SPECIAL THEME: NUTRITION

Food insecurity, food choices, and body mass index in adults: nutrition transition in Trinidad and Tobago

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Background	This study evaluated whether food insecurity and obesity were associated in a population sample in Trinidad.
Methods	A sample was drawn of 15 clusters of households, in north central Trinidad. Resident adults were enumerated. A questionnaire was administered including the short form Household Food Security Scale (HFSS). Heights and weights were measured. Analyses were adjusted for age, sex, and ethnic group.
Results	Data were analysed for 531/631 (84%) of eligible respondents including 241 men and 290 women with a mean age of 47 (range 24–89) years. Overall, 134 (25%) of subjects were classified as food insecure. Food insecurity was associated with lower household incomes and physical disability. Food insecure subjects were less likely to eat fruit (food insecure 40%, food secure 55%; adjusted odds ratio [OR] = 0.60, 95% CI: 0.36–0.99, P = 0.045) or green vegetables or salads (food insecure 28%, food secure 51%; adjusted OR = 0.46, 95% CI: 0.27–0.79, P = 0.005) on ⩾5–6 days per week. Body mass index (BMI) was available for 467 (74%) subjects of whom 41 (9%) had BMI <20 kg/m^2, 157 (34%) had BMI 25–29 kg/m^2, and 120 (26%) had BMI ⩾30 kg/m^2. Underweight (OR = 3.21, 95% CI: 1.17–8.81) was associated with food insecurity, but obesity was not (OR = 1.08, 95% CI: 0.55–2.12).
Conclusions	Food insecurity was frequent at all levels of BMI and was associated with lower consumption of fruit and vegetables. Food insecurity was associated with underweight but not with present obesity.
Keywords	Obesity, body mass index, food insecurity, socioeconomic status, food intake, Trinidad and Tobago, West Indies

The health transition in middle-income countries is associated with falling mortality rates and the emergence of non-communicable diseases as the main causes of death.[1] As the importance of undernutrition declines, obesity has emerged as a significant public health problem.[2,3] The reasons for the increase in obesity are not fully understood but decreasing levels of physical activity and increasing availability of foods high in fat or refined carbohydrate are thought to be important contributing factors.[3,4]

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In low-income countries, obesity is associated with affluence but in high-income countries obesity is more often associated with lower socioeconomic status.[5] This observation suggests that, in a more food-abundant environment, socioeconomic factors such as education and income level may modify the relationship between food availability and obesity. In the middle-income countries, these relationships are less consistent. Obesity may be associated with affluence in some situations but with poverty in others.[6] Underweight and obesity may sometimes co-exist in the same neighbourhoods,[7] or even in the same households.[8] These findings suggest an apparent paradox that obesity may exist in households that are food insecure.[9] It has been suggested that limited availability of food may lead to obesity.[9] This might occur if food insecurity leads to the consumption of obesity promoting types of food,[9] or to overeating when food becomes

available, or to metabolic changes that permit more efficient use of energy.[10]

Food insecurity has been defined as the 'limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in socially acceptable ways'.[11] The concept of food insecurity includes problems with the quantity and quality of the food available, uncertainty about the supply of food, and experiences of going hungry.[12] Blumberg *et al.*[13] recently described a short form of the Household Food Security Scale (HFSS) which includes six items. These concern experiences of cutting the size of meals or skipping meals because of lack of money for food, being hungry but not eating because of an inability to afford food, food not lasting and not having enough money to buy more, and being unable to afford balanced meals. According to this instrument, respondents are classified as food insecure if they give affirmative responses to two of the six items.

In the Caribbean region in 2000, the per capita GNP of the English speaking countries ranged from US$2440 in Jamaica to US$4980 in Trinidad and Tobago and US$9280 in Barbados.[14] These figures contrast with values of US$24 500 in the UK and US$34 260 in the USA.[14] Food security continues to be a significant concern for public policy in the Caribbean. According to the UN Food and Agriculture Organization, 13% of the Trinidad and Tobago population were undernourished in 1997–1999.[15] Most attention has been directed at the nutritional status of children and the need to provide meals in school to increase dietary intakes in order to improve nutritional and educational outcomes.[16,17] However, in children in Trinidad and Tobago, overweight, as well as underweight, appears to be prevalent.[18] Obesity in adults is also important in the Caribbean region. Beckles *et al.* found that between 27% and 32% of women in Port of Spain, Trinidad were obese.[19] Rotimi *et al.* found that the prevalence of obesity in populations of West African descent increased with increasing economic development. Using the criterion of body mass index (BMI) $\geqslant 31.1$ kg/m^2 for men and BMI $\geqslant 32.3$ kg/m^2 for women, the prevalence of obesity was 10.3% in men and 30.1% in women in Barbados.[20]

In the Eastern Caribbean, a study of the relationship between food insecurity and BMI in adults is both relevant and feasible because both conditions are likely to be common. We carried out a population survey in Trinidad with the aim of evaluating the prevalence of both food insecurity and obesity, and the relationship between them. We evaluated associations of food insecurity with general health, food choices, physical activity levels, and socioeconomic status.

Methods

Sample and subjects

We took a sample of approximately 300 households based on the resources available for the survey. The sample was drawn by the Central Statistical Office. The target area was one of the constituencies in north central Trinidad which was considered to provide a good representation of the ethnic and socioeconomic characteristics of the population of Trinidad and Tobago. The area includes a range of settings from a relatively affluent residential suburb of the capital, to areas with small houses on the lower slopes of the northern range characterized by poverty and overcrowding. The area has traditionally been involved in

agriculture including market gardening, but this has declined as residential areas spread. There are also good numbers of fruit trees (mango, citrus etc.). A two-stage sampling procedure was used. At the first stage, 15 out of the 66 enumeration districts (ED) in the constituency were selected. This was done by ranking the ED according to size (number of households) then, after a random start, ED were systematically selected. At the second stage, a cluster of approximately 20 households was randomly selected from the clusters in each ED. The fieldworkers visited each household, enumerated all adults, and invited adults aged $\geqslant 25$ years to participate in the survey. The study received research ethics committee approval and subjects gave written informed consent to participation.

Questionnaire

Subjects were asked to complete an interview-administered questionnaire. This included items on food choices, food security, cigarette smoking, alcohol use, physical activity, general health, and socioeconomic variables. The questionnaire was administered by trained interviewers who usually work on surveys for the Central Statistical Office. Many of the questionnaire items were adapted, with permission, from the report of the Health Survey for England 1994.[21]

The short form of the HFSS was included as described by Blumberg *et al.*[13] This instrument is also referred to as the food security core module.[22] We found that the six items were readily understood in face-to-face interviews. A short food frequency questionnaire was included. Subjects were asked how often they ate the following groups of foods: sweet biscuits or cake; fruit; green vegetables and salads; fish (including shellfish); sweets or chocolate; burgers, fried chicken or pizzas; beans, peas lentils etc.; ground provisions including yam, cassava, potatoes, dasheen, edoes etc.; roti; and rice. Categories used were more than once a day, once every day, 5–6 days a week, 3–4 days a week, 1–2 days a week, at least once a month, less than once a month, rarely or never. For analysis, for foods that were consumed frequently the categories were reduced to eaten $\geqslant 5$–6 days a week or not, and for less frequently consumed foods, categories were reduced to eaten at least weekly or not. Cigarette smoking was analysed using the categories non-smoker, ex-smoker, and current smoker. Physical activity levels were analysed using two global questions from the NHANES I study:[23] 'Do you get much exercise in things you do for recreation (sport, walking for exercise, anything like that) or hardly any exercise or in between?' and 'In your usual day, aside from recreation are you physically very active, moderately active or quite inactive?' Responses to these questions were strongly associated with more detailed questions concerning recreational, work, and household activities. The questionnaire included the following item concerning physical limitation from the SF12: 'During the last 4 weeks, were you limited in the kind of work or other regular daily activities you do, as a result of your physical health?'[24] Subjects were also asked about the monthly income of their household using ten categories ranging from $\leqslant$TT$200 (US$33.3) to $\geqslant$TT$51 201 (US$8533.5). For analysis the lowest three, and highest four, categories were combined. Subjects were asked 'How would you describe your ethnic group?' Responses were classified into the categories, 'African', 'Indian', 'white', 'Chinese', 'mixed', 'other', or 'not known'. This represented a shortened form of the categories used in the Trinidad and

Tobago national census.[25] For analysis the categories were further reduced to 'Afro-Trinidadian', 'Indo-Trinidadian', 'Mixed', and 'Other and not known'. Subjects were also asked about the water supply in the home, whether the head of the household was male or female, the number of adults and children in the home, their personal educational attainment, and employment status, as described previously.[18]

Measurements

Measurements of height and weight were taken by the nutritionists and food demonstrators from the Nutrition Division of the Ministry of Health. The measurement procedures generally followed those used in the Health Survey for England 1994.[21] Height was measured using a portable stadiometer (Seca 'Leicester' height pole). Values were recorded to the last complete 0.1 cm and 0.05 cm was added at the time of analysis to correct the bias. Weight was measured using portable electronic scales (Soehnle) to the nearest 0.1 kg. Waist and hip circumferences were measured using tape measures.

The waist was defined as the midpoint between the lower rib margin and the iliac crest, and the hips as the maximum circumference over the buttocks.[21] Two measurements were made but if these two measurements differed by >2 cm then a third measurement was taken. Subjects were measured in light clothing but without shoes. Fieldworkers also noted whether there was any difficulty recording any of the measurements.

Analysis

For these analyses, age was taken as the difference between the date of birth and the measurement date. For 11 cases where date of birth not available, the reported age last birthday plus one half was used. Underweight was defined as a BMI <20 kg/m^2. Overweight was defined as BMI ⩾25 kg/m^2 and obesity as BMI ⩾30 kg/m^2. In order to allow for the sampling design, random effects logistic regression models were fitted using the statistical package MLwiN version 1.10.[26,27] A three-level model was specified with individuals nested within households, and households within clusters of households. Logistic regression models were fitted using first order maximum quasi-likelihood estimation because penalized quasi-likelihood estimation did not lead to convergence.[26] P-values were obtained by comparing the coefficient with its standard error in the three-level model. Intraclass correlation coefficients (ICC) were estimated by restricted maximum likelihood. The ICC at household level were estimated allowing for the effect of cluster of households. Adjusted means were obtained from a random effects model allowing for clustering by household only, using the 'xtreg' command with the maximum likelihood option in Stata.[28]

Results

There were approximately 300 households listed, and 631 adults aged ⩾25 years were enumerated. Questionnaire data were obtained for 548 (87%) subjects. Among the 15 clusters, the response rates ranged between 56% and 100% with middle class areas giving lower response rates. Measurements were obtained for 482 (76%) subjects. Two subjects for whom data were collected were aged 23.8 and 24.8 years respectively but these were included in the analyses. The mean age was 46.8 years (SD 14.1 years, range 23.8–89.1 years). There were 250 men

and 298 women. The ICC for food insecurity was 0.60 at household level and 0.14 at cluster level. Ethnicity (ICC = 0.36) and household income (ICC = 0.13) were also correlated within clusters of households.

Table 1 shows the responses obtained for the six items of the HFSS, together with the distribution of summed affirmative responses. Of the 548 respondents, 17 had missing data for all items on the HFSS. These cases were excluded, and the remaining analyses were confined to 531 (84%) of subjects with data for food security with measurements available for 467 (74% total). Of these, 134 (25%) were classified as being food insecure. Among 77 subjects with missing values for income, 7 (9%) were food insecure compared with 127/454 (28%) with known income levels. In 64 subjects with missing values for BMI, 10 (16%) were food insecure compared with 124/467 (27) with known BMI.

Table 2 shows the prevalence of food insecurity according to demographic, socioeconomic, and household characteristics. Odds ratios (OR) were estimated after adjusting for age, gender, and ethnic group. Food insecurity was not associated with age or gender, but subjects of Indo-Trinidadian ethnicity were less likely to be food insecure than Afro-Trinidadians in this sample. This difference remained after additional adjustment for household income (OR = 0.25, 95% CI: 0.13–0.49). After adjusting for age, sex, and ethnicity, there was a strong negative association between household income and food insecurity (test for trend $P < 0.001$). Food insecurity was strongly associated with the presence of physical limitation ($P = 0.001$). This association was not explained by adjusting for income, in addition to age sex and ethnic group (adjusted OR = 3.12, 95% CI: 1.55–6.27). There was evidence of a negative association between increasing educational attainment and food insecurity (test for trend, $P = 0.005$). However, food insecurity was not associated with employment status, the type of water supply in the home, or whether the head of household was male or female. There was little evidence of a trend towards increasing food insecurity with increasing number of children in the family ($P = 0.176$).

Subjects who were food insecure were less likely to be frequent consumers of fruit or green vegetables or salads (Table 3). The single item of the HFSS to which affirmative responses were given most frequently was in response to the statement 'We

Table 1 Responses to individual items on the Household Food Security Scale

	Total (531)
a) Affirmative responses to individual items	
Cut size of meals or skipped meals	93 (18)
If yes, how often (almost every month/some months)	70 (13)
Ate less because not enough money	75 (14)
Hungry but couldn't afford food	31 (6)
Food didn't last and no money for more (often/sometimes)	109 (21)
Couldn't afford to eat balanced meals (often/sometimes)	162 (31)
b) Summed affirmative responses	
0	339 (64)
1	58 (11)
2	44 (8)
3	25 (5)
4	22 (4)
5	27 (5)
6	16 (3)

Table 2 Distribution of food insecurity according to social and demographic factors. Figures are frequency (percentage)

		Food insecure/Total (%) 134/531 (25)	Odds ratio (95% CI)[a]
Gender	Men	59/241 (24)	–
	Women	75/290 (26)	1.18 (0.76–1.68)
Age group	<35	38/129 (29)	–
	35–44	32/138 (23)	0.88 (0.46–1.68)
	45–54	28/110 (25)	1.00 (0.50–1.97)
	55–64	22/82 (27)	1.23 (0.60–2.51)
	≥65	14/69 (20)	0.80 (0.36–1.78)
	Not known	0/3 (0)	–
Ethnic group	Afro-Trinidadian	69/155 (45)	–
	Indo-Trinidadian	32/246 (13)	0.31 (0.16–0.58)
	Mixed	31/106 (29)	0.56 (0.29–1.07)
	Other and not known	2/24 (8)	0.19 (0.04–0.84)
Monthly household income (US$)	≤133	35/72 (49)	–
	≤267	32/91 (35)	0.48 (0.21–1.13)
	≤533	26/110 (24)	0.32 (0.13–0.75)
	≤1067	29/89 (33)	0.52 (0.21–1.27)
	>1067	5/92 (5)	0.08 (0.02–0.27)
	Not known	7/77 (9)	0.15 (0.05–0.45)
Education	Primary	54/167 (32)	–
	Secondary	62/230 (27)	0.61 (0.34–1.10)
	Technical	9/27 (33)	0.81 (0.28–2.35)
	University	5/84 (6)	0.18 (0.06–0.54)
	Not known	4/23 (17)	0.38 (0.10–1.44)
Employment	Paid employment	86/334 (26)	–
	Looking for work	8/15 (53)	1.65 (0.48–5.72)
	Home duties	16/69 (23)	0.93 (0.42–2.04)
	Retired	15/74 (20)	0.70 (0.27–1.81)
	Disabled	6/16 (38)	1.98 (0.54–7.30)
	Other and not known	3/23 (13)	0.58 (0.14–2.41)
Physical Limitation	No	102/456 (22)	–
	Yes	31/74 (42)	2.96 (1.54–5.68)
	Not known	1/1	–
Piped water in home	Yes	101/450 (22)	–
	No	33/77 (43)	1.58 (0.70–3.57)
	Not known	0/4 (0)	–
Head of household	Man	88/392 (22)	–
	Woman	46/133 (35)	1.74 (0.97–3.11)
	Not known	0/6 (0)	–
No. of children	0	50/224 (22)	–
	1	33/97 (34)	1.28 (0.62–2.63)
	2	25/105 (24)	1.01 (0.49–2.11)
	3	7/26 (27)	1.25 (0.38–4.07)
	≥4	18/38 (47)	2.20 (0.82–5.91)
	Not known	1/41 (2)	–

[a] Adjusted for age, gender, and ethnic group only.

couldn't afford to eat balanced meals'. Table 4 shows the association between this item and frequent consumption of fruit or vegetables. There was evidence of a trend to less frequent consumption of fruit and vegetables with decreasing ability to afford balanced meals. There were no differences according to food insecurity for consumption of rice, bread, legumes, fish, confectionery, or 'fast foods' (Table 3). Subjects who were food insecure tended to be more likely to eat 'ground provisions' (yam, cassava, potatoes, dasheen, edoes etc.) at least weekly. There were no differences in smoking habits or recreational exercise habits according to food security but the food insecure were more likely to report that they were 'quite inactive' in terms of non-recreational activity. However, this association

was mostly accounted for by additionally adjusting for physical limitation (adjusted OR = 1.81, 95% CI: 0.79–4.14, $P = 0.162$).

Table 5 shows the mean values for anthropometric variables according to food insecurity for men and women, after adjusting for age and ethnicity. In the food insecure group mean weights and heights tended to be slightly lower, but this was only confirmed statistically for height in women. The distribution of the sample by BMI category is shown in Table 6. Overall, 55% of men and 62% of women were overweight or obese, and 21% of men and 29% of women were obese. The distribution of food insecurity according to BMI category is shown in Table 7. Food insecurity was common at all levels of BMI. However, the lowest frequency of food insecurity was at intermediate BMI

Table 3 Food choices, smoking, and exercise habits according to level of food insecurity. Figures are frequency (percentage)

Food choices	Food secure (397)	Food insecure (134)	Odds ratio[a] (95% CI)	P-value
Whether eaten at least 5–6 days a week				
Fruit	218 (55)	53 (40)	0.60 (0.36–0.99)	0.045
Green vegetables and salad	202 (51)	37 (28)	0.46 (0.27–0.79)	0.005
Rice	254 (64)	87 (65)	0.96 (0.57–1.61)	0.874
Bread or bread rolls	272 (69)	84 (63)	0.74 (0.43–1.25)	0.260
Legumes (beans, peas, or lentils)	173 (44)	67 (50)	1.07 (0.64–1.77)	0.795
Whether eaten at least weekly				
Ground provisions[b]	253 (64)	103 (77)	1.70 (0.96–3.01)	0.069
Fish (including shellfish)	255 (64)	70 (52)	0.66 (0.40–1.10)	0.109
Sweets, chocolate etc.	116 (29)	31 (23)	0.78 (0.44–1.38)	0.388
Sweet biscuits or cakes	161 (41)	47 (35)	0.98 (0.59–1.63)	0.930
Burgers, fried chicken, or pizzas	106 (27)	40 (30)	1.23 (0.71–2.12)	0.460
Smoking habit				
Non-smoker	260 (65)	76 (57)	–	
Ex-smoker	92 (23)	25 (19)	0.73 (0.40–1.34)	0.310
Current smoker	44 (11)	33 (25)	1.53 (0.77–3.03)	0.229
Not known	1 (0)	0 (0)	–	
Recreational physical activity				
Much exercise	162 (41)	44 (33)	–	
Hardly any exercise	151 (38)	66 (49)	1.49 (0.88–2.53)	0.142
In between	82 (21)	22 (16)	0.86 (0.44–1.69)	0.670
Not known	2 (1)	2 (1)	–	
Non-recreational physical activity				
Physically very active	141 (36)	38 (28)	–	
Moderately active	207 (52)	75 (56)	1.53 (0.89–2.62)	0.121
Quite inactive	42 (11)	19 (14)	2.29 (1.04–5.07)	0.041
Not known	7 (2)	2 (1)	–	

[a] Adjusted for age, gender, and ethnic group.

[b] Yam, cassava, potatoes, dasheen, edoes etc.

Table 4 Consumption of fruit and vegetables in relation to whether subjects could afford to eat balanced meals. Figures are frequency (percentage)

Could not afford balanced meals	Total	Eaten ≥5–6 days per week	
		Fruit	Vegetables and salads
Often	24	6 (25)	5 (21)
Sometimes	138	64 (46)	43 (31)
Never	369	201 (54)	191 (52)
P-value[a]		0.034	<0.001

[a] Test for trend from three-level model.

levels (BMI 20.0–24.9 kg/m^2 in women and 25.0–29.9 kg/m^2 in men). After adjusting for age, gender, and ethnicity, compared with those of normal BMI, the relative odds of being underweight were higher for those who were food insecure (Table 8). However, food insecurity was not associated with an increased relative odds of overweight or obesity. There was no statistical evidence for an interaction between gender and BMI group in their association with food insecurity. There was no clear association between household income and BMI category (Tables 7 and 8).

Discussion

At the community level, food insecurity and obesity were common and often coexisted. At the level of the household and individual, low income and physical limitation were strongly associated with food insecurity. The economic situation of a substantial minority of households appeared to restrict their food choices. Consistent with this, 31% of the sample reported that they 'sometimes' or 'often' could not afford to eat balanced meals and food insecurity was associated with lower consumption of green vegetables and salads. This hypothesis that food insecurity and obesity might be associated was not supported in these cross-sectional data because food insecurity was common at every level of BMI, and there was no clear association between food insecurity and obesity.

Limitations of study

The main limitation of the study related to the size and structure of the sample. We aimed to sample an area that could be considered typical of the socioeconomic conditions of Trinidad and Tobago. However, compared with previous national studies, this sample included a higher proportion with university education and a lower proportion without piped water supply in the home.[18] The overall response rate was satisfactory but the response rate tended to be somewhat lower in more affluent areas which could have positively biased the assessment of the prevalence of food insecurity. In addition, data for household income were not obtained for 16%, and BMI for 24%, of initial responders. The strengths of the survey were the carefully standardized instruments which were administered by trained staff. The HFSS has been extensively studied in the US.[29] As Trinidad and Tobago is an English speaking country, we used

Table 5 Mean values (standard error) for anthropometric variables adjusted for age and ethnicity, by sex and food security

	Mean (standard error) adjusted for age and ethnicity		
	Food secure	Food insecure	*P*-value
Men			
No.	146	52	
Height (cm)	171 (0.64)	170 (1.07)	0.301
Weight (kg)	77.2 (1.28)	74.9 (2.24)	0.398
Body mass index (kg/m^2)	26.2 (0.39)	25.9 (0.67)	0.618
Waist circumference (cm)	93.4 (1.03)	91.5 (1.75)	0.335
Hip circumference (cm)	102.3 (0.84)	100.5 (1.41)	0.268
Waist hip ratio	0.91 (0.01)	0.91 (0.01)	0.702
Women			
No.	197	72	
Height (cm)	159 (0.42)	157 (0.72)	0.032
Weight (kg)	70.0 (1.22)	67.7 (2.08)	0.356
Body mass index (kg/m^2)	27.5 (0.46)	27.3 (0.78)	0.792
Waist circumference (cm)	88.6 (0.89)	88.4 (1.51)	0.927
Hip circumference (cm)	105.4 (0.87)	104.2 (1.48)	0.489
Waist hip ratio	0.84 (0.01)	0.85 (0.01)	0.473

Table 6 Distribution of body mass index category by gender. Figures are frequency (percentage)

Body mass index (kg/m^2)	Men (198)	Women (269)	Total (467)
<20.0	14 (7)	27 (10)	41 (9)
20.0–24.9	75 (38)	74 (28)	149 (32)
25.0–29.9	68 (34)	89 (33)	157 (34)
≥30.0	41 (21)	79 (29)	120 (26)

the scale without modification in order to allow comparability of results. We did not attempt to specifically evaluate the questionnaire for use in Trinidad and Tobago. However, the unexplained ethnic differences in food insecurity might raise the possibility of cultural differences in response to this instrument.

Comparison with other work

Survey data suggest that up to 12% of US households may experience some food insecurity,[11] although a smaller proportion experience food insecurity with hunger.[11,12] Recent studies have associated food insecurity with BMI. Olson reported analyses of data for 193 women living in rural locations in New York state. She found that the mean BMI of women living in food insecure households was higher than for women living in food secure households. Only for women with severe food insecurity was BMI lower than for the food secure.[30] In a nationally representative sample of 6506 men and women in Finland, Sarlio-Lahteenkorva and Lahelma found that thin people showed the most food insecurity but obese subjects reported fearing or experiencing running out of money for food, and buying cheaper foods because of financial restrictions more frequently than subjects with normal BMI.[31] In data from a national US survey of food intakes, Townsend *et al.* found an association between

Table 7 Distribution of food insecurity and household income according to body mass index category. Figures are frequency (percentage)

		Body mass index category				
	All	<20.0	20.0–24.9	25.0–29.9	≥30.0	Not known
Men	241	14	75	68	41	43
Food insecure	59	6 (43)	22 (29)	12 (18)	12 (29)	7 (16)
Household income (US$ per month)						
≤133	32 (13)	3 (21)	11 (15)	10 (15)	5 (12)	3 (7)
≤267	40 (17)	3 (21)	12 (16)	10 (15)	9 (22)	6 (14)
≤533	46 (19)	3 (21)	14 (19)	15 (22)	9 (22)	5 (12)
≤1067	46 (19)	2 (14)	15 (20)	14 (21)	7 (17)	8 (19)
>1067	45 (19)	2 (14)	9 (12)	11 (16)	7 (17)	16 (37)
Not known	32 (13)	1 (7)	14 (19)	8 (12)	4 (10)	5 (12)
Women	290	27	74	89	79	21
Food insecure	75	8 (30)	16 (22)	25 (28)	23 (29)	3 (14)
Household income (US$ per month)						
≤133	40 (14)	3 (11)	9 (12)	16 (18)	11 (14)	1 (5)
≤267	51 (18)	8 (30)	8 (11)	15 (17)	15 (19)	5 (24)
≤533	64 (22)	3 (11)	20 (27)	16 (18)	21 (27)	4 (19)
≤1067	43 (15)	4 (15)	13 (18)	14 (16)	11 (14)	1 (5)
>1067	47 (16)	5 (19)	14 (19)	17 (19)	7 (9)	4 (19)
Not known	45 (16)	4 (15)	10 (14)	11 (12)	14 (18)	6 (29)

Table 8 Relative odds of under- or overweight in relation to food insecurity and household income. Figures are odds ratios (95% CI) for body mass index (BMI) category compared with normal weight (BMI 20.0–24.9 kg/m^2)

	Odds ratio (95% CI)[a]		
	Underweight (BMI <20.0)	Overweight or obese (BMI ≥25.0)	Obese (BMI ≥30.0)
Food insecurity	3.21 (1.17–8.81)[c]	1.05 (0.61–1.79)	1.08 (0.55–2.12)
Household income[b]	0.78 (0.56–1.07)[d]	0.87 (0.73–1.05)	0.86 (0.69–1.07)

[a] Adjusted for age, sex, and ethnic group, BMI 20.0–24.9 as reference.

[b] Test for linear trend.

[c] $P = 0.024$.

[d] Allowing for clustering by household only because of non-convergence with three-level model.

food insecurity and overweight in women but not men.[32] Alaimo *et al.*[10] found that food insufficiency was associated with overweight in older white US girls but not in African American or Mexican American children. These studies provide preliminary evidence that food insecurity may be surprisingly frequent in high-income countries, and may be associated either with thinness or with obesity. Our results suggest that food insecurity may be more frequent in the setting of a middle-income country.

In a study from the US, Casey *et al.*,[33] found that children from low-income food insufficient families consumed less fruit. Tarasuk[34] found that Canadian women from food insecure households reported lower consumption of vegetables, fruit, and meat than women from food secure households. Kendall *et al.*[35] reported decreasing consumption of fruit and vegetables with increasing food insecurity in a rural area in New York state. These observations are consistent with our data which showed that subjects who were food insecure were less likely to eat fruit or vegetables and salads frequently.

In a study from Argentina, Aguirre observed that consumption of fruit and vegetables accounted for 19% of food consumption among the highest income quintile but 14% in the lowest income quintile.[36] She noted that the price of 500 g lettuce would buy 700 g beef or 1.5 kg of pasta or 1.4 kg of bread. The price structure of food appeared to promote the consumption of foods with higher energy content. Consumption of vegetables has been negatively associated with obesity in some studies.[37] Bell and Rolls found that in women, consumption of energy dense foods gave a 20% higher energy intake but with similar ratings for hunger or fullness.[38] Data from NHANESIII showed that consumption of energy-dense nutrient-poor foods accounted for higher energy intakes and reduced compliance with dietary recommendations.[39]

Physical limitations may prevent people gaining access to food both directly by reducing their ability to acquire food, and indirectly by influencing their ability to work and obtain income. Our results showed a strong association between food insecurity and physical limitation. Physical limitations also accounted for the lower levels of physical activity among those who were food insecure. It was difficult to account for the marked ethnic difference observed for food insecurity, which was not explained by differences in household income. It is possible that there are cultural differences in perception and reporting of food insecurity, and this possibility makes the application of more objective measures of food supply desirable.

Nutrition transition

Our results show that even in a relatively affluent middle-income country perceptions of food insecurity may be widespread, especially among those on low incomes, but at the same time obesity is also an important problem. Middle income countries are considered to be engaged in a process of nutrition transition[40] through which widespread under-nutrition is gradually replaced by a situation in which dietary intakes and physical activity patterns predispose to the development of obesity and associated non-communicable disorders. Current economic policies aim to promote economic development and thus reduce the conditions in which food insecurity is found. However, liberalization of trade may have the effect of increasing the importation of processed foods, or used cars, thereby perhaps contributing to the development of obesity. Popkin[40] has observed that key questions concern how potentially unfavourable health outcomes of these processes may be avoided, prevented, or reversed.

Conclusions

In Trinidad, food insecurity was common in association with low income and physical limitation. There was evidence that subjects who were food insecure, or who were unable to afford to eat a balanced diet, were less likely to consume fruits and vegetables or salads frequently. Overweight and obesity were frequent in all groups but there were no clear associations between either food insecurity, or household income, and obesity.

Any relationship between food security and obesity is likely to evolve over time. Future studies might therefore use prospective designs at key stages of the life course, in order to provide further insights into these relationships, which appear to be particularly relevant in middle-income country settings.

KEY MESSAGES

- Obesity is increasing in middle-income countries but the reasons for the increase are not fully understood.

- Some studies from high-income countries have suggested that food insecurity may be associated with obesity.

- We evaluated food insecurity and body mass index in a population sample of adults in Trinidad and Tobago.

- In this sample, 25% of subjects were food insecure and 60% were overweight or obese. Compared with food secure subjects, people who were food insecure showed an increased relative risk of underweight, but food insecurity was as frequent in those of normal weight as in those who were overweight or obese.

- Food insecurity was associated with underweight but not with present obesity in these cross-sectional data.

References

[1] Gribble JN, Preston SH. *The Epidemiological Transition. Policy and Planning Implications for Developing Countries*. Washington DC: National Academy Press, 1993.

[2] Popkin BM. The nutrition transition and obesity in the developing world. *J Nutr* 2001;**131:**871S–73S.

[3] World Health Organization. *Obesity: Preventing and Managing the Global Epidemic*. Report of a WHO Consultation. WHO Technical Report Series No. 894. Geneva: World Health Organization, 2000.

[4] Harnack LJ, Jeffrey RW, Boutelle KN. Temporal trends in energy intake in the United States: an ecologic perspective. *Am J Clin Nutr* 2002;**71:**1478–84.

[5] Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. *Psychol Bull* 1989;**105:**260–75.

[6] Monteiro CA, Conde WL, Popkin BM. Independent effects of income and education on the risk of obesity in the Brazilian adult population. *J Nutr* 2001;**131:**881S–86S.

[7] Doak CM, Adair LS, Monteiro C, Popkin BM. Overweight and underweight coexist within households in Brazil, China and Russia. *J Nutr* 2000;**130:**2965–71.

[8] Florencio TM, Ferreira HS, de Franca AP, Cavalcante JC, Sawaya AL. Obesity and undernutrition in a very-low-income population in the city of Maceio, northeastern Brazil. *Br J Nutr* 2001;**86:**277–84.

[9] Dietz WH. Does hunger cause obesity? *Pediatrics* 1995;**95:**766–67.

[10] Alaimo K, Olson CM, Frongillo EA Jr. Low family income and food insufficiency in relation to overweight in US children: is there a paradox? *Arch Pediatr Adolesc Med* 2001;**155:**1161–67.

[11] Carlson SJ, Andrews MS, Bickel GW. Measuring food insecurity and hunger in the United States: Development of a national benchmark measure and prevalence estimates. *J Nutr* 1999;**129:**510S–06S.

[12] Alaimo K, Briefel RR, Frongillo EA Jr, Olson CM. Food insufficiency exists in the United States: results from the third National Health and Nutrition Examination Survey (NHANES III). *Am J Public Health* 1998;**88:**419–26.

[13] Blumberg SJ, Bialostosky K, Hamilton WL, Briefel RR. The effectiveness of a short form of the Household Food Security Scale. *Am J Public Health* 1999;**89:**1231–34.

[14] World Bank. *World Development Indicators Database*. Washington: World Bank, 2001.

[15] United Nations Food and Agriculture Organization. The state of food security in the world. http://www.fao.org/docrep/003/y1500e/y1500e06.htm#P0_3 accessed 15 April 2002.

[16] Walker SP, Powell CA, Hutchinson SE, Chang SM, Grantham-McGregor SM. Schoolchildren's diets and participation in school feeding programmes in Jamaica. *Public Health Nutr* 1998;**1:**43–49.

[17] Gulliford MC, Mahabir D, Rocke BC, Chinn S, Rona RJ. Free school meals and children's social and nutritional status in Trinidad and Tobago. *Public Health Nutr* 2002;**5:**625–30.

[18] Gulliford MC, Mahabir D, Rocke B, Chinn S, and Rona RJ. Overweight, obesity and skinfold thicknesses of children of African or Indian descent in Trinidad and Tobago. *Int J Epidemiol* 2001;**30:**989–98.

[19] Beckles GL, Miller GJ, Alexis SD *et al.* Obesity in women in an urban Trinidadian community. Prevalence and associated characteristics. *Int J Obes* 1985;**9:**127–35.

[20] Rotimi CN, Cooper RS, Ataman SL *et al.* Distribution of anthropometric variables and the prevalence of obesity in populations of west African origin: the International Collaborative Study on Hypertension in Blacks (ICSHIB). *Obes Res* 1995;**3(Suppl.2):**95S-105S.

[21] Colhoun H, Prescott-Clarke P. *Health Survey for England 1994*. London: HMSO, 1996.

[22] USDA Food and Nutrition and Economic Research Service. Food security/hunger core module. http://www.ers.usda.gov/briefing/foodsecurity/surveytools/core0699.pdf accessed 19 November 2002.

[23] Gillum RF, Mussolino ME, Ingram DD. Physical activity and stroke incidence in women and men. The NHANES I Epidemiologic Follow-up study. *Am J Epidemiol* 1996;**143:**860–69.

[24] Jenkinson C, Layte R. Development and testing of the UK SF-12. *J Health Serv Res Policy* 1997;**2:**14–18.

[25] Republic of Trinidad and Tobago. Central Statistical Office. *1990 Population and Housing Census. Vol. 2. Age Structure, Religion, Ethnic Group, Education*. Port of Spain: Office of the Prime Minister. Central Statistical Office, 1994.

[26] Goldstein H. *Multilevel Statistical Models*. London: Arnold, 1996.

[27] Woodhouse G. *Multilevel Modelling Applications. A Guide for Users of MLn*. London: Institute of Education, University of London, 1998.

[28] Stata Corporation. *Stata Reference Manual. Release 7. Vol. 4*. Su-Z. College Station, TX: Stata Corporation, 2001.

[29] Frongillo EA. Validation of Measures of Food Insecurity and Hunger. *J Nutr* 1999;**129:**506.

[30] Olson CM. Nutrition and health outcomes associated with food insecurity and hunger. *J Nutr* 1999;**129:**521S–24S.

[31] Sarlio-Lahteenkorva S, Lahelma E. Food insecurity is associated with past and present economic disadvantage and body mass index. *J Nutr* 2001;**131:**2880–84.

[32] Townsend MS, Peerson J, Love B, Achterberg C, Murphy SP. Food insecurity is positively related to overweight in women. *J Nutr* 2001;**131:**1738–45.

[33] Casey PH, Szeto K, Lensing S, Bogle M, Weber J. Children in food-insufficient, low-income families: prevalence, health, and nutrition status. *Arch Pediatr Adolesc Med* 2001;**155:**508–14.

34 Tarasuk VS. Household food insecurity with hunger is associated with women's food intakes, health and household circumstances. *J Nutr* 2001;**131**:2670–76.

35 Kendall A, Olson CM, Frongillo EA. Relationship of hunger and food insecurity to food availability and consumption. *J Am Diet Assoc* 1996; **96**:1019–24.

36 Aguirre P. Socio-anthropological aspects of obesity in poverty. In: Pena M, Bacallao J (eds). *Obesity and Poverty: A New Public Health Challenge*. Scientific Publication No. 576, pp. 11–22. Washington DC: PAHO/WHO, 2000.

37 Lahti-Koski M, Pietinen P, Heliovaara M, Vartiainen E. Associations of body mass index and obesity with physical activity, food choices, alcohol intake, and smoking in the 1982–1997 FINRISK studies. *Am J Clin Nutr* 2002;**75**:809–17.

38 Bell EA, Rolls BJ. Energy density of foods affects energy intake across multiple levels of fat content in lean and obese women. *Am J Clin Nutr* 2001;**73**:1018.

39 Kant AK. Consumption of energy-dense, nutrient-poor foods by adult Americans: nutritional and health implications. The Third National Health and Nutrition Examination Survey, 1988–1994. *Am J Clin Nutr* 2000;**72**:929–36.

40 Popkin BM. An overview on the nutrition transition and its health implications: The Bellagio meeting. *Public Health Nutr* 2002;**5**: 93–103.

# Commentary: Assessing food insecurity in Trinidad and Tobago

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Gulliford and colleagues report in this issue of the *International Journal of Epidemiology* on a study in Trinidad and Tobago that investigated whether household food insecurity was associated with obesity in this middle-income country.[1] They found that food insecurity was associated with underweight but not with obesity. Food insecurity was also associated with decreased consumption of fruits and vegetables, a result previously reported in several studies, and with physical limitations, a result previously reported for elders in the US.[2]

Prior studies of the association of food insecurity and obesity have been done in high-income countries and found that white women and adolescent girls in families that were food insecure were more likely to be obese. One study in New York State in 1993 found that, whereas mild or moderate food insecurity was associated with a higher risk of obesity, severe food insecurity was associated with a lower risk.[3,4] These prior results suggest a possible explanation for why Gulliford and colleagues observed that food insecurity was related to underweight and not obesity, if the severity of food insecurity in their sample was relatively high.

To evaluate this possible explanation, we can compare the percentages of affirmative responses for the six items in the abbreviated food security measure with those reported from other samples. The percentages of affirmative responses in the Trinidad and Tobago sample for the six items were 21, 31, 18, 14, 13, and 6, listing the items in order of expected severity. The corresponding values for the same items in the US sample from the 1995 Current Population Survey[5] were 12.4, 11.5, 7.1, 6.8, 5.0, and 3.4. The percentages for these items in the Trinidad and Tobago sample were about two times higher than in the 1995 US sample, and were similar to those of the 1993 New York State sample.[6] Also, the second item listed (item 3 in Figure 1) that
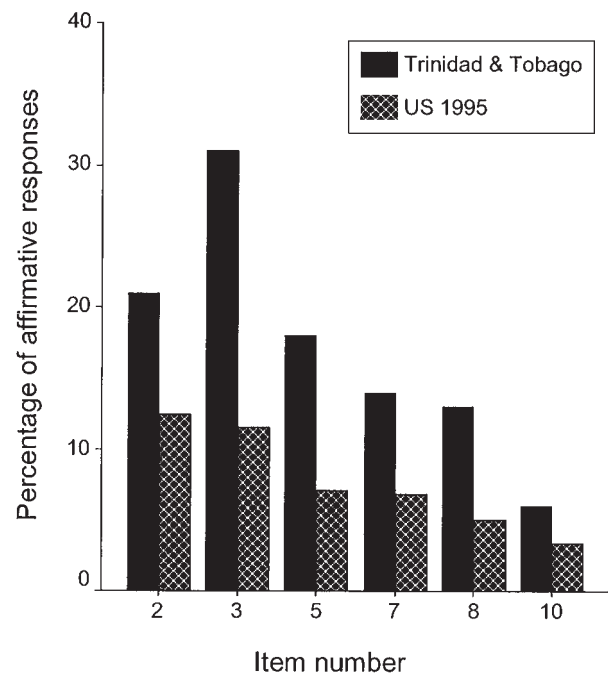
Figure 1 Comparison of percentages of affirmative responses to six food security measurement items in samples from Trinidad and Tobago and the US. Item numbers are from Blumberg *et al.* as cited in Gulliford *et al.*[1]

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