

Self-administration of a food security scale by adolescents: item functioning, socio-economic position and food intakes

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Abstract

Objective: To evaluate the reliability and validity of a six-item food security scale when self-administered by adolescents.

Design: Cross-sectional questionnaire survey including the six-item food security measure, socio-economic variables and a food-frequency questionnaire.

Setting: Representative sample of 29 schools in Trinidad.

Subjects: In total 1903 students aged approximately 16 years.

Results: Item affirmatives ranged from 514 (27%) for the 'balanced meal' item to 128 (7%) for the 'skipped or cut meals often' item and 141 (7%) for the 'hungry' item. Item-score correlations ranged from 0.444 to 0.580. Cronbach's α was 0.77. Relative item severities from the Rasch model ranged from -1.622 (standard error 0.043) for the 'balanced meal' item to 1.103 (0.068) for the 'skipped or cut meals often' item and 0.944 (0.062) for the 'hungry' item. The 'hungry' item gave a slightly lower relative severity in boys than girls. Food insecurity was associated with household overcrowding (adjusted odds ratio comparing highest and lowest quartiles 2.61, 95% confidence interval 1.75 to 3.91), lack of pipe-borne water in the home, low paternal education or paternal unemployment. After adjusting for socio-economic variables, food insecurity was associated with less frequent consumption of fruit (0.75, 0.60 to 0.94) or fish (0.72, 0.58 to 0.88) but more frequent consumption of biscuits or cakes (1.47, 1.02 to 2.11).

Conclusions: The food security scale provides a valid, reliable measure in adolescents, although young people report being hungry but not eating relatively more frequently than adults. Food-insecure adolescents have low socio-economic position and may eat less healthy diets.

Keywords
Food security
Socio-economic position
Dietary intakes
Adolescents

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'¹. The assessment of experienced food insecurity through the use of standard survey instruments is now attracting increasing attention. Research sponsored by the US Department of Agriculture led to the development of an 18-item questionnaire, from which six items were selected for a short form of the instrument^{2,3}. These measures are grounded in qualitative data that were used to identify questions, or items, to which affirmative responses indicate increasing degrees of food insecurity². Both the long- and short-form instruments have been well evaluated for application to adult samples². It has been shown that food insecurity or food insufficiency may be associated with low income⁴, physical disability⁵, unfavourable patterns of food intake^{5–7} and perhaps with overweight or obesity⁸. An important question for future research into food insecurity

concerns whether these instruments can be used in different settings from the one in which they were developed, or in different age groups.

The food security status of adolescents is of particular concern because this is a phase of rapid physical and cognitive development; exposures at this time may have lasting influences during the future course of life; and patterns of behaviour may be established which may be difficult to modify. Some studies have documented unfavourable health or educational outcomes associated with food insufficiency in adolescents⁹. However, the assessment of food insecurity by adolescents themselves has only begun to be described¹⁰. In the present paper we describe an evaluation of the six-item food security scale for application in an adolescent sample.

Our approach to evaluation of the food security scale is based on methods that were used to develop the instrument. The classification of food insecurity is derived from analysis of item responses using the Rasch model,

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which is used to estimate the location of each item in relation to underlying degree of food insecurity. The estimated locations are positioned on an arbitrary scale and provide estimates of the relative severity of each item¹¹. The Rasch model can be used to evaluate the validity of item responses obtained in different samples and settings because the same items should give similar relative severities in different contexts. The validity of the classification of food insecurity obtained by applying the scale may be further evaluated by testing whether the classification shows expected associations with socio-economic variables or diet¹².

We present herein an analysis of data provided by a survey that was carried out in Trinidad and Tobago, an English-speaking Caribbean country with an estimated per capita gross national income of \$US 6750¹³. We have previously shown that the six-item food security scale provides a satisfactory classification of food insecurity in adults in Trinidad¹². In this work we investigated whether the six-item food security scale could be self-administered by a sample of adolescents.

Methods

Sample

The sample was drawn by the government's Central Statistical Office. The target population was adolescents in Trinidad who had their 16th birthday during the school year. The sampling frame was a list of all 101 secondary schools including government schools, government denominational schools and registered private secondary schools. Schools were selected with probability proportional to size after stratifying by seven geographical administrative areas. Within each school, we randomly selected approximately 100 individual subjects from

the school roll in order to give a total sample of approximately 3000. The study received research ethics committee approval and was approved by the Ministries of Health and Education in Trinidad and Tobago. Subjects gave written informed consent to participate.

Data collection

The study questionnaire was developed from standard instruments and pilot administration was completed prior to the main survey to assess students' ability to complete the items. Questionnaires were self-completed by students in the classroom while fieldworkers were present to answer any questions from the students. The questionnaire included the short-form household food security questionnaire in the form described by Blumberg *et al.*³. In this paper the six numbered items^{3,12} are referred to as follows: 2, 'food did not last'; 3, 'balanced meal'; 5, 'cut or skipped meals'; 7, 'ate less than should'; 8, 'cut or skipped meals often'; 10, 'hungry but did not eat'. Item wordings are given in Table 1. Ethnicity was self-reported using the categories African, Indian, white, Chinese, mixed and other. For analysis these were reduced to the categories African-Caribbean, Indo-Caribbean, mixed and 'other and not known'. Questions concerning the home situation included: 'Does your mother (or father) live with you at home?', 'What was the highest grade of schooling your mother (father) completed?', 'Does your mother (father) currently work in paid employment?'. Subjects were asked 'What is the drinking water supply that you use at home?' using the categories: piped supply in house, piped supply in yard, private tank not piped, public standpipe, public tank, other and not known. Questions were included concerning the number of adults and children in the home, and the number of rooms (not including the bathroom and toilet, and excluding the kitchen if it was used only for

Table 1 Affirmative item responses and relative item severities for whole sample ($n = 1903$)

| | | Affirmatives (column %) | Item-score point biserial correlation | Relative item severity (standard error)* | Item-fit statistics† | |
|---------------------|---|----------------------------|---|--|----------------------|--------|
| | | | | | Infit | Outfit |
| 3. | I/we couldn't afford to eat balanced meals (BM) | 514 (27) | 0.444 | -1.622 (0.043) | 1.132 | 1.279 |
| 2. | The food that I/we bought just didn't last, and I/we didn't have money to get more (FL) | 449 (24) | 0.562 | -1.297 (0.045) | 0.888 | 0.848 |
| 5. | Did you (or other people in your household) ever cut the size of your (their) meals or skip meals because there wasn't enough money for food?‡ (SM) | 234 (12) | 0.580 | 0.053 (0.056) | 0.798 | 0.756 |
| 7. | Did you ever eat less than you felt you should because there wasn't enough money to buy food?‡ (EL) | 152 (8) | 0.505 | 0.818 (0.061) | 0.853 | 0.811 |
| 8. | How often did this happen? (skipped or cut size of meals) (SMO) | 128 (7) | 0.506 | 1.103 (0.068) | 0.807 | 0.676 |
| 10. | Were you ever hungry but didn't eat because you couldn't afford enough food?‡ (H) | 141 (7) | 0.472 | 0.944 (0.062) | 0.923 | 0.804 |
| Cronbach's α | | | 0.77§ | | | |

* Under the Rasch model, item thresholds are scaled to an arbitrary mean; by convention zero is used here.

† See text for explanation.

‡ Item prefaced with 'In the last 12 months'.

§ Cronbach's α for six-item scale.

cooking). These were used to estimate the number of persons per room as an index of overcrowding. A short food-frequency questionnaire covered the consumption of the following types of food: sweet biscuits or cakes; salted biscuits; fruit; bread or bread rolls; green vegetables and salads; fish including shellfish; sweets, chocolate, etc.; burgers, fried chicken or pizzas; beans, peas or lentils, etc.; ground provisions (yam, cassava, potatoes, dasheen, edoes, etc.); roti; and rice. Response categories 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 often than one a month', 'rarely or never'. For analysis these were reduced to 'eaten \geq 5–6 days per week' for more frequently consumed foods, and 'eaten at least weekly' for less frequently consumed foods.

Analysis

In order to evaluate the food security scale, item response models were fitted to the data using BILOG-MG version 3.0 software from Scientific Software International¹⁴. Item-score correlations were estimated as the point biserial correlation between each item and the total¹⁴. Initially a one-parameter logistic (Rasch) model was fitted to the data as a single group¹¹. Item-fit statistics were calculated as described by Nord¹¹. The item infit and outfit statistics gauge the extent to which item response deviates from the pattern expected under the Rasch model. The expected value for both the infit and outfit statistics is one, with values between 0.8 and 1.2 considered within acceptable limits. Infit values above one indicate that the item discriminates less well than the other items. The outfit statistic is sensitive to deviations from expected responses and values substantially above one indicate a higher-than-expected proportion of erratic responses. We explored whether there was evidence of differential item functioning (DIF) by gender or by both gender and ethnicity. The combined data for boys and girls were fitted to a one-parameter logistic model but with separate relative item severities estimated for each gender (or each gender-ethnic group-specific category) after adjusting for differences in the frequency of food insecurity between groups. In the DIF model, the mean of the adjusted relative item severities is constrained to be the same for each group. A likelihood-ratio test was used to evaluate whether allowing for DIF improved goodness-of-fit. Multiple logistic regression was used to estimate associations between explanatory variables and food insecurity status, or between food insecurity and food frequency responses. Robust variance estimates were used to allow for clustering by school.

Results

Thirty schools were sampled but one dropped out, leaving 29 schools with 3067 eligible students sampled for the survey. After excluding students who were absent or who

declined to participate, there were 1973 (64%) subjects with questionnaires and measurement forms returned. A further 70 subjects were excluded because of missing values for one or more of the six food security items. There were then 1903 (62%) subjects available for analysis. There were 802 boys and 1101 girls, with mean age 16.0 years (standard deviation 0.32, range 14.5–17.1 years). The response rates ranged from 19 to 85% at different schools with a mean of 66 respondents per school. There were 419 (22%) subjects classified as food-insecure (two or more affirmatives) and 67 (4%) classified as having food insecurity with hunger (five or more affirmatives). The proportion of respondents who were food-insecure varied between 4 and 47% at different schools, but there was no association between the proportion who were food-insecure and the school's response rate.

Table 1 shows the proportion of affirmatives, point biserial correlations, estimated relative severity from the Rasch model and item-fit statistics for each item. The 'balanced meal' item gave the highest proportion of affirmatives¹² and the lowest relative severity while the other items showed increasing relative severities². The 'hungry but did not eat' item gave a relative severity which was similar to the 'eat less' and 'skipped meals often' items. Item-fit statistics generally gave acceptable results, suggesting that the Rasch model provided a good fit to the data. The outfit statistic was somewhat elevated for the 'balanced meal' item, suggesting that this item gave more responses which deviated from the expected pattern.

A model for differential item functioning by gender gave a better fit than the Rasch model ($\chi^2 = 25.1$, *df* 5, $P < 0.001$), as did a model for differential item functioning by ethnic group and gender ($\chi^2 = 126.56$, *df* 25, $P < 0.001$). Figure 1 shows the adjusted relative severities for each item plotted separately by gender and ethnic group, together with the estimated 95% confidence intervals. Note that the mean of the adjusted relative severities is constrained to be the same in each group but is non-zero. In boys, the adjusted relative severity for the hunger item was slightly lower than in girls, and this finding held for each ethnic group. In both boys and girls, the adjusted relative severity for the 'balanced meal' item was slightly lower in Indo-Caribbean subjects than in the other groups¹². However, the relative severity of each of the other items was very similar in each ethnic group and in boys and girls.

Table 2 shows the distribution of food insecurity, based on two affirmative responses, according to gender, ethnicity and socio-economic variables. In univariate analyses, food insecurity was associated with household overcrowding, lack of a pipe-borne drinking water supply in the home, unemployment of the father and lower maternal or paternal education. Food insecurity was more frequent in homes headed by a single mother. There were 29% of Afro-Caribbean subjects in single-mother headed households compared with 12% of Indo-Caribbean

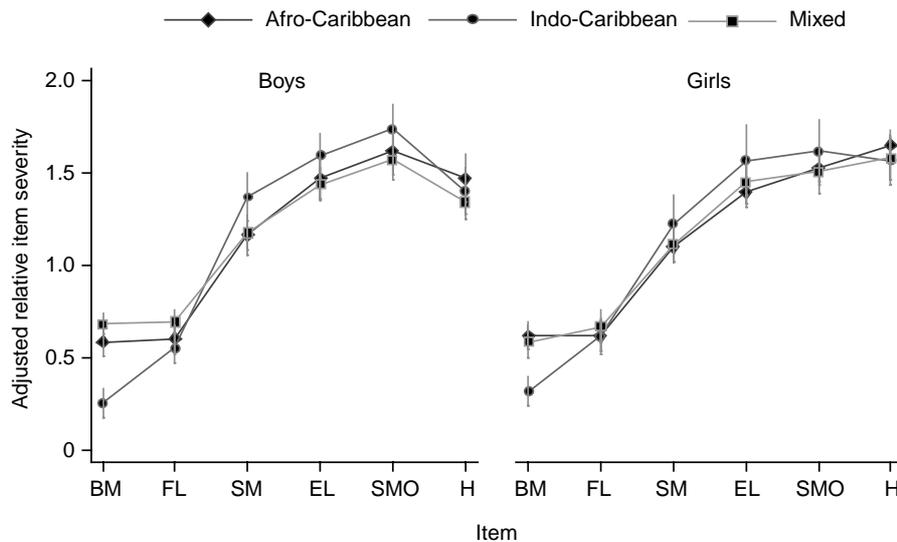


Fig. 1 Adjusted relative item severities (with 95% confidence intervals indicated by vertical bars) for each food security item by ethnic group and gender. Item identifiers as in Table 1

subjects. In a multiple regression model, maternal employment and education were not independently associated with food insecurity but all the remaining variables showed independent associations and were used for adjustment in subsequent analyses. Food insecurity was less frequent among Indo-Caribbean subjects than in Afro-Caribbean subjects and this association was robust to adjustment for socio-economic variables. Food insecurity with hunger (five or six affirmatives) was experienced by 67 adolescents overall including 21 Afro-Caribbean, nine Indo-Caribbean and 37 of mixed, other or not known ethnicity.

Table 3 shows the distribution of food security scores according to quartile of overcrowding in the home. Among subjects who were food-insecure without hunger, 15% were in the lowest quartile of overcrowding and 29% were in the highest quartile. Among subjects who were classified as having food insecurity with hunger, 9% were in the lowest quartile and 39% were in the highest quartile. When contrasted with food-secure subjects (zero or one affirmative), the relative risk associated with the highest quartile of overcrowding compared with the lowest was 2.39 (95% confidence interval 1.61 to 3.54) for food insecurity without hunger and 6.31 (2.58 to 15.4) for food insecurity with hunger.

Table 4 shows the association of food insecurity with frequency of consumption of different food items. In unadjusted analyses food insecurity was associated with less frequent consumption of fruit, green vegetables and salads, fish, burgers, fried chicken or pizzas, and roti. Food-insecure subjects were more frequent consumers of sweets and chocolate and sweet biscuits or cake. After adjusting for variables that might have a direct effect on food consumption as well as an effect mediated through food insecurity, food insecurity was still found to be associated with less frequent consumption of fruit or

fish but more frequent consumption of sweet biscuits or cake.

Discussion

Our results support the cross-cultural validity of the short form of the food security scale and show that this scale may be successfully self-administered by adolescents.

When self-administered to adolescents, the items in the food security scale gave reliable responses based on the item-score correlations and the acceptable value for Cronbach's α . It has been proposed that Cronbach's α should be above 0.70 but probably not higher than 0.90¹⁵. Very high values for α suggest that some items may be redundant. α increases with increasing numbers of items in a scale¹⁵ and the six-item food security scale will give lower values for α than the long form of the instrument even when the average inter-item correlations are similar. The validity of responses was supported both by the generally satisfactory fit with the Rasch model and by the anticipated associations with lower socio-economic position and food choices. In this adolescent age group there was evidence that the 'hungry but did not eat' item gave a lower relative threshold than in adults, with some evidence that the threshold for hunger was lower in boys than girls. In a survey of adults in Trinidad¹² 'hungry but did not eat' was more severe than 'ate less than should' by 1.95 logistic units, and more severe than 'cut or skipped meal often' by 1.78 logistic units. In the adolescent survey, the differences between these pairs of items were 0.13 and -0.16 units, respectively. This suggests that adolescents would be more likely to report being hungry yet unable to eat and might, as a result, be more likely to be classified as having food insecurity with hunger than adults who had equivalent response patterns to the other items. However, the 'hungry but did not eat' item asks directly about

Table 2 Associations of food insecurity with socio-economic variables

| Variable | Category | Total in category | Food insecure (row %) | Adjusted OR (95% CI)* | P-value† |
|---------------------------|------------------------------------|-------------------|-----------------------|-----------------------|----------|
| Sex | Boys | 802 | 177 (22) | 0.92 (0.73 to 1.17) | 0.504 |
| | Girls | 1101 | 242 (22) | | |
| Ethnic group | Afro-Caribbean | 441 | 137 (31) | 0.34 (0.24 to 0.48) | <0.001 |
| | Indo-Caribbean | 654 | 97 (15) | | |
| | Mixed | 676 | 169 (25) | | |
| | Other/not known | 132 | 16 (12) | | |
| Over-crowding quartile | ≤0.75 | 443 | 60 (14) | 1.47 (1.06 to 2.03) | <0.001 |
| | >0.75 to 1.00 | 464 | 93 (20) | | |
| | >1.00 to 1.50 | 407 | 107 (26) | | |
| | >1.50 | 368 | 127 (35) | | |
| Drinking water supply | Not known | 221 | 32 (14) | 0.96 (0.64 to 1.44) | <0.001 |
| | Piped in house | 1386 | 254 (18) | | |
| | Piped in yard | 114 | 38 (33) | | |
| | No piped supply | 304 | 100 (33) | | |
| Father employed | Yes | 1569 | 315 (20) | 1.85 (1.12 to 3.06) | 0.025 |
| | No | 277 | 87 (31) | | |
| Father's education | Not known | 57 | 17 (30) | 1.33 (0.67 to 2.63) | 0.029 |
| | University | 172 | 19 (11) | | |
| | Technical | 236 | 40 (17) | | |
| | Secondary | 597 | 118 (20) | | |
| | Primary | 256 | 73 (29) | | |
| | None | 15 | 6 (40) | | |
| Mother employed | Yes | 627 | 163 (26) | 1.81 (0.88 to 3.73) | 0.299 |
| | No | 1092 | 227 (21) | | |
| | Not known | 783 | 184 (24) | | |
| Mother's education | Not known | 28 | 8 (29) | 1.46 (0.57 to 3.73) | 0.412 |
| | University | 134 | 20 (15) | | |
| | Technical | 273 | 46 (17) | | |
| | Secondary | 875 | 189 (22) | | |
| | Primary | 340 | 102 (30) | | |
| | None | 9 | 3 (33) | | |
| Number of parents at home | Not known | 272 | 59 (22) | 1.11 (0.61 to 2.03) | 0.024 |
| | Both parents | 1136 | 215 (19) | | |
| | Father only | 132 | 27 (20) | | |
| | Mother with male head of household | 109 | 26 (24) | | |
| | Mother only | 404 | 124 (31) | | |
| | Neither parent | 122 | 27 (22) | 0.88 (0.48 to 1.60) | |

OR – odds ratio; CI – confidence interval.

*ORs were adjusted for each of the variables shown as well as age and clustering by school.

† P-value for overall test of association of variable with food security status.

experiences of hunger and we interpret the findings to show that adolescents may be more susceptible to experiencing hunger than older adults.

As in adults, the pattern of responses differed in some respects from US data, with the item about 'balanced meals', rather than the item about 'food not lasting', giving the lowest relative severity. This finding also held in Brazilian data¹⁶. There was some evidence of differential functioning of the 'balanced meal' item in relation to ethnicity. The item has also presented difficulties in other settings^{16–18}. Several alternative wordings have been suggested including 'did you run out of money to have a healthy and varied diet?'¹⁶ or 'we couldn't afford to eat healthy meals' or 'we couldn't afford to eat nutritious meals'. These alternatives might appear to be preferable but improved fit to the Rasch model has not been demonstrated. Indeed, the concept of a 'healthy meal' may be interpreted differently in different groups just as the 'balanced meal' concept appears to be. The resolution of

this issue requires analysis of data for different versions of the item from a sufficiently large survey. Other forms of differential item functioning of the food security module have also been demonstrated in US data¹⁹. The reversal of the relative severities of the two low-severity items had the advantageous consequence that the problematic 'balanced meal' item was moved further from the cut-point of two affirmatives, which is used to define food insecurity. The classification of food insecurity based on two affirmatives was considered to remain valid^{3,12} and this was further supported by the nature of the associations with socio-economic and dietary variables.

Food insecurity is more frequent in subjects of Afro-Caribbean rather than Indo-Caribbean ethnicity⁵ and the present data shed further light on this finding. In our previous study⁵, selection bias from cluster sampling was possible²⁰. The present results from a national sample make this possible explanation less plausible. It is also unlikely that ethnic differences in food insecurity could be

Table 3 Association of food insecurity classification with overcrowding*

| Overcrowding quartile (persons per room) | Number of affirmative responses to food security items | | | |
|--|--|--------------------------|--|--|
| | None (<i>n</i> = 1143) | One (<i>n</i> = 341) | Two to four (food-insecure without hunger) (<i>n</i> = 352) | Five or six (food-insecure with hunger) (<i>n</i> = 67) |
| ≤ 0.75 | 27 | 22 | 15 | 9 |
| > 0.75 to 1.00 | 25 | 25 | 23 | 19 |
| > 1.00 to 1.50 | 19 | 23 | 26 | 22 |
| > 1.50 | 15 | 20 | 29 | 39 |
| Not known | 14 | 10 | 7 | 10 |

* Data are expressed as % of the column total.

explained by differential functioning of the questionnaire items because the only significant ethnic difference in the estimated relative item severities was for the 'balanced meal' item and this was in the opposite direction to the observed difference in food insecurity. The marked ethnic differences in the proportion of households headed by a single mother draw attention to the generally more extended family networks of Indo-Caribbean communities^{21,22}. It is possible that family and broader social support affords some protection against food insecurity. In a recent study, Martin *et al.*²³ suggested that social capital may be associated with decreased risk of hunger after adjusting for income, education and employment status. This suggestion merits further investigation.

In the present data, subjects who were food-insecure ate fruit or fish less frequently and were more frequent consumers of sweet biscuits and cakes. This is consistent with the results of previous studies^{4-7,24}. The price structure of food may encourage low-income subjects,

who may be food-insecure, to favour the consumption of energy-dense²⁵ nutrient-poor foods which may predispose to the development of obesity^{26,27}.

Comparison with other work

Connell *et al.*¹⁰ recently reported a study in which cognitive testing of the food security items was carried out with a sample of 39 older children aged between 11 and 15 years in southern Mississippi. Their findings led to slight modification of the wording of several items but, for five of the six items included here, the wording remained close to the original¹⁰. The item concerning 'how often' subjects skipped a meal was omitted from a nine-item instrument which they tested in a sample of 345 older children aged 12 to 15 years. These data supported the use of these food security items, with a cut-point of two affirmatives, to evaluate food security in adolescents. Our results suggest that it may be feasible to use fewer than nine items, which may be advantageous in surveys of this age group.

Limitations

The strengths of the study were the large sample and the standardised methods of measurement. The main limitation of the study was a response rate of approximately 62%. This is comparable to response rates obtained in other surveys. In the national Health Survey for England 1998²⁸, weight measurements were obtained on 64% of subjects in eligible households. The anticipated effect of this non-response will be to lead to under-representation of low-income groups who may be at greater risk of food insecurity. Adolescents from these groups may also have less access to education and may be less well represented in the registered school population by the age of 16 years. These biases would tend to diminish the associations identified. We preferred the standard wording for food

Table 4 Association of food security status with frequency of consumption of 12 food items

| Food item (total analysed) | Food-secure* | Food-insecure* | Univariate OR (95% CI) | Adjusted OR (95% CI)† |
|---|--------------|----------------|------------------------|-----------------------|
| Eaten ≥ 5–6 days per week | | | | |
| Fruit (1879)‡ | 647 (44) | 155 (37) | 0.75 (0.60 to 0.95) | 0.75 (0.60 to 0.94)§ |
| Green vegetables and salads (1890) | 455 (31) | 105 (25) | 0.75 (0.60 to 0.94) | 0.85 (0.68 to 1.06) |
| Rice (1898) | 1075 (73) | 316 (76) | 1.18 (0.92 to 1.52) | 1.10 (0.83 to 1.44) |
| Peas, beans, lentils, etc. (1885) | 487 (33) | 156 (38) | 1.22 (0.97 to 1.52) | 1.05 (0.84 to 1.31) |
| Bread or bread rolls (1898) | 1028 (69) | 307 (73) | 1.22 (0.93 to 1.59) | 1.17 (0.91 to 1.52) |
| Sweets, chocolate, etc. (1886) | 713 (49) | 226 (54) | 1.25 (1.00 to 1.58) | 1.20 (0.91 to 1.58) |
| Eaten at least weekly | | | | |
| Ground provisions (1896) | 903 (61) | 248 (59) | 0.94 (0.69 to 1.26) | 0.98 (0.70 to 1.36) |
| Fish including shellfish (1885) | 646 (44) | 144 (35) | 0.68 (0.56 to 0.83) | 0.72 (0.58 to 0.88)¶ |
| Sweet biscuits or cakes (1895) | 1136 (77) | 347 (83) | 1.47 (1.00 to 2.14) | 1.47 (1.02 to 2.11) |
| Salted biscuits (1882) | 640 (44) | 169 (41) | 0.89 (0.70 to 1.14) | 0.91 (0.70 to 1.18) |
| Burgers, fried chicken or pizzas (1891) | 895 (61) | 220 (53) | 0.72 (0.56 to 0.91) | 0.79 (0.60 to 1.03) |
| Sada roti (1890) | 796 (54) | 173 (42) | 0.61 (0.44 to 0.82) | 0.82 (0.61 to 1.13) |

OR – odds ratio; CI – confidence interval.

* Number of subjects (column %) who ate foods with the frequency indicated.

† Adjusted for sex, age, ethnic group, overcrowding, water supply, father's education, father's employment and number of parents at home.

‡ Adjusted total after omitting cases with 'not known' values.

§ *P* = 0.014.

¶ *P* = 0.002.

|| *P* = 0.036.

security items²⁹, believing that standard instruments should generally not be modified unless there is a compelling reason²⁰ and then only based on adequate cognitive and pilot survey testing. As noted earlier, few suggested improvements have been shown to have superior psychometric properties when judged according to the methods used by the developers of the instrument. We used a short, simple food-frequency questionnaire suitable for self-administration. We acknowledge that a more detailed instrument might have provided more detailed and useful dietary information.

Conclusions

The short-form household food security scale may be suitable for use in school-based surveys of older adolescents. By evaluating the goodness-of-fit of the Rasch model, we were able to show that the cut-point for food insecurity without hunger is valid in this age group. There was evidence that the threshold for reporting experiences of being hungry but unable to eat is lower in this age group than in adults, especially in boys. This finding probably results from a greater susceptibility to experience hunger in this age group. Adolescents who are food-insecure are more frequently found in homes with fewer amenities, less educated or unemployed fathers, or with a single mother as head of household. There was evidence that food insecurity with hunger was associated with greater household overcrowding than food insecurity without hunger, thus providing indirect support for the use of this cut-point. After adjusting for socio-economic variables, food insecurity was associated with less favourable dietary intakes. Future studies should evaluate and compare different versions of the 'balanced meal' item, compare different modes of administration of the food security scale, and compare parents' perceptions with those of their children. Research should also evaluate the relationship between food insecurity, diet and nutrition, and health outcomes in this age group.

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