women), while the sex differences in obesity decrease overall and SES differences decrease for women. Stage 3 of the obesity transition is characterized by a noticeable reduction of the sex-difference in obesity prevalence and a reversal of socioeconomic differences, with higher SES groups now displaying a lower prevalence of obesity compared to lower SES groups.

Disparities by SES are evident throughout the obesity transition. In the early stages, which occur in low resource settings, individuals with higher SES tend to have greater access to food resulting in a higher prevalence of obesity compared to those with lower SES, who are more likely to suffer from undernutrition. Economic development often leads to changes in dietary habits and traditional diets, which are based on wholesome foods, are gradually replaced by diets that are rich in processed and high-calorie foods (Lameko, 2022). Initially, affluent individuals typically have better access to and affordability of these processed foods. Consequently, this shift in dietary patterns, together with an increasingly sedentary lifestyle and changing modes of transportation, contribute to a greater increase in obesity rates among higher SES groups (Dinsa *et al.*, 2012).

As economies develop, the obesity transition progresses and ultra-processed foods become more abundant and accessible. This shift in the food environment leads to changes in obesity patterns across socioeconomic groups. Lower SES groups are more likely to consume high-calorie foods, as financial constraints limit their ability to prioritize nutritional quality over cost (Cardel *et al.*, 2016). Studies have also indicated that lower SES individuals have lower physical activity (Althoff *et al.*, 2017).

Urbanization is another consequence of economic development which may have implications for both obesity prevalence and the SES-gradient. The prevalence of obesity exhibits distinct patterns in urban and rural environments, because of factors including lifestyle choices and socio-economic conditions. Urban areas often experience a fast-paced lifestyle, characterized by sedentary jobs and increased accessibility to processed foods. The convenience of fast-food outlets and hectic schedules can contribute to unhealthy dietary habits and, consequently, a higher prevalence of obesity (Ajayi *et al.*, 2016). However, in later stages of the obesity transition, higher-income individuals in higher SES neighborhoods in urban areas may have healthier lifestyles and better access to healthier food options, potentially reducing obesity risks (Congdon, 2019). It is worth noting that there is some overlap between SES and urban-rural disparities (Neuman *et al.*, 2013).

1.2 Obesity in small island developing states

Small Island Developing States (SIDSs), a United Nations-recognized group of island and coastal states sharing common development challenges, are disproportionately represented among countries with the highest adult obesity prevalence globally (NCD Risk Factor Collaboration (NCD-RisC) *et al.*, 2024). However, SIDSs vary widely in terms of both obesity prevalence and economic development. These states are often characterized by limited land area, geographic isolation and unique socio-economic circumstances, which contribute to a complex landscape of health challenges, particularly for women, who are disproportionately affected by the obesity epidemic in many SIDSs.

Women in SIDSs are at the forefront of these rising obesity rates, influenced by intersecting socio-cultural, economic and environmental factors. Once centered around locally sourced and fresh foods, traditional diets have been gradually replaced by imported ultra-processed, energy-dense and nutrient-poor food, intensifying the obesity problem (Haynes *et al.*, 2022; Barnett, 2020; FAO, 2021), which, in combination with an increase in sedentary lifestyles, may have contributed do the rise in obesity rates across SIDSs (Annear, 2022). Women, who often bear the primary responsibility for food preparation and household nutrition, are both directly and indirectly impacted by these dietary shifts. The increasing availability and affordability of processed foods, combined with time constraints because of work or caregiving roles, can limit women's ability to maintain traditional cooking practices and healthy food choices. The Food and Agricultural Organization (FAO) has highlighted the concerning trend of food import dependency in SIDSs, particularly in the Pacific and Caribbean regions, where over 60% of the food consumed is imported (FAO, 2016). This shift is driven by various factors, including globalization, increased tourism and changes in agricultural practices (Guell *et al.*, 2021).

The historical focus on cash crops such as sugar cane, palm oil, copra and export-oriented fruit and vegetables resulting in mono-crop agriculture is another explanation for the high obesity rates in SIDSs. This focus on cash crops for export, particularly in the Caribbean, can be traced back to the legacy of colonial exploitation (Guell *et al.*, 2021). In contrast, Pacific Island countries have historically practiced more diverse agriculture with an emphasis on subsistence farming (Barnett, 2020). However, contemporary agricultural systems in most SIDSs have shifted toward prioritizing cash crops over internal consumption, leading to increased reliance on imported food.

The agricultural systems in SIDSs face ongoing challenges, including the increasing frequency of extreme weather events because of climate change, which can disrupt and displace local food production, leading to further reliance on imported food (FAO, 2016).

Furthermore, like most other developing countries, SIDSs often face challenges in implementing effective public health interventions. These countries may have limited health-care resources, infrastructure and funding, making it difficult to develop comprehensive obesity prevention and treatment programs (WHO, 2023).

In addition to the agricultural and environmental factors, cultural norms and beliefs surrounding body image and food play a significant role influencing behaviors related to obesity in SIDSs. In some SIDSs, there is a cultural preference for larger body sizes in women, considering them a sign of wealth, abundance or attractiveness. This perspective may lead to a more accepting attitude toward overweight or obesity among women and a reluctance to address or perceive it as a health concern (Teevale, 2011).

Existing empirical work on the obesity transition has largely focused on large low- and middle-income countries and on broad global comparisons (Dinsa *et al.*, 2012; Neuman *et al.*, 2013; Jaacks *et al.*, 2019). For Small Island Developing States, evidence is more fragmented: studies often document high and rising obesity prevalence, food import

dependence and constraints on prevention and treatment capacity (FAO, 2016; Guell *et al.*, 2021; Haynes *et al.*, 2022; WHO, 2023), but few analyses explicitly position multiple SIDSs along the obesity transition framework while simultaneously describing socioeconomic and urban–rural gradients among women. This limits comparative understanding of where SIDSs sit in the transition and which groups are most exposed as development proceeds.

1.3 The current study

Empirical work on the obesity transition suggests that obesity patterns evolve with development and that socioeconomic gradients can change across stages of the transition (Jaacks *et al.*, 2019). Evidence from low- and middle-income countries further shows that the association between socioeconomic status and obesity is heterogeneous and may vary across contexts and population groups, including women (Dinsa *et al.*, 2012). However, obesity-transition evidence specific to SIDSs remains comparatively limited, despite high and heterogeneous obesity burdens and distinctive food-system vulnerabilities; related SIDSs-focused reviews highlight an uneven evidence base on diet-related interventions and policies across SIDSs (Haynes *et al.*, 2022; Brown *et al.*, 2022). This creates a knowledge gap on whether SIDSs follow similar obesity-transition patterns and how within-country socioeconomic and spatial (urban–rural) gradients manifest in small, trade-dependent island economies. We address this gap by combining long-run aggregate trends with micro-level survey data to position six SIDSs along the obesity transition and to document gradients in female obesity probability by socioeconomic status and place of residence. The aim of this study is to assess and compare the stage of the obesity transition in six SIDSs (Fiji, Haiti, Maldives, Samoa, Timor-Leste and Vanuatu) and to examine socioeconomic and urban–rural differences in the probability of female obesity across these settings. The choice of countries was guided by availability of micro-level data which are needed to study SES and urban–rural disparities. The countries studied share common characteristics such as remote locations, growing and sometimes low-skilled populations, limited land-based resources, small domestic markets and high dependence on international trade. These characteristics provide a unique backdrop to explore the interplay between socioeconomic factors and obesity in island settings.

First, we explore changes in obesity prevalence for men and women over time using aggregate data from the NCD Risk Factor Collaboration (NCD-RisC) *et al.* (2024). Then we explore SES and urban–rural differences in the probability of female obesity using micro level data from the Multiple Indicator Cluster Surveys (MICS) and Demographic and Health Surveys (DHS).

2. Material and methods

2.1 Data sources

This study draws on two complementary data sources. First, to examine long-run trends in obesity prevalence and compare patterns between men and women, we use aggregate country-level estimates from the NCD Risk Factor Collaboration (NCD Risk Factor Collaboration [NCD-RisC] *et al.*, 2024), which provides harmonized data on non-communicable disease risk factors for countries and territories worldwide. Second, to analyze socioeconomic and urban–rural differences in the probability of female obesity, we use nationally representative micro-level data from the DHS and the MICS. The micro-level data span 2008–2023 and include Fiji (MICS 2021), Haiti (DHS 2009, 2016), Maldives (MICS 2009, 2017), Samoa (MICS 2020), Timor-Leste (DHS 2009, 2016) and Vanuatu (MICS 2008, 2023), totaling more than 67,000 individual observations. DHS and MICS are large-scale household surveys conducted in many low- and middle-income countries and

designed to provide nationally representative data on population health and living conditions. In this study, the DHS data are drawn from the female questionnaire, which includes information on reproductive health, living standards and health status. The MICS provides comparable information on women, children and households. Together, these surveys form the basis for the individual-level analysis, while NCD-RisC is used for the descriptive analysis of aggregate obesity trends over time.

2.2 Measurements and variables

To study the association between SES and obesity, we construct the Body Mass Index (BMI) for our study population. BMI is commonly used in comparative obesity studies and is suitable here because it is consistently available across the DHS and MICS data sets, allowing comparable measurement across countries and over time (Wu *et al.*, 2024). However, BMI does not directly capture body composition, fat distribution or obesity-related clinical impairment and should, therefore, be interpreted as a population-level indicator rather than a comprehensive clinical measure of obesity (Rubino *et al.*, 2025). Here our outcome variable *Obese* is defined as 1 = BMI ≥ 30 and 0 = BMI < 30. For Asian populations (in this case, Timor Leste and the Maldives and the sub-population-group Indo-Fijians in Fiji), a specific Asian BMI is applied (*Obese* is defined as 1 = BMI ≥ 25 and 0 = BMI < 25). Asians tend to have a higher proportion of body fat and less lean muscle mass compared to other populations at the same BMI. This means that Asians may have a higher risk of developing obesity-related health conditions, such as Type 2 diabetes and cardiovascular diseases, at lower BMI levels than other populations. In response to these concerns, the WHO have proposed revised BMI cut-off points specifically for Asian populations, where Obesity class 1 means a BMI of > 25 (WHO Western Pacific, 2000).

To measure SES, we use wealth level across all data sets. The wealth variable is constructed using the DHS and MICS Wealth Index variables and is used as a proxy for socioeconomic status because it is consistently available across data sets and allows comparable measurement across countries. However, because it mainly reflects household living standards, it captures only one dimension of SES. The Wealth Index is a combined indicator that assesses the overall living standard of a household. It is derived by considering various easily measurable factors, including the ownership of specific assets like televisions and bicycles, the materials used for housing construction and the types of water access and sanitation facilities available to the household. Through principal components analysis, every household asset included in the survey is assigned a weight or factor score. Wealth quintiles are created from these factors scores, namely, (1) Poorest, (2) Poorer, (3) Middle, (4) Richer and (5) Richest.

All models control for age groups: (1) 15–19, (2) 20–29, (3) 30–39 and (4) 40–49. We also perform analysis separated according to rural or urban place of residence and across time.

The regression models adjust for age group only. This parsimonious specification is chosen because the purpose of the analysis is descriptive rather than causal and because age is a key correlate of obesity that is consistently measured across all DHS and MICS data sets. Limiting the adjustment set also facilitates comparability across countries and survey waves. We do not include a broader set of covariates because several potential controls, such as education, employment or place of residence, may themselves be part of the pathways through which socioeconomic status is associated with obesity (see Table 1 for variable means).

Our regression models have a binary outcome (obese) and are fitted with logistic regressions. The categorical parameter estimates are displayed by odds ratios, showing the odds of being obese relative to the reference group. To complement the odds ratios, we estimate predicted margins of obesity from the logistic regression models. For the cross-

Table 1. Variable means, %

Country	Fiji	Haiti		Maldives		Samoa	Timor-Leste		Vanuatu	
Year	2021	2009	2016	2009	2017	2020	2009	2016	2008	2023
Obese	45.51	6.90	10.08	44.61	51.62	68.07	4.95	9.36	14.64	22.36
Wealth groups										
Poorest	18.42	19.49	19.06	22.08	28.11	16.40	19.43	16.41	15.78	20.04
Poorer	20.15	18.64	19.50	25.87	27.59	17.13	19.47	18.35	20.15	19.36
Middle	19.50	21.06	20.54	27.33	27.04	18.97	20.70	20.23	16.35	18.32
Richer	20.22	19.95	21.24	15.69	11.31	21.35	21.47	23.67	17.30	20.29
Richest	21.71	20.86	19.66	9.03	5.95	26.15	18.93	21.34	30.42	21.98
Age groups										
15–19	16.27	25.65	24.44	1.49	13.99	20.60	26.38	26.11	17.36	17.76
20–29	29.16	35.36	34.46	39.32	32.97	31.84	31.31	30.82	39.64	30.77
30–39	30.38	22.74	24.50	35.63	33.05	24.53	24.87	23.67	28.80	32.39
40–49	24.19	16.25	16.59	23.56	19.99	23.03	17.44	19.40	14.20	19.08

Source(s): Authors' calculations based on Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) microdata: Fiji (MICS 2021), Haiti (DHS 2009, 2016), Maldives (MICS 2009, 2017), Samoa (MICS 2020), Timor-Leste (DHS 2009, 2016) and Vanuatu (MICS 2008, 2023)

country comparison (Figure 2), predicted margins are obtained from a pooled model including an interaction between wealth group and country, adjusted for age. For the urban–rural analysis (Figure 3), predicted margins are estimated separately by country from models including an interaction between wealth group and place of residence, adjusted for age. For countries with repeated survey waves (Supplementary Figure 1), predicted margins are estimated separately by country from models including an interaction between wealth group and survey year, adjusted for age.

The regression results should be interpreted as descriptive associations rather than causal effects, as the models include limited controls and unobserved confounding factors may influence the estimated relationships.

3. Results

3.1 Descriptive patterns

This subsection uses aggregate country-level estimates from the NCD Risk Factor Collaboration (NCD-RisC) 2024 to describe long-run trends in adult obesity prevalence among women and men in the six SIDSs. The subsequent analyses of socioeconomic and urban–rural differences, by contrast, rely on individual-level DHS and MICS microdata for women only. These descriptive trends provide the aggregate context for assessing countries' positions within the obesity transition, particularly by showing overall obesity levels, changes over time and sex differences in prevalence.

Figure 1 uses these aggregate estimates to show the development of adult obesity prevalence in the six SIDSs between 1990 and 2022. The figure presents age-standardized prevalence estimates for men and women and shows excess female obesity in all countries included. Figure 1 (left) presents trends based on the standard definition of adult obesity (BMI ≥ 30). For the Maldives and Timor-Leste, Figure 1 (right) additionally presents trends using the Asian BMI threshold (BMI ≥ 25), in line with WHO recommendations for Asian populations, to better reflect obesity-related health risks and avoid underestimating obesity prevalence in these populations. However, because this threshold differs from the standard

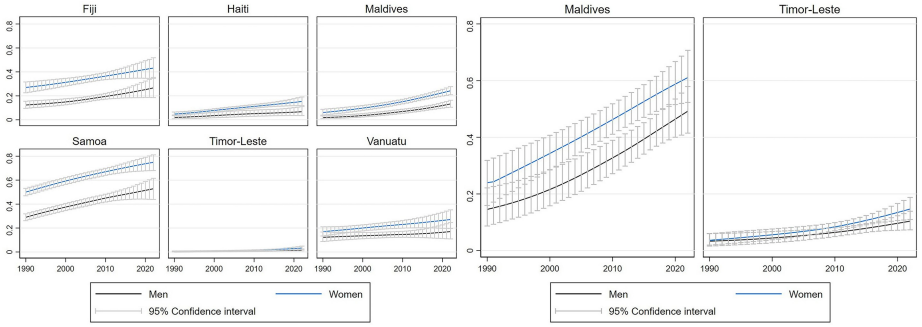

Figure 1. Development of age-standardized adult obesity prevalence among women and men in Fiji, Haiti, Maldives, Samoa, Timor-Leste and Vanuatu, 1990–2022. Left panel: standard obesity definition (BMI ≥ 30). Right panel: alternative trends for the Maldives and Timor-Leste using the Asian BMI threshold (BMI ≥ 25)

Note: The right panel is not directly comparable to the standard obesity series because a different BMI threshold is applied.

Source: NCD Risk Factor Collaboration (NCD-RisC) 2024

BMI ≥ 30 definition used for the other countries, absolute prevalence levels are not fully comparable across countries. The right-hand panel should, therefore, be interpreted as an alternative threshold-based illustration rather than as directly comparable standard obesity prevalence. Because these sources differ in methodology and level of aggregation, they should be viewed as complementary rather than directly interchangeable. In addition, NCD-RisC does not distinguish between ethnic groups within countries, and we are, therefore, unable to apply Asian-specific BMI thresholds separately to Indo-Fijians in the aggregate trend analysis, as we do in the DHS/MICS-based microdata analysis. The patterns shown in Figure 1 should, therefore, be interpreted as broad descriptive trends rather than formal statistical tests of differences across countries or over time. Overall, obesity rates have increased over time in all countries, although substantial variation exists in both levels and trajectories.

The patterns shown in Figure 1 should be interpreted as broad descriptive trends rather than formal statistical tests of differences across countries or over time. The stage classifications are based on an overall interpretation of multiple descriptive indicators, including prevalence levels, sex differences and socioeconomic gradients, rather than on any single trend shown in Figure 1. Overall, the figure suggests that obesity rates have increased over time in all countries, although substantial variation exists in both levels and trajectories.

Samoa has a high obesity prevalence already in 1990 with a female obesity prevalence around 50% and a male prevalence exceeding 20%. At the end of the period, in 2022, female obesity in Samoa reached 75%, with male obesity of 50%.

Samoa's neighboring country Fiji has a lower level at the start of the period and a flatter development over the years, starting with a prevalence of 27% for women and 12% for men. At the end of the period, the prevalence is 43% for Fijian women and more than 25% for Fijian men.

Vanuatu, another Melanesian country in the South Pacific, exhibits relatively lower obesity rates which are increasing to 27% for women and 17% for men by the end of the period. Haiti in the Caribbean also experienced an upward trend, but at a lower level. In 1990, the percentage of obese women was only 4%, but it has steadily increased and reached 15% in 2022. Men have also shown slight increases, albeit at much lower levels. The Maldives had an obesity prevalence of 6% in 1990, with an increase to approximately 24%

among women in 2022. There is also an increase for men in the Maldives, from 2% in 1990 to 13% in 2022. Timor-Leste shows a small increase, from 0.4% to 3.2% for women. Toward the end of the period, an excess female obesity is evident. Turning to Figure 1 (right), which presents trends using the Asian BMI threshold (BMI ≥ 25) for Timor-Leste and the Maldives, it is evident that the increases over time become more pronounced, with female prevalence in the Maldives reaching above 60% in 2022. Timor-Leste is showing increasing signs of rising obesity for both men and women, particularly since 2010, the increases have been accelerating. However, it is worth noting that the current levels of obesity are still relatively low (at 14% for women in 2022 with the Asian BMI threshold).

3.2 Analysis

To study the SES gradient of female obesity in SIDSs, we conducted multivariate regressions with binary outcomes. The country classifications presented below are based on an overall interpretation of prevalence levels, sex differences and socioeconomic gradients and should, therefore, be understood as indicative rather than definitive. Table 2 presents the odds ratios for obesity in all six countries for different wealth groups.

In the four SIDSs with the lowest gross domestic product per capita (Haiti, Samoa, Timor-Leste and Vanuatu), we observe a clear positive social gradient, with wealthier groups having higher odds of obesity. This pattern is consistent with earlier stages of the obesity transition. The differences in odds between the groups are most pronounced in Haiti where the richer group had approximately nine times higher odds of obesity compared to the poorest group. In Samoa, the positive association, although evident, is less pronounced. In the Maldives, we do not observe a clear wealth gradient in obesity. However, the estimates suggest that the richest group may have the lowest odds of obesity, which is consistent with an emerging Stage 3 obesity transition profile. In Fiji, obesity appears to be most concentrated in the middle wealth group, which may indicate a transition between Stages 2 and 3.

Figure 2 presents age-adjusted predicted margins of obesity derived from a pooled logistic regression model with an interaction between wealth group and country. The figure shows the predicted probability of obesity across wealth groups for each country. As in Figure 1, we observe cross-country variation, with Samoa, Fiji and the Maldives having higher predicted probabilities of obesity across wealth groups than the remaining three countries. We also observe the positive social gradient discussed above for the lower-income countries and flatter gradients for Fiji and the Maldives.

To further examine how wealth gradients evolve over time in countries with more than one survey wave, Supplementary Figure 1 presents age-adjusted predicted margins of obesity derived from country-specific logistic regression models with an interaction between wealth group and survey year. In the Maldives, the predicted probability of obesity increased from 2009 to 2017, with the largest increase among the poorest. While the 2009 results show a clear positive wealth gradient, the 2017 pattern appears flatter, suggesting a possible shift toward a negative gradient. In Haiti and Timor-Leste, the predicted probability of obesity also increased across all wealth groups, although both countries continue to display patterns consistent with earlier stages of the obesity transition, with the richest group still showing the highest predicted prevalence.

Finally, to examine whether wealth gradients differ by place of residence, Figure 3 presents age-adjusted predicted margins of obesity derived from country-specific logistic regression models with an interaction between wealth group and urban–rural residence. In Fiji, the Maldives and Samoa, the predicted probabilities show limited variation by place of residence. In Vanuatu, the estimates suggest a possible urban–rural difference for the poorest groups, although these differences are not statistically significant and should, therefore, be

Table 2. Associations of obesity and level of wealth for all countries

Income groups	Fiji	Haiti	Maldives	Samoa	Timor-Leste	Vanuatu
Poorest (*ref.*)						
Poorer	1.100 (0.114)	1.648*** (0.302)	0.938 (0.0648)	1.402*** (0.184)	1.043 (0.149)	1.422* (0.222)
Middle	1.413*** (0.149)	3.602*** (0.594)	1.051 (0.0729)	1.468*** (0.188)	1.686*** (0.218)	1.774*** (0.274)
Richer	1.252** (0.129)	5.634*** (0.898)	1.016 (0.0921)	1.890*** (0.240)	2.752*** (0.331)	2.971*** (0.437)
Richest	1.058 (0.107)	9.117*** (1.429)	0.813* (0.0944)	2.016*** (0.247)	3.845*** (0.456)	3.572*** (0.510)
Observations	4,744	9,050	6,837	3,812	11,824	3724

Note(s): Standard Errors in parentheses, Model adjust for age. ***$p < 0.01$; **$p < 0.05$ and *$p < 0.1$

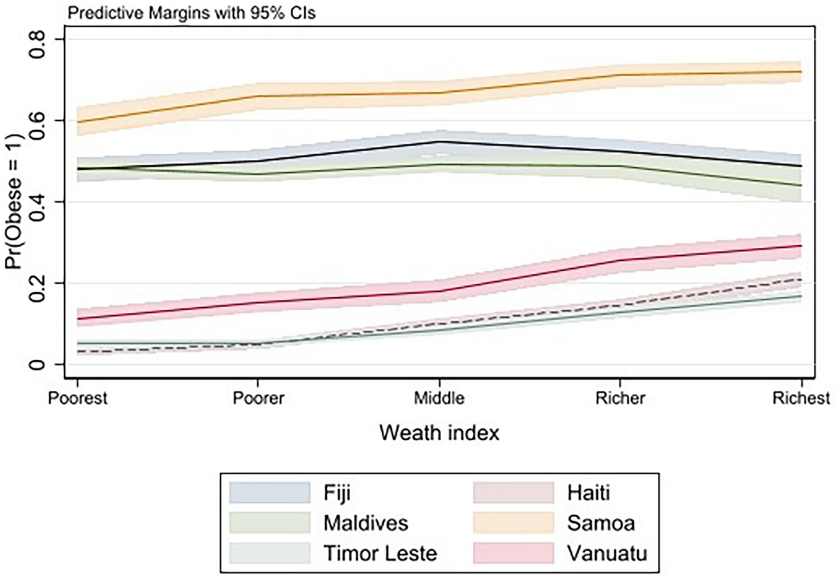

Figure 2. Cross-country age-adjusted predicted margins of obesity derived from a pooled logistic regression model with an interaction between wealth group and country

Source: DHS, MICS

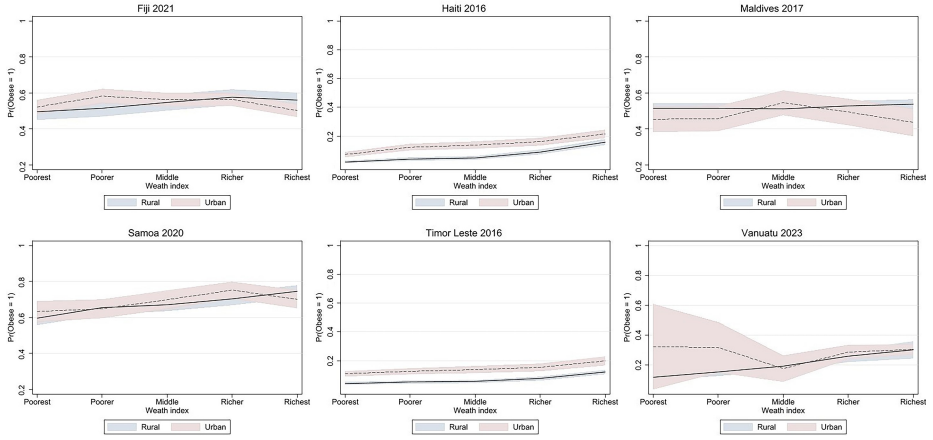

Figure 3. Urban and rural differences in age-adjusted predicted margins of obesity for wealth groups, derived from country-specific logistic regression models with an interaction between wealth group and place of residence

Note: Wealth index is divided into quintiles separately for urban and rural areas No urban rural differences for Vanuatu because of small numbers

Source: DHS, MICS

interpreted with caution. In the other low-income countries, Timor-Leste and Haiti, a different pattern emerges. The estimates suggest a higher predicted probability of obesity among women living in urban areas. This pattern is consistent with literature pointing to differences in food environments, physical activity and work patterns across urban and rural settings, although these mechanisms are not directly tested in the present analysis. In both countries, the results continue to suggest a positive social gradient in obesity irrespective of place of residence, with a somewhat steeper gradient in Haiti.

4. Discussion

4.1 Comparative perspective

In comparative terms, the positive socioeconomic gradients observed in Haiti, Timor-Leste, Vanuatu and Samoa are consistent with patterns reported for many lower-resource settings, where higher socioeconomic status initially confers greater access to calorie-dense foods and more sedentary lifestyles (Dinsa *et al.*, 2012; Jaacks *et al.*, 2019; Popkin *et al.*, 2012). As countries move through the transition, the gradient tends to attenuate and may reverse as ultra-processed foods become cheap and ubiquitous and higher-SES groups adopt healthier diets and activity patterns (Swinburn *et al.*, 2011; Popkin *et al.*, 2012. The Maldives and (to a lesser extent) Fiji exhibit early signals of this later-stage dynamic, which resembles the negative SES-gradient commonly documented in high-income settings (Jaacks *et al.*, 2019).

The urban–rural patterns we observe also align with prior evidence that obesity often concentrates in urban areas during earlier development, before spreading more evenly – or even shifting toward rural areas – as food systems and transportation change (Neuman *et al.*, 2013; Ajayi *et al.*, 2016). In our data, the most pronounced urban–rural differences are in Haiti and Timor-Leste, suggesting that place-based factors (infrastructure, labor markets, food availability and health services) may be particularly salient in earlier-stage SIDSs.

Following the conceptual model of the obesity transition, our results suggest examples of all three stages across the six SIDSs under study. Across the six SIDSs, the patterns indicate different positions along the transition: in earlier-stage settings obesity probability remains more concentrated among better-off women, while later-stage profiles show diffusion beyond affluent groups and a weakening of the positive gradient (Dinsa *et al.*, 2012; Jaacks *et al.*, 2019).

The evidence suggests that socioeconomic and spatial gradients in SIDSs are not uniform, and some SIDSs display patterns comparable to late-transition settings despite their small size and distinct structural constraints (Jaacks *et al.*, 2019).

Timor-Leste appears to display an early-stage obesity transition profile, with relatively low levels of overall obesity for both men and women. Using the Asian BMI threshold, female obesity in Timor-Leste exceeds 5%, and the increase in prevalence, especially among richer groups, is consistent with an early-stage transition pattern. This pattern is consistent with early-stage transition evidence where obesity emerges first among higher-SES groups before diffusing more broadly (Dinsa *et al.*, 2012; Jaacks *et al.*, 2019).

Haiti also shows patterns consistent with the first stage of the obesity transition. Female obesity prevalence is around 10%, and there is an undeniable positive relationship between SES and obesity with higher wealth groups having a higher probability of obesity. Over time, there is increasing prevalence for all SES groups, however with a remaining positive relationship between SES and obesity. Vanuatu appears to display patterns consistent with Stage 2 of the obesity transition, including a clear social gradient and female obesity prevalence above 20% in 2022 (Figure 1). Timor-Leste, Vanuatu and Haiti are in the bottom half in terms of gross domestic product per capita, which also fits well with the conceptual model of the obesity transition, as the model suggests a positive relationship between SES and obesity at lower levels of economic development.

Samoa shows several characteristics consistent with Stage 2 of the obesity transition. Although Samoa had a female obesity prevalence of above 25% already in 1975 (WHO Global Health Observatory – processed by Our World in Data, 2024), and currently well above what is typical of Stage 2 countries, there is still a positive relationship between obesity and SES, which is a clear indication of Stage 2. Samoa is a lower-middle-income country and may experience reversing of the SES-gradient with further economic development. However, as third-fourth of Samoan women are obese in 2022, reduction in obesity is needed across all subgroups of the population to reverse the Samoan obesity trend. Samoa is a global leader in obesity, alongside a few other South Pacific islands like Tonga (81.5% for women and 63.4% for men), Tokelau (74.9% for woman and 67.1% for men), Cook Islands (67.1% for women and 66.1% for men) and Tuvalu (73.2% for women and 57.7% for men (NCD Risk Factor Collaboration [NCD-RisC] *et al.*, 2024).

Fiji, Samoa's somewhat richer neighbor, can be placed somewhere between Stages 2 and 3 in the transition. Fiji has a high prevalence of obesity for both men and women, women close to 40% and men surpassing 30%. Over time, we see signs of men catching up with women in Fiji, which suggests Stage 3. We also learn that obesity is carried by the middle class in Fiji, which can be interpreted as a changing relationship between SES and obesity. However, there is no clear negative SES-gradient observed; thus, we are reluctant to place Fiji entirely in Stage 3, rather somewhere between Stages 2 and 3. It is worth noticing here that the Fijian population consists of two major ethnic groups: Native Fijians (*Itaukei*) and Indo-Fijian originating from India. The Indo-Fijian, rather large share of the Fijian population (around 35% in 2010), is a likely explanation for the lower obesity prevalence in Fiji compared to Samoa. Fiji is also located in Melanesia and not in Polynesia which is the case for Samoa. Most top obesity countries of the Pacific (see above) are Polynesian countries.

Finally, the Maldives shows indications of a negative relationship between obesity and SES, suggesting a Stage 3 transition profile. This is especially evident for the Maldives when we compare the data set from 2009 with the data set from 2017. Between 2009 and 2017, obesity increased more for poorer quintiles, leading to a small positive SES-gradient in 2009 to shift to a small negative SES-gradient in 2017. However, because the negative SES gradient is observed mainly at the upper end of the wealth distribution, this pattern should be interpreted cautiously and may indicate an emerging rather than fully established Stage 3 profile. As the Maldives developed further, the negative SES-gradient is likely to become stronger.

The patterns and prevalence of obesity can also vary because of different contextual settings. Sociocultural, economic and environmental aspects play a crucial role in moderating the effects of economic development on obesity prevalence among women, for instance, cultural characteristics, cuisines, body size perceptions and wealth distribution are all important factors influencing obesity prevalence (Jaacks *et al.*, 2019; Swinburn *et al.*, 2011; Popkin *et al.*, 2012). These influences often manifest differently for women. For instance, cultural norms surrounding ideal female body shapes can either reinforce or counteract health messaging around obesity. In some settings, larger female bodies are idealized as symbols of fertility, wealth or social standing, which may discourage weight loss or the recognition of obesity as a health risk (Teevale, 2011). Additionally, women's roles as primary caregivers and household food providers may expose them more directly to food environments, influencing their dietary habits and activity levels in gender-specific ways. Race and ethnicity also play a significant role in shaping obesity patterns, and this has important implications when studying diverse populations. These disparities may be because of various factors, including differences in genetic backgrounds influencing body composition and fat distribution, as well as variations in cultural body image standards (Teevale, 2011). Our results also revealed differences in obesity patterns across urban and

rural settings in two countries (Haiti and Timor-Leste). While we did not observe consistent urban-rural divides in the remaining countries, it remains critical to explore how women's lives differ in these environments – particularly in relation to access to health care, education, employment and physical activity opportunities and how these factors may evolve as countries move across transition stages (Jaacks *et al.*, 2019).

Although this paper is primarily descriptive in nature and seeks to assess obesity transition patterns in selected SIDSs, it is essential to recognize how country- and gender-specific factors may shape the patterns of obesity observed across the six countries. While these SIDSs share common structural challenges, they also differ in key areas such as levels of economic development, health infrastructure and dietary patterns. These differences interact with gendered social roles and responsibilities, further complicating women's risk of obesity. The findings should, therefore, be interpreted with caution and in light of the study's measurement and data constraints.

5. Conclusion

The results of this study show that obesity in SIDSs is not only widespread but also patterned by socioeconomic status and, in some settings, by place of residence. Taken together, the findings support the relevance of the obesity transition framework for understanding female obesity in SIDSs, while also highlighting substantial heterogeneity across countries.

The aim of this study was to assess and compare obesity transition patterns in six SIDSs (Fiji, Haiti, Maldives, Samoa, Timor-Leste and Vanuatu), with particular attention to socioeconomic and urban–rural differences in the probability of female obesity. The results suggest that Haiti, Timor-Leste, Vanuatu and Samoa display earlier-stage obesity transition patterns, characterized by positive socioeconomic gradients, with Timor-Leste appearing to be at a particularly early stage. Fiji appears to occupy an intermediate position between Stages 2 and 3, with signs of men catching up to women in obesity prevalence and indications of a changing relationship between SES and obesity. The Maldives shows patterns consistent with an emerging Stage 3 profile, with obesity increasing more among lower-SES groups over time. These stage assessments should be understood as comparative, evidence-based interpretations of prevalence levels, sex differences and socioeconomic gradients, rather than as fixed classifications derived from strict operational thresholds.

The cross-country differences identified here are likely shaped by contextual factors discussed in previous literature, including food environments, urbanization, sociocultural norms and broader economic conditions. However, these mechanisms are not directly tested in the present study and should, therefore, be interpreted as literature-based explanations rather than as empirical findings from our analysis.

The main contribution of the study is to, therefore, not only document high obesity levels in SIDSs but also show that the social patterning of female obesity differs across island contexts in ways that are consistent with different positions along the obesity transition. This provides a comparative basis for more targeted research and policy responses in SIDSs.

At the same time, the findings should be interpreted in light of several limitations. First, obesity is measured using BMI only, which facilitates comparability but does not capture body composition, fat distribution or obesity-related clinical impairment. Second, this study combines different data sources, NCD-RisC for aggregate trends and DHS/MICS for individual-level analysis, which differ in methodology and level of aggregation. Third, the regression models are deliberately parsimonious and adjust only for age, which improves comparability but leaves open the possibility of omitted variable bias. Fourth, the micro-level analyses are restricted to female samples, which means that within-country SES and urban–rural gradients are not assessed for men. Finally, comparability is constrained by

differences in survey years and, for selected populations, by the use of alternative BMI thresholds.

5.1 Implications for policy, practice and society

Our findings imply that prevention strategies in SIDSs should be sensitive to the specific socioeconomic gradients observed in each country. In countries where the positive SES-gradient remains pronounced, such as Haiti, Timor-Leste, Vanuatu and Samoa, interventions may need to address obesity risks among women in higher-wealth groups while also anticipating broader diffusion as the transition progresses. In Fiji and the Maldives, where the gradients appear flatter or shifting, prevention strategies may need to pay greater attention to how obesity is spreading beyond the most advantaged groups.

The urban patterns observed in Haiti and Timor-Leste further suggest that place-based prevention may be especially relevant in some earlier-stage settings. Because female obesity has intergenerational consequences through pregnancy and early-life nutrition (Godfrey *et al.*, 2017), policy responses in SIDSs can also yield broader societal benefits through maternal and child health, non-communicable disease prevention and women's well-being. Strengthening primary prevention, healthier food environments and targeted community-based interventions may, therefore, be particularly important.

5.2 Implications for research

For research, the comparative patterns identified here motivate further work on the mechanisms that may shape SES and urban–rural gradients in SIDSs, including food prices, import dependence, labor market change and gendered time constraints. A natural next step would be to link repeated household surveys to policy, market and food-system indicators to test such mechanisms more directly. Future research would also benefit from broader adiposity measures beyond BMI, richer model specifications and clearer operational criteria for obesity-transition stage classification.

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Further reading

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Supplementary material

The supplementary material for this article can be found online.

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