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Household Water Insecurity and its Association with Overweight and Obesity among Adults in Rio de Janeiro, Brazil

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Abstract

Background

Water Insecurity (WI) is defined as the inability to reliably and safely access sufficient water to satisfy basic human needs and promote individual well-being. Households in WI face limited ability to maintain a healthy diet, raising the risk of food insecurity (FI). Although the co-occurrence of FI and obesity has been documented in epidemiological studies, there is limited evidence evaluating the relationship between WI and obesity. The present study aimed to evaluate the association between WI and weight status among adults in Rio de Janeiro, Brazil.

Methods

This study used data from the Survey on Food and Nutritional Insecurity in the Municipality of Rio de Janeiro, a representative population-based study. WI was assessed using the 1st Portuguese version of the Water Insecurity Scale. The Body Mass Index was calculated based on their self-reported weight and height. Associations were estimated using relative risk ratios (RRRs) with 95% confidence intervals, in a multinomial logistic regression model.

Results

The prevalence of overweight and obesity increased as WI worsened. After adjusting for potential confounding variables, low WI was associated with being overweight among men (aRRR = 1.80; p = 0.031) and the severe level of WI, with being overweight among women (aRRR = 2.06; p = 0.049). In relation to obesity, women with low (aRRR = 2.14; p = 0.010) and moderate WI (aRRR = 2.06; p = 0.005) were more than twice as likely to have an average weight. Among men, WI was significantly associated with obesity ($p < 0.05$), being higher among families with moderate WI (aRRR = 3.04; p = 0.001).

Conclusion

WI was a risk factor for overweight and obesity among women, and for obesity among men.

Introduction

It was estimated that, in 2024, one in four people worldwide (2.1 billion) lacked access to safely managed drinking water, with the population of low-income countries, rural areas, and ethnic minority groups being disproportionately more affected[1]. Water Insecurity (WI) is defined as the inability to reliably and safely access sufficient water to satisfy basic human needs and promote individual well-being[2]. Currently, the use of accurate and reliable measurement of WI is highly useful for identifying vulnerable populations, developing policies and programs to reduce its burden, and advancing progress

toward Sustainable Development Goal 6 (SDG 6), as a part of the 2030 Agenda for Sustainable Development[3] (UN, 2015), thereby ensuring access to safe water for all[4].

In this sense, the quantitative experiential Household Water Insecurity Experiences Scale (HWISE) was proposed in 2019 by a large team of international researchers[5]. The Water Insecurity Experience Scale (WISE) focuses on multiple dimensions by measuring WI based on residents' experiences regarding adequacy, reliability, accessibility and safety of water in their household.

Until now, in Brazil, four studies have used the 1st Portuguese version of WISE to assess WI in Brazil[6,7,8,9]. The II National Survey on Food Insecurity in the COVID-19 Scenario[6] is the only national and representative research that evaluated the WI in the country using this Portuguese version of WISE[10]. In this survey, 42% of households with WI experienced severe food insecurity[6].

Food Insecurity has been associated with obesity in adults, especially among women. Among the hypotheses for this association is that resource shortage leads to the consumption of ultra-processed food (UPF), which are more economically accessible and have lower nutritional value, contributing to an increase in obesity, predominantly among socially vulnerable populations[12,13].

In this context, the choice of foods linked to obesity may also be related to water scarcity. In households that face constant water supply shortages and a lack of high-quality drinking water, the consumption of a healthy and varied diet is compromised[14]. Studies addressing this topic suggest the substitution of drinking water with sugar-sweetened beverages (e.g., sodas, artificial juices)[15,16] and the replacement of fruits and vegetables with UPFs. Research indicates that the foods incorporated into the diet are associated with an increase in obesity and other chronic diseases, as these products are typically energy-dense, and high in added sugars and saturated fats[17,18,19].

Concerning obesity, there has been a notable increase in rates in Brazil. Data from the Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey (in Portuguese "*Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico – Vigitel*") show that 24.3% of Brazilian adults were classified as having obesity, with women exhibiting the most significant increase (24.8%)[20]. In the state of Rio de Janeiro, located in the Southeast region of Brazil, the estimated prevalence of obesity was notably high, affecting 26.2% of the population [20].

The municipality of Rio de Janeiro, one of the largest metropolises in Latin America, and also one of the cities with the most striking levels of social inequality in the country, presents a clear example of the coexistence of WI and obesity. In 2024, the first municipal survey mapping food insecurity was conducted, highlighting moderate and severe food insecurity levels that were higher than state estimates, along with strong racial and territorial inequalities[21]. Additionally, around 70% of families experiencing WI also coexisted with food insecurity; the most severe level of food insecurity affected nearly 1/3 of families who lacked guaranteed regular access to water[21].

Given the increase in obesity rates, mainly among women in Brazil, alongside the scarcity of studies linking water scarcity to obesity, and the importance of understanding this seemingly paradoxical relationship, the present study aimed to evaluate the association between WI and weight status among adults in Rio de Janeiro (Brazil), one of the largest metropolitan areas in Latin America, considering sex. It is expected that the findings of this study will contribute to improving the formulation of public policies aimed at promoting food and nutritional security and reducing obesity.

Methods

This study used data from the Survey on Food and Nutritional Insecurity in the Municipality of Rio de Janeiro[9], a population-based survey representative of the municipality's population. Rio de Janeiro is internationally recognized for its cultural heritage and tourism, being also among the Brazilian municipalities with the highest gross domestic product (GDP)[22]. Despite this, its economic prominence contrasts with persistent social inequalities, making it one of the most unequal cities in the country. For the sample size calculation, the distribution of census tracts across neighborhoods in the city's five residential zones was taken into account[9]. For further details on the Survey on Food and Nutritional Insecurity in the Municipality of Rio de Janeiro - including sample size calculation and questionnaire used - please refer to the official publication[9].

Sample and data collection

The probabilistic and representative sample comprised 2,000 households. The sample size calculation was based on an expected prevalence of severe food insecurity of 15.9% in the state of Rio de Janeiro, with a 95% confidence interval (CI95%) and a maximum margin of error of ± 2.2 percentage points for overall estimates. More details about the sample design are available in previous studies[9,23,24,21]. In this study, only adults (20–59 years) were included, and their household socio-demographic data. Pregnant women (0.4%) were excluded, resulting in a final sample of 1,986 individuals.

Before the interview, all participants were informed about the research objectives and invited to sign the informed consent form. The informed consent form, as well as the research protocol, were submitted to the institutional ethics committee and received approval in accordance with Brazilian legal requirements. Face-to-face household interviews were conducted between November 1, 2023, and February 19, 2024, by a team trained by the researchers responsible for this manuscript. Data were collected using a mobile application on handheld devices, with only one interview per household. Respondents were aged 18 years or older and, whenever possible, corresponded to the household reference person (head of household).

Study variables

Water Insecurity (WI)

WI was assessed via the current WISE Portuguese version[6]. The Scale asks about 12 experiences related to problems with water over the previous four weeks, including modified or limited behaviors (e.g., being unable to wash hands), psychosocial impacts (e.g., worry about water), and supply interruptions. Respondents were asked to report how frequently they or anyone in their household experienced these issues. Data was collected with response options of 'never' (0 times), 'rarely' (1–2 times), 'sometimes' (3–10 times), 'often' (11–20 times), and 'almost every day' (more than 20 times). In this study, the responses were scored as dichotomous: never (0 points); rarely, sometimes, often and almost every day (1 point). The proposal to classify four ordinal categories of household WI was used, considering the cut-points established to classify individuals and households as experiencing four levels of water insecurity: "no-to-marginal WI" (0 score), "low WI" (1–3), "moderate WI" (4–9), or "high WI" (10–12) [25]. The choice of using dichotomous responses to classify households into the four levels of WI was considered in the study by Bose et al.[25], which suggests a valid alternative to polytomous response options for measuring the occurrence of WI experiences. Besides that, the use of the WISE with dichotomous response to evaluate WI levels in Brazil was a recommendation made by an expert panel that is complementing the validation process of the current Portuguese version of the Brazilian WISE for the use in population studies in the country.

Body Mass Index

The BMI (kg/m²) of the participants was calculated based on their self-reported weight (kg) and height (m). Using the WHO cut-off points[26], BMI was classified into the following categories: normal weight (BMI 18.6–24.9 kg/m^2), overweight (BMI 25–29.9 kg/m^2), and obesity (BMI ≥ 30kg/m^2). The underweight category was excluded from the statistical analysis due to low representativeness in the sample (1,7%).

Other variables

The analyses included the following information about the household reference person: sex (female/male); age (20–39 years, 40–59 years); self-reported skin color (white, black and brown); and years of schooling (≤ 8, > 8 years). Household-related data included: per capita family income expressed in multiples of the minimum wage (minimum wage at the study time US $264) (1st tertile, 2nd tertile, 3rd tertile); five planning areas of residence (Central zone, South zone, North zone, Southwest zone, West zone); and food insecurity. Food insecurity was assessed using the Brazilian Household Food Insecurity Scale (in Portuguese "*Escala Brasileira de Insegurança Alimentar – EBIA"*), classified as food security, mild food insecurity, moderate/severe food insecurity[27].

Analyses

Considering the complex sampling design and the expansion factors provided, analyses were performed using the Survey Data Analysis command (prefix '*svy*') in Stata software, version 16.1[27]. Prevalence

estimates and 95% CIs were calculated for all study variables. The chi-square test was used to compare the difference between head of household characteristics, household-related data, and food insecurity with WI; and between WI and BMI for women and men. Multinomial logistic regression models were employed to identify the association between WI and BMI strata, with models stratified by sex (men and women) and adjusted for covariates. The covariates used for the adjustment were the ones that showed a significance level of $p < 0.20$ in the bivariate multinomial logistic regression model between head of household characteristics, household-related data, food insecurity and BMI (data not shown). The selected variables were head of household age and years of schooling, per capita household income, area of residence and food insecurity. The findings are presented as not-adjusted (RRR) and adjusted relative risk ratios (aRRR), along with their 95% confidence intervals (95%CI); p-values < 0.05 were considered statistically significant.

Ethical considerations

This study followed the guidelines of Brazilian National Health Council Resolution No. 510/2016 and was approved by the Research Ethics Committee of the Clementino Fraga Filho University Hospital at the Federal University of Rio de Janeiro in May 2022 (CAAE: 54473421.6.0000.5257).

Results

Table 1 shows the prevalence of overweight and obesity, as well as the sociodemographic indicators assessed, by water security and WI levels. Adults with obesity (10.6%), aged 20–39 years (8.7%), with lower education (11.7%), and families in the lower income tercile (13.9%) had high WI. Households located in planning areas with the highest economic disparities (Central and North) had a higher prevalence of moderate and high WI ($p < 0.001$), whereas families living with severe food insecurity had a significantly higher proportion of high WI when compared with families in mild food insecurity and food security ($p < 0.001$).

The prevalence of BMI strata by WI cut-offs and sex is presented in Fig. 1. The prevalence of overweight and obesity increased with the worsening of WI. However, among women (Fig. 1a), this increase was statistically significant ($p < 0.001$), with the prevalence of overweight reaching its highest value at high WI (44.3%; 95% CI: 32.7–56.5) and the prevalence of obesity reaching its highest value at moderate WI (24.2%; 95% CI: 19.2–29.9). Among men (Fig. 1b), this relationship was not statistically significant ($p = 0.076$).

Table 1
Prevalence of body mass index (BMI)1 and socioeconomic and demographic characteristics according to water security and levels of water insecurity (WI)2. I Survey on Food Insecurity in the Municipality of Rio de Janeiro, Rio de Janeiro, Brazil, 2024.

Variables	No-to-marginal WI	Low WI	Moderate WI	High WI	*P*[3]
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	
BMI					0.001
Normal weight	47.8 (44.1–51.6)	18.3 (15.5–21.6)	26.0 (22.7–29.5)	7.9 (5.9–10.4)	
Overweight	41.6 (37.6–45.6)	20.3 (14.1–24.0)	29.9 (26.2–33.9)	8.2 (6.2–10.8)	
Obesity	29.6 (24.6–35.2)	21.1 (16.4–26.8)	38.7 (33.0-44.8)	10.6 (7.4–14.9)	
Age, y					< 0.001
20–39	40.2 (37.4–43.1)	19.8 (17.4–22.3)	31.3 (28.6–34.1)	8.7 (7.2–10.6)	
40–59	47.7 (44.5–51.0)	21.0 (18.3–24.0)	24.8 (21.9–27.8)	6.5 (5.0-8.5)	
Sex					0.602
Men	42.6 (39.4–45.9)	21.3 (18.7–24.5)	27.5 (24.6–30.7)	8.4 (6.6–10.6)	
Woman	43.4 (40.5–46.3)	19.7 (17.4–22.3)	29.5 (26.8–32.3)	7.4 (6.0-9.2)	
Skin colour					0.183
White	47.5 (43.7–51.3)	18.7 (15.8–22.0)	28.3 (22.9–29.9)	7.6 (5.6–10.1)	
Black	38.8 (34.5–43.4)	20.6 (17.0-24.7)	31.8 (27.6–36.3)	8.9 (6.6–11.7)	
Brown	43.7 (40.4–47.0)	21.0 (18.3–24.1)	27.9 (24.9–31.1)	7.4 (5.8–9.5)	
Education, years of study					< 0.001

Notes: [1]weight (kg)/height (m^2) classified according to the WHO cut-off points [26]; [2]According to the current WISE Portuguese version[6] and cut-offs according to Bose et al[25]; [3]P values refer to the $\chi 2$ test for differences in proportions; [4]per capita household income in minimum wages: R$ 1,320.00 Brazilian reals, or US $264.00 (2023–2024); [5]According to the Brazilian Household Food Insecurity Measurement Scale[27].

Variables	No-to-marginal WI	Low WI	Moderate WI	High WI	*P*[3]
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	
≤ 8	34.0 (30.2–38.0)	20.5 (17.2–24.3)	33.8 (29.9–37.9)	11.7 (9.2–14.8)	
> 8	47.5 (44.9–50.1)	20.2 (18.1–22.4)	26.2 (23.9–28.6)	6.2 (5.0-7.6)	
Per capita household income[4]					< 0.001
3rd tertile	62.4 (57.9–66.8)	21.7 (18.0–26.0)	14.3 (11.3–18.0)	1.5 (0.9–2.6)	
2nd tertile	48.0 (43.6–52.5)	19.2 (15.7–23.3)	28.0 (24.1–32.2)	4.8 (3.3–7.1)	
1st tertile	26.5 (23.6–29.7)	20.6 (17.8–23.7)	39.0 (35.6–42.5)	13.9 (11.6–16.6)	
Planning area of residence					< 0.001
Central	36.2 (32.4–10.2)	17.5 (14.7–20.8)	34.0 (30.3–37.9)	12.2 (9.8–15.2)	
South	58.0 (53.8–62.1)	16.7 (13.8–20.0)	18.6 (15.5–22.1)	6.8 (5.0-9.3)	
North	26.1 (22.5–30.0)	29.8 (26.0-33.8)	33.3 (29.4–37.4)	10.9 (8.5–13.9)	
Southwest	66.2 (62.0-70.2)	10.4 (8.1–13.4)	18.5 (15.4–22.2)	4.9 (3.3–7.1)	
West	49.5 (45.1–53.9)	14.5 (11.6–17.9)	31.7 (27.7–36.9)	4.4 (2.9–6.7)	
Food security and levels of food insecurity (FI)[5]					< 0.001
Food security	57.7 (55.0-60.3)	19.5 (17.4–21.8)	20.8 (18.8–23.1)	2.0 (1.4–2.9)	
Mild FI	23.2 (19.1–27.8)	21.3 (17.2–26.0)	45.9 (40.7–51.2)	9.6 (6.9–13.3)	

Notes: [1]weight (kg)/height (m^2) classified according to the WHO cut-off points [26]; [2]According to the current WISE Portuguese version[6] and cut-offs according to Bose et al[25]; [3]P values refer to the $\chi 2$ test for differences in proportions; [4]per capita household income in minimum wages: R$ 1,320.00 Brazilian reals, or US $264.00 (2023–2024); [5]According to the Brazilian Household Food Insecurity Measurement Scale[27].

Variables	No-to-marginal WI	Low WI	Moderate WI	High WI	*p*[3]
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	
Moderate/severe FI	10.1 (7.1–14.0)	23.1 (18.2–28.9)	37.3 (31.6–43.4)	29.5 (24.3–35.3)	

Notes: [1]weight (kg)/height (m^2) classified according to the WHO cut-off points [26]; [2]According to the current WISE Portuguese version[6] and cut-offs according to Bose et al[25]; [3]P values refer to the χ2 test for differences in proportions; [4]per capita household income in minimum wages: R$ 1,320.00 Brazilian reals, or US $264.00 (2023–2024); [5]According to the Brazilian Household Food Insecurity Measurement Scale[27].

The difference in the relationship between WI and BMI strata between men and women was modified after adjustment for socioeconomic and demographic factors (Table 2). Among women, only high WI remained significantly associated with overweight (aRRR = 2.06; 95%CI:1.00-4.25). For obesity, significant associations were observed for low WI and moderate WI, with RRRs of 2.14 (95%CI:1.20–3.81) and 2.06 (95%CI:1.24–3.45), respectively. Among men, only low WI was associated with overweight (aRRR = 1.80; 95%CI 1.05–3.08) and, in relation to obesity, significant associations were observed across all levels of exposure: low WI (aRRR = 2.16; 95%CI:1.08–4.31), moderate WI (aRRR = 3.04; 95%CI: 1.61–5.74), and high WI (aRRR = 2.92; 95% CI 1.15–7.39).

Table 2
Relative risk ratios (RRRs) and 95% confidence intervals (95%CIs) for the association of water insecurity (WI)1 levels with overweight and obesity status2, among women and men. I Survey on Food Insecurity in the Municipality of Rio de Janeiro, Rio de Janeiro, Brazil, 2024.

Variable	Women				Men			
	RRR (95CI%)	***P***	**aRRR[3] (95CI%)**	***P***	**RRR (95CI%)**	***P***	**aRRR[3] (95CI%)**	***P***
Overweight								
Low WI	1.19 (0.78–1.82)	0.409	1.25 (0.78–1.99)	0.347	1.31 (0.81–2.12)	0.226	**1.80 (1.05–3.08)**	**0.031**
Moderate WI	**1.47 (1.03–2.09)**	**0.034**	1.38 (0.92–2.07)	0.120	1.11 (0.73–1.71)	0.607	1.56 (0.94–2.57)	0.082
High WI	**2.16 (1.18–3.95)**	**0.013**	**2.06 (1.00-4.25)**	**0.049**	0.57 (0.29–1.11)	0.098	0.80 (0.35–1.80)	0.591
Obesity								
Low WI	**2.20 (1.28–3.78)**	**0.004**	**2.14 (1.20–3.81)**	**0.010**	1.46 (0.78–2.75)	0.236	**2.16 (1.08–4.31)**	**0.029**
Moderate WI	**2.83 (1.80–4.44)**	**< 0.001**	**2.06 (1.24–3.45)**	**0.005**	**1.93 (1.13–3.28)**	**0.016**	**3.04 (1.61–5.74)**	**0.001**
High WI	**3.23 (1.54–6.78)**	**0.002**	2.18 (0.89–5.38)	0.089	1.39 (0.65–2.96)	0.392	**2.92 (1.15–7.39)**	**0.023**

Notes: [1] According to the current WISE Portuguese version[6] and cut-offs proposed by Bose et al[25]; [2]According to the WHO cut-off points [26] considering normal weight as a reference category; [3]Ajusted for age (20–39 = reference category, 40–59), per capita household income (1st tertile= reference category, 2nd tertile, 3rd tertile), years of schooling (> 8 = reference category, < 8), area of residence (Central zone = reference category, South zone, North zone, Southwest zone, West zone) and food insecurity (food security; mild food insecurity; moderate/severe food insecurity).

Discussion

Research investigating the use of the WI indicator to capture water access in Brazil is recent. The first Portuguese version of the questions comprising WISE, used in this study, sparked interest among Brazilian researchers to complement the validation process of the Brazilian Water Insecurity Scale (in Portuguese "*Escala Brasileira de Insegurança Hídrica, EBIH"*) for use in population studies, which was recently completed but whose results are not yet available.

Beyond understanding how WI affects the Brazilian population, it is necessary to advance in the investigation of the effects and/or relationships between WI and health outcomes resulting from inadequate access to quality water. Thus, considering the results of this study on the association between WI and obesity among women and men from a representative urban sample in the municipality of Rio de Janeiro, this work expands the use of the scale for potential effects of inadequate water access on adequate and healthy food consumption. It is worth noting that this study focuses on one of Latin America's largest metropolises and one of Brazil's most economically prominent cities by GDP. Nevertheless, it exhibits high prevalence rates of food insecurity, which are unequally distributed across its territory[21].

As previously mentioned, evidence regarding the consequences of WI for nutritional outcomes is increasingly well-documented, with direct associations being consistently observed with increased consumption of sugar-sweetened beverages[28], reduction of consumption of fresh and minimally processed foods, accompanied by a consequent decrease in dietary diversity[29], and an increase in consumption of ultra-processed foods[30]. All these factors are associated with increased overweight among individuals. Connors et al.[31], using data from the annual Mexican National Health and Nutrition Survey (ENSANUT), found that a higher level of household WI was associated with a higher prevalence of self-reported noncommunicable diseases (NCDs) and NCD risk factors among Mexican adults. These findings highlight the need for improved water access and availability, positioning this as a still underrecognized strategy to mitigate the burden of NCDs. The effects of WI on diet changes were also observed among North American children and adolescents, resulting in an increase in sugar-sweetened beverages consumption and a rise in total calorie consumption[32].

A major reason why the role of WI in food insecurity and diet quality remains poorly understood is that experiences related to water access and use have traditionally not been measured[33]. A plausible hypothesis is that perceiving water as unsafe may lead to changes in dietary behaviors[34]. A systematic review found that the most frequent strategies used in a WI situation were modification of dietary intake patterns and the replacement of water by sugar-sweetened beverages[30].

This behavior was observed in a qualitative study conducted in Brazil as part of the EBIH validation process[35]. According to the authors, during water shortages, families living in São Cristóvão (a municipality in Sergipe, a state in Northeast Brazil) and in Rio de Janeiro reported changes in food preparation during focus groups. The focus group data further indicated that WI led to the preparation of simpler meals that required fewer utensils to wash afterward; families reported the need to purchase ready-to-eat foods and meals (e.g., frozen lasagnas, instant noodles, and sandwiches) and sodas for consumption instead of water, due to uncertainty regarding its quality[35].

Water scarcity also hinders food preparation, especially fresh and minimally processed foods that require water for various cooking stages. This can discourage their consumption and reduce dietary diversity, thereby limiting the intake of essential nutrients. Studies indicate that individuals may prefer to

consume foods requiring little to no water for preparation, such as ultra-processed foods, while decreasing the consumption of those that require more water for both preparation and cooking, such as grains and vegetables[36,37].

Miller et al.[38] also observed, in a study conducted in African countries, that experiences with suboptimal water access and use are associated with poor nutrition. In that study, it was noted that households also had to reorganize their practices when facing WI evaluated by WISE, prioritizing ultra-processed, less nutritious, and quick-to-prepare foods, such as sodas, cookies, and processed meats[38].

Lower dietary diversity is another effect of WI, given that food production is highly dependent on irrigated agriculture. According to the latest Agricultural Census conducted in 2017[39], Brazil has an irrigated area of 6,694,245 ha. Most rural properties rely directly on rainwater. However, the growing water crises that have occurred recently in some Brazilian regions—in addition to the recurrent, centuries-old droughts in the Brazilian Northeast Semi-Arid region—highlight the challenges of maintaining water resources. The municipality of Rio de Janeiro, where this study was conducted and the capital of the state of the same name, lacks the productive capacity to supply food to its entire population, leaving the metropolitan area of Rio de Janeiro State responsible for meeting this demand[40].

During water shortages, food and nutritional security is commonly compromised due to a lower diversity of foods available for human consumption. This impact is greater among households with lower per capita income, who live in economically unequal territories and face disparities in access to water and basic sanitation, given the need to restrict the preparation of diverse meals due to a lack of cooking water[38]. Additionally, it is worth noting that the metropolitan region of Rio de Janeiro experiences a paradox: despite being located within one of the world's largest river basins for urban supply, the resident population lives under vulnerable conditions regarding access to basic sanitation and water supply[41].

Beyond food consumption, experiencing certain aspects of WI increases the likelihood of mental health impacts. A systematic review, which included a total of 25 studies involving 23,103 participants from 16 countries spanning Africa, Asia, and the Americas, demonstrated a statistically significant association between WI and common symptoms of mental disorders[42]. In a systematic review evaluating how food insecurity may be associated with NCDs in Brazil, Laurentino et al.[43] indicated that psychological alterations (such as fear, uncertainty, anxiety, depression, and others) are mediated by the presence of food insecurity, thereby being associated with changes in dietary behavior. According to the authors, this represents one of the pathways linking food insecurity to obesity in Brazil. Consequently, given that WI is also linked to mental disorders symptoms, it is plausible to consider this pathway as another stress-induced mechanism contributing to obesity.

It is also important to highlight that territories with greater social vulnerability presented a higher prevalence of WI. These areas are also characterized by inequalities in access to healthy foods[44], featuring a higher presence of food deserts[45], and are perceived by their residents as having low

availability of fresh and minimally processed foods alongside affordable UPF prices[22]. This scenario points to a combination of factors within the territory that help explain the relationship between WI and obesity, suggesting that part of this association can be attributed to the scarcity of resources and infrastructure in the most vulnerable areas.

In large Latin American metropolises like Rio de Janeiro, in addition to inequalities in food environments and barriers to food access, the territory is characterized by high levels of urban violence. This violence directly affects its population's lifestyles, which can result in poorer conditions for physical activity and higher chances of obesity[46]. Also, a consequence of these territorial inequalities in Rio de Janeiro, poorer health conditions and difficulties in accessing care are found in low-income residential areas, such as favelas. These areas are commonly dominated by organized crime groups, which influence local infrastructure and water access[47].

Regarding the differences in the association between WI and obesity between men and women, this study observed that WI affects them distinctly, which may impact diet quality in different ways. According to a report by the Trata Brasil Institute (in Portuguese "*Instituto Trata Brasil*", 2022)[48] based on data from the Continuous National Household Sample Survey, the average income of women living in households without access to treated water was 45.1% lower than that of women residing in households with access to this service. According to Wutich[49], when facing WI, women prioritize other household members in a manner similar to what occurs with food insecurity, even exposing themselves to dehydration and other illnesses for the benefit of others. Women also report conserving more water during food preparation compared to men engaged in the same activity, and this water conservation may be linked to choices involving ready-to-eat foods[38].

This study has limitations. It is part of a broader research initiative examining the relationship between WI and food insecurity, and it was not specifically designed to assess the relationship between WI and obesity. Another limitation is that, due to its cross-sectional design, it is not possible to establish causal inference regarding the temporality between the occurrence of WI and obesity. Additionally, it is important to consider that obesity is a multifactorial condition influenced by biological, behavioral, socioeconomic, and environmental factors. Although the analyses adjusted for important confounders (food insecurity and sociodemographic factors), residual confounding cannot be ruled out. Unmeasured factors, such as physical activity, dietary patterns, food purchasing behaviors, and neighborhood characteristics, may have influenced the observed associations.

Furthermore, the mechanisms linking WI to obesity are likely indirect and mediated through pathways such as food insecurity, dietary quality, stress, and coping strategies. Because these pathways were not directly examined, the present findings cannot identify the mechanisms underlying the observed associations. Despite these limitations, this study provides strong evidence suggesting that household WI may be an important social determinant of obesity and other nutrition-related health outcomes.

Conclusion

To the best of our knowledge, this is the first study to evaluate the relationship between WI and obesity in Brazil, making these findings an important milestone for the debate on utilizing WISE as a tool to monitor water access among the Brazilian population.

In partnership with the Extraordinary Secretariat for Combating Hunger and Food Insecurity (in Portuguese "*Secretaria Extraordinária de Combate à Fome e à Insegurança Alimentar"*) of the Ministry of Development and Social Assistance, Family, and Fight Against Hunger (in Portuguese "*Ministério do Desenvolvimento, Assistência Social, Família e Combate à Fome - MDS"*), Brazilian researchers recently completed the validation process of the EBIH after semantic adjustments to the wording of several questions and the recommendation of a dichotomous format for population surveys[50]. The internal validity results, derived from exploratory and confirmatory factor analyses, were presented at an expert meeting on the topic in Brasília in May 2026. As one of the outcomes of this meeting, experts and MDS representatives suggested testing the external validity of WI captured by the EBIH to subsequently recommend its implementation in a national survey.

Taken together, the findings of this study reinforce the need for longitudinal and mechanistic research to elucidate the pathways linking household WI to obesity, one of the most prevalent chronic conditions and a major risk factor for NCDs. A better understanding of these pathways may help clarify the role of WI as a social determinant of health and inform the development of more effective policies and interventions. Furthermore, incorporating household WI into national monitoring systems could strengthen the assessment of the country's progress toward achieving the SDGs, while enabling timely policy adjustments and more targeted interventions to reduce social and health inequalities[10].

Abbreviations

WI
Water Insecurity
FI
food insecurity
RRR
relative risk ratios
aRRR
adjusted relative risk ratios
SDG
Sustainable Development Goal
HWISE
Household Water Insecurity Experiences Scale
WISE
Water Insecurity Experiences Scale
UPF
ultra processed foods

VIGITEL
Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico
GDP
gross domestic product
CI
confidence interval
WHO
World Health Organization
BMI
body mass index
EBIA
Escala Brasileira de Insegurança Alimentar
P
p value
EBIH
Escala Brasileira de Insegurança Hídrica
NCD
noncommunicable diseases
MDS
Ministério do Desenvolvimento, Assistência Social, Família e Combate à Fome MDS

Declarations

Ethics approval and consent to participate:

This study followed the guidelines of Brazilian National Health Council Resolution No. 510/2016 and was approved by the Research Ethics Committee of the Clementino Fraga Filho University Hospital at the Federal University of Rio de Janeiro in May 2022 (CAAE: 54473421.6.0000.5257).

Consent for publication:

All authors gave their consent for publication.

Competing interests:

None

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Author Contribution

RS-C, AAF, ACFS, PCPCJr, and JB-L participated in the manuscript conception; RS-C was responsible for the study conception, wrote the manuscript, and had primary responsibility for the final content; AAF, JB-L, PCPCJr : collaborated in the interpretation of the results, wrote and revised the final content of the manuscript; SCFS and PCPCJr : contributed to the interpretation of the findings, critically reviewed several manuscript versions, and the writing of the final version; JB-L, LTG and JCB had responsibility for the analysis, prepare the Tables and Figure, and wrote the original draft. All authors reviewed the manuscript.

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None.

Data Availability

Data cannot be shared publicly because of confidentiality. Data are available for researchers who participated in the “I Survey on Food and Nutritional Insecurity in the Municipality of Rio de Janeiro”.

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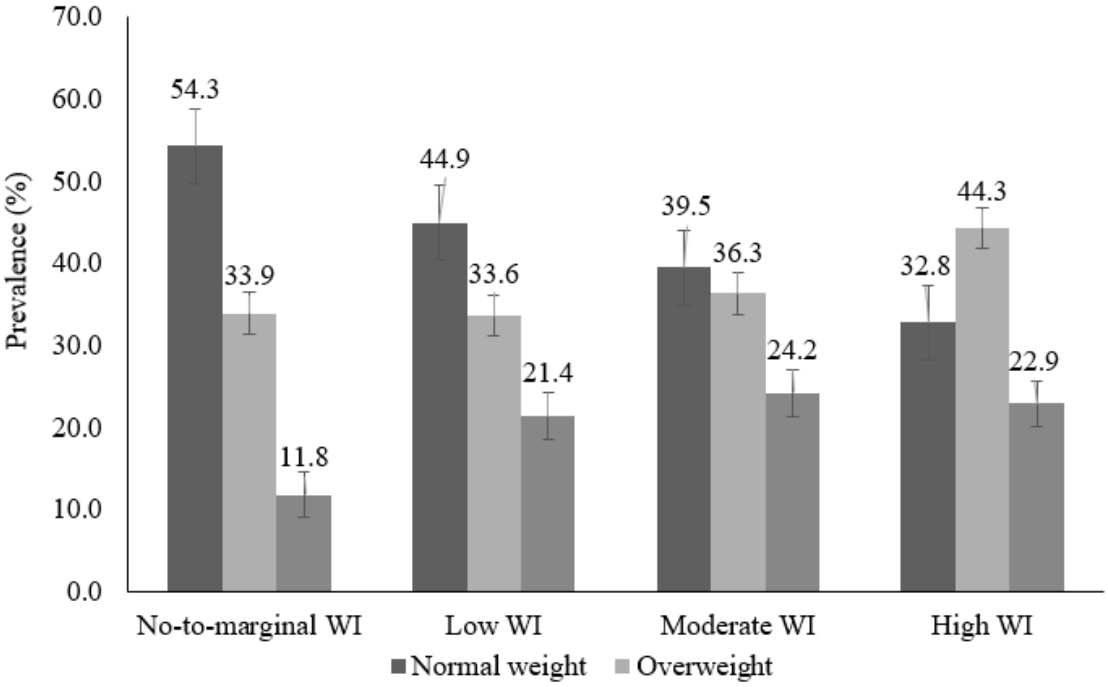
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Figures

1a) Women[3]



1b) Men[4]

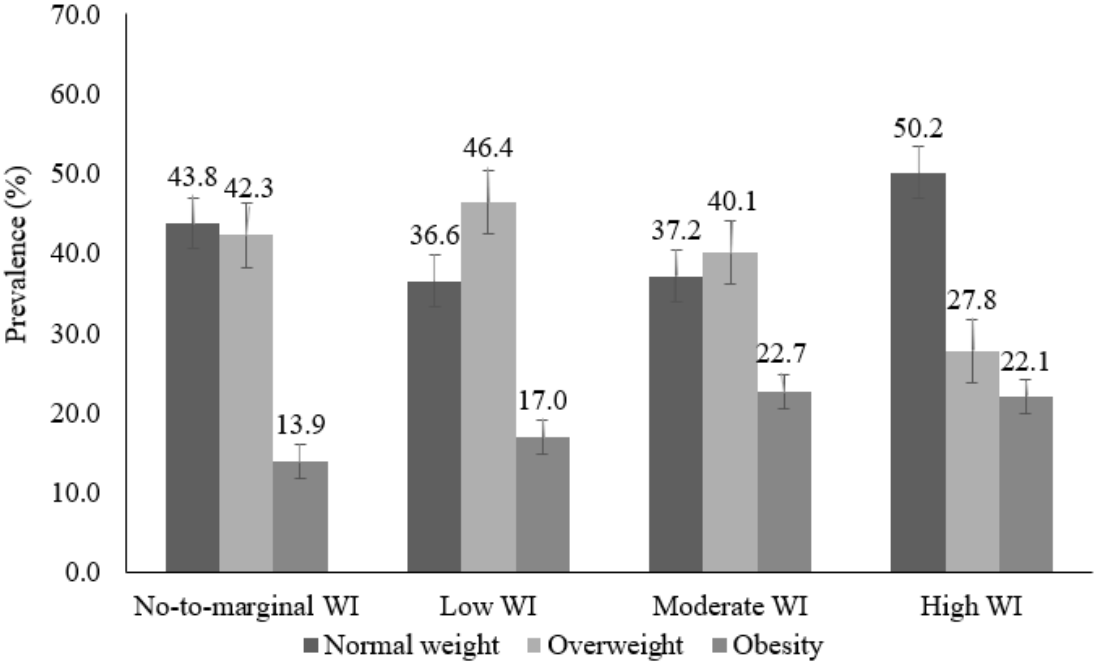


Figure 1

Prevalence of nutritional status[1] according to water insecurity (WI)[2] levels among men and women. I Survey on Food Insecurity in the Municipality of Rio de Janeiro, Rio de Janeiro, Brazil, 2024.

Notes:[1]According to the WHO cut-off points[26]; [2]According to the current WISE Portuguese version[6] and cut-offs according to Bose et al[25]; [3] $p < 0.001$ (women); [4]$p = 0.0706$ (men), estimated considering the $\chi 2$ test for differences in proportions.