

## ORIGINAL RESEARCH

# Food insecurity: Its prevalence and relationship to fruit and vegetable consumption

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**Abstract**

**Background:** Food insecurity in UK households is a substantial and growing concern. The present study identified those at risk of food insecurity and explored the relationship between food security and fruit and vegetable consumption.

**Methods:** Data were examined from the Food and You survey (2016) for a large representative sample ( $n = 3118$ ) living in England, Wales and Northern Ireland. A 'Food Security Score' and a 'Food Changes Score' (relating to financially driven changes to food habits) were compiled and relationships with fruit and vegetable consumption were examined.

**Results:** The prevalence of marginal, low and very low food security was 12.6%, 5.4% and 2.8%, respectively. Significant correlations were observed between food security and fruit and vegetable consumption. Food security and food changes, independently, were significant predictors for fruit and vegetable consumption. With every unit increment in the Food Security Score (i.e., more food insecure), an 11% decrease in the odds of being a high fruit and vegetable consumer was evident. Likewise, the odds of being a high fruit and vegetable consumer decreases by 5% with every increment in the financially driven Food Changes Score.

**Conclusions:** A notable proportion (more than one-fifth) experienced marginal, low or very low food security. Food insecurity and financially driven food changes were accompanied by decreases in the odds of being a high fruit and vegetable consumer. Findings underline the potential consequences of food insecurity, and point to further work aiming to examine other dietary implications, as well as strategies to mitigate against food insecurity and its detriment.

**KEY WORDS**

diet, food insecurity, food security, fruit, fruit and vegetable consumption, vegetables

## INTRODUCTION

Household food insecurity in high-income economies has serious public health consequences,<sup>1</sup> and the number of households affected in countries such as the USA, Canada,

Australia is a growing concern.<sup>2</sup> In the UK, food insecurity is substantial and growing<sup>3</sup> with levels being among the worst in Europe.<sup>3</sup> Despite being one of the world's highest ranked economies,<sup>4</sup> an estimated 3.4 million people live in UK households where at least one person is moderately

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or severely food insecure.<sup>5</sup> This is according to the United Nations Food and Agriculture Organisation (FAO) Voices of the Hungry project, based on relatively small samples of 1000 people,<sup>6</sup> and also potentially under representative of the highly vulnerable groups. Food insecurity has been reported to be linked to poverty associated with austerity and welfare changes.<sup>7</sup>

Central to food security are issues such as food availability, accessibility and affordability.<sup>8</sup> Moreover, food security encompasses the 'physical, social and economic access to sufficient, safe and nutritious food' to meet an individual's 'dietary needs and food preferences for an active and healthy life'.<sup>9</sup> Conversely, food insecurity has been defined as a 'household-level economic and social condition of limited or uncertain access to adequate food'<sup>10</sup> and limited or uncertain 'availability of nutritionally adequate and safe foods' or limited or uncertain 'ability to acquire acceptable foods in socially acceptable ways'.<sup>11</sup> Largely associated with socio-economic status, factors such as household income, working status, education, social network and capital have been found to be relevant to food insecurity.<sup>12</sup> Income, specifically, is an influential predictor for food security, and a UK study revealed receipt of means-tested benefits and perception of financial insecurity to be critical to food insecurity.<sup>13</sup> In every region of the world, women are slightly more likely than men to be food insecure,<sup>14</sup> and differences in food provision and preparation roles, as well as dietary intake [e.g., fruit and vegetable (FV) consumption<sup>15,16</sup>], are also apparent.

There have been calls to ascertain levels of food security in the UK and identify those most at risk.<sup>17</sup> Likewise, a new national initiative to measure food insecurity has been welcomed by social advocacy groups.<sup>18</sup> Both reflect increasing concerns, particularly regarding the growing numbers affected and the subsequent impact on public health and disease prevention.

Food security influences individuals' diets, and studies have examined associations between food insecurity and diet quality.<sup>19–21</sup> Notably, US research has suggested that, independent of poverty and socio-demographic differences, food-insecure individuals have poorer quality diets than food-secure adults.<sup>19</sup> Furthermore, food-insecure adults reportedly use food sources differently; analysis of the US National Health and Nutrition Examination Survey data indicated that the dietary quality of foods sourced from grocery stores was higher in the highly food secure individuals.<sup>22</sup>

Food security influences food choice. Accessibility to nutritious foods is central to food security and, likewise, is a pre-requisite to an adequate diet. Poor diet has been implicated in the global disease and mortality burden, and the need to improve diets has been highlighted.<sup>23</sup> Chief risk factors are diets high in sodium and those low in fruit, vegetables, whole grains, nuts and seeds, and omega-3 fatty acids, with each of these factors accounting for at least 2% of deaths globally.<sup>23</sup> Furthermore, the relevance of FV consumption to an adequate diet and food-based dietary guidelines internationally is established.<sup>24</sup> Therefore, the present study

aimed to identify subgroups of the population that may be considered more at risk with respect to food security, as well as to explore the relationship between food security and FV consumption.

## METHODS

The present study used data from the Food and You survey, a biennial cross-sectional survey administered by the Food Standards Agency. The Food and You survey focusses on the UK population's self-reported food-related behaviours, attitudes and knowledge.<sup>25</sup> Using a random probability cross-sectional design, a representative sample from all included countries (England, Wales and Northern Ireland) is obtained, with data collected via face-to-face interviews with a trained interviewer.<sup>26</sup> Further details on the methodology, including the sample design and sampling frame, are available elsewhere.<sup>26</sup> In 2016, for the first time, the Food and You survey included items on food security.<sup>25</sup> Cognitive testing techniques were used to check respondents' understanding and ability to select response options and the sensitivity of questions, before the full questionnaire was piloted; further details are available.<sup>26,27</sup> The presented study used data from this wave in 2016.<sup>28</sup> The data relate to a representative sample ( $n = 3118$ ) aged  $\geq 16$  years, recruited with an overall response rate of 52.6%.<sup>26</sup> The Government Social Research guidelines were adhered to, including participants' informed consent (for participants under the age of 18 years, consent from the legal guardian/parent was obtained); ethical approval for the data collection was obtained from NatCen internal Research Ethics Committee<sup>29</sup> (NatCen 2019, personal communication).

Ten items from a validated measure of food security, included in the survey, were used in the presented study; these corresponded to the US Adult Food Security Survey Module developed by the US Department of Agriculture (USDA).<sup>30–32</sup> These items revolved around food-related behaviours and/or experiences related to difficulties in meeting food needs<sup>30,31</sup> (Table 1). In the study, these data were used to compile a Food Security Score (range: 0–10) on the basis of the Adult Food Security Scale.<sup>32</sup> The score corresponded to a measure of the severity of food insecurity<sup>30</sup> where a higher score indicated a *lower* food security. Cronbach's alpha coefficient was calculated and showed good internal consistency (0.86), which corresponded well with coefficients from other studies using the USDA measure for food security.<sup>33</sup> The original dataset also categorised respondents according to USDA food security status, that is, high, marginal, low and very low food security. High food security status reflects households with no difficulties or anxiety accessing adequate food, whereas marginal food security status households experience difficulties at times or anxiety (but overall, the quality, variety and quantity are not substantially affected). Low food security households decrease the quality, variety and desirability of food consumed, at the same time maintaining the overall quantity and normal eating patterns. In very low food secure

**TABLE 1** Items relating to food security and financially driven food changes

<b>Food security</b>
'I/We worried whether my/our food would run out before I/we got money to buy more'
<i>Was that often true, sometimes true, or never true for you/your household in the last 12 months?</i>
'The food that I/we bought just didn't last, and I/we didn't have money to get more'
<i>Was that often true, sometimes true, or never true for you/your household in the last 12 months?</i>
'I/We couldn't afford to eat balanced meals'
<i>Was that often true, sometimes true, or never true for you/your household in the last 12 months?</i>
<i>In the last 12 months, since last (name of current month), did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food? (if yes) How often did this happen – almost every month, some months but not every month, or in only 1 or 2 months?</i>
<i>In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?</i>
<i>In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food?</i>
<i>In the last 12 months, did you lose weight because there wasn't enough money for food?</i>
<i>In the last 12 months, did you or other adults in your household ever not eat for a whole day because there wasn't enough money for food? (if yes) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?</i>
<b>Financially driven food changes</b>
<i>Have you made any of these changes in the last 12 months for financial reasons?</i>
<i>Eaten at home more</i>
<i>Cooked at home more</i>
<i>Eaten fewer takeaways</i>
<i>Eaten out less</i>
<i>Made packed lunches more</i>
<i>Bought items that were on special offer more</i>
<i>Changed the places you buy food for cheaper alternatives</i>
<i>Changed the food you buy to cheaper alternatives</i>
<i>Prepared food that could be kept as leftovers more</i>
<i>Kept leftovers for longer before eating</i>
<i>Eaten food past its use-by date more</i>

households, the eating patterns of at least one member of the household was disrupted with reduced intake.<sup>25,34</sup>

A further eleven items in the survey related to respondents' changes based on finances (Table 1). For the present study, these were deemed less 'severe' and used to compile the Food Changes Score, which ranged from 0 to 11, with a lower score reflecting fewer changes made. Cronbach's alpha coefficient for the food changes scale was 0.83, showing good internal consistency. Also in this study, a food changes status was compiled, with cases banded into four categories (i.e., no, few, some and many food changes made).

Fruit and vegetable consumption was established with three items: How often do you eat raw fruit? How often do you eat raw vegetables, including salad? How often do you eat cooked vegetables? The response options ranged from 'at least once a day' to 'never'. Responses for these items were combined to provide a FV score, with a higher FV score corresponding to more frequent consumption. Internal scale

reliability was assessed using mean inter-item correlation (because there were three component items), which was calculated at 0.30, within the optimal range of 0.2–0.4.<sup>35</sup> Respondents were categorised based on their FV scores (i.e., never/rarely, sometimes, often and regularly consumes FV).

The dataset was analysed using SPSS, version 21 (IBM Corp.). Weighting was applied accordingly (further details are available elsewhere<sup>25</sup>), and descriptive analysis undertaken, with a focus on levels of food security and food changes by key demographic variables. Kendall's correlation tests, a nonparametric measure of the strength of the relationship between two ordinal variables, were conducted to examine scores. To examine the relationship between age and also gender and food security status, food changes status and FV consumption, chi-squared tests of independence were undertaken. A logistic regression model was developed to examine the relationship between Food Security Score and Food Changes Scores and FV consumption (dichotomised to high and low). The model was adjusted for gender, age, household income, education, working status and country.  $p < 0.05$  was considered statistically significant.

## RESULTS

Food security status and financially driven changes varied across demographic characteristics, Figure 1 and Table 2. The sample comprised 3118 participants (51.2% women); one-third of participants were 35–54 years (33.4%), and three-fifths (60.6%) were in work, with 22% being retired. Almost one-third had a degree/diploma in higher education as their highest attained qualification (32.1%).

Most (79.2%) were in the category of high food security; the remainder experienced marginal (12.6%), low (5.4%) and very low food security (2.8%). Food security status was associated with gender ( $\chi^2 = 16.41$ ,  $df = 3$ ,  $n = 3118$ ,  $p < 0.001$ ,  $\phi_c = 0.07$ ); more men (80.9%) were highly food secure compared to women (77.7%) and more women had a low and very low food security status. Interestingly, when considering only respondents with responsibility for all or most of the food preparation/cooking and food/grocery shopping (most of whom were women), then this association did not hold. There were significant associations between these responsibilities and gender (food preparation/cooking  $\phi_c = 0.41$ ; food/grocery shopping  $\phi_c = 0.38$ ); the odds of being responsible for all or most of the food preparation/cooking for women was 4.70 times that of men; the equivalent for food/grocery shopping for women was 4.64 times that of men.

The most food secure age group was  $\geq 75$  years, with the least secure being the youngest (16–24 years). Here, low and very low food security accounted for 9.2% and 6.3%, respectively, of the youngest respondents; furthermore, one-fifth fell in the marginal food security band (21.2%). A general pattern of increasing food security with age was observed; food security status and age had a significant association but with a small effect size ( $\chi^2 = 174.04$ ,  $df = 18$ ,  $n = 3115$ ,  $p < 0.0001$ ,  $\phi_c = 0.14$ ). A greater proportion of unemployed

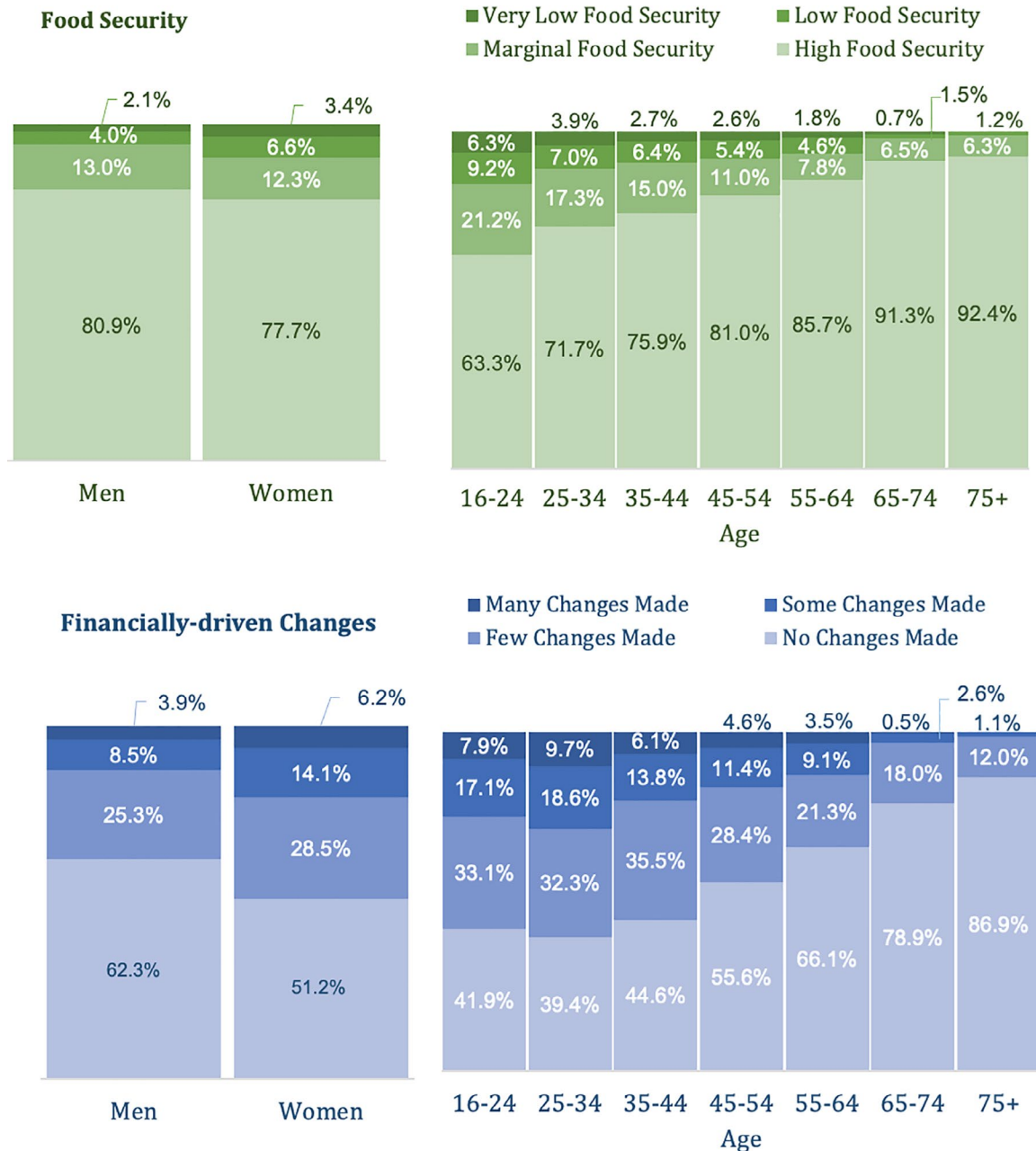


FIGURE 1 Food security status and financially driven changes: distribution (%) by gender and age

respondents had very low (19.8%) or low food security (15.1%) compared to other groups. The retired were the most food secure (91.5% with high food security status). The percentage of highly food secure individuals increases with household income. Households with the highest income were overwhelmingly in the highly food secure status (90.7%); in contrast, only 59.6% of those with an income less than £10,399 were highly food secure, and 14.5% were categorised as very low food secure.

When considering financially driven changes, more than two-fifths of respondents reported at least one change; for example, bought items that were on special offer more (20.3%) and changed the place to buy food for cheaper alternatives (17.6%). More women (48.8%) than men (37.7%)

reported at least one change, and a significant association (with a small effect size) was observed ( $\chi^2 = 39.09$ ,  $df = 1$ ,  $n = 3118$ ,  $p < 0.0001$ ,  $\phi = 0.11$ ). Likewise, more women (than men) reported any individual change (Figure 2); the associations between each change (except for eaten out less) and gender were significant (small effect sizes). When restricting the sample to only those with main responsibility for all or most of the food/grocery shopping and food preparation/cooking, the association between gender and reporting at least one change remained significant and weak ( $\chi^2 = 14.04$ ,  $df = 1$ ,  $n = 1310$ ,  $p < 0.0005$ ,  $\phi = 0.10$ ). Interestingly however, the association did not hold for four changes: eaten food past its use-by date more, kept leftovers for longer before eating, changed the places you buy food for cheaper alternatives and

TABLE 2 Food security status and financially driven changes according to demographic characteristics

	<i>n</i> (%)	Food security status (%)				Financially driven changes (%)			
		High Food security	Marginal Food security	Low Food security	Very low food security	No changes made	Few changes made	Some changes made	Many changes made
Total sample ( <i>n</i> = 3118)		79.2	12.6	5.4	2.8	56.6	27.0	11.4	5.1
Working status ( <i>n</i> = 3117)									
In work	1890 (60.6)	80.8	12.7	5.1	1.4	52.5	28.6	13.5	5.4
Unemployed	92 (3.0)	46.2	19.0	15.1	19.8	33.6	31.5	20.0	15.0
Retired	686 (22.0)	91.5	6.2	1.9	0.5	80.5	17.1	1.8	0.6
Other <sup>a</sup>	449 (14.4)	60.8	20.9	9.7	8.6	41.9	34.4	15.3	8.4
Education ( <i>n</i> = 3108)									
GCSE (or equivalent)	602 (19.4)	71.9	15.4	8.6	4.1	54.4	30.3	9.9	5.4
Trade apprenticeship	95 (3.1)	87.6	7.2	2.5	2.7	65.4	19.6	12.0	3.0
A/AS level (or equivalent)	505 (16.2)	76.7	12.0	8.2	3.1	46.2	29.5	17.6	6.7
Degree/diploma in higher education (or equivalent)	999 (32.1)	84.6	9.8	3.7	1.9	55.2	25.7	12.5	6.6
Higher/postgraduate Degree	341 (11.0)	87.0	10.6	2.2	0.2	56.9	31.5	9.6	2.0
Other <sup>b</sup>	78 (2.5)	70.6	26.0	2.5	0.8	63.9	17.0	10.0	9.2
None of the specified	488 (15.7)	74.8	15.8	5.2	4.2	69.5	22.9	5.7	1.9
Household income ( <i>n</i> = 2326)									
Less than £10,399	206 (8.9)	59.6	17.5	8.5	14.5	41.5	32.4	17.0	9.0
£10,400–£25,999	663 (28.5)	69.2	18.1	8.6	4.1	55.4	26.7	9.3	8.6
£26,000–£51,999	699 (30.1)	82.4	12.0	4.4	1.1	56.5	27.0	11.2	5.3
More than £52,000	758 (32.6)	90.7	6.5	2.6	0.3	60.3	25.0	11.5	3.2

Note: Not all questions were answered by all respondents.

<sup>a</sup>Other includes looking after family or home, full-time student/at school.

<sup>b</sup>Other qualifications (including overseas).

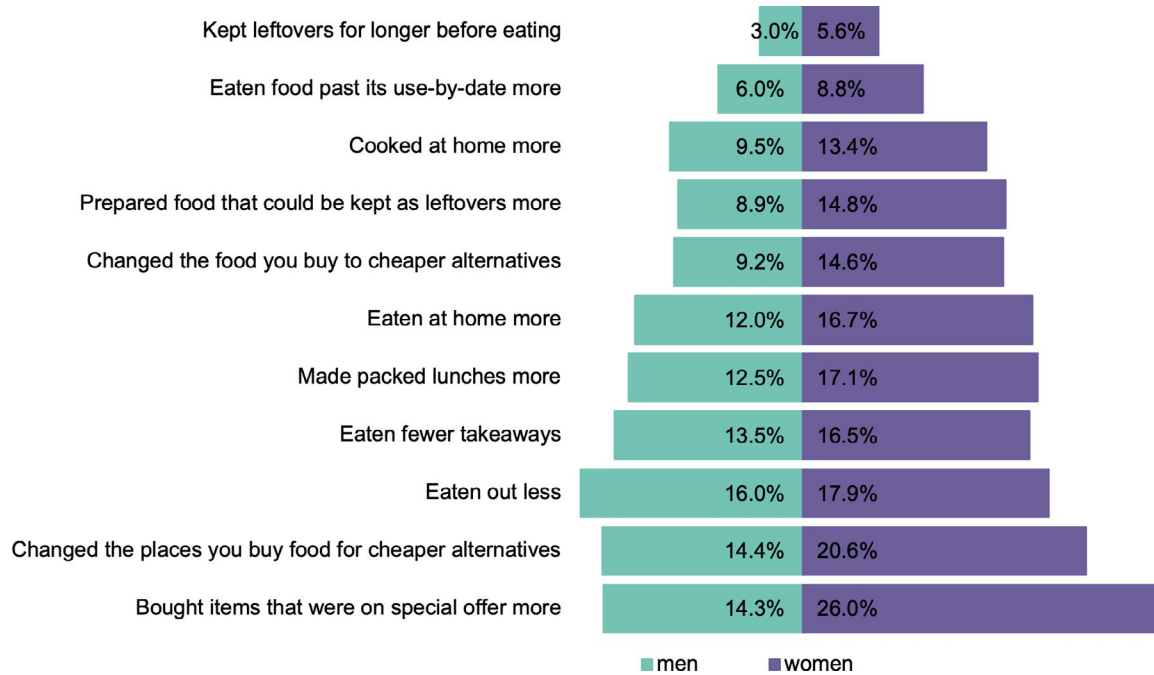


FIGURE 2 Financially driven changes as reported by men and women (% of men and women, separately)

made packed lunches more. For all changes, an association between age and reporting financially driven changes was observed; with the largest effects being observed for 'no changes' ( $\chi^2 = 327.92$ ,  $df = 6$ ,  $n = 3113$ ,  $p < 0.0001$ ,  $\phi_c = 0.33$ ) where most 16–24 year olds (58.1%) and 25–34 year olds (60.6%) reported at least one change compared to a minority of those aged 75 years or more (13.1%) and 65–74 year olds (21.1%).

Gender was associated with FV consumption ( $\chi^2 = 146.42$ ,  $df = 3$ ,  $n = 3119$ ,  $p < 0.0001$ ,  $\phi_c = 0.22$ ) and more than one-half of women (52.6%) were regular consumers of FV compared to less than one-third of men (31.7%). FV consumption was also associated with age ( $\chi^2 = 115.19$ ,  $df = 18$ ,  $n = 3114$ ,  $p < 0.0001$ ,  $\phi_c = 0.11$ ); one-half of 65–74 year olds were regular consumers of FV (50.7%) compared to less than one-third of 16–24 year olds (30.8%).

Kendall's correlation tests revealed a significant but weak negative correlation ( $\tau = -0.116$ ,  $p < 0.0001$ ) between food security (higher Food Security Score corresponds to lower food security) and FV consumption (FV score), and between food changes (higher Food Changes Score corresponds to more changes) and FV consumption (FV score;  $\tau = -0.043$ ,  $p < 0.005$ ). There was a significant association between food security status and FV consumption ( $\chi^2 = 91.07$ ,  $df = 9$ ,  $n = 3118$ ,  $p < 0.0001$ ,  $\phi_c = 0.10$ ). More individuals of a higher food security status were in the highest consumers of FV compared to those of a lower food security status. Likewise, a significant association between food changes status and FV consumption was observed ( $\chi^2 = 50.28$ ,  $df = 9$ ,  $n = 3119$ ,  $p < 0.0001$ ,  $\phi_c = 0.07$ ). Effect sizes for both these associations are small.

The logistic regression model developed to examine the relationship between Food Security and Food Changes

Scores with FV consumption as the dependent variable (dichotomised to high and low) was statistically significant ( $\chi^2 = 345.01$ ,  $df = 23$ ,  $n = 2452$ ,  $p < 0.0001$ ) and able to differentiate between those who reported a higher and a lower frequency for FV consumption, correctly classifying 65.4% of cases and explaining 18.4% (Nagelkerke  $R^2$ ) of the variance in FV consumption. Food Security and Food Changes Scores, independently, were significant predictors ( $p < 0.001$  and  $p < 0.05$ , respectively) for FV consumption. When controlling for age, gender, household income, working status, education and country, with every unit increment in the Food Security Score (i.e., less food secure), there was an 11% decrease [odds ratio (OR) = 0.89; 95% confidence interval (CI) = 0.83–0.95] in the odds of being a high FV consumer. Likewise, the odds of being a high FV consumer decreased by 5% (OR = 0.95; 95% CI = 0.91–0.99) with every unit increment in the Food Changes Score.

Other variables contributed to FV consumption, most notably gender [women were almost three times as likely (OR = 2.88) to report having a higher FV consumption than men], age [individuals aged 65–74 years being almost four times as likely (OR = 3.88) to report a high FV consumption compared to those aged 16–24 years] and education [those with a degree/diploma in higher education or a higher/postgraduate degree were more likely (OR = 1.77 and OR = 3.10, respectively) to report high FV consumption compared to those whose highest qualifications were GCSEs].

## DISCUSSION

The present study examined food security and financially driven food changes in relation to FV consumption in a large

representative sample across England, Wales and Northern Ireland. Furthermore, the study demonstrated the relationship between food security and FV consumption. The findings revealed that, although most individuals were food secure, with no difficulty or anxiety around accessing adequate food, the prevalence rates of marginal, low and very low food security were 12.6%, 5.4% and 2.8%, respectively. This outlines the extent and nature of food insecurity, and responds to calls aiming to identify those at most risk.<sup>17</sup> It is interesting to consider these levels with reference to, for example, the prevalence of very low food security in the USA, at 4.3%.<sup>36</sup> The prevalence rates in the presented study can also be compared with FAO data for the UK (measured on a different scale, the Food Insecurity Experience Scale), which indicated a 3-year average for 2017–2019 of 5% at the moderate or severe level and 1.3% at the severe level for food insecurity.<sup>5</sup>

The present study also revealed a relationship between gender and both food security status and food changes status, with more women experiencing low and very low food security, and making more financially driven food changes. This may be a reflection of women as the traditional gatekeepers when it comes to food provision. In this representative sample, the odds of being responsible for all or most of the food preparation/cooking were more than four times higher for women than those for men; likewise, for all or most of the food/grocery shopping, the odds were more than four times higher for women than those for men. It may follow that women are more aware of levels of household food security by virtue of their responsibility for food provision. Interestingly, this argument is supported by the data, whereby food security and gender were no longer significantly associated when the sample was restricted to those respondents with responsibility for food. This was less apparent for financially driven food changes, where gender was still a significant variable for some changes. The role of gender in food security is critical; globally, women have been shown to have a higher probability of being food insecure compared to men.<sup>37</sup> Furthermore, in the developed regions of the European Union, women are almost five percentage points more likely to experience food insecurity of some level than men.<sup>37</sup>

As well as gender, age was also important in considering those most at risk, with younger individuals being more likely to have lower food security status and also make more financially driven food changes. An inverse association between age and food insecurity has been reported previously in the USA<sup>38</sup> and Australia.<sup>39</sup>

When examining food security and FV consumption, the more food insecure a person and the more changes to an individual's food habits because of financial reasons, the more likely they were to report a lower frequency of FV consumption. For every unit increment in the Food Security Score (i.e., less food secure), there was an 11% decrease in the likelihood of reporting a higher FV consumption. The number of financially driven food changes was also associated with FV consumption, showing a 5% decrease in the odds of

reporting a higher FV consumption for every unit increment in the Food Changes Score. This provides evidence that an individual's food security status can influence the frequency of consumption of certain foods, in support of literature on the adverse relationship between food insecurity and dietary patterns.<sup>40</sup> Moreover, given the place of FV within dietary guidelines, and as a public health priority, then its relationship with food security is pertinent.

Previous work from across the world has found an association between food security and FV consumption.<sup>41–44</sup> A US study of low-income pregnant women found that, as the food security decreased, fresh FV variety in the home declined, which was then associated with reduced FV consumption.<sup>41</sup> An analysis of the Korean National Health and Nutrition Examination Survey showed food insecurity to be associated with inadequate dietary intake, including lower FV consumption.<sup>42</sup> Both studies measured food security based on the US Household Food Security Survey Module. A Brazilian study also adapted this module and found food insecurity to negatively affect FV consumption,<sup>43</sup> alongside other work reporting food-insecure households to have a more monotonous diet, largely composed of high energy foods.<sup>45</sup>

In the present study, it is important to acknowledge the limitations, including the self-report nature of the data. Likewise, the relevance of social desirability and social approval bias in general dietary self-report is relevant, as is the possibility of under-reporting of food insecurity. The study's cross-sectional nature and the model specificity, in terms of the variables included, should be acknowledged (e.g., food skills and nutrition knowledge were not considered). Furthermore, it is important to recognise the complex nature of food habits and the interplay of other variables, not included in the analysis. The Food Changes and FV scores are unique to this study, and should be considered in the context of the items, when comparing across studies. Furthermore, the FV score, based on three items, was at an individual level and incorporated raw fruit, raw/cooked vegetables and salad, but did not, for example, capture tinned fruit, and may have also been under-reported with respect to compound dishes.

This findings of the present study contribute to the mounting evidence concerning the prevalence of food insecurity, and likewise inform the development of dedicated strategies and interventions to address household food security. Given the observed relevance of the food gatekeeper (i.e., the individual with responsibility for most/all food), in addition to the greater risk of food insecurity in lower income households, as well as in those who are younger and unemployed, efforts should be targeted at those most relevant.

Other implications lie in the relationships observed between food security (also financially driven food changes) and FV consumption. With dietary risk factors being implicated in the global burden of non-communicable disease and diets low in FV being specifically highlighted,<sup>23</sup> there is a need to establish and address the full implications of food security on the diet of those affected. Future studies focussing on wholegrains, fast food consumption

and dietary patterns would provide a better understanding of diet across food security status in the UK. Food insecurity has been found to be associated with dietary outcomes for populations in US,<sup>19</sup> Canada<sup>20</sup> and France.<sup>21</sup> Likewise, studies could provide an understanding of the complexities of how compromised food security relates to lower FV consumption. This is critical to inform wider targeted strategies, and reflects recommendations to consider food insecurity alongside hunger, malnutrition and obesity, given their shared causal factors.<sup>3</sup> In this way, steps can be taken to ameliorate the dietary consequences on the individuals and households most affected.

## CONCLUSIONS

Most of the population were considered to be in the category of high food security; a notable proportion, however, experienced marginal (12.6%), low (5.4%) or very low food security (2.8%). Food insecurity, as well as financially driven food changes, were accompanied by decreases in the odds of being a high FV consumer. As the prevalence of food insecurity in the UK rises, and its implications on diets materialise, the calls to develop measures to address food insecurity become more urgent, and there is a need to incorporate food security within strategies aiming to improve dietary practices. This reflects recommendations to consider hunger, malnutrition and obesity alongside food insecurity. Given the mounting evidence of its pervasive nature and the existing health inequalities, there is an imperative to act in an attempt to limit the reach and consequences of food insecurity.

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## CONFLICT OF INTERESTS

The authors have no conflicts of interest.

## AUTHOR CONTRIBUTIONS

HE conceived the study. OT, HE and MH analysed and interpreted the data. OT drafted the manuscript, and all authors contributed to the revision of the manuscript, and also read and approved the final manuscript submitted for publication.

## TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

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