

The relationship between food insecurity and overweight/obesity differs by birthplace and length of US residence

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Abstract

Objective: To examine whether the cross-sectional association between food insecurity and overweight/obesity varied according to birthplace and length of residence in the USA among California women.

Design: Using cross-sectional, population-based data from the California Women's Health Survey (CWHS) 2009–2012, we examined whether the association between food insecurity and overweight or obesity varied by birthplace–length of US residence.

Setting: California, USA.

Subjects: Women (*n* 16 008) aged 18 years or older.

Results: Among US-born women, very low food security (prevalence ratio (PR) = 1.21; 95% CI 1.11, 1.31) and low food security (PR = 1.19; 95% CI 1.10, 1.28) were significantly associated with higher prevalence of overweight/obesity, after controlling for age, marital status, race/ethnicity, poverty and education. Among immigrant women who lived in the USA for 10 years or longer, very low food security was significantly associated with higher prevalence of overweight/obesity, after controlling for covariates (PR = 1.16; 95% CI 1.07, 1.27). Among immigrant women who had lived in the USA for less than 10 years, low and very low food security were not significantly associated with overweight/obesity, after controlling for covariates.

Conclusions: Food insecurity may be an important pathway through which weight may increase with longer US residence among immigrant women. Public health programmes and policies should focus on increasing food security for all women, including immigrant women, as one strategy to reduce the prevalence of overweight/obesity.

Keywords
Food security
Immigrants
Women
Obesity
Overweight

Several studies in the USA have found that food insecurity is significantly associated with higher BMI and greater risk of obesity among women overall^(1–3) and for specific subgroups such as Latina women^(4,5). However, little is known about the association between food insecurity and BMI among immigrant women or the role of length of residence in the USA on this relationship. Evidence suggests that although BMI is lower among immigrants compared with US natives⁽⁶⁾, BMI increases with longer US residence^(7–11) particularly among women⁽¹¹⁾.

Immigrants tend to come to the USA from developing countries undergoing epidemiological and nutrition transitions. In these countries, the prevalence of obesity is increasing^(12,13) and food insecurity is generally higher than in the USA⁽¹⁴⁾. Processed, energy-dense foods have

been typically less available in developing countries than in developed countries, although this is changing with the increasing distribution of processed foods around the globe⁽¹⁴⁾. Even though immigrant women may have experienced food insecurity in their countries of origin, longer residence in host societies may increase exposure to energy-dense diets as well as vulnerability to higher BMI, overweight and obesity. Thus, although immigrant women may have lower average BMI than their US-born counterparts, over time, immigrant BMI patterns may mirror those of social groups in their host societies.

Initially, nativity outside the USA and dietary norms in countries of origin may act as protective factors against higher BMI among US immigrants. With longer residence in host societies, changes in fruit and vegetable

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consumption^(15,16) and lack of access to healthy foods in poor neighbourhoods^(17–20) where low-income immigrants are more likely to live may increase food insecurity and lead to higher BMI and overweight/obesity among immigrants. Thus, we might expect food insecurity to be associated with higher rates of overweight and obesity among immigrant women with longer US stays, as compared with immigrants with shorter US stays.

To inform current and future interventions to prevent obesity and improve health among all women, research is needed to disentangle the role of both food insecurity and length of residence in the variation of obesity among US-born and foreign-born women. To strengthen knowledge about the roles of food insecurity and length of residence in the epidemiology of obesity among US immigrant women compared with native women, we utilized a large sample of women in California to investigate whether the association between food insecurity and overweight/obesity varied according to birthplace and length of residence.

Methods

Participants

We used four years of data from the California Women's Health Survey (CWHs) 2009–2012. CWHs is an annual, cross-sectional, population-based telephone survey of non-institutionalized households, and methods have been described elsewhere⁽²¹⁾. Briefly, using random digit dialling, one woman aged 18 years or older per household was randomly selected to participate in a telephone interview. Respondents were interviewed in English and Spanish. CWHs data are weighted to account for the complex sampling design and adjust for non-response and households without telephones. In the combined four years, there were a total of 18 930 respondents. After excluding pregnant women (n 235), those with implausible (>65 or <10 kg/m²) or missing BMI values (n 2385) and respondents missing information on food insecurity (n 51) or birthplace/length of residence (n 251), our analytic sample included 16 008 women. Women with missing BMI values refused to provide either weight and/or height, usually because the respondents did not complete the entire survey (partial completes).

Weight status

BMI was calculated as self-reported weight in kilograms divided by the square of self-reported height in metres. Obesity, overweight and normal weight were defined using standard cut-off points: BMI ≥ 30.0 kg/m² as obese, BMI = 25.0–29.9 kg/m² as overweight and BMI = 18.5–24.9 kg/m² as normal weight. Women who were underweight (BMI < 18.5 kg/m²) comprised 2.6% of the total weighted sample (n 328) and were excluded from all analyses due to small

sample size (cells with ten or fewer observations) when compared by food security status and birthplace–length of residence.

Food security

Food security was assessed using the six-item short form of the US Household Food Security Module, developed and validated by the US Department of Agriculture⁽²²⁾. Each question in the six-item short-form module was scored following the US Department of Agriculture protocol. The scores for each question were summed to create a food security score for each participant. Women were classified using the US Department of Agriculture guidelines as follows: food secure (raw score = 0–1), low food security (raw score = 2–4) or very low food security (raw score = 5–6)⁽²³⁾. Food insecurity refers to both low and very low food security categories.

Birthplace–length of residence

Birthplace and length of residence were combined into one single variable with three categories: (i) US-born; (ii) foreign-born living in the USA for 10 years or longer; and (iii) foreign-born living in the USA for less than 10 years. We used this 10-year threshold because prior research among immigrants has reported that BMI tends to increase after 10 years of US residence⁽⁹⁾.

Covariates

We used directed acyclic graphs to select covariates to include in multivariable models. Directed acyclic graphs are useful tools to select covariates that meet criteria as potential confounders^(24,25). We selected the following demographic and socio-economic factors: age centred at its mean; a quadratic term for age to assess potential non-linear age effects on overweight/obesity; self-reported race/ethnicity (white, African American/black, Hispanic/Latina, Asian); marital status (married/living with partner, separated/divorced/widowed, never married); education (less than high school, high school or some college, college graduate or higher); and federal poverty level ($<185\%$, $\geq 185\%$). Food assistance (defined as participating in the Supplemental Nutrition Assistance Program (SNAP) or the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in the past 12 months) and having children under 18 years old in the household were included as covariates in sensitivity analyses. Due to small sample size, we excluded 304 women who did not self-identify with these four race/ethnicity categories: white, African American/black, Hispanic/Latina or Asian.

Statistical analysis

We compared average BMI and prevalence of normal weight, overweight and obesity along with distributions of other variables among women in each food security

group. We used χ^2 statistics for categorical variables and ANOVA for continuous variables to assess the statistical significance of observed differences.

Adjusted prevalence ratios (PR) of overweight/obesity and their 95% confidence intervals were calculated using Cox proportional hazards models for complex surveys (PROC SURVEYPHREG) in the statistical software package SAS version 9.3. Due to small cell sizes for immigrants with less than 10 years of US residence, we combined overweight and obese categories to calculate PR and confidence intervals. To examine potential effect modification by birthplace-length of residence, a product term (food security and birthplace-length of residence) was included in Cox models using the overall sample. Because a Wald test for product terms is not calculated in PROC SURVEYPHREG, we used PROC SURVEYLOGISTIC to calculate the *P* value for a Wald test for the product term. Because the *P* value for the product term was 0.1, additional models were stratified by birthplace-length of residence.

SAS version 9.3 survey procedures were used for all analyses to adjust for the complex survey sampling design. The level of significance was defined as *P* < 0.05 for all tests except for product terms.

Results

In the overall sample, 28% of women reported food insecurity (17% had low food security, and 11% had very low food security; Table 1). Food-insecure women were more likely to be immigrants; immigrants born in Mexico comprised the largest group (33.6%) of all food-insecure women. Food-insecure women were also less likely to be married and to be more socio-economically disadvantaged than food-secure women.

Overall, the prevalence of obesity was highest among women with very low food security (43%), and second highest among women with low food security (35%; Table 2).

Table 1 Characteristics of the sample by food security status, California Women’s Health Survey (CWHs) 2009–2012*†

	Food secure (<i>n</i> 12 272; 72.5%)		Low food secure (<i>n</i> 2 288; 16.9%)		Very low food secure (<i>n</i> 1 448; 10.6%)	
	Mean or <i>n</i>	SE OR weighted %	Mean or <i>n</i>	SE OR weighted %	Mean or <i>n</i>	SE OR weighted %
Age (years), mean and se	47.5	0.26	42.2	0.46	43.7	0.50
Race/ethnicity						
White	9001	56.8	745	26.6	517	29.7
African American/black	412	5.3	118	7.0	94	9.7
Hispanic/Latina	2170	22.0	1347	57.6	814	56.3
Asian	689	15.8	78	8.8	23	4.3
Marital status						
Married	8498	63.6	1388	56.1	741	50.2
Separated/divorced/widowed/living with partner	2933	18.3	615	21.1	520	30.9
Never married	996	18.1	283	22.9	187	18.9
Birthplace/US length of residence						
US-born	9902	74.5	1059	48.3	722	49.7
Foreign-born, ≥10 years of residence in USA	2095	21.9	1063	44.2	637	44.7
Foreign-born, <10 years of residence in USA	226	3.6	131	7.5	72	5.6
Birth country or region‡						
Americas	11 173	85.8	2155	91.3	1373	94.2
USA	9902	74.3	1059	47.8	722	49.4
Mexico	895	8.6	922	36.3	541	36.6
Central America	142	1.3	133	5.5	97	6.5
Canada	114	0.7	§	–	§	–
South America	88	0.7	27	1.1	13	0.8
Caribbean	32	0.2	14	0.4	§	–
Western Pacific Region	360	7.1	48	5.2	25	3.6
South-East Asian Region	118	2.7	15	1.2	§	–
Europe Region	480	3.1	32	1.0	23	1.4
Eastern Mediterranean Region	87	1.0	14	1.1	§	–
African Region	33	0.4	§	–	§	–
Education						
<High school	865	7.8	910	35.8	608	39.7
High school or some college	5674	47.1	1043	49.1	669	47.6
College or higher	5724	45.1	333	15.1	169	12.7
Federal poverty level						
≤185%	2332	27.1	1616	74.6	1163	83.5
>185%	8973	72.9	582	25.4	240	16.5

*Chi-square tests of heterogeneity are statistically significant between food-secure, low food-secure and very low food-secure groups (*P* < 0.01). Percentages may not add to 100 due to rounding.

†All percentages and means corrected for the complex design of the CWHs using SAS survey procedures.

‡Defined using WHO epidemiological sub-regions.

§Not reported due to small cell sizes.

Table 2 Unadjusted prevalence of overweight and obesity according to food insecurity, for the overall sample and by birthplace–US length of residence for women in California, California Women's Health Survey (CWHs) 2009–2012*

	Obese		Overweight		Normal weight	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Overall						
Food secure	2477	20.3	3540	27.9	5987	51.8
Low food secure	836	34.5	751	31.1	669	34.4
Very low food secure	613	43.0	441	29.9	369	27.1
Foreign-born, <10 years in USA						
Food secure	34	12.5	70	30.7	114	56.8
Low food secure	37	21.8	47	31.8	45	46.4
Very low food secure	34	44.1	18	24.2	20	31.7
Foreign-born, ≥10 years in USA						
Food secure	389	16.2	669	30.8	983	53.1
Low food secure	385	32.8	396	36.2	277	31.0
Very low food secure	267	41.7	231	35.2	130	23.1
US-born						
Food secure	2044	21.8	2783	27.0	4870	51.2
Low food secure	402	38.3	296	26.2	336	35.5
Very low food secure	304	44.0	186	25.9	216	30.1

*All percentages corrected for the complex design of the CWHs using SAS survey procedures.

Table 3 Adjusted obesity/overweight prevalence ratios (PR) according to food insecurity, overall and by birthplace–US length of residence for women in California, California Women's Health Survey (CWHs) 2009–2012*

	PR† of obesity and overweight	95 % CI
Overall sample		
Food secure	Reference	
Low food secure	1.18	1.10, 1.27
Very low food secure	1.20	1.11, 1.31
Foreign-born, <10 years in USA		
Food secure	Reference	
Low food secure	0.98	0.73, 1.30
Very low food secure	1.02	0.77, 1.36
Foreign-born, ≥10 years in USA		
Food secure	Reference	
Low food secure	1.07	0.99, 1.17
Very low food secure	1.16	1.07, 1.27
US-born		
Food secure	Reference	
Low food secure	1.19	1.10, 1.28
Very low food secure	1.21	1.11, 1.31

*All prevalence ratios and confidence intervals corrected for the complex design of the CWHs using SAS survey procedures.

†Prevalence ratios adjusted for age, age-squared, race/ethnicity, marital status, education, poverty and survey year. In the overall model, also adjusted for birthplace–length of residence and food security × birthplace–length of residence.

This pattern persisted among the US-born and immigrants with longer and shorter US stays. The prevalence of overweight was generally similar among low and very low food-secure women, for all groups except immigrants with US residence of less than 10 years, although their sample size was small.

In the overall sample, low and very low food security were positively associated with overweight/obesity, compared with food-secure women, adjusting for age, age-squared, race/ethnicity, marital status, education, poverty and birthplace–length of residence (Table 3).

PR stratified by birthplace–length of residence and adjusted for age, age-squared, race/ethnicity, marital status, education and poverty are presented here. Among US-born women, very low food security (PR = 1.21; 95 % CI 1.11, 1.31) and low food security (PR = 1.19; 95 % CI 1.10, 1.28) were significantly associated with overweight/obesity compared with food-secure women. Among immigrant women with 10 or more years of US residence, relative to food-secure women, very low food security was significantly associated with greater likelihood of overweight/obesity (PR = 1.16; 95 % CI 1.07, 1.27); low food security was positively associated with overweight/obesity, but the confidence interval included the null (PR = 1.07; 95 % CI 0.99, 1.17). Among immigrant women with less than 10 years of US residence, neither very low food security (PR = 1.02; 95 % CI 0.77, 1.36) nor low food security (PR = 0.98; 95 % CI 0.73, 1.30) was significantly associated with overweight/obesity. In sensitivity analyses adjusting for food assistance (SNAP or WIC) and children under 18 years old in the household, PR were similar to those reported above.

Discussion

In a large representative sample of women in California, we found that food insecurity was associated with higher likelihood of overweight/obesity among US-born women and immigrant women with longer US stays, after adjustment for sociodemographic factors. These results concur with other US studies using cross-sectional data which found that food insecurity was associated with higher BMI, overweight and obesity among women in California⁽¹⁾ and Latina women^(4,5). Similarly, using measured weight and height, one longitudinal study found that food insecurity was significantly associated with weight gain in a large representative sample of women in the USA⁽³⁾.

Our study builds upon this literature by investigating whether the association between food insecurity and weight status varied according to birthplace–length of residence. We found that the association between food insecurity and weight status was more pronounced among immigrant women with longer residence in the USA than among immigrant women with shorter residence in the USA. Prior research has found that compared with men, women may be more susceptible to higher BMI with longer US residence⁽¹¹⁾. Among women, food insecurity is associated with obesity in Mexico⁽²⁶⁾, South Korea⁽²⁷⁾ and some ethnic groups in Iran⁽²⁸⁾. Food insecurity was associated with underweight, but not excess weight, among women in Colombia⁽²⁹⁾.

Our study's findings suggest that food insecurity may be an important pathway that may influence susceptibility to overweight/obesity as immigrant women live longer in the USA. The experience of food insecurity combined with greater exposure to some features of a developed society may be underlying mechanisms that lead to higher BMI, overweight and obesity among immigrant women.

For example, in the USA, lower-quality diets rich in energy-dense but nutrient-poor foods, such as refined grains, ground beef and processed meats, are more likely to be consumed by people with lower socio-economic resources⁽³⁰⁾ and tend to be cheaper per kilojoule than diets high in nutrient-dense foods like fruits and vegetables^(31,32). The high cost per kilojoule of fruits, vegetables and other healthy foods may be out of reach for low-income populations to purchase and consume regularly⁽³¹⁾. Limited availability of supermarkets in some poor and minority neighbourhoods (where immigrants of low socio-economic status are likely to live) may impede access to fruits, vegetables and other nutrient-rich foods⁽³³⁾. Observational studies have found that access to supermarkets is associated with a healthier diet^(33,34). However, experimental studies with control groups have found that supermarket access is not significantly associated with diet or weight status^(35–37). Marketing incentives for low-cost, energy-dense foods are particularly damaging to groups of low socio-economic status⁽³⁰⁾; this may in turn influence food-insecure immigrant women with longer US stays to replace healthier diets for energy-dense, nutrient-poor foods that represent a source of affordable energy. In contrast, recent immigrant women may escape the influence of such incentives, as they may hold on to purchasing behaviours from their countries of origin or because they may not be as exposed to heavy food advertising and marketing in the USA as the general population⁽³⁸⁾. Nutrition education interventions may be less effective at increasing the consumption of healthy foods for those of low socio-economic status, compared with those of higher socio-economic status⁽³⁹⁾.

The obesogenic environment in the USA may affect immigrants slowly over many years. Foreign nativity and norms in countries of origin may act as protective factors

against higher BMI and may be more powerful than the influence of food insecurity alone. Some studies have found that immigrants from Mexico and Korea are more likely to consume fruits and vegetables than US natives^(15,40,41). A prior study found that Latino immigrants may rely on staples that are rich in fibre, such as beans and corn tortillas, and micronutrients, such as tomatoes, during periods of food insecurity⁽⁴⁾. These patterns could buffer against the harmful effects of food insecurity among immigrant women in their first few years of residence in the USA. However, with longer residence in the USA, immigrant women may begin to respond to food shortages in similar ways as their counterparts with longer US residence and women born in the USA; for example, they may decrease consumption of lower-energy-density foods rich in micronutrients and fibre, and replace them with cheaper, energy-dense, low-nutrient foods that are frequently consumed by those in socio-economically disadvantaged groups in the USA⁽³⁰⁾.

Additionally, the observed food insecurity patterning in BMI by birthplace and length of residence may be due to factors closely linked to food insecurity such as psychosocial stress and biological functioning (e.g. allostatic load)⁽⁴²⁾. A prospective study found that experiencing psychosocial stress was associated with increased BMI over a 13-year follow-up period among black women⁽⁴³⁾. Some evidence suggests that women with greater central fat have greater levels of cortisol secretion when experiencing stress⁽⁴⁴⁾ and that experiencing chronic stress, as measured by allostatic load, may cause increased weight gain⁽⁴⁵⁾. This could explain the difference in our study's observed association between food insecurity and overweight/obesity among recent immigrant women *v.* those with longer US stays. During longer exposure to US culture and social norms, immigrant women may have had longer exposure to psychosocial stress associated with experiences of discrimination and integration into the new society^(46–49), as well as stress related to prolonged food insecurity; recent immigrant women may not have had a sufficient dose of such stressors to manifest in higher BMI.

We were unable to assess the role of environmental and social factors that may influence the differential association between food insecurity and overweight/obesity by birthplace–length of residence because such data are not available in the CWHHS⁽²¹⁾. Future research is needed to improve our understanding of this relationship and particularly explain why the association between food insecurity and overweight/obesity differs by birthplace–length of residence. Social programmes such as food assistance like SNAP and WIC may be important mediating factors of the relationship between food insecurity and overweight/obesity. Future studies should examine the potential mediating role of food assistance programmes in the food insecurity–overweight/obesity association among native women as well as immigrant women with various lengths of residence in the USA. Future studies should also

examine whether immigrant diet changes are differentially patterned by food insecurity status and whether these patterns explain the increased BMI with longer US residence. The relationship between food insecurity and risk of obesity has been found to differ by race/ethnicity, where the prevalence of obesity increased with increasing food insecurity for Asians, blacks and Hispanics, but not for non-Hispanic white women⁽¹⁾. Additional research is needed to examine the interaction between food insecurity and birthplace and length of residence within racial/ethnic groups. Finally, we could not examine the association between food insecurity and overweight/obesity according to country of origin due to small sample sizes; future studies should investigate these associations with samples disaggregated by country of origin.

The current study used cross-sectional data; thus, we are unable to make causal inferences. Self-reported height and weight were used to calculate BMI, which is highly correlated with technician-measured BMI among adults⁽⁵⁰⁾. However, because self-reported BMI has also been found to underestimate BMI and prevalence of overweight/obesity by age and race/ethnicity⁽⁵¹⁾, we controlled for these factors, so underestimation of BMI may have been minimized.

Conclusions

The present study provides evidence suggesting that the association between food insecurity and overweight/obesity is more pronounced among immigrant women with longer US stays compared with recent immigrant women. Our findings imply that food insecurity combined with prolonged exposure to a developed society may increase vulnerability to higher BMI, overweight and obesity among immigrant women. Further investigations on the possible influences of food insecurity on stress, changes in diet and biological mechanisms underlying such differences are needed. To promote healthy weight among all women, programmes and policies should focus on reducing food insecurity and increasing access to healthy foods. Food assistance programmes should consider both birthplace and length of residence in their eligibility criteria and programme implementation. Overweight and obesity prevention programmes may be more effective at reducing overweight and obesity among women overall by addressing food insecurity among socio-economically disadvantaged women, including recent immigrant women.

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