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Research article

Association between food insecurity and obesity in an agricultural community of women from El Jadida, Morocco

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Abstract: Background: Food insecurity (FI) has received much attention in the last decades due to its strong association with obesity. Indeed, it has begun to be a serious concern, especially in developing countries undergoing a nutritional transition. **Objective**: The aim of this study was to examine the association between FI, food intake and the risk of obesity in an agricultural community of women from El Jadida Province in Morocco. **Materials and methods**: The survey included a sample of 214 women. Weight and height were measured, and the body mass index was calculated. FI was measured using a household FI access scale. Food intake was evaluated using two 24-hour dietary recalls. Variance tests and Chi-square tests are applied for means ± standard deviations comparisons and proportions with percentages of continuous and categorical variables, respectively. **Results**: The female population surveyed had an average age of 44 ± 13 years, 42% were obese, 36% were overweight, and 86% were centrally obese (CO). FI was observed in 78% of the sample, and it is found to be associated with both overweight, general obesity (GO) and CO ($P \leq 0.001$). The risk of GO was extremely high in women with mild FI (unadjusted OR = 31.33, 95% CI: 7.01, 140.06). This association remained high after adjustment for socio-demographic variables (adjusted OR = 24.98, 95% CI: 5.36, 116.35). Compared with food secure women, the risk of CO was significantly higher in women with moderate FI (unadjusted OR = 16.44, 95% CI: 3.56, 75.91). This association remained significant after adjustment for socio-demographic variables (OR adjusted = 36.51, 95% CI: 4.81, 276.7). FI was associated with high daily energy ($P < 0.013$) and low iron

intakes (P < 0.019). **Conclusion**: There is a high prevalence of FI associated with overweight, GO and CO and with high energy intake among the rural female population. Hence, intervention programs must consider food security in the fight against obesity and its associated problems, by ensuring women's access to a variety of high quality foods and the achievement of a balanced diet at the local and national levels.

Keywords: food insecurity; general obesity; central obesity; dietary intake; women; Morocco

Abbreviations: FI: Food insecurity; GO: General obesity; CO: Central obesity; OR: Odds ratio; CI: Confidence interval; FAO: Food and Agriculture Organization; WHO: World Health Organization; WC: Waist circumference; BMI: Body mass index; HFIAS: Household Food Insecurity Access Scale; USAID: United States Agency for International Development; SPSS: Statistical package for the social sciences; SD: Standard deviations

1. Introduction

Food insecurity (FI) is a serious public health problem affecting millions of households worldwide [1]. Globally, according to the latest estimates from the Food and Agriculture Organization (FAO), the prevalence of moderate and severe FI is estimated at 16.3% and 9.7% respectively [2]. In the MENA region, FI was estimated in adult population at 9.5% between 2014 and 2015 by FAO and with an increase in the following five years[3,4]. In North Africa, this prevalence is estimated at 19.9% and 8.7% respectively [2].

As stated in Sustainable Development Goal 2, the different dimensions of food security are food availability, food access and food stability. Drivers of FI, including low productivity, reduced purchasing power, and inefficient production systems cause various forms of malnutrition [5]. Malnutrition, the most important outcome of FI, can adversely effect the health of different vulnerable groups, especially women and children [6,7]. In women, it results in foetal malnutrition and low birth weight of babies, and adult malnutrition leads to lower productivity on farms and in the labour market [8,9]. Recent studies indicate that mothers living in food insecure households are likely to limit their dietary intake to ensure that their children are being well-fed [10], which can compromise their nutritional status and lead to low intakes of energy and essential nutrients [11]. This can also lead to high energy and low nutrient density intakes. As a result, FI can induce under-nutrition or over-nutrition or a coexistence of both at the individual or household level, which is called double burden of malnutrition [12].

Unfortunately, and to our knowledge, the data on the prevalence of FI are lacking in Morocco. The only available study was conducted in 2013 in the city of Casablanca reporting that 70.9% of households were living with different degrees of FI including 37.4% in severe FI [13]. In addition, attention has been focused on the association of FI with general obesity (GO) for decades [14,15]. The latter is defined as an abnormal or excessive accumulation of body fat caused by a continuous imbalance between the intake and expenditure of energy in an individual [16]. In the Moroccan population, the prevalence of overweight and GO has been estimated at 53% and 20% respectively [17].

On the other hand, food insecure households have an unbalanced diet that does not provide energy and nutrients in the proportions necessary for normal growth [18]. Studies have shown that

women in FI are more likely to be obese than women who are food secure [18,19]. In developing countries, this relationship is attributed to the nutrition transition, due to the adoption of a lower-quality diet rich in sugar and fat and lifestyle changes characterized by a more sedentarily [20,21]. A diet rich in energy and low in nutrients has also been associated with both GO and FI [22]. These two public health problems are paradoxically linked to each other and are thought to affect the most marginalized communities [23,15].

The aim of this study was therefore to determine the prevalence of FI and to examine the association between FI, risk of obesity, and dietary intake in an agricultural population of women living in El Jadida province of Morocco.

2. Materials and methods

2.1. Study population

This prospective study was conducted over the period from the first of March 2017 to 31 August 2017 on 214 women in the urban and rural areas, aged 18 years old and over, resident in El Jadida province for more than 6 months. Pregnant women at the time of the interview are excluded.

A structured questionnaire was used to collect data on demographic and socio-economic characteristics, anthropometric measures, state of household food security and dietary intakes.

2.2. Socio-demographic and socio-economic characteristics

The participant's socio-demographic and socio-economic status were collected through the structured interviews including, age, marital status, number of children alive, area of residence, number of pregnancies, household size and household income.

2.3. Anthropometric parameters

These parameters were measured on participants according to the World Health Organization (WHO) standards [24]. Hence, weight was measured in light clothing and without shoes to the nearest 0.1 kg on a mechanical scale SECA. The height was measured in the participants to the nearest 0.1 cm using a wall tape with their heels joined, straight legs, arms dangling and shoulders relaxed.

The waist circumference (WC) was measured on the respondents stand with feet 2.5 cm apart, legs straight, arms dangling, and shoulders relaxed, the measuring tape was placed uncompressed at midway between the iliac crest and the last rib, at the end of expiration. Women that have WC $\geq$ 88 cm are considered suffering from central obesity [25].

The amount and distribution of body fat were assessed by measuring the thickness of the subcutaneous adipose tissue with a Lange Skinfold Calliper. The Skinfold thickness was measured on the left side of the body at four sites: biceps and triceps (limb), sub scapular and supra-iliac (trunk). The sum of the four skinfold thickness measures were considered as an indicator of total subcutaneous fat.

The body mass index (BMI), a measure that estimates the fat mass of individuals, was calculated by dividing the weight in kg by the square of the height expressed in meters:

BMI = Weight (kg)/height^2 (m^2). Classified into the four BMI categories, according to the WHO [26], the participants were considered underweight when BMI < 18.5, normal weight when 18.5 ≤ BMI < 25, overweight if 25 ≤ BMI < 30 and obese if BMI ≥ 30.

2.4. Measure of FI

The Household Food Insecurity Access Scale (HFIAS) was used to estimate FI in this study of population [27]. It is an indicator originally developed by the Food and Nutrition Technical Assistance Project of the United States Agency for International Development (USAID). It is about estimating the degree of FI from the answers given to the questions in the household's food access scale during the last four weeks preceding the interview. The HFIAS is composed of 9 questions reported according to four levels of exposure (often, sometimes, rarely and never). The responses mentioned are given a code of 3, 2, 1, or 0 respectively. The maximum score for a household is 27 (the household's response to all nine questions was "often", coded as 3) and the minimum score is 0 (the household never answered all the questions of occurrence). Households can also be divided into four categories to describe the prevalence of FI, namely: food security (0–1 point), mild FI (2–7 points), moderate FI (8–14 points) and severe FI (15–27 points). Higher scores mean greater FI [28].

2.5. Dietary intake assessment

Data on dietary intake are collected using two 24-hour dietary recalls (one on a weekday and one on the weekend). Participants were asked to remember all foods and beverages consumed the day before the interview. The respondents also indicate the consumed quantities and the type of meal. Food intakes were converted to estimate energy and their composition in nutrient intakes using the Bilnut program (S.C.D.A. NUTRISOFT-BILNUT, version 2.01). The values obtained were then compared to the reference nutrient intakes.

2.6. Statistical analysis

Data analysis was performed using SPSS (Statistical Package for the Social Sciences) for Windows version 23.0. Descriptive analysis was conducted to determine the characteristics of the participants in this study, namely the socio-demographic variables, anthropometric measures, FI measurement and dietary intake. Variance tests (ANOVA) and Chi-square tests are applied for means ± standard deviations and proportions with percentages of continuous and categorical variables, respectively. The Bonferroni correction for multiple comparisons is applied using simultaneous confidence intervals to determine significant differences between class means.

In addition, a logistic regression analysis was performed to explore the association between FI with obesity status (BMI ≥ 30 kg/m^2) and with WC at risk (≥88 cm). The results of logistic regressions were expressed in odds ratio (OR) adjusted with a 95% as confidence interval (CI). P values below 0.05 are considered statistically significant for all tests.

2.7. Ethical aspects

The questionnaire used in this study was validated by a scientific committee of the Chouaib Doukkali University of El Jadida and the data collection was started after receiving an authorization from the Province of El Jadida in Morocco. The free and informed written consent was obtained from all participants before beginning the survey. The procedures and objectives of the study were also clearly explained to the participants. The confidentiality and anonymity of the information collected were also respected.

3. Results

The involved respondents' average age was 44 ± 13 years, 42% of them were obese, 36% overweight and 86% have CO (WC ≥ 88 cm). 78% of the participants experience different levels of FI, among them mild FI in 31.3%; moderate FI in 25.7% and severe FI among 21%. Only 22% of the respondents are in food security.

3.1. Socio-demographic characteristics

As shown in Table 1, the women with higher number of pregnancies and with children alive are more likely to be in household with FI. Similarly, women living in the rural area are more in severe FI compared to those living in the urban area ($P < 0.014$).Household with a higher size are likely to be in mild and severe FI.

Concerning the marital status of the respondents, the Table 1 shows clearly that single or married women are more in mild or moderate FI compared to widowed or divorced women ($P \leq 0.001$). Also, severe FI is associated with low monthly incomes while higher level of income is found to be linked with lower risk of FI in the women sample ($P \leq 0.001$).

3.2. Anthropometric parameters by household FI status

The Table 2 results show that the anthropometric parameters were significantly higher for women in FI than those in food security. Moreover, the risk of overweight, GO and CO was significantly higher for women living in households with FI than those living in food security ($P \leq 0.001$).

Table 1. Household FI according to sociodemographic characteristics.

Variables		Food secure (n = 47)	Mild FI (n = 67)	Moderate FI (n = 55)	Severe FI (n = 45)	Total (n = 214)	P-value
Number of children alive	Mean ± SD	2.49 ± 1.97	3.67 ± 1.68	2.81 ± 1.94	4.02 ± 2.50	3.29 ± 2.08	**≤ 0.001**
Number of pregnancies		2.90 ± 1.82	4.11 ± 2.00	3.26 ± 2.13	4.84 ± 3.04	3.81 ± 2.36	**≤ 0.001**
Household size		5.45 ± 2.54	6.06 ± 2.24	4.76 ± 1.85	5.73 ± 2.00	5.52 ± 2.21	**0.012**
Area of residence n (%)	Urban	13 (27.7)	24 (35.8)	21(38.2)	5 (11.1)	63 (29.4)	**0.014**
	Rural	34 (72.3)	43 (64.2)	34 (61.8)	40 (88.9)	151 (70.6)	
Marital status n (%)	Single or married	39 (83)	59 (88.1)	48 (87.3)	35 (77.8)	181 (84.5)	**≤ 0.001**
	Widowed or separated	8 (17)	8 (11.9)	7 (12.7)	10 (22.2)	33 (15.5)	
Family income n (%)	Low	35 (74.5)	34 (50.7)	30 (54.5)	40 (88.9)	139 (65)	**≤ 0.001**
	Medium or high	12 (25.5)	33 (49.3)	25 (45.5)	5 (11.1)	75 (35)	

Note: Adjustment for multiple comparisons: Bonferroni. The mean difference is significant at the 0.05 level. Area of residence, arital status and Family income were all significantly related to Household food insecurity using a Chi-square analysis ($P < 0.05$). Abbreviations: SD: Standard deviation; N: Number; FI: Food insecurity.

Table 2. Anthropometric measurements and prevalence of general and central obesity by household FI.

Variables		Food secure (n = 47)	Mild FI (n = 67)	Moderate FI (n = 55)	Severe FI (n = 45)	Total (n = 214)	P-value
BMI	Mean ± SD	23.60 ± 3.1	31.33 ± 4.8	30.50± 4.81	31.08± 5.23	29.37 ± 5.5	**≤ 0.001**
WC		90.67 ± 12.8	103.09 ± 13.3	104.96 ± 13.1	99.84 ± 20.3	100.16 ± 15.7	**≤ 0.001**
Sum of all Skinfold thicknesses (mm)		66.52 ± 21.4	79.98 ± 26.8	90.06± 27.2	85.78± 25.7	80.63 ± 26.7	**≤ 0.001**
BMI n (%)	Normal weight	41 (87.2)	2 (3)	3 (5.5)	1 (2.2)	47(22)	**≤ 0.001**
	Overweight	4 (8.5)	26 (38.8)	27 (49.1)	20 (44.4)	77 (36)	
	Obese (GO)	2 (4.3)	39 (58.2)	25 (45.5)	24 (53.3)	90 (42)	
WC n (%)	WC < 88 cm	18 (38.3)	3 (4.5)	2 (3.6)	7 (15.6)	30 (14)	**≤ 0.001**
	WC ≥88 cm (CO)	29 (61.7)	64 (95.5)	53 (96.4)	38 (84.4)	184 (86)	

Note: For body mass index (BMI) groups: low BMI ≤ 18.5 kg/m^2; normal BMI = 18.5 to <25 kg/m^2; overweight BMI = 25 to <30 kg/m^2; obese or general obesity (GO) if BMI ≥ 30 kg/m^2. For waist circumference (WC): central obesity (CO) when (WC ≥ 88 cm). Adjustment for multiple comparisons: Bonferroni. The mean difference is significant at the 0.005 level. Abbreviations: SD: Standard deviation; N: Number; BMI: Body mass index; WC: Waist circumference; FI: Food insecurity.

3.3. General and central obesity risk by household FI

As shown in Table 3, the risk of GO is exceedingly high in women with mild FI (unadjusted OR = 31.33, 95% CI: 7.01, 140.06). This association remained high after adjusting for the number of children alive, the number of pregnancies, the household size, the marital status, the monthly income and the area of residence (adjusted OR = 24.98, 95% CI: 5.36, 116.35). In addition, women in moderate FI were more likely to have a risk of CO than women in food security (unadjusted OR = 16.44, 95% CI: 3.56, 75.91). This association remains significant after adjustment for the socio-demographic variables (OR adjusted = 36.51, 95% CI: 4.81, 276.7).

Table 3. General and central obesity risk (odds ratio) by household FI in El Jadida.

FI category	n	GO (n = 90)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	CO (n = 184)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Food secure	47	2	1.00 (ref)	1.00 (ref)	29	1.00 (ref)	1.00 (ref)
Mild FI	67	39	31.33*** **(7.01, 140.06)**	24.98*** **(5.36, 116.35)**	64	13.24*** **(3.61, 48.51)**	11.76*** **(2.54, 54.33)**
Moderate FI	55	25	18.75*** **(4.13, 85.09)**	16.75*** **(3.50, 79.98)**	53	16.44*** **(3.56, 75.91)**	36.51*** **(4.81, 276.7)**
Severe FI	45	24	25.71*** **(5.55, 119.07)**	18.23*** **(3.73, 89.01)**	38	3.36** **(1.24, 9.14)**	2.11 **(0.60, 7.33)**

Note: Food insecurity model is adjusted for age, number of children alive, number of pregnancies, family size, family income, marital status and area of residence. Multiple logistic regression models with polynomial contrast were used to generate P for trend. Significance levels: *P < 0.05; **P < 0.01; ***P < 001. Abbreviations: N: Number; OR: Odds ratio; CI: Confidence interval; GO: General obesity; CO: Central obesity; FI: Food insecurity.

3.4. General and central obesity according to sociodemographic characteristics

The Table 4 results show that women with higher number of pregnancies and children alive, and single or married are more likely to be in household with general and CO.

Table 4. General and central obesity according to sociodemographic characteristics.

Variables		BMI			P-value	WC		P-value
		Normal weight	Overweight	Obese		WC < 88 cm	WC ≥ 88 cm	
Number of children alive	Mean ± SD	2.46 ± 2.02	2.95 ± 1.62	3.96 ± 2.26	**≤ 0.001**	2.36 ± 2.2	3.41 ± 2.03	**0.017**
Number of pregnancies		3 ± 2.13	3.33 ± 1.74	4.58 ± 2.69	**≤ 0.001**	2.48 ± 2.1	3.99 ± 2.33	**0.003**
Household size		5.4 ± 2.53	5.36 ± 2.1	5.72 ± 2.14	0.534	5.03 ± 2.34	5.6 ± 2.19	0.192
Area of residence n (%)	Urban	14 (29.8)	24 (31.2)	25 (27.8)	0.89	10 (33.3)	53 (28.8)	0.379
	Rural	33 (70.2)	53 (68.8)	65 (72.2)		20 (66.7)	131 (71.2)	
Marital status n (%)	Single or Married	41 (87.3)	60 (77.9)	80 (88.9)	**≤ 0.001**	22 (73.4)	159 (86.4)	**≤ 0.001**
	Widowed or separated	6 (12.8)	17 (17.1)	10 (6.6)		8 (26.7)	25 (13.6)	

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Variables		BMI			P-value	WC		P-value
		Normal weight	Overweight	Obese		WC < 88 cm	WC ≥ 88 cm	
Family income n (%)	Low	35 (74.5)	48 (62.3)	56 (62.2)	0.376	21 (70)	118 (64.1)	0.598
	Medium or high	12 (25.6)	29 (37.7)	34 (37.8)		9 (30)	66 (35.9)	

Note: Adjustment for multiple comparisons: Bonferroni. The mean difference is significant at the 0.05 level. The mean difference is significant at the 0.005 level. Marital status was significantly related to Household food insecurity using a Chi-square analysis ($P < 0.05$). Abbreviations: SD: Standard deviation; N: Number; BMI: Body mass index; WC: Waist circumference.

3.5. Daily nutrient intakes by household FI

The Table 5 shows that women with FI have a significantly higher daily intake of energy than women in food security ($P < 0.013$), while iron intakes were lower for participants with severe FI ($P < 0.019$).

Table 5. Mean (± SE) of daily nutrient intakes by household food insecurity in El Jadida.

Nutrients (RDA)	Food secure (n = 47)		Mild FI (n = 67)		Moderate FI (n = 55)		Severe FI (n = 45)		Total (n = 214)		P-value
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Energy (2200 kcal)	2413.6	878.2	2716.4	990.1	3134.8	1502.2	2691.1	946.3	2752.1	1136.6	**0.013**
Carbohydrates (130 g)	447.27	624.66	508.70	877.53	457.84	869.72	381.45	609.59	455.38	770.37	0.865
Proteins (46 g)	203.41	209.51	315.27	946.56	347.07	643.80	246.60	715.77	284.44	707.87	0.731
Fat	176.8	208.4	216.6	411.5	362.5	894.1	202.8	611.3	242.5	589.0	0.363
Iron (18 mg)	13.5	11.6	27.0	44.0	18.5	19.4	12.6	8.8	18.8	27.9	**0.019**
Calcium (1000 mg)	692.4	447.4	697.9	486.9	816.7	499.8	782.7	627.7	745.0	514.2	0.502
Sodium (1500 mg))	3083.1	1810.6	3261.0	2321.0	3528.7	2391.0	3167.2	2081.0	3271.0	2179.1	0.750
Potassium (4700 mg)	2597.1	1587.8	2767.2	1646.5	2622.2	1683.0	2840.0	1299.9	2707.9	1568.7	0.848
Magnesium (310–320 mg)	333.9	219.7	377.5	279.6	449.0	298.8	411.6	320.6	393.5	283.3	0.205
Vit C (75 mg)	91.3	132.7	98.2	103.3	87.5	113.7	80.2	98.6	90.2	111.6	0.865
Vit E (15 mg)	4.1	7.1	18.9	82.1	20.8	72.8	12.8	66.7	14.9	66.3	0.582
Vit B1 (1.1 mg)	3.0	9.2	3.7	11.0	3.9	8.0	2.2	6.1	3.3	9.0	0.774
Folate (400 µg)	273.8	163.4	315.2	345.5	273.4	190.5	340.6	527.5	300.7	331.9	0.695

Note: RDA: Recommended Dietary Allowance. Food and Nutrition Board. Institute of Medicine. National Academies. 2010. Adjustment for multiple comparisons: Bonferroni. The mean difference is significant at the 0.005 level. Abbreviations: SE: Standard error; RDA: Recommended Dietary Allowance; FI: Food insecurity; N: Number.

4. Discussion

The data reports that the study female population is mostly overweight (36%) or obese (42%) with 86% of the participants having CO. The results report also that 78% of the respondents were in FI and that the risk of GO is extremely high for women with mild FI (unadjusted OR = 31.33, 95% CI: 7.01, 140.06). This association remained high after adjustment for the socio-demographic variables (adjusted OR = 24.98, 95% CI: 5.36, 116.35). Compared to women with food security, the risk of CO is markedly high among women with moderate FI (unadjusted OR = 16.44, 95% CI: 3.56, 75.91), which association is significant after adjustment for the socio-demographic variables (OR adjusted = 36.51, 95% CI: 4.81, 276.7).

Morocco is a developing country undergoing an epidemiological and nutritional transition accompanied by a change in lifestyles with changes in the dietary pattern [29]. In addition, the prevalence of GO is continuously and dramatically increasing over the last decades, especially among women [29]. The prevalence of GO in the present study are higher than that reported in previous studies conducted on the female population in the same region, which also showed that GO was higher in urban than in the rural areas [30]. In addition, the same studies reported that BMI and WC were associated with several risk factors for cardiovascular disease, including high blood pressure and diabetes [31]. This prevalence is also higher than that reported in 2017 by WHO at national level and by in another study conducted in the southern region of Morocco [17,32]. The increase in the rate of GO at local and national levels could be linked, in part to the nutrition transition undergoing in Moroccan which is associated with changes in diet rich in energy, sugar and fat and with a sedentary lifestyle [33].

Information on socio-demographic characteristics collected here shows that women in FI have more children alive ($P \leq 0.001$). The number of children can contribute to FI. Indeed, having more children will increase not only the child's education and health costs, but also the overall household expenditures [34]. Furthermore, our results revealed that both mild and severe FI were associated with higher household size ($P < 0.012$), which corroborates with several studies that found an increase in FI with increasing household size due to limited resources [35]. A larger household may, in fact, run out of food because food needs increase with household size, thus increasing the risk of FI [34,36].

The results of this study also showed that low household income is significantly associated with severe FI. This is consistent with many studies in developed and developing countries reporting that low income is a risk in food insecure households [37,38]. Furthermore, due to low income, poor households have less purchasing power, not allowing them to provide sufficient and diverse food for the household [39].

Furthermore, the results indicate that women living in rural areas are more affected by severe FI than those living in urban areas. Indeed, FI is often considered a rural phenomenon, especially in lower-middle-income countries [40]. Nevertheless, recent studies have shown that urbanization may also contribute to FI, especially in the monetary economies where urban and suburban households rely primarily on stable access to income for their health and well-being [41]. In our study, mild and moderate FI was also associated with married or single women status ($P < 0.001$). Related to this finding, the American NHANES study (1999–2002) analysed the role of marital status in the relationship between weight status and FI, and found that only married or widowed women had marginal risk of FI and higher obesity than single women [42,14].

On the other hand, data from the present study show that FI was strongly associated with GO. These findings are consistent with those of several studies that have shown that women in FI may experience cyclical overeating and dietary restriction as they attempt to protect their children from FI [42,43]. This puts them at risk for FI and GO [44]. In addition, to manage their family's diet on a limited budget, women living in FI may skip meals and choose inexpensive, low- micronutrient, high energy foods over nutrient-rich foods to limit their hunger, which can increase their energy intake and lead to weight gain [45].

The results of our study also show that women with FI have significantly higher daily energy intake than food secure women ($P < 0.013$). Similarly, Jomaa et al. (2017) reported an association of food insecurity in mothers with a high percentage of daily energy intakes [46]. In terms of macronutrient intakes, there was no significant difference between food secure and food insecure women studied probably because intakes are generally already high relative to RDAs in all groups. In contrast, iron intakes were lower among participants in severe FI ($P < 0.019$). Consistent with these findings, data from the Canadian Community Health Survey revealed lower intakes of essential nutrients, particularly iron and calcium, in individuals with FI compared with food security [47]. The U.S. NHANES survey found no difference in energy intake, but high energy meals among food insecure women [48]. Other studies have shown a negative impact of FI on the quality of women's diets due to the lack of dietary diversity and thus a lack of nutrients [45,49]. All these reported studies and the current data highlight the serious problem of diet quality, rich in energy but low in nutrients, and their association with FI and weight gain.

Previous national studies assessing the prevalence of obesity in Morocco had not assessed the association between FI, GO, and dietary intake among women. This study aimed to assess the prevalence and association between FI, GO, and dietary intake among women in El-Jadida province.

The results of this study would be significant, especially for similar middle-income countries, as they could help policymakers and public health professionals design interventions to improve women's nutrition and health and address FI and GO among high-risk population groups. In addition, it would be interesting to explore in depth the factors affecting FI and to study the promoting role of nutrition education in changing women's behaviours toward certain dietary habits combating obesity.

5. Limitations of the study

The main limitations of this study are the small sample size. In addition, although relevant, the results of this study are not representative of the entire adult female population of Morocco. Extending this study to a larger representative sample would be wise to generalize the results obtained. Finally, we performed two 24-hour dietary recalls which are prone to inevitable errors in this method of dietary assessment which depends on women's memory and which can lead to under or over reporting of intakes. However, we attempted to minimize this margin of error through our concise interview with participants to more accurately determine the amount of servings of food ingested.

6. Conclusions

In conclusion, this study is, to our knowledge, the first in Morocco to investigate the relationship between FI and obesity risk among women. The main findings showed that the

prevalence of FI was high. In addition, it was associated with overweight, GO and CO, and high energy intake, which could increase the risk of CVD and lead to adverse effects and health consequences in women. Therefore, intervention programs need to consider food security in addressing obesity and associated problems by providing appropriate resources and services with the aim of ensuring women access to a variety of high quality foods and achieve a balanced diet at local and national levels. This study could be considered as a roadmap for policy makers to find an innovative solution to overcome the problem of obesity associated to FI, especially in marginalized areas.

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Conflicts of interest

The authors declare that they have no competing interest.

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