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Smith, L., Barnett, Y., López-Sánchez, G. F., Shin, J. I., Jacob, L., Butler, L., Cao, C., Yang, L., Schuch, F., Tully, M., & Koyanagi, A. (2022). Food insecurity (hunger) and fast-food consumption among 180 164 adolescents aged 12-15 years from sixty-eight countries. *British Journal of Nutrition*, *127*(3), 470-477. https://doi.org/10.1017/S0007114521001173

Published in:
British Journal of Nutrition

Publication Status:
Published (in print/issue): 14/02/2022

DOI:
10.1017/S0007114521001173

Document Version
Author Accepted version

Title: Food insecurity (hunger) and fast-food consumption among 180,164 adolescents aged 12-15 years from 68 countries

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This peer-reviewed article has been accepted for publication but not yet copyedited or typeset, and so may be subject to change during the production process. The article is considered published and may be cited using its DOI
10.1017/S0007114521001173
The British Journal of Nutrition is published by Cambridge University Press on behalf of The Nutrition Society

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ABSTRACT

Food insecurity has been shown to be associated with fast-food consumption. However, to date, studies on this specific topic are scarce. Therefore, the aim of the present study was to investigate the association between food insecurity and fast-food consumption in adolescents aged 12-15 years from 68 countries (7 low-income, 27 lower middle-income, 20 upper middle-income, 14 high-income countries). Cross-sectional, school-based data from the Global School-based Student Health Survey were analyzed. Data on past 30-day food insecurity (hunger) and fast-food consumption in the past 7 days were collected. Multivariable logistic regression and meta-analysis were conducted to assess associations. Models were adjusted for age, sex, and body mass index. There were 180,164 adolescents aged 12-15 years [mean (SD) age 13.8 (1.0) years; 50.8% boys] included in the analysis. Overall, severe food insecurity (i.e., hungry because there was not enough food in home most of the time or always) was associated with 1.17 (95%CI=1.08-1.26) times higher odds for fast-food consumption. The estimates pooled by country-income levels were significant in low-income countries (adjusted odds ratio [aOR]=1.30; 95%CI=1.05-1.60), lower middle-income countries (aOR=1.15; 95%CI=1.02-1.29), and upper middle-income countries (aOR=1.26; 95%CI=1.07-1.49), but not in high-income countries (aOR=1.04; 95%CI=0.88-1.23). The mere co-occurrence of food insecurity and fast-food consumption is of public health importance. To tackle this issue, a strong governmental and societal approach is required to utilize effective methods as demonstrated in some high-income countries such as the implementation of food banks and the adoption of free school meals.

Key Words: Food insecurity; Fast-food; Multi-country; Adolescents

INTRODUCTION

Fast-food is food that can be prepared quickly and easily and is sold in restaurants and snack bars as a quick meal or to be taken out [1, 2], and often consists of meals such hamburgers and chips [3]. However, it should be noted that fast food products likely vary considerably across countries and cultures. [3]. Currently, fast-food consumption is on the rise globally, especially among adolescents in both low- and middle-income countries (LMICs) and high-income countries (HICs) [4, 5]. Fast-food often consists of poor nutrition. For example, one study carried out by Heart UK identified that many UK high street restaurants and fast-food chains serve meals with four times the UK's national maximum daily recommended levels of saturated fat in a single meal [6]. Furthermore, fast-food consumers are known to have higher intakes of energy, fat, saturated fatty acids, trans fatty acids, added sugar and sodium, as well as lower intakes of fiber, macronutrients and vitamins [7].

Research has shown that fast-food consumption is associated with increased risk for physical conditions such as obesity, insulin resistance, and elevated total cholesterol [7], while some studies have shown that it can also negatively impact mental health. For example, one study in 13486 Iranian children and adolescents found that fast-food consumption may increase the risk for psychiatric distress and violent behaviors [8]. Other research has identified a link between fast-food consumption and depression [9] or suicide attempts [10]. Owing to these detrimental health outcomes, it is important to identify risk factors of fast-food consumption in order to implement effective strategies to reduce this behavior.

One potentially important but understudied correlate of fast-food consumption is food insecurity. Food insecurity is a condition in which households lack access to adequate food because of limited money or other resources [11]. Although not all individuals in food insecure households experience hunger, severe food insecurity can lead to hunger. The prevalence of

food insecurity has been reported to be high in both LMICs and HICs. For example, the prevalence of food insecurity in the US in 2019 has been estimated to be 10.5% [12]. Food insecurity may lead to fast-food consumption as people tend to shift to more calorie dense but less nutritious food when food is scarce [13]. Specifically, food insecure people may prefer calorie dense food to compensate for times when food is scarce. Alternatively, increasing cravings for high-calorie foods may be induced as a coping strategy for stress associated with food insecurity [14].

However, to date, there are only a few studies specifically on this topic across all age groups, and all have been conducted in HICs. For example, in one study including 4746 multiethnic middle and high school students in the US, it was found that food-insecure youths reported eating more fast-food but fewer family meals and breakfasts per week than did youths who are food secure [15]. In another study including 2564 Australian households, it was found that having run out of money to buy food was associated with increased likelihood of purchasing fast-food from chain restaurants on a weekly basis [16].

The co-occurrence of food insecurity and fast-food consumption in young people is of particular concern as both are detrimental to health, and both have been shown to track across the lifespan leading to an increased risk for adverse health outcomes even in adulthood [17, 18]. Moreover, studying this association among adolescents is of particular importance as adolescence is a crucial life stage characterized by dramatic modifications in lifestyle patterns. These modifications include unhealthier food choices and eating outside the home (mainly at fast food restaurants), amongst others [19-21]. Therefore, the aim of the present study was to investigate the association between food insecurity and fast-food consumption in adolescents aged 12-15 years from 68 countries, representing all economic settings.

METHODS

Publicly available data from the Global School Health Survey (GSHS) were analyzed. Details on this self-administered survey can be found at http://www.who.int/chp/gshs and http://www.cdc.gov/gshs. Briefly, the GSHS was jointly developed by the WHO and the US Centers for Disease Control and Prevention (CDC), and other UN allies. The core aim of this survey was to assess and quantify risk and protective factors of major non-communicable diseases. The survey draws content from the CDC Youth Risk Behavior Survey (YRBS) for which test-retest reliability has been established [22]. The survey used a standardized two-stage probability sampling design for the selection process within each participating country. For the first stage, schools were selected with probability proportional to size sampling. The second stage involved the random selection of classrooms which included students aged 13-15 years within each selected school. All students in the selected classrooms were eligible to participate in the survey regardless of age. Data collection was performed during one regular class period. The questionnaire was translated into the local language in each country and consisted of multiple choice response options; students recorded their response on computer scannable sheets. All GSHS surveys were approved, in each country, by both a national government administration (most often the Ministry of Health or Education) and an institutional review board or ethics committee. Student privacy was protected through anonymous and voluntary participation, and informed consent was obtained as appropriate from the students, parents and/or school officials. Data were weighted for non-response and probability selection.

From all publicly available data, we selected all nationally representative datasets that included the variables used in the current analysis. If there were more than two datasets from

the same country, we chose the most recent dataset. Thus, a total of 68 countries were included in the current study. The characteristics of each country or survey are provided in **Table 1**. For the included countries, the survey was conducted between 2009 and 2017, and consisted of 7 low-income (n=12,462), 27 lower middle-income (n=67,333), 20 upper middle-income (n=72,861), and 14 high-income (n=27,508) countries based on the World Bank classification at the time of the survey for the respective countries.

Fast-food consumption

Fast-food consumption was assessed with the question "During the past 7 days, on how many days did you eat food from a fast-food restaurant?" with country specific examples on fast-food restaurants. Those who consumed fast-food on at least one day in the past 7 days were considered to be consumers of fast-food [10]. The examples of fast-food included in the questionnaire of each country are provided in Table S1 of the supplementary material. However, it should be noted that the validity of the question on fast food consumption has not been examined and thus is unknown.

Food insecurity (hunger)

Food insecurity (hunger) was assessed by the question "During the past 30 days, how often did you go hungry because there was not enough food in your home?" Answer options were "never", "rarely", "sometimes", "most of the time", and "always". A brief hunger screening tool based on a similar single question showed 85% sensitivity and 80% specificity compared with the Household Food Security Scale [23]. For some analyses, a dichotomized variable on severe food insecurity (hunger) was used (i.e., most of the time/always or else) [24].

Control variables

The control variables included sex, age, and body mass index (BMI). Trained survey staff conducted measurement of weight and height. BMI was calculated as weight in kilograms divided by height in meters squared. Obesity and overweight were defined as >2 SDs and >1 SD above the median for age and sex based on the 2007 WHO Child Growth reference, respectively, and adolescents who were below -2 SDs were considered to be underweight [25]. All other subjects were considered to be normal weight.

Statistical analysis

Statistical analyses were performed with Stata 14.2 (Stata Corp LP, College station, Texas). We restricted the analysis to those aged 12-15 years as data on the exact age outside of this age range was not available, and because most students were within this age range. Using the overall sample, we used logistic regression analysis to estimate the association between different levels of food insecurity (hunger) (independent variable) and fast-food consumption (dependent variable), while adjusting for age, sex, BMI, and country. Adjustment for country was done by including dummy variables for each country in the model as in previous GSHS publications [26, 27]. We also conducted interaction analysis by including a product term (food insecurity X sex) in the regression analysis in order to assess whether associations differ by sex. Next, we conducted country-wise logistic regression analysis to assess the association between severe food insecurity (i.e., most of the time/always hungry) and fast-food consumption, while adjusting for age, sex, and BMI. We focused on severe food insecurity (hunger) for this analysis as preliminary analysis showed that this level of food insecurity (hunger) is associated with particularly high odds for fast-food consumption. In order to assess between-country heterogeneity, we calculated the Higgins's I^2 which represents the degree of heterogeneity that is not explained by sampling error with a value of <40% often

considered as negligible and 40-60% as moderate heterogeneity [28]. A pooled estimate (overall and by country income level) was obtained based on country-wise estimates using meta-analysis with random effects. All variables were included in the regression analysis as categorical variables with the exception of age (continuous variable). Sampling weights and the clustered sampling design of the surveys were taken into account to obtain nationally representative estimates. Results from the logistic regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at $p<0.05$.

RESULTS

A total of 180,164 adolescents aged 12-15 years [mean (SD) age 13.8 (1.0) years; 50.8% boys] were included in the analysis. The prevalence of fast-food consumption in the past 7 days overall was 50.1%. Overall, the proportion of adolescents who went hungry due to lack of food at home in the past 30 days by frequency were: rarely 17.6%; sometimes 24.5%; most of the time 3.5%; and always 2.7%. There was a wide range in the prevalence of fast-food consumption and severe food insecurity (i.e., most of the time/always hungry) by country with the ranges being 21.0% (Pakistan) to 85.9% (Qatar) and 0.9% (Vietnam) to 17.1% (Afghanistan), respectively, while the prevalence of severe food insecurity was particularly high in low-income countries (**Table 1**). The prevalence of fast-food consumption increased with greater frequency of food insecurity (hunger) (**Figure 1**). Based on a multivariable logistic regression analysis, compared to no food insecurity (hunger), being hungry most of the time and always were associated with significant 1.25 (95%CI=1.09-1.44) and 1.31 (95%CI=1.11-1.54) times higher odds for fast-food consumption, respectively (**Figure 2**). No significant interaction by sex was observed. The country-wise association between severe food insecurity (hunger) and fast-food consumption is shown in **Figure 3**. Overall, the pooled

estimate based on all 68 countries was OR=1.17 (95%CI=1.08-1.26) with a moderate level of between-country heterogeneity (I^2=50.2%). The estimates pooled by country-income levels were significant in low-income countries (OR=1.30; 95%CI=1.05-1.60), lower middle-income countries (OR=1.15; 95%CI=1.02-1.29), and upper middle-income countries (OR=1.26; 95%CI=1.07-1.49), but not in HICs (OR=1.04; 95%CI=0.88-1.23), although a moderate level of between-country heterogeneity was present for all income levels (I^2=44.3%-58.3%) with the exception of low-income countries (I^2=0.0%).

DISCUSSION

In this large sample of children and adolescents from 68 countries representative of all economic settings, it was found that the prevalence of fast-food consumption increases linearly with increasing severity of food insecurity (hunger). Based on a meta-analysis, it was found that severe food insecurity (i.e., hungry most of the time or always due to not enough food at home) was associated with 1.17 (95%CI=1.08-1.26) times higher odds for fast-food consumption compared to those without severe food insecurity. This association was significant in low-income countries (OR=1.30), lower middle-income countries (OR=1.15), and upper middle-income countries (OR=1.26) but not in HICs.

The finding that food insecurity is associated with higher odds for fast-food consumption is in line with previous literature that has identified a positive association between food insecurity and fast-food consumption [15, 16]. There may be several plausible pathways that explain why food insecure adolescents are more likely to consume fast-food. First, research has suggested that food insecure families tend to choose more energy-dense food and this may be because energy-dense foods composed of refined grains, added sugars, or fats may represent the lowest-cost option to the consumer [29]. Alternatively, this behavior may be

explained by a preference for calorie dense food owing to compensation for periods with scarcity of food or poor health literacy. Second, dietary habits and food insecurity track across the life span. Therefore, parents of food insecure households may be more likely to have been food insecure in their childhood and have been consuming fast-food often, and ingrained this habit in their offspring [17, 18]. Third those who are food insecure are more likely to suffer from mental health complications [24] and mental health complications are associated with fast-food consumption [30]. For example, previous studies have shown that food insecurity may lead to higher levels of stress [14], and it is possible that increasing cravings for high-calorie foods may be induced as a coping strategy for this stress [14]. Finally, literature suggests that those who are from a lower socio-economic status (and thus more likely to be food insecure) live in closer proximity to fast-food outlets. Thus, it is possible that food insecure people are more likely to consume fast-food owing to convenience and greater availability [31].

It is important to note that although the pooled estimate showed a significant association between food insecurity and fast-food consumption in the overall sample and in LMICs, such an association was not observed for HICs although a moderate level of between-country heterogeneity was observed within HICs. The findings from HICs are not in line with previous studies from this setting (i.e., US and Australia) [15, 16] but it is important to note that the HICs included in our study were not Western countries with a large variation in terms of geographical location. Moreover, there are some important differences between our study and those previous studies that may explain the discrepant findings. For example, the previous study in the US used data now over two decades old [15] and the previous study carried out in Australia collected data from the main food shopper in each household and thus did not focus on adolescents per se [16]. At least in our study, the observed differences between country-

income levels may be related to national actions to combat food insecurity. For example, in some HICs, food banks are readily available [32] and have been found to reduce levels of food insecurity [33]. Moreover, in many HICs, children and young people are provided with free and healthy school meals [34, 35]. However, both of these kinds of initiatives are rare in LMICs. Finally, although speculative, it is possible that food insecure adolescents and their parents in some countries included in our study may be more aware of the deleterious health effects of fast-food, or that fast-food is not readily available or affordable in some settings, and this might explain some of the between-country heterogeneity observed. However, clearly, further studies are necessary to understand the reason for the moderate level of between-country heterogeneity observed in our study.

The large multi-country sample of children and adolescents is a clear strength of the present study. However, findings must be interpreted in light of its limitations. First, the study was cross-sectional in nature and thus the direction of the association is not known. However, it is highly unlikely that fast-food consumption per se leads to food insecurity. Moreover, the mere co-occurrence of these two conditions is of importance as they are both associated with adverse physical and mental health outcomes. Second, the study relied on self-reported data which could have been affected by factors such as recall and social desirability biases. Third, our measure on food insecurity (hunger) was based on a single question based on hunger due to lack of food at home, which can be considered a rare and extreme manifestation of food insecurity, and we were thus unable to assess all aspects of food shortage and inadequacy. Moreover, our measure of fast-food did not ask about the type of fast food being consumed. Indeed, certain types of fast food may be more detrimental to both physical and mental health than others. Future research should aim to investigate the present association using fast-food type as an outcome. It should also be noted that the validity of our question on fast food

consumption has not been examined and thus is unknown. Fourth, there is much overlap between poverty and food insecurity. Thus, it is possible that the association observed in our study may also partly be explained by other aspects of poverty that could not be adjusted for in our analysis due to lack of data. Fifth, information on factors such as parent's SES, family structure, and other environmental factors (e.g., availability of fast-food in the neighborhood) were not available in the dataset. Thus, the influence of these factors in the association between food insecurity and fast-food consumption could not be assessed. Sixth, the countries included in our study are not representative of all countries that belong to the country-income level. For example, the high-income countries included in our study were all from non-Western settings. Sixth, some students aged 15 years in our study may have major national examinations where they will likely have extended study hours. This may influence students to consume snacks/ foods that are high in energy and affordable. However, the present study did not collect data on this and was thus unable to account for its potential influence. Finally, our study only focused on one aspect of dietary intake and behavior. Thus, future studies should examine the association between food insecurity and other aspects of dietary behavior such as intakes of nutrients (e.g., sodium, saturated fats, added sugar), breakfast skipping, and overall dietary quality.

In conclusion, in the present large sample of children and adolescents from 68 countries representing all economic settings, food insecurity was associated with fast-food consumption in LMICs but not in HICs although a moderate level of between-country heterogeneity was present. The mere co-occurrence of food insecurity and fast-food consumption is of public health importance and to tackle this issue requires a strong governmental and societal approach potentially utilizing effective methods as demonstrated in some HICs such as the implementation of food banks and the adoption of free school

meals. However, whether such methods would be feasible and effective in LMICs is not known and future research is thus required to identify the efficacy of implementing such approaches in low economic settings. Finally, interventions to increase knowledge on the deleterious health effects of fast-food may be important especially for food-insecure households.

Conflict of interest: None.

Funding: This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Acknowledgements: This paper uses data from the Global School-Based Student Health Survey (GSHS). GSHS is supported by the World Health Organization and the US Centers for Disease Control and Prevention.

Author contribution: All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Table 1 Survey characteristics and prevalence of fast-food consumption and severe food insecurity by country

Country	Year	Response rate (%)	N[a]	Fast-food consumption (%)	Severe food insecurity (%)
Low-income countries					
Afghanistan	2014	79	1,493	63.3	17.1
Benin	2016	78	717	46.3	12.5
Cambodia	2013	85	1,812	25.5	7.7
Liberia	2017	71	541	42.9	9.8
Mozambique	2015	80	668	65.5	12.0
Nepal	2015	69	4,616	75.3	4.4
Tanzania	2014	87	2,615	35.6	6.4
Total				50.4	6.9
Lower middle-income countries					
Bangladesh	2014	91	2,753	53.3	13.3
Belize	2011	88	1,600	66.2	7.1
Bolivia	2012	88	2,804	56.9	8.2
East Timor	2015	79	1,631	67.0	11.0
Egypt	2011	85	2,364	49.3	4.5
El Salvador	2013	88	1,615	57.4	3.9
Ghana	2012	82	1,110	69.9	14.8
Guatemala	2015	82	3,611	56.8	2.7
Guyana	2010	76	1,973	56.0	8.0
Honduras	2012	79	1,486	48.0	3.7
Indonesia	2015	94	8,806	54.7	4.2
Kiribati	2011	85	1,340	43.9	12.8
Laos	2015	70	1,644	44.8	1.0
Mauritania	2010	70	1,285	63.2	9.4
Mongolia	2013	88	3,707	55.2	1.9
Morocco	2016	91	3,975	62.2	8.8
Pakistan	2009	76	4,998	21.0	5.6
Philippines	2015	79	6,162	51.9	7.2
Samoa	2017	59	1,058	67.3	13.9
Solomon Islands	2011	85	925	65.9	10.3
Sri Lanka	2016	89	2,254	42.8	3.4
Sudan	2012	77	1,401	41.5	9.2
Swaziland	2013	97	1,318	41.3	8.0
Syria	2010	97	2,929	42.8	11.1
Vanuatu	2016	57	1,288	57.6	8.4
Vietnam	2013	96	1,743	29.7	0.9
Yemen	2014	75	1,553	34.5	11.1
Total				48.5	6.5
Upper middle-income countries					
Algeria	2011	98	3,484	51.9	8.1
Antigua & Barbuda	2009	67	1,235	56.6	7.2
Argentina	2012	71	21,528	31.5	3.5
Costa Rica	2009	72	2,265	54.4	1.1
Dominica	2009	84	1,310	47.1	5.5
Dominican Republic	2016	63	954	46.7	2.0
Fiji	2016	79	1,537	64.2	11.6
Iraq	2012	88	1,533	55.7	8.8
Jamaica	2017	60	1,061	58.4	6.2

Lebanon	2017	82	3,347	77.1	3.1
Malaysia	2012	89	16,273	48.3	4.5
Maldives	2014	60	1,781	35.1	6.0
Mauritius	2017	84	1,955	57.4	8.2
Namibia	2013	89	1,936	53.9	10.2
Paraguay	2017	87	1,972	54.4	2.4
Peru	2010	85	2,359	50.0	3.2
Suriname	2016	83	1,453	63.8	9.5
Thailand	2015	89	4,132	80.1	4.3
Tonga	2017	90	2,067	69.6	11.8
Tuvalu	2013	90	679	44.4	8.0
Total				56.7	5.2
High-income countries					
Bahamas	2013	78	1,308	72.1	7.1
Barbados	2011	73	1,504	62.4	4.4
Brunei Darussalam	2014	65	1,824	66.2	6.2
Chile	2013	60	1,353	32.3	1.1
Curaçao	2015	83	1,498	70.5	4.0
French Polynesia	2015	70	1,902	71.4	11.4
Kuwait	2015	78	2,034	75.1	6.4
Oman	2015	92	1,669	71.9	4.4
Qatar	2011	87	1,781	85.9	7.7
Seychelles	2015	82	2,061	70.5	12.6
Saint Kitts & Nevis	2011	70	1,471	61.6	4.7
Trinidad & Tobago	2017	89	2,763	67.1	8.2
United Arab Emirates	2016	80	3,471	76.6	7.5
Uruguay	2012	77	2,869	44.7	1.5
Total				47.8	3.1

[a] Restricted to those aged 12-15 years.

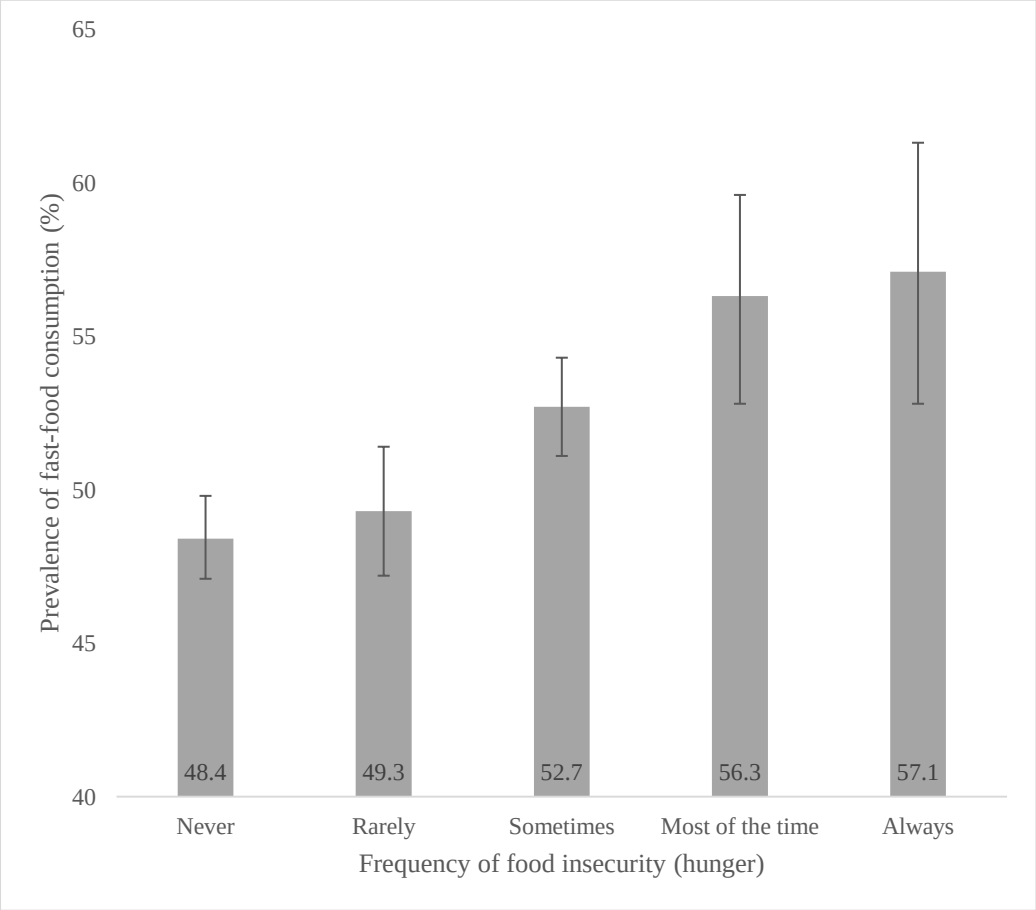

Figure 1 Prevalence of fast-food consumption by frequency of food insecurity (hunger)
Bars denote 95% confidence interval.
P-value <0.001 (Chi-squared test).

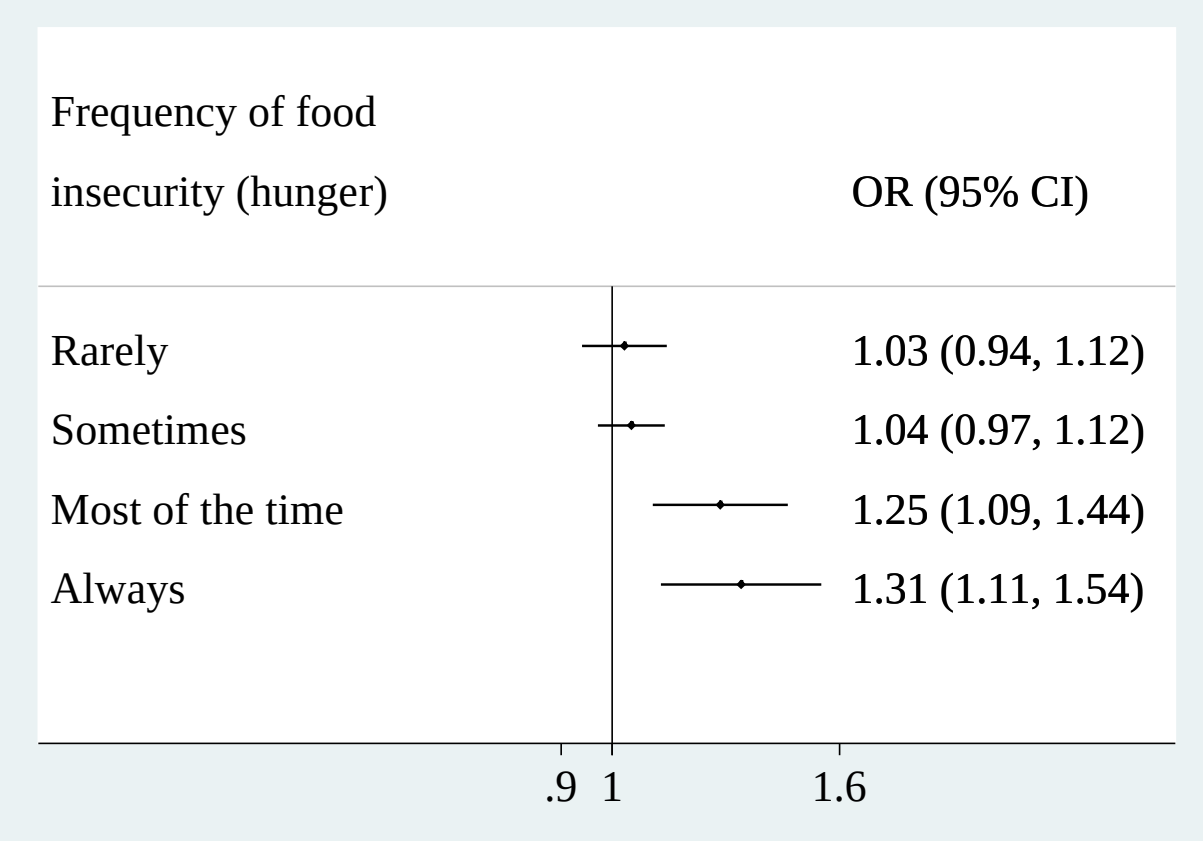

Figure 2 Association between frequency of food insecurity (hunger; exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression

Abbreviation: OR Odds ratio; CI Confidence interval

Reference category is no food insecurity.

Model is adjusted for age, sex, body mass index, and country.

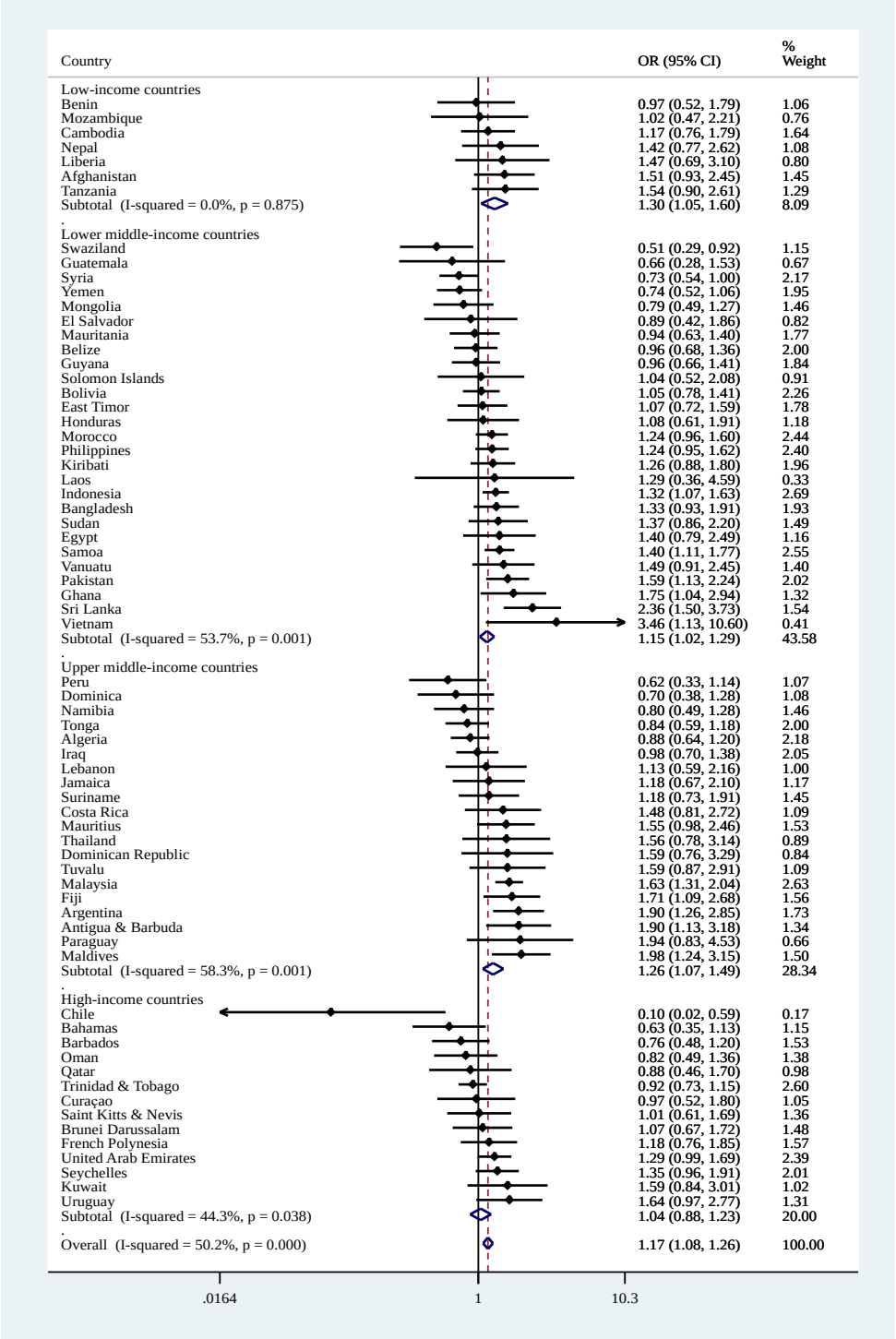

Figure 3 Country-wise association between severe food insecurity (hunger) (exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, and body mass index.

Overall estimates were obtained by meta-analysis with random effects.