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A Computer-Based Incentivized Food Basket Choice Tool - Presentation and Evaluation*

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Abstract

We present and evaluate a new incentive-based tool to measure people’s dietary choices in a low-cost and time effective manner. Respondents are asked to allocate a fixed monetary budget across a choice of around a hundred grocery items with the prospect of receiving these items with some probability delivered to their home by a real supermarket. The tool has the advantage of offering a broad coverage of dietary choices, allows inference of macro-nutrients and calorie, and allows the researcher to fix the choice set participants can choose from. We compare the information derived from our incentivized tool, and compare it to alternative low-cost ways of measuring dietary intake, namely the food frequency questionnaire and a one-shot version of the 24-hour dietary recall, which are both based on self-reports. We invited 255 low income participants to our laboratory and collected measures using these three alternative tools. We compare the calorie intake indicators derived from each tool with a number of biometric measures for each subject, namely weight, body-mass-index (BMI) and waist size. The results show that the dietary information collected is only weakly correlated across the three tools. We also find that only the calorie intake measure from our incentivized tool is positively and significantly related to each of these biometric indicators. By contrast, we find no significant correlations for either of the two measures based on self-reports. We therefore argue that our tool may be useful for research conducted with limited time and budget.

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学术兴趣在营养领域已经显著增长，并跨越多个学科，包括社会科学和医学。其中一个主要的挑战是，研究人员和从业者需要测量人们摄入的膳食。这个挑战很重要，因为准确测量摄入的膳食是政策干预设计和评估的关键。存在各种已被评估和验证的工具，从简单的调查到更复杂的方法，如24小时膳食回忆（Beaton, 1979），这是一个基于问卷的工具，要求受访者提供所有食物和饮料的详细信息，包括份量大小、品牌、配菜、调味品和配菜。这些回忆既可以由合格的营养师执行，也可以自我执行，被认为是营养研究的金标准。这种方法的主要优点是它旨在测量实际摄入的膳食。然而，这种工具的可靠性取决于记忆力的准确性以及真实的报告。它有时需要对每个人进行多次录入，以获得更真实的饮食状况，这使得这种测量相对昂贵。此外，自我报告数据的问题尤为严重，因为研究已经表明，肥胖或有肥胖风险的人更可能低估他们的实际摄入量，这可能限制任何结果的可靠性（Lichtman et al., 1992）。

另一方面，我们发现基于购买而不是实际摄入的方法，如使用扫描数据（如Griffith和O’Connell (2009), Griffith et al. (2015) and Griffith and O’Connell (2010)）。在这里的困难是，购买和消费行为之间可能存在差异，更难将个人消费与家庭消费区分开。

这篇论文为这个方法论争论做出了贡献，提出了一种新的激励信息收集方法，可以相对便宜地在实验室或在线环境下执行。其基本思想是激励受访者提供准确的反应，建立在已有实证研究的基础上（例如，Adamowicz et al., 1998; Carlsson et al., 2007）。我们的方法与最近研究中实验性地评估干预措施对饮食选择的影响相符合，如Bollinger et al., 2011; Lynch Jr and Zauberman, 2006）。这些选择显然不是一天中所有饮食选择的反映。确实，任何健康的饮食选择或热量减少，以餐的选择来衡量，可能被更高的热量选择所抵消，除非它们被适当地补偿。
consumption of unhealthy or higher-calorific options in another meal, as partially observed in Wisdom et al. (2010). The idea here is to collect information about food purchases in a low-cost and efficient way.

The tool we proposed is inspired by current and common online supermarket interfaces. As part of this tool, subjects are allocated a fixed budget and asked to select among a range of around a hundred food and drink items typically found at a local supermarket such as fruit and vegetables or ready meals. The range has been selected from real on-line supermarket items and includes popular items. Participants are incentivized to make ‘honest’ choices by having a chance of receiving their basket at home. All choices are recorded, with the tool also containing individualized nutritional data for each food and drink item available from the online supermarket, including calorie content, fats and sugar, thus allowing the researcher to calculate the nutritional composition of each subject’s choices.

One important feature of the tool is that it allows researchers to determine the food choice set. That is, researchers can determine what foods people can choose from. This is potentially useful because there is a concern that dietary choices may be limited by supply - the idea that food deserts exist and make it hard for certain groups of the population to access certain foods, such as fresh fruit and vegetables. With this tool, one can fix the choice set and study the demand conditional on this choice set.

To evaluate the usability and functionality of our proposed food choice tool, we invited low income individuals (n=255) to our laboratory. Our focus on low income individuals stems from the well documented socio-economic gradient in chronic diseases (Dalstra et al., 2005). We are interested in comparing the information obtained with alternative ways one could collect information with limited time constraints and budgets. We also collected information using two alternative measures of dietary intake, namely a Food Frequency Questionnaire (FFQ), a one-shot version of a self-administered 24-hour dietary recall. We first compare the nutritional profiles of each subject across the three tools to assess whether the results obtained are similar to one another. Secondly, we correlate the total calorie intake derived from each of the three dietary measures with a number of subject-specific biometric measures, weight, body-mass index (BMI) and waist size, all of which have a well-documented relationship with dietary intake (Newby et al., 2003).

Overall, we find that the measures are not strongly correlated. We find no significant relationship between the calorie, fat and saturated fat intakes inferred from the three methods. When comparing the nutrient content inferred from each tool with the biometric measures, the only statistically-significant and positive results obtained are for the calorific intake measures obtained via our food choice tool. By contrast, we do not find any statistically-significant relationship between calorie intake measures from the FFQ or 24-hour dietary recall and our various biometric measurements. This lack of correlation may be due to a systematic bias in the reported levels of calorific intake by participants (similar to that suggested in Macdiarmid and Blundell (1998)) and a predominance of noisy observations which would raise standard errors and thus suppress significance levels.
Our incentivized food choice tool has a number of important advantages. First, it provides a quick and relatively inexpensive way of capturing people’s dietary choices, without having to repeatedly administer a survey in order to obtain multiple data points. This is particularly important in field work where multiple surveys may be both infeasible and prohibitively costly. Second, the online supermarket-based interface allows for a much broader array of food and drink items to be selected, encompassing all main meals and snacks for up to an entire week (depending on the budget allocated), thereby providing a more complete and representative record of the participants’ typical purchasing behavior. Third, by incentivizing participant responses by delivering the food and drink choices for all or a selection of participants, the tool can help to circumvent any issues associated with inaccuracies and under-reporting prevalent in self-reported survey measures (Podsakoff and Organ, 1986). Fourth and as already mentioned, it allows researchers to fix the choice set.

2 Related Literature

This paper contributes to the growing literature on the use and development of various measures of dietary choices. The nutrition and epidemiology literature has proposed several tools which could be utilized in order to gauge people’s diets. The 24-hour dietary recall is perhaps the most widely-used method of eliciting intake patterns by nutritionists and epidemiologists (Johnson, 2002), particularly since people’s memory of what they actually consumed may be more precise, although as pointed out by Block et al. (1982) the variability of intake from day to day may hamper the representativeness of one-day recalls. Another popular method for eliciting dietary patterns is the Food Frequency Questionnaire (FFQ), which typically asks respondents to indicate the frequency with which they have consumed a fixed list of food and drink items over the past month (Cade et al., 2004). The benefits of using the FFQ are largely based around its practicality as well as its ability to minimize day-to-day variation in diet since it is nominally a one-shot measure (Kristal et al., 1992), although doubts regarding its accuracy have been widely-cited in the literature due to the closed-nature of the questions asked and the possibility of errors or under-reporting (Resnicow et al., 2000). Several other methods have also been proposed, like dietary food logs and diet history, each with their own pros and cons, although the pervasiveness of the aforementioned two methods remains Shim et al. (2014).

By contrast, our proposed food choice tool seeks to elicit dietary choices by incentivizing them. Previous work in the literature has also sought to utilize revealed preferences in order to derive information regarding people’s dietary choices. For example, Griffith and O’Connell (2009), Griffith et al. (2015) and Griffith and O’Connell (2010) all make use of highly-detailed panel data based on consumers’ scanned supermarket purchases in order to obtain estimates of household dietary choices across a variety of nutrients and food categories, while controlling for prices. In addition, several experiments (both in the lab and in the field) have relied on incentivized or real-world choices (Kozup et al., 2003; Elbel et al., 2009;
In particular, our paper is closely-related to the branch of the sizeable literature of real choice experiments (RCEs) in the context of dietary choices (Chang et al., 2009; List and Gallet, 2001; Loomis et al., 2009). For example, Lusk and Schroeder (2004) use a randomized choice experiment in order to assess participants’ willingness to pay for five different types of quarter-pounder steaks of varying quality and characteristics, while Alfnes et al. (2006) used similar methods in order to elicit preferences regarding the color of salmon. Our paper builds on these ideas by developing a unified, intuitive tool to assess dietary choices, where the setting is familiar and choices are realizable, thereby incentivizing true responses. This tool can be utilized in a variety of settings, from lab and field experiments to online administration, and represents a relatively inexpensive way of eliciting choices when compared to other tools like the 24 hour dietary recall.

Our paper also contributes to the well-established literature on survey design and information elicitation techniques. The fundamental driving force behind the emergence of this literature is the skepticism surrounding self-reported responses (e.g. Gonyea, 2005). In fact, various authors like Podsakoff and Organ (1986) have pointed out the significant potential drawbacks of relying on self-reported survey methods for data elicitation, including respondent inability to recall vital information, possible dissonance between respondent actions or beliefs and his/her self-image, leading to biased responses, and problems with understanding the questions asked.

This issue is particularly relevant since, as pointed out in Bertrand and Mullainathan (2001), response errors or omissions are typically correlated with key individual characteristics and behavioral tendencies, thus potentially introducing biases in any inferred results. Within this context, several alternative elicitation techniques for surveys have been proposed across several disciplines, including open-ended (as opposed to closed) questions and bidding games (Diener et al., 1998), randomized response techniques (Warner, 1965) and item count techniques (Raghavarao and Federer, 1979). The concept of our tool is based on revealed preferences, building on the theoretical underpinnings provided in Berg et al. (2010) regarding the ability of material incentives to generate economically-consistent and truthful behavior.

3 The Food Choice Tool

The incentivized information-elicitation method developed in this paper is a computer-based food choice tool. As discussed earlier, the aim of this tool is to elicit reliable and accurate dietary patterns from respondents, which in turn can be used to evaluate the effectiveness or otherwise of various interventions aimed at changing these behaviors. This tool has a simple user interface that is based on an online supermarket with a wide array of food and drink items that can be selected. The items are organized under six main headings (each represented by a separate tab at the bottom of the page): fruit and vegetables, meat and fish,
bread and grains, confectionery and snacks, ready meals and drinks. The food and drinks have been selected as the most popular items in their respective categories as of March 2016 (the month of the tool’s inception), as listed on one of the UK’s leading supermarkets’ official website. In total our food choice tool contains 120 different items; these are listed below in Table 1, while Table 2 provides the average nutrient content (per 100g) of each of the six food categories.

In the food choice tool, each item is listed along with a thumbnail picture and its price, which is the actual price as at March 2016 based on listings on the same leading supermarket’s website, thereby ensuring that the prices reflect actual high street prices. The tool operates like a basic online supermarket, where respondents can select any food or drink item by specifying a quantity in the space provided next to each item. There are no restrictions on food choices, neither in terms of which items can be selected, nor in terms of the quantity of each item that can be picked. A number of screenshots of the tool, showing the various food and drink items on offer as well as the user interface, are shown in Figure 1.

The last tab/category shown in the tool is the ‘Shopping Cart’ page, which lists all of the items (and quantities) selected by the user, together with the total amount ‘spent’. It is relatively straightforward to set a fixed budget that participants can spend; this should ideally reflect average household weekly or periodic spending at the supermarket in order to garner a more complete picture of participants’ food intake. The system will then notify participants whenever this budget has been exceeded via a pop-up dialog box, inviting them to delete any items as appropriate. Once the participant is satisfied with the choices made, he/she can press a button at the bottom of the ‘Shopping Cart’ tab labeled ‘Checkout’ in order to save the choices and close the program. Note that if the pre-set budget has been exceeded, the system will not close down and instead notify the user to modify his/her selection.

Incentivizing the choices made is one of the main features of this tool, in order to avoid the pitfalls associated with self-reported or survey based information elicitation methods. The appeal of our food choice tool lies in the fact that incentives can be flexible and thus tailored to suit a variety of research budgets and logistical realities. The most straightforward and direct method would be to inform all users beforehand that their choices would be ordered from an actual supermarket and delivered to them within a few days, depending on their requirements. However, this may prove to be infeasible, both financially and logistically, as it requires ordering each basket and organizing food deliveries for each participant. Therefore, we propose an alternative solution whereby once all choices have been made, one or several participants are picked at random, with only their chosen baskets ordered and delivered. This randomized scheme mitigates against the problem of financial and logistical infeasibility. Moreover the literature on random lottery incentive systems in experimental economics shows that the choices made under this regime are not systematically different from those made under a full-pay system (Starmer and Sugden, 1991; Cubitt et al., 1998).

The food choice tool records all food and drink choices made by each user, both in terms
of quantities and amounts spent per item/category. Crucially, the tool also contains detailed nutritional data for each of the 120 items listed, including information regarding total calorie content, total fats, saturated fats, carbohydrates, sugar, salt, protein and fibre, both as aggregates and also per 100g. Therefore, our proposed food choice tool can also measure the nutritional composition of each user’s food choices, thereby providing a record of their individual dietary patterns. This tool provides clear benefits over other self-reported measures by incentivizing people’s responses to ensure greater reliability of data, while also improving the representativeness of food choices due to its supermarket interface and budgetary allowance, meaning that selected baskets would reflect multiple meals as opposed to one-shot meals or snacks.

Although our proposed tool has various important benefits, there are important specific aspects, which may turn into shortcomings depending on the question one is interested in. First, our tool focuses on planned food expenditures rather than impulse purchases that yield immediate gratification, given that the winning basket would not be immediately delivered. A significant body of work has shown how these two types of food expenditure can differ (Stern, 1962; Kollat and Willett, 1967), and in particular how impulse purchases are associated with self-control failures and thus spending on unhealthy items (Baumeister, 2002; Thomas et al., 2011). Thus, it may be the case that the estimates of dietary intake obtained via our tool may under-represent the actual amount of unhealthy food consumed by respondents. Second, as with scanner data measures, it is not clear that this provides an accurate measure of consumption. Finally, the tool is does not necessarily capture individual behaviour, as we cannot enforce that individuals only purchase items for their own consumption.

In the version of the tool we propose here, participants do not have access to the nutritional information for any of the food and drink items; rather, the food choice tool only displayed a thumbnail image of each item, together with a short description and its price (in £). This design differs somewhat from the standard grocery shopping experience, both in-store and online, since typically consumers would have access to each product’s nutritional information, and would be able to consult this information prior to making their purchasing decisions. We opted to omit such information in order to expedite the food selection process in the lab, thereby enabling a relatively quick collection of information. Furthermore, evidence suggests that people do not regularly read nutritional labels when purchasing their food and drink items from supermarkets, particularly when it comes to familiar and/or repeat purchases (e.g. Cowburn and Stockley, 2005; Graham and Jeffery, 2011). This said, it would be relatively simple to include nutritional or other relevant information in the tool if one would wish to do so.
4 Experimental Design

Having laid out the key aspects of our proposed tool, we now proceed to compare it to other leading tools used by nutritionists and epidemiologists. To this end, we ran a laboratory-based experiment whereby participants were asked to complete a food frequency questionnaire (FFQ), a 24-hour dietary recall, as well as our supermarket-based food choice tool. We then compare the measures of nutritional intake derived from each tool, and relate them to a number of biometric indicators namely body-mass index (BMI), weight and waist size.

The experiment was part of a wider study on health and nutrition, which was held at the Behavioural Laboratory at the University of Edinburgh (BLUE). Briefly, the initial wave of the study, which ran in June 2016, focused on the impact of different types of health information, as well as time availability, on food choices. As described in a different paper (Belot et al., 2016) we sought to compare the impact on dietary choices resulting from the provision of no health information (our control group), the provision of generic health information on heart disease and diabetes, derived from the UK’s National Health Service (NHS) and Harvard Medical School, as well as the provision of tailored health information group, who were asked to undertake a computer-based health assessment that provided personalized information regarding their individual risk of contracting heart disease and diabetes relative to the average person their age and gender living in Scotland. Note that in this study, the measure of dietary choices used was derived from our incentivized food choice tool, which was completed following the health information stage. In addition, we also looked at how varying the time available for participants to make their food and drink choices from our food choice tool influenced the nutritional composition of their choices.

The second wave of the study, which is relevant to this paper, ran from Monday 12th to Friday 16th September 2016, and was also held at the BLUE lab. Each day consisted of four time slots: 9.30am-11am, 11.30am - 1pm, 2.30pm - 4pm, 5.30pm - 7pm, and participants were able to indicate their preferred time slot(s) beforehand. We conducted the experiment in 20 identical sessions of up to 18 individuals per session, spread over 5 consecutive days. Participants had received an information leaflet in advance at their home address as part of the wider study, which kicked-off in June 2016, and which also contained some information regarding this phase of the study, as well as a consent form. All procedures were done in accordance with the ethical guidelines established by BLUE and the University of Edinburgh’s School of Economics, and the study was granted full ethical approval beforehand.

4.1 Sample and Recruitment Procedure

The sample for our experiment consisted of 255 participants from low-income backgrounds (< £26,500 annual income) living in the surrounding precincts of the University of Edinburgh’s main campus. More specifically, participants had to satisfy the following eligibility criteria:

- Must be over 18 years of age;
• Must live in Edinburgh;
• Must be fluent in English;
• Must have an annual household income below £26,500;
• Must not be currently undertaking any regular medical treatment;
• Must not be pregnant.

We recruited participants using various advertisement channels, such as information leaflets delivered by post to home addresses in the more deprived neighborhoods in the vicinity of the University, online advertisements and promotional emails. All participants were given £50 compensation for participating in this study.

4.2 Procedure

Upon arriving at the BLUE lab, all participants were asked to measure their height and weight using the equipment provided (assistance was provided where necessary), and were also provided with individual tape measures in order to record their waist size. They were then directed to an individual computer in the laboratory. Participants were then asked to fill out an initial computer-based questionnaire which included questions related to demographics, socio-economic background, education, employment status, as well as various questions related to their prior knowledge regarding health, nutrition and their own health status. A snapshot of our sample’s main characteristics is provided below in Table 3.

The first dietary measure we collected was a short-form food frequency questionnaire (FFQ), based on the US National Cancer Institute’s Dietary Screener Questionnaire. The Dietary Screener lists a total of 23 food and drink items with specific descriptors (e.g. White fish in batter or breadcrumbs - like fish and chips), and respondents are asked to indicate the frequency with which they consumed each item over the last 30 days. The FFQ contains a total of eight (8) frequency options, ranging from ‘Rarely or Never’ to ‘5+ a day’, with the exception of the seven meat and fish items (e.g. Beef, Lamb, Pork, Ham - steaks, roasts, joints, mince or chops) which had only six (6) options ranging from ‘Rarely or Never’ to ‘At least everyday’. The National Cancer Institute’s Dietary Screener Questionnaire has been subject to multiple evaluation studies, both in terms of the actual questions used as well as its overall performance and validity (e.g. Thompson et al., 2004; George et al., 2012). A copy of the actual FFQ administered to participants is provided in Appendix I. The questionnaire was self-administered by the participants, and on average took 7 minutes to complete.

Once all participants completed the FFQ, we then moved on to the next stage of the study – a 24-hour dietary recall. For the purposes of our study, we used a web-based self-administered tool called INTAKE24, whereby users are asked to input all the food and drink items consumed over the last 24 hours. The system has been devised specifically for the UK
by Newcastle University in collaboration with Food Standards Scotland, and thus contains all the major food and drink brands typically consumed by UK households, including own-brand products by the leading supermarket chains. It also features visual indicators for portion sizes, and automatically prompts users to recall items which are typically overlooked in such self-reported tools, for example snacks, sauces, side-dishes, drinks and condiments. These prompts are repeated throughout the session to minimize the risk of under-reporting.\(^1\) The use of web-based dietary recalls offers various advantages over traditional face-to-face interviews, including lower costs, the possibility of larger-scale studies across different cities, more individual privacy which may lead to improved accuracy of responses due to less pressure or embarrassment, and less interviewer-specific heterogeneities which may bias results. In fact, a number of studies (Arab et al., 2011; Baranowski et al., 2012) have shown that self-administered online dietary recalls yield data that are statistically-comparable in terms of accuracy to those derived from face-to-face recalls. A screenshot of the INTAKE24 user interface is provided in Appendix II.

The final measure of dietary choices analyzed in this study was our own food choice tool. At the start of this intervention, all participants were allocated a budget of £30 in order to spend on the food and drink items available from our tool. Participants were allowed to spend their budget on any of the items listed in the online supermarket, just as long as they did not exceed the £30 limit. We opted for a randomized incentive scheme, whereby at the end of each of our 20 sessions, one subject per session (maximum of 18 participants per session) was drawn at random and his/her food basket was delivered to his/her home address within one week at his/her preferred day and time slot by a leading UK supermarket. All subjects were informed of this arrangement beforehand, including the name of the supermarket, and were reminded prior to selecting their food and drink items\(^2\). In addition, participants were told to make their choices as though they were at their local supermarket for their weekly shop. While it is not obvious that participants will shop just for themselves these instructions can be made more specific if this is a concern to researchers using the tool. In our situation, if they were shopping for other members in the household, however, we would expect our shopping basket to be less likely to be correlated with body measurements. Once all participants had made their food and drink choices, lots were drawn to determine the winning participant and ensure that the process is as transparent and fair as possible.

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\(^1\)Prior to using the system, participants were asked to watch a step-by-step video tutorial showing how to utilize the INTAKE24 interface.

\(^2\)Since participants had already utilized the food choice tool as part of another experimental session in June, this meant that they were fully aware of how the incentive scheme works. Additionally, this also ensured that all participants were familiar with the tool’s user interface and were able to use it appropriately. During the June session participants were also given a mock tool containing everyday household items which they were encouraged to navigate and use beforehand in order to familiarize themselves with the actual food choice tool and its interface. To further ensure familiarity, a quick demonstration of the food choice tool was also presented to remind participants of the tool’s features.
5 Results

5.1 Summary Statistics

We begin by looking at the nutrient data derived from each of our three measures. As described earlier, our proposed food choice tool contains nutritional information for each of the items displayed in the online supermarket interface, enabling us to derive the total nutrient content per basket (i.e., total calories per basket, total fats, etc.), as well as the nutrient content per £ spent. Similarly, the INTAKE24 software has a database of over 1,560 food and drink items, each with a detailed breakdown of the nutrient content based on the portion size selected by the user.

The food frequency questionnaire (FFQ) is somewhat different, given that no information regarding portion sizes is recorded in the actual survey, thus complicating the conversion from frequency to nutrient intake. Nonetheless, for the purposes of our study we have developed a simple conversion protocol, inspired in part by existing methods widely used in the literature by Mulligan et al. (2014) and Thompson et al. (2005).

We first calculate the average nutrient content per 100g for each of the 23 food and drink categories listed in the FFQ, based on the most popular products sold at one of the UK’s leading supermarkets for each category. The categories and food items associated with each category used in these calculations, together with their corresponding nutrient contents, are shown in Appendix III. The next step is to relate the responses from the FFQ to these nutrient values. As mentioned earlier, participants were asked to state the frequency with which they consumed items pertaining to each of the 23 categories, with 8 options ranging from ‘Rarely or Never’ to ‘5+ a day’, with the exception of the seven meat and fish items which had only six options. We therefore convert these frequency responses to estimates of daily intake, by assigning a numerical value to each response based on average daily consumption frequency per week. For example, if a respondent indicated that s/he consumes a particular food/drink category ‘Rarely or Never’, then her/his response is assigned a value of 0; if her/his response was ‘Once per week’, then s/he is assigned a value of $1/7 = 0.14286$, reflecting the fact that on average this particular food category was only consumed once a week. We then multiply this value with the average nutrient value described above for each nutrient, to obtain an estimate of daily consumption of each nutrient.

So for example, if a subject recorded her cheese/yoghurt consumption over the last month as ‘1-2 times a day’, then this would correspond to a numerical value of 1.5, which would then be multiplied with each average nutrient for cheese/yoghurt as listed in Appendix III to derive her nutritional intake for that particular category. For example, in this case her calorie intake for cheese/yoghurt would be $1.5 \times 245.5 = 368.25$. Table 4 summarizes the average nutrient values of our participants from each of the three tools used in this study.
5.2 Comparison of Measures

We now move on to comparing the three measures utilized in this paper in order to see how well they correlate with one another. The rationale behind this analysis is that even though the 3 tools are distinct in their own right and yield different aggregate nutrient measures, they should still be capturing the same overall trend or composition, given that they are purportedly measuring the same indicators for the same sample of participants.

Table 5 reports the pairwise correlation matrices for each of the six nutrients measured from our three measurement tools: total calories, fat, saturated fat, carbohydrates, sugar and protein. Note that whereas both the 24-hour dietary recall and the food frequency questionnaire report estimates of intake for each nutrient per day (e.g. daily calorie intake for each subject), our food choice tool only estimates the total calorie content for the entire basket of food and drink items selected, and is hence not directly comparable to the other two measures. Nonetheless, it is still reasonable to expect that any nutrient values obtained via our food choice tool should a priori be correlated with those obtained from the other two self-reported measurement tools.

As seen below, the correlations across the three tools is somewhat mixed. We observe no correlations among any of the tools when it comes to calorie intake, fat and saturated fat, as seen from the first 3 panels. Nonetheless, the nutrient value for carbohydrate intake as captured by our proposed incentivized tool is correlated with the measure obtained from the dietary recall, while the sugar intake measure is correlated with that obtained from both the 24-hour dietary recall and the FFQ. Similarly, the only correlations observed between the FFQ and the dietary recall are observed in terms of sugar and protein, which is interesting to note given that they are both self-reported measures of dietary intake. Therefore, although we do see some correlation across our proposed food choice tool and the other measures, the results also confirm the significant differences that exist between the three tools.

5.3 Relationship between Reported Calorie Intake and Biometric Indicators

We now compare the calorie measures from each tool to three common biometric indicators – weight (in kilograms), body-mass index (BMI) and waist size (in inches). The link between calorie intake and all three indicators has long been established in the literature (Newby et al., 2003; Guo et al., 2004; Romieu et al., 2004). Therefore, a positive and statistically-significant correlation between calorie intake as captured by our tools and each indicator is expected a priori. We focus exclusively on calorie intake rather than any of the other nutrient measures since, as pointed out by Livingstone and Black (2003) energy intake is the basis for one’s diet, with all other nutrients “must be provided within the quantity of food needed to fulfill the energy requirement.” Furthermore, the link between other nutrients like fat intake and each biometric indicator is not particularly robust or well-established (Newby
et al., 2003), meaning that erroneous conclusions may be derived by focusing on these other nutrients.

Note that the intention here is not to determine the validity or otherwise of any of the three tools under consideration, particularly since we are only relying on a single calorie reading from each of the tools. In addition, the nutrition and epidemiology literature have used several methods to validate both the use of the FFQ as well as the 24-hour dietary recall, including cross-tool comparisons (Bingham et al, 1994) and the use of biomarkers like 24-hour urine collections (Bingham, 2002) and blood nutrient concentration (McKeown et al, 2001). Rather, the intention in this case is to see how closely our estimates correlate with key body measurements derived from our participants, which may in turn provide some evidence to support the use of our incentivized tool as a tractable measure of dietary intake in such studies, particularly when it is infeasible to take multiple dietary readings.

We therefore estimate the following equation:

$$B_{j,i} = \alpha + \beta_k C_{k,i} + X'\gamma_j + \nu_{j,i}$$  \hspace{1cm} (1)

where $B_{j,i}$ is one of the four biometric indicators mentioned above (height, weight, BMI) for subject $i$; $C_{k,i}$ is the amount of calories pertaining to subject $i$ as captured by dietary assessment tool $k$; $X$ is a vector of control variables like age, gender, socio-economic indicators and session-specific fixed effects$^3$, and $\nu_{j,i}$ is a random disturbance term.

The results are shown in Table 6, where each panel shows the results from estimating equation 1 for each of the dietary assessment methods used in this paper (calories have been normalized by 1,000). We can see that the only method whose measure of calorie intake correlates with the biometric indicators is our proposed food choice tool, as shown in Panel A. In fact, calorie intake from the food choice tool is positively and significantly-correlated with all four of the biometric indicators. The magnitudes of the coefficients of interest are somewhat low - for example a 10% increase in calorie intake is associated with a 1.5% increase in BMI. Nonetheless, the fact that our calorie intake measure is correlated with each biometric measure provides further evidence to support the use of our incentivized food choice tool as a measure of people’s dietary intake. This is particularly true given that calorie intake from neither the 24-hour dietary recall (Panel B) nor from the food frequency questionnaire (FFQ) exhibit a statistically-significant correlation with any of the indicators used. Furthermore, although the slope coefficients for calories across the 3 tools are statistically-equivalent in magnitude when assessing weight, they are not statistically-equivalent for any of the other biometric measures.

There are two possible explanations for these null results: (i) a systematic misreporting of calorie intake by respondents when using both the FFQ and dietary recall, (ii) the presence of a substantial amount of noise in our data, which would raise standard errors and suppress

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$^3$ A complete list of control variables used in this study is provided in Appendix IV
significance levels. The first explanation is related to recent evidence on the under-reporting of calorie intake in official statistics compiled by the UK government (Harper and Hallsworth, 2016). These data, which are collated using self-reported measures of dietary intake, have shown a persistent decline in calorie intake among the general population in recent years, despite the fact that average weight and BMI has been on the rise. This corresponds to the negative (albeit not statistically-significant) coefficients we observe on our calorie intake explanatory variables in Table 6 for both the recall and the FFQ. However, we cannot discount the second explanation either, since as pointed out earlier the nutrition literature typically advocates the administration of multiple 24-hour dietary recalls in order to reduce noise within the data. In our experiment, we only consider one reading from both tools as is often the case with limited time or budgets, meaning that any conclusions regarding the reliability or otherwise of these measures must be tempered somewhat by this consideration. Additionally, the closed nature of our food choice tool with its limited range of products may also have contributed towards lowering noise levels within the data relative to the other two measures.

5.3.1 Heterogeneity in Calorie Reporting

We now look at how the relationship between calorie intake as measured by our 3 tools and the various biometric measures varies within different subgroups. We examine different BMI groups as well as across both genders. The aim of this exercise is to see whether any subgroups are more prone to calorie under-reporting in our data. This analysis is motivated by the fact that various studies have shown that people who are obese or overweight are more likely to under-report their dietary intake (Lichtman et al., 1992).

Tables 7 and 8 below look at how the relationship between calorie intake and our biometric measures across the three tools varies by respondents’ BMI grouping. For simplicity, we split our sample into 2 groups - those respondents whose BMI is 25 and above, i.e. the overweight and obese group (Table 7), and those with a BMI below 25, i.e. those with a normal weight relative to their height (Table 8). As seen from below, it seems as though the positive and significant relationship observed between calorie choices in our incentivized food choice tool and the biometric measures is mainly driven by those respondents who are either overweight or obese. This implies that the use of incentivized tools to measure calorific intake may be particularly appropriate for eliciting truthful responses from people who are either overweight or obese - typically the same cohort who as discussed earlier tend to under-report in typical dietary surveys. By contrast, we once again do not observe any statistically-significant results for the other two self-reported measures in Table 7, although when it comes to the FFQ we do find positive and significant coefficients in Table 8 when looking at people in the normal weight category. This indicates that self-reported measures like the FFQ may be appropriate for capturing the dietary patterns of people of normal weight, albeit insufficient when it comes to higher weight categories.
In tables 9 and 10 we perform a similar subgroup analysis, only this time analyzing differences according to gender. None of our estimates from any of our dietary measurement tools are statistically-significant for male participants (table 9). However, we do find positive and significant results for our female subgroup (table 10) when using our proposed food choice tool, across all biometric measures. Thus, it appears as though using incentivized tools for capturing dietary measures may be more effective for female participants rather than males, while self-reported measures are equally ineffective for both genders.

5.4 Sensitivity of Dietary Selection in Food Choice Tool

Having looked at our incentivized food choice tool as a predictor of people’s biometric measurements and dietary intake, we now turn to assessing its functionality. More specifically, in this section we analyze the sensitivity of people’s food choices to changes in the food/drink category first shown to participants upon logging into the system. In order to access the food choice tool, participants in the experiment were first asked to type in their username, after which the tool was loaded and they were immediately shown one of the six categories of food and drink items mentioned earlier, namely fruit and vegetables, meat and fish, bread and grains, confectionery and snacks, ready meals and drinks. The category displayed onscreen varied randomly across participants in order to avoid any systematic priming effects, and obviously participants were free to browse any of the other categories once the system loaded. Nonetheless, it is possible to assess whether initial exposure to any of these categories had any significant impact on both the type of food selected, as well as the nutrient content of their chosen food baskets. This is an important consideration, and is related to the substantial literature on mindless food choices and how people tend to opt for those food and drink items that are easily accessible, in various settings from supermarkets to restaurants and cafeterias (Wansink et al., 2009; Wisdom et al., 2010; Hanks et al., 2012). Thus, initial food category exposure may have some impact on participants’ food choices in our tool, and must be taken into account and controlled for when conducting experiments or other studies using this tool.

Table 11 summarizes participants’ initial exposure to each supermarket category in our food choice tool. As seen below, the initial category shown to participants upon login was fairly evenly-distributed across the six categories.

We can now formally assess whether initial exposure to any one of these 6 categories had any impact on participants’ food and drink choices. We estimate the following equation:

\[ Y_{ji} = \alpha + \sum_{k=1}^{5} \beta_{ki} Front_{ki} + X_i' \gamma + \epsilon_i; \forall j \neq k \]  

(2)

where \( Y_{ji} \) is our dependent variable, which in this case will be either total expenditure on each of the \( j = \{1, 2, 3, 4, 5, 6\} \) supermarket categories by subject \( i \), or the total number of
items selected per category by \(i\). Our explanatory variables of interest are represented by \((6-1)\) five dummy variables \(Front_{ki}\), whereby each dummy takes a value of 1 if subject \(i\) was first exposed to that particular food/drink category when using our food choice tool. To facilitate the interpretation of our results, we use the same baseline (omitted) category as the one used in our dependent variable. Thus for example, if we consider total expenditure on fruit and vegetables as our dependent variable, then the baseline or omitted category for our initial exposure dummies will be the fruit and vegetables category. The rationale behind this specification is that if initial exposure to a particular category led to increased expenditure on items pertaining to that same category, then all of the coefficients on the other category dummies should be negative and statistically-significant. \(X_i\) is the same vector of control variables used in table 6, with a full list of variables provided in Appendix IV.

Table 12 presents our findings. Panel A shows the results obtained when using total expenditure on each category as our dependent variable; Panel B uses the total number of items selected per category while Panel C utilizes the total nutrient content of each subject’s chosen basket. As seen below, the results are somewhat mixed. We start with Panel A, column 1, where we observe negative and significant coefficients on both the confectionery and drinks categories, indicating that initial exposure to the fruit and veg category led to higher expenditure on fruit and veg relative to when the initial category was confectionery and drinks, to the tune of £3.12 and £2.62 respectively. The coefficients on the other categories are also negative, albeit not precisely estimated. In column 2 we also obtain a statistically-significant coefficient on the drinks category, although in this case it is positive, contrary to prior expectations. The rest of the results in the remaining columns are largely insignificant, indicating that on the whole there does not seem to be any systematic effect of initial category exposure on food expenditure.

Similarly mixed results are observed in Panel B, where we consider the total number of items selected in each category as our dependent variables. Once again we observe negative and significant coefficients in column 1 for confectionery, drinks and also ready meals, which provides some evidence that in this case initial exposure to fruit and veg did indeed increase subject’s fruit and veg choices relative to the other categories. We also observe some systematic impact when it comes to bread and grains (column 3), where we have negative and significant coefficients on both confectionery and drinks, although the other category coefficients are not significant. Nonetheless, as before we also find a positive and significant coefficient on the drinks category in column 2 in relation to meat and fish, which would seemingly indicate that people exposed to the drinks category selected more meat items that participants whose initial category was meat and fish, contrary to expectations. Thus, although in this instance there is some evidence of systematic bias in the choices of participants based on which category they were initially exposed to (especially with regards to fruit and veg), overall this does not seem to be the case for most of our food and drink categories. Therefore, the pattern that emerges here is that although varying the initial category exposure in our food choice tool can have a significant impact on actual choices,
there is limited evidence of this systematically nudging or boosting choices within the same category of exposure.

Finally, in Panel C we run similar regressions as in 2, only this time using the nutrient values (calories, fat, saturated fat, carbohydrates, sugar and protein) of each subject’s food basket as our dependent variables. In this case, our baseline omitted category is always the drinks category. As expected, exposure to almost each of the categories led to a statistically-significant increase in both calorie and carbohydrate intake. This may be no surprise given that drinks are our reference category; however the results do seem to indicate that participants initially exposed to one of the food categories (except ready meals) on average chose items with more calories and more carbohydrates than those whose initial category was drinks. The actual differences in calorie and carbohydrate intake are not statistically-significant across the categories. The only other effect observed is that participants exposed to bread and grains initially chose food items with a higher sugar content, by about 25%, relative to those exposed to drinks. Therefore, the results in Panel C indicate that although there might not be any systematic influence of initial category exposure in terms of increased spending on the exposed category, there may still be some important impact in terms of the nutritional composition of one’s choices. Thus, the results discussed in table 12 highlight the importance of taking this initial category exposure into account in any analysis that makes use of our proposed incentivized food choice tool.

6 Concluding Remarks

In this paper, we present and evaluate a new low-cost tool for eliciting information about food choices in an incentivized manner. People are allocated a fixed budget to spend on various food and drinks items from across six different categories, namely fruit and vegetables, meat and fish, bread and grains, confectionery and snacks, ready meals and drinks. The proposed food choice tool has several important benefits. Firstly, our tool can gather information regarding people’s food choices in a relatively quick and inexpensive manner, without having to resort to multiple readings as with other tools used by nutritionists and epidemiologists. Secondly, the inherent flexibility of the tool means that it can be adjusted and tailored to suit a wide variety of research needs, and can be administered in various settings, even online. Thirdly, since our tool is designed to mimic an online supermarket, it captures a relatively wide variety of foods and drinks, encompassing a number of meals and snacks, thus enabling a more representative picture of people’s dietary choices to be formulated. Finally, by incentivizing people’s responses via the possibility of receiving their chosen food basket, this tool is able to avoid some of the pitfalls commonly associated with self-reported measures of dietary intake, particularly when it comes to misreporting (Burger and Owens, 2010).

To test out the functionality of our new tool, we conducted a lab experiment among 255 real-world participants at the University of Edinburgh’s BLUE lab, whereby participants’ di-
etary intake was recorded using three different tools, namely a food frequency questionnaire, a 24-hour dietary recall and our own food choice tool. Both the food frequency questionnaire and the dietary recall are heavily-used in the nutrition and epidemiology literature and have been validated, although both tools must be administered more than once in order to obtain more representative estimates of dietary intake. In addition, their reliability in terms of the representativeness of the measurements obtained has been called into question recently due to the fact that they both rely on self-reported dietary intake (Lichtman et al., 1992).

We first sought to compare the values for nutrient profile across each of the three tools to see how well they match up to one another. The results were somewhat mixed, although no statistically-significant correlation was observed across the tools when considering calories, fat and saturated fat. We then proceeded to compare the total calorie intake recorded for each subject by the three tools to a number of individual biometric measures which are known to be positively-correlated with calorie intake, namely weight, body mass index (BMI) and waist size. The results showed that only the calorie intake measure from our incentivized food choice tool was positively and significantly related to each of the four biometric measures. By contrast, the calorie measures obtained from both the food frequency questionnaire and the 24 hour dietary recall were not significantly related to any of the biometric measures under consideration. Analysis of different subgroups within our sample showed that the positive and significant correlation observed for our incentivized tool was mainly driven by overweight or obese participants, which must be seen in light of recent evidence on under-estimation of calorie intake among this cohort when using self-reported measurement tools like a food frequency questionnaire or a 24 hour dietary recall (Harper and Hallsworth, 2016).

Finally, we examined whether our food choice tool was sensitive to particular design choices, specifically by assessing whether variation in the initial category of food that participants were exposed to upon accessing the tool had any impact on their actual choices. The results were somewhat scattered, with limited evidence that initial exposure had any impact on encouraging greater purchases from that same category, although we did find some statistically-significant impacts across categories. Thus, these findings showed the importance of adequately controlling for initial category exposure when conducting any work based on this tool.

The findings in this paper provide further evidence that incentive-based tools for information elicitation can provide significant benefits in terms of capturing people’s underlying preferences and behaviors. Amidst growing concern regarding self-reported data in surveys, this study highlights the possibility of integrating novel techniques that incentivize truthful responses into standard surveys across a wide range of applications, while keeping issues related to cost and practicality in check. This paper also lends further credence to the concerns raised in Bertrand and Mullainathan (2001) and Harper and Hallsworth (2016) regarding the systematic biases in self-reported survey responses, and thus the need to control for such errors when conducting any empirical investigation.
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### Tables & Figures

**Figure 1: Screenshots of the Food Choice Tool**

| Item                          | Description                        | Cost Per Item (£) | Quantity | Sub Total (£) |
|-------------------------------|------------------------------------|-------------------|----------|---------------|
| Cadbury Dairy Milk Chocolate, 350g | £2.50                              | 0                 | £0.00    |
| Green & Black's Organic 70% Dark Chocolate, 100g | £2.50                              | 0                 | £0.00    |
| Man Ban, x4                   | £2.50                              | 0                 | £0.00    |
| Breakfast Ban, x4             | £2.50                              | 0                 | £0.00    |
| Malt-O-Meal Peanuts Puffs, 34g | £0.50                              | 0                 | £0.00    |
| Nutella, 310g                 | £2.50                              | 0                 | £0.00    |

**Shopping Cart**

| Item                          | Description                        | Price (£) | Quantity | Total (£) |
|-------------------------------|------------------------------------|-----------|----------|-----------|
| Royal Gala Apple, x5          | (£1.00)                            | 1         | £1.00    |
| Finesse Bananas, x6           | (£0.30)                            | 1         | £0.30    |
| Easy Nectar Oranges, x6       | (£0.35)                            | 1         | £0.35    |
| Red Seedless Grapes, 150g     | (£2.00)                            | 1         | £2.00    |
| Conference Pears, x4          | (£1.25)                            | 1         | £1.25    |
| Raspberries, 150g             | (£2.00)                            | 1         | £2.00    |

| Item                          | Description                        | Price (£) | Quantity | Total (£) |
|-------------------------------|------------------------------------|-----------|----------|-----------|
| Eggplant (large, x7)          | (£0.50)                            | 1         | £0.50    |
| Silver Gladioli, x5           | (£0.45)                            | 1         | £0.45    |
| Red Potatoes, 1.1kg           | (£1.80)                            | 1         | £1.80    |
| Peppers, x5                   | (£1.00)                            | 1         | £1.00    |
| Chicken Breast整100g, 250g    | (£1.00)                            | 1         | £1.00    |
| Red Chive Whole Leaf, 25g     | (£1.00)                            | 1         | £1.00    |

**Total** £16.20
Table 1: List of Food and Drink Items in the Food Choice Tool

| Fruit and Veg                        | Meat and Fish                        | Bread and Grains                      |
|--------------------------------------|--------------------------------------|---------------------------------------|
| Royal Gala Apples, x5                | Chicken Breast Fillets, 460g         | Sliced White Bread, 800g               |
| Fairtrade Bananas, x5                | Chicken Kiev, Garlic, x2             | Sliced 50/50 Bread, 800g               |
| Oranges, x6                          | Chicken Goujons, 245g                | White Baguettes, x2                   |
| Red Grapes, 500g                     | Chicken Pie, 550g                    | Brown Baguettes, x2                   |
| Conference Pears, x4                 | Beef Rump Steak, 250g                | White Rolls, x8                       |
| Raspberries, 150g                    | Beef Mince, 500g                     | Wholemeal Rolls, x8                   |
| Strawberries, 400g                   | Steak Burgers, 340g                  | Crumpets, 400g                        |
| Peaches, x4                          | Steak and Ale Pie, 550g              | Plain Naan Bread, 260g                 |
| Kiwi Fruit, x4                       | Pork Chops, 450g                     | Brown Soda Bread, 400g                 |
| Lemons, x5                           | Pork Sausages, 400g                  | Tortilla Wraps, x8                    |
| Cherry Tomatoes, 650g                | Mini Pork Pies, 300g                  | Basmati Rice, 1kg                     |
| White Mushrooms, 300g                 | Smoked Bacon, 300g                   | Brown Basmati Rice, 1kg               |
| Maris Piper Potatoes, 2.5kg          | Lamb Chops, 275g                     | Penne Pasta, 1kg                      |
| Sweet Potatoes, 1.25kg               | Salmon fillets, 240g                 | Wholewheat Penne, 1kg                 |
| Mixed Peppers, x3                    | Cod fillets, 250g                    | Spaghetti, 500g                       |
| Carrots, 1kg                         | Sea Bass Fillets, 180g               | Wholewheat Spaghetti, 500g            |
| Onions, 1kg                          | King Prawns, 150g                    | Cous Cous, 1kg                        |
| Fine Beans, 200g                     | Breaded Cod, 350g                    | Quinoa, 300g                          |
| Sweetcorn, x2                        | Smoked Haddock with Cheese, 400g     | Egg Noodles, 375g                     |
|                                      | Salmon en Croute, 380g               |                                       |
|                                      | Cod Fish Fingers, 480g               |                                       |
|                                      | Mackerel in Garlic Butter, 340g      |                                       |
|                                      |                                       |                                       |
|                                      | Confectionery                        | Drinks                                |
|                                      | Dairy Milk Chocolate, 200g           | Blackcurrant Squash, 850ml            |
|                                      | 70% Dark Chocolate, 100g             | Orange & Passion Fruit Drink, 4x275ml |
|                                      | Mars Bars, x4                        | Coconut Water, 1L                     |
|                                      | Snickers, x4                         | Sports Drink, 1L                      |
|                                      | M&M’s Peanut, 165g                   | Energy Drink, 1L                      |
|                                      | Nutella, 400g                        | Ginger Beer, 1.5L                     |
|                                      | Starmix Candy, 215g                  | Tonic Water, 1L                       |
|                                      | Jelly Babies, 190g                   | Coke, 1.75L                           |
|                                      | Marshmallows, 200g                   | Irn Bru, 2L                           |
|                                      | Chocolate Chip Brioche, x8           | Fanta, 2L                             |
|                                      | Chocolate Digestives, 300g           | Orange Juice, 1L                      |
|                                      | Chocolate HobNobs, 262g              | Mango & Passion Fruit Smoothie, 750ml |
|                                      | Shortbread Fingers, 400g             | Still Water, 6x500ml                   |
|                                      | Custard Creams, 400g                 | Chocolate Milkshake, 1L               |
|                                      | Chocolate Cookies, 175g              | Soya Milk, 1L                         |
|                                      | Pringles Original, 190g              |                                       |
|                                      | Salt & Vinegar Chips, 150g           |                                       |
|                                      | Cheese & Onion Crisps, 6x25g         |                                       |
|                                      | Corn Chips, 200g                     |                                       |
|                                      | Croissants, x8                       |                                       |
|                                      |                                       |                                       |
|                                      | Ready Meals                          |                                       |
|                                      | Cheese & Tomato Pizza, 10”           |                                       |
|                                      | Pepperoni Pizza, 10”                 |                                       |
|                                      | Beef Lasagne, 430g                   |                                       |
|                                      | Macaroni Cheese, 430g                |                                       |
|                                      | Chicken & Bacon Pasta Bake, 430g     |                                       |
|                                      | Cottage Pie, 450g                    |                                       |
|                                      | Beef Stew, 450g                      |                                       |
|                                      | Chicken Tikka & Rice, 500g           |                                       |
|                                      | Beef Burrito, 400g                   |                                       |
|                                      | Chicken Chow Mein, 450g              |                                       |
|                                      | Beef Satay, 380g                     |                                       |
|                                      | Chicken Ramen, 380g                  |                                       |
|                                      | Pigs in Blankets, 260g               |                                       |
|                                      | Vegetarian Cannelloni, 430g          |                                       |
|                                      | Vegetable Spring Rolls, 60g          |                                       |
|                                      | Vegetable Biryani, 500g              |                                       |
|                                      | Lentil Cottage Pie, 400g             |                                       |
|                                      | Mushroom Risotto, 430g               |                                       |
|                                      | Tomato Soup, 600g                    |                                       |

Note: In this table we list all of the 120 food and drink items included in our proposed Food Choice tool, under each respective category.
### Table 2: Average Nutrient Content per Category (per 100g)

| Category          | Calories | Fat  | Sat Fat | Carbs | Sugar | Protein |
|-------------------|----------|------|---------|-------|-------|---------|
| Fruit and Veg     | 47.4     | 0.5  | 0.1     | 9.7   | 7.2   | 1.4     |
| Meat and Fish     | 233.2    | 13.9 | 4.9     | 7.5   | 0.8   | 19.4    |
| Bread and Grains  | 212.1    | 1.9  | 0.4     | 40.6  | 2.4   | 7.0     |
| Confectionery     | 471.9    | 22.5 | 9.1     | 59.4  | 33.1  | 6.4     |
| Ready Meals       | 157.7    | 6.9  | 2.6     | 15.3  | 2.6   | 7.1     |
| Drinks            | 40.5     | 0.2  | 0.1     | 9.9   | 9.2   | 0.6     |

*Note:* This table summarizes the average nutrient content, per 100g, of each of the six food and drink categories used as part of our proposed food choice tool. We consider six key nutrients, namely calories (in kcal), fat, saturated fat, carbohydrates, sugar and protein.

### Table 3: Baseline Characteristics of Sample

| Variable                     | Mean | Std. Dev. |
|------------------------------|------|-----------|
| % Males                      | 37.6%| 48.5      |
| % White                      | 87.8%| 32.7      |
| Married                      | 67.5%| 46.9      |
| Age                         | 36.9 | 11.426    |
| Employed                     | 58.0%| 49.4      |
| Unemployed                   | 8.6% | 28.1      |
| Income above £25,000         | 7.1% | 25.7      |
| Income £20,000-25,000        | 30.2%| 46        |
| Income £15,000-20,000        | 21.6%| 41.2      |
| Income £10,000-15,000        | 21.2%| 40.9      |
| Income £5,000-10,000         | 12.5%| 33.2      |
| Weight                       | 72.9 | 16.977    |
| BMI                          | 25.4 | 5.357     |
| Waist                        | 33.3 | 6.734     |
| Blood Sugar Normal           | 89.8%| 30.3      |
| Family History Heart Disease| 20.8%| 40.7      |
| Regular Diet                 | 77.6%| 41.7      |
| Vegetarian                   | 15.3%| 36.1      |
| Smoker                       | 16.5%| 37.2      |

*Note:* This table provides a summary of the key characteristics of the sample used as part of this study. In total, our sample consists of 255 participants, who were recruited from the surrounding precincts of the University of Edinburgh’s main campus in the city of Edinburgh. To be eligible to participate in this study, participants were required to have a good understanding of English, an annual household income below £26,500, no pre-existing medical conditions and not be pregnant.
Table 4: Nutrient Measures from each Dietary Assessment Tool

| Variable                      | 1. Food Choice Tool | 2. 24-Hour Dietary Recall | 3. Food Frequency Questionnaire |
|-------------------------------|---------------------|---------------------------|--------------------------------|
| Calories per Basket           | 10137.845           | 2032.167                  | 1320.178                       |
| Fat per Basket                | 252.122             | 83.376                    | 51.252                         |
| Saturated Fat per Basket      | 86.858              | 31.147                    | 21.324                         |
| Carbohydrates per Basket      | 1440.242            | 240.152                   | 151.273                        |
| Sugar per Basket              | 594.055             | 102.4                     | 62.958                         |
| Protein per Basket            | 477.628             | 74.47                     | 55.855                         |

**N = 255**

Note: This table lists the average measurements for each nutrient, obtained from the three measures of dietary intake employed in this study, namely our own proposed food choice tool, a 24-hour dietary recall and a food frequency questionnaire (FFQ). The six nutrients measured are calories (in kcal), fat, saturated fat, carbohydrates, sugar and protein (all in grams). Both the 24-hour dietary recall and the FFQ report average nutrient intake per day, whereas our food choice tool reports the average nutrient content of each participant’s chosen food and drink basket.
Table 5: Correlation Matrices for Dietary Intake Measures

|       | Food Choice Tool | Recall | FFQ |
|-------|------------------|--------|-----|
| **(1) Calories** |                  |        |     |
| Food Choice Tool | 1                |        |     |
| Recall           | 0.06             | 1      |     |
| FFQ              | 0.05             | 0.05   | 1   |
| **(2) Fat**      |                  |        |     |
| Food Choice Tool | 1                |        |     |
| Recall           | 0.01             | 1      |     |
| FFQ              | 0.09             | 0.07   | 1   |
| **(3) Saturated Fat** |          |        |     |
| Food Choice Tool | 1                |        |     |
| Recall           | 0.06             | 1      |     |
| FFQ              | 0.10             | 0.07   | 1   |
| **(4) Carbs**    |                  |        |     |
| Food Choice Tool | 1                |        |     |
| Recall           | 0.13**           | 1      |     |
| FFQ              | 0.11             | 0.07   | 1   |
| **(5) Sugar**    |                  |        |     |
| Food Choice Tool | 1                |        |     |
| Recall           | 0.16**           | 1      |     |
| FFQ              | 0.21**           | 0.16** | 1   |
| **(6) Protein**  |                  |        |     |
| Food Choice Tool | 1                |        |     |
| Recall           | 0.11             | 1      |     |
| FFQ              | 0.08             | 0.19** | 1   |

Note: Asterisks (**) denote variables significant at 5% level. This table reports the pairwise correlations for the three measures of dietary intake used in this study, namely our proposed food choice tool, a 24-hour dietary recall and a food frequency questionnaire (FFQ), across the six nutrient measures under consideration, namely calories, fat, saturated fat, carbohydrates, sugar and protein. The idea is to assess how the measurements for each nutrient derived from each tool correlate with one another.
Table 6: Validity of Dietary Assessment Tools

|                        | (1) Weight | (2) BMI   | (3) Waist |
|------------------------|------------|-----------|-----------|
| **Panel A: Food Choice Tool** |            |           |           |
| Supermarket Calories   | 0.733*     | 0.369**   | 0.564***  |
|                        | (0.386)    | (0.150)   | (0.209)   |
| Constant               | 35.12***   | 17.00***  | 25.39***  |
|                        | (12.68)    | (4.006)   | (3.906)   |
| **Panel B: 24-Hr Dietary Recall** |            |           |           |
| Recall Calories        | -0.490     | -0.425    | -0.257    |
|                        | (0.917)    | (0.274)   | (0.267)   |
| Constant               | 43.80***   | 21.74***  | 31.81***  |
|                        | (13.04)    | (3.818)   | (4.495)   |
| **Panel C: Food Frequency Questionnaire** |            |           |           |
| FFQ Calories           | 0.692      | -0.215    | -0.17     |
|                        | (1.469)    | (0.477)   | (0.49)    |
| Constant               | 41.91**    | 21.11***  | 31.474*** |
|                        | (12.52)    | (3.7)     | (4.48)    |
| Controls               | Y          | Y         | Y         |
| Observations           | 255        | 255       | 255       |

Note: Robust standard errors in parentheses. Asterisks (***) and (*) denote variables significant at 1%, 5% and 10% levels respectively. This table reports the results from our linear regression estimates of equation 1. In each panel, we regress the subjects’ biometric measures (weight, body-mass index and waist size) on the calorie intake values obtained from each of the dietary intake measurement tools, namely the food choice tool, the 24 hour dietary recall and the food frequency questionnaire (FFQ), along with a number of control variables (listed in Appendix IV). Note that for aesthetic reasons, in each panel calories have been multiplied by 1,000, and thus any coefficient estimates must be interpreted appropriately.
Table 7: Subgroup Analysis - BMI 25 and Over

|                  | (1)  | (2)  | (3)  |
|------------------|------|------|------|
|                  | Weight | BMI  | Waist |
| **Panel A: Food Choice Tool** |       |      |      |
| Supermarket Calories | 0.858 | 0.570** | 0.369* |
|                   | (0.628) | (0.258) | (0.210) |
| Constant          | 38.15 | 21.62*** | 32.24*** |
|                   | (25.17) | (5.727) | (5.396) |
| **Panel B: 24-Hr Dietary Recall** |       |      |      |
| Recall Calories   | 1.20  | 0.183 | 0.345 |
|                   | (1.40) | (0.444) | (0.446) |
| Constant          | 46.74* | 28.32*** | 36.21*** |
|                   | (24.46) | (4.902) | (4.821) |
| **Panel C: Food Frequency Questionnaire** |       |      |      |
| FFQ Calories      | 1.04  | -0.0806 | 0.139 |
|                   | (2.90) | (0.795) | (0.966) |
| Constant          | 48.21** | 28.65*** | 36.71*** |
|                   | (24.07) | (4.711) | (4.747) |
| Controls          | Y     | Y     | Y     |
| Observations      | 114   | 114   | 114   |

Note: Robust standard errors in parentheses. Asterisks (***) , (**) and (*) denote variables significant at 1%, 5% and 10% levels respectively. This table reports the results from our linear regression estimates of equation 1, only this time focusing solely on those subjects whose body-mass-index (BMI) is 25 or over. The idea behind this subgroup analysis is to assess whether the results presented in 6 differ among those subjects who are classified as being either overweight or obese (relative to their height). In each panel, we once again regress the subjects' biometric measures (weight, body-mass index and waist size) on the calorie intake values obtained from each of the dietary intake measurement tools, namely the food choice tool, the 24 hour dietary recall and the food frequency questionnaire (FFQ), along with a number of control variables (listed in Appendix IV). Note that for aesthetic reasons, in each panel calories have been multiplied by 1,000, and thus any coefficient estimates must be interpreted appropriately. Robust standard errors are used.
Table 8: Subgroup Analysis - BMI Under 25

|                      | (1)  | (2)  | (3)  |
|----------------------|------|------|------|
|                      | Weight | BMI | Waist |
| Panel A: Food Choice Tool |        |      |      |
| Supermarket Calories  | 0.0130 | -0.0129 | 0.442 |
|                      | (0.278) | (0.0645) | (0.295) |
| Constant             | 60.38*** | 23.59*** | 26.63*** |
|                      | (8.651) | (1.804) | (4.776) |
| Panel B: 24-Hr Dietary Recall |        |      |      |
| Recall Calories      | -0.382 | -0.367** | -0.262 |
|                      | (0.951) | (0.169) | (0.236) |
| Constant             | 61.38*** | 24.30*** | 31.69*** |
|                      | (9.786) | (1.667) | (5.332) |
| Panel C: Food Frequency Questionnaire |        |      |      |
| FFQ Calories         | 2.27** | 0.242 | -0.0233 |
|                      | (1.00) | (0.272) | (0.553) |
| Constant             | 56.87**** | 23.07*** | 31.13*** |
|                      | (9.181) | (1.699) | (5.742) |
| Controls             | Y     | Y     | Y     |
| Observations         | 141   | 141   | 141   |

Note: Robust standard errors in parentheses. Asterisks (***), (**), and (*) denote variables significant at 1%, 5% and 10% levels respectively. This table reports the results from our linear regression estimates of equation 1, only this time focusing solely on those subjects whose body-mass-index (BMI) is below 25. The idea behind this subgroup analysis is to assess whether the results presented in 6 differ among those subjects who are classified as being of normal weight (relative to their height). In each panel, we once again regress the subjects’ biometric measures (weight, body-mass index and waist size) on the calorie intake values obtained from each of the dietary intake measurement tools, namely the food choice tool, the 24 hour dietary recall and the food frequency questionnaire (FFQ), along with a number of control variables (listed in Appendix IV). Note that for aesthetic reasons, in each panel calories have been multiplied by 1,000, and thus any coefficient estimates must be interpreted appropriately.
Table 9: Subgroup Analysis - Male Participants

|                  | Panel A: Food Choice Tool | Panel B: 24-Hr Dietary Recall | Panel C: Food Frequency Questionnaire |
|------------------|---------------------------|-------------------------------|-------------------------------------|
|                  | Weight | BMI | Waist | Weight | BMI | Waist | Weight | BMI | Waist |
| Supermarket Calories | -0.0327 | -0.0950 | 0.486 | -0.110 | -0.431 | 0.0549 | -0.983 | -0.843 | 0.519 |
| Constant         | 59.59*** | 19.87*** | 37.73*** | 59.45*** | 19.86*** | 45.28*** | 60.31*** | 19.43*** | 44.81*** |
|                  | (0.461) | (0.146) | (0.340) | (1.51) | (0.438) | (0.381) | (2.72) | (0.778) | (1.14) |

Controls | Y | Y | Y |
Observations | 96 | 96 | 96 |

Note: Robust standard errors in parentheses. Asterisks (***)*, (**), and (*) denote variables significant at 1%, 5% and 10% levels respectively. This table reports the results from our linear regression estimates of equation 1, only this time focusing solely on male subjects. The idea behind this subgroup analysis is to assess whether the results presented in 6 differ among men. In each panel, we once again regress the subjects’ biometric measures (weight, body-mass index and waist size) on the calorie intake values obtained from each of the dietary intake measurement tools, namely the food choice tool, the 24 hour dietary recall and the food frequency questionnaire (FFQ), along with a number of control variables (listed in Appendix IV). Note that for aesthetic reasons, in each panel calories have been multiplied by 1,000, and thus any coefficient estimates must be interpreted appropriately.
Table 10: Subgroup Analysis - Female Participants

|                      | (1) Weight | (2) BMI     | (3) Waist |
|----------------------|------------|-------------|-----------|
| **Panel A: Food Choice Tool** |            |             |           |
| Supermarket Calories | 1.11*      | 0.572***    | 0.450**   |
|                      | (0.567)    | (0.215)     | (0.185)   |
| Constant             | 33.88**    | 17.29***    | 25.15***  |
|                      | (15.09)    | (4.938)     | (4.613)   |
| **Panel B: 24-Hr Dietary Recall** |            |             |           |
| Recall Calories      | -1.00      | -0.414      | -0.455    |
|                      | (1.32)     | (0.406)     | (0.332)   |
| Constant             | 45.85***   | 23.28***    | 30.11***  |
|                      | (15.36)    | (4.864)     | (4.528)   |
| **Panel C: Food Frequency Questionnaire** |            |             |           |
| FFQ Calories         | 1.06       | -0.000769   | -0.137    |
|                      | (1.96)     | (0.629)     | (0.615)   |
| Constant             | 42.78***   | 22.50***    | 29.40***  |
|                      | (14.78)    | (4.677)     | (4.440)   |
| Controls             | Y          | Y           | Y         |
| Observations         | 159        | 159         | 159       |

Note: Robust standard errors in parentheses. Asterisks (***), (**) and (*) denote variables significant at 1%, 5% and 10% levels respectively. This table reports the results from our linear regression estimates of equation 1, only this time focusing solely on female subjects. The idea behind this subgroup analysis is to assess whether the results presented in 6 differ among females. In each panel, we once again regress the subjects’ biometric measures (weight, body-mass index and waist size) on the calorie intake values obtained from each of the dietary intake measurement tools, namely the food choice tool, the 24 hour dietary recall and the food frequency questionnaire (FFQ), along with a number of control variables (listed in Appendix IV). Note that for aesthetic reasons, in each panel calories have been multiplied by 1,000, and thus any coefficient estimates must be interpreted appropriately.
Table 11: Initial Category Exposure in Food Choice Tool

| Variable          | Mean | Std. Dev. |
|-------------------|------|-----------|
| Fruit and Veg     | 12.9%| 33.6      |
| Meat and Fish     | 17.3%| 37.9      |
| Bread and Grains  | 18%  | 38.5      |
| Confectionery     | 17.6%| 38.2      |
| Ready Meals       | 16.1%| 36.8      |
| Drinks            | 18%  | 38.5      |

N 255

*Note:* This table shows the proportion of subjects who, upon accessing the food choice tool, were initially exposed to each of the six food and drink categories available, namely fruit and vegetables, meat and fish, bread and grains, confectionery and snacks, ready meals and drinks.
Table 12: Sensitivity of Food Choices to Initial Category Exposure

| Panel A: Total Expenditure per Category | (1) Fruit | (2) Meat | (3) Bread | (4) Confec | (5) Ready Drinks |
|----------------------------------------|-----------|---------|----------|-----------|-----------------|
| Front Fruit                            | 0.00308   | 0.651   | -0.811*  | -1.595*   | 0.00129         |
|                                        | (1.703)   | (0.609) | (0.488)  | (0.931)   | (0.648)         |
| Front Meat                             | -0.821    | -0.327  | -0.0967  | -0.796    | 0.115           |
|                                        | (1.122)   | (0.488) | (0.430)  | (1.015)   | (0.572)         |
| Front Bread                            | -0.895    | -1.069  | 0.591    | -1.737    | 0.539           |
|                                        | (1.194)   | (1.390) | (0.509)  | (1.087)   | (0.594)         |
| Front Conf                             | -3.123**  | 1.768   | 0.0561   | -0.720    | -0.326          |
|                                        | (1.216)   | (1.468) | (0.555)  | (1.131)   | (0.563)         |
| Front Ready                            | -1.739    | 0.571   | -0.831*  | -0.410    | 0.592           |
|                                        | (1.149)   | (1.482) | (0.446)  | (0.460)   | (0.715)         |
| Front Drinks                           | -2.362**  | 2.804** | -0.668   | -0.0418   | -1.579          |
|                                        | (1.116)   | (1.383) | (0.454)  | (0.469)   | (1.115)         |
| Constant                               | 14.24     | 13.84***| 1.605    | 1.270     | 2.003           |
|                                        | (2.967)   | (3.834) | (1.407)  | (1.257)   | (1.600)         |

| Panel B: Items Chosen per Category     | (1) Fruit | (2) Meat | (3) Bread | (4) Confec | (5) Ready Drinks |
|----------------------------------------|-----------|---------|----------|-----------|-----------------|
| Front Fruit                            | 0.0369    | 0.356   | -0.604** | -0.632*   | -0.186          |
|                                        | (0.511)   | (0.452) | (0.290)  | (0.382)   | (0.261)         |
| Front Meat                             | -0.958    | -0.399  | -0.157   | -0.353    | 0.0512          |
|                                        | (0.795)   | (0.360) | (0.262)  | (0.405)   | (0.233)         |
| Front Bread                            | -0.882    | -0.303  | 0.339    | -0.458    | 0.291           |
|                                        | (0.918)   | (0.410) | (0.307)  | (0.446)   | (0.232)         |
| Front Conf                             | -2.337**  | 0.547   | 0.0325   | -0.298    | -0.0674         |
|                                        | (0.926)   | (0.439) | (0.417)  | (0.456)   | (0.244)         |
| Front Ready                            | -1.757**  | 0.111   | -0.724** | -0.303    | 0.189           |
|                                        | (0.842)   | (0.434) | (0.347)  | (0.287)   | (0.286)         |
| Front Drink                            | -1.639**  | 0.846** | -0.686** | -0.126    | -0.628          |
|                                        | (0.810)   | (0.424) | (0.340)  | (0.288)   | (0.452)         |
| Constant                               | 11.91     | 4.09*** | 1.771*   | 0.594     | 0.967           |
|                                        | (2.188)   | (1.169) | (1.022)  | (0.735)   | (0.759)         |

| Panel C: Nutrients per Food Basket     | Calories | Fat   | Sat Fat | Carbs   | Sugar  | Protein |
|----------------------------------------|----------|-------|---------|---------|--------|---------|
| Front Fruit                            | 1135.3*  | -30.08| -8.573  | 342.6***| 16.00  | -6.022  |
|                                        | (620.7)  | (24.42)| (10.30) | (130.9) | (56.03)| (38.69) |
| Front Meat                             | 1249.1** | -10.60| -3.043  | 313.2***| 61.23  | 12.78   |
|                                        | (562.6)  | (20.46)| (8.557) | (109.3) | (51.27)| (33.41) |
| Front Bread                            | 1844.3***| 5.101 | 3.333   | 463.1***| 150.5**| -19.51  |
|                                        | (521.5)  | (23.24)| (9.861) | (100.5) | (49.80)| (32.53) |
| Front Conf                             | 1267.8** | 20.59 | 12.74   | 216.8*  | -20.55 | 50.44   |
|                                        | (623.5)  | (21.78)| (9.088) | (118.9) | (52.88)| (32.53) |
| Front Ready                            | 303.8    | -17.90| -0.505  | 161.5   | 56.70  | -39.92  |
|                                        | (669.6)  | (23.69)| (10.07) | (125.2) | (56.34)| (37.69) |
| Constant                               | 9052.1***| 243.1***| 64.67** | 1130.5***| 743.6***| 490.8***|
|                                        | (1681.9) | (60.21)| (26.11) | (342.8) | (153.9)| (86.00) |

Controls: Y Y Y Y Y Y

Observations: 255 255 255 255 255 255

Note: Robust standard errors in parentheses. Asterisks (***) and (**) denote variables significant at 1%, 5% and 10% levels respectively. This table reports the results from our linear regression estimates of equation 2. Panel A regresses total expenditure on each food and drink category (in £) on a series of dummy variables denoting which category the subjects were initially exposed to upon accessing the food choice tool. In Panel B a similar regression is carried out, only this time our dependent variable in each column is the total number of items per category selected by each subject. Note that in both Panels A and B the omitted category in each column corresponds to the category used as the dependent variable, in order to facilitate the interpretation of results. For example, in Panel A, Column 1, since our dependent variable is total expenditure on fruit and vegetables, the omitted (dummy) initial category is also fruit and vegetables. In Panel C we also perform a similar regression, although in this case the dependent variable is the aggregate value of one of the six nutrients captured by our food choice tool. In this case, the omitted category across each of the six columns is the drinks category. In Panels A to C we also include a number of control variables in our regression models (listed in Appendix IV).
Appendices

Appendix I: Copy of Food Frequency Questionnaire

These questions are about food and drink you consumed during the past month, that is, the past 30 days. When answering, please include meals and snacks at home, at work, in restaurants, or anywhere else.

Please enter your username

Please enter your desk number

Please tick how often you ate at least ONE portion of the following foods and drinks over the past month (a portion includes a handful of grapes, an orange, a serving of carrots, a side salad, a slice of bread, a glass of liquid).

|                      | Rarely or Never | Less than 1 a Week | Once a week | 2-3 times a week | 4-6 times a week | 1-2 times a day | 3-4 times a day | 5+ a day |
|----------------------|----------------|--------------------|-------------|-----------------|-----------------|----------------|----------------|---------|
| Fruit (tinned/fresh) | O              | O                  | O           | O               | O               | O              | O              | O       |
| Fruit juice          | O              | O                  | O           | O               | O               | O              | O              | O       |
| Salad (not garnish   | O              | O                  | O           | O               | O               | O              | O              | O       |
| added to sandwiches  | O              | O                  | O           | O               | O               | O              | O              | O       |
| Vegetables           | O              | O                  | O           | O               | O               | O              | O              | O       |
| (tinned / frozen /   | O              | O                  | O           | O               | O               | O              | O              | O       |
| fresh but not        | O              | O                  | O           | O               | O               | O              | O              | O       |
| potatoes             | O              | O                  | O           | O               | O               | O              | O              | O       |
| Chips / fried        | O              | O                  | O           | O               | O               | O              | O              | O       |
| potatoes             | O              | O                  | O           | O               | O               | O              | O              | O       |
| White rice or        | O              | O                  | O           | O               | O               | O              | O              | O       |
| potatoes             | O              | O                  | O           | O               | O               | O              | O              | O       |
like baked, boiled, mashed or sweet potatoes
Beans or pulses like baked beans, lentils, chick peas, dahl
Tea or coffee sweetened with sugar or honey, including iced tea and frappuccino

Please tick how often you ate at least ONE portion of the following foods and drinks over the past month (a portion includes a 30g bowl of cereal, 25g of cheese, a packet of crisps, 2 biscuits, a slice of bread, a glass of liquid).

| Food Description                                                                 | Rarely or Never | Less than 1 a Week | Once a week | 2-3 times a week | 4-6 times a week | 1-2 times a day | 3-4 times a day | 5+ a day |
|--------------------------------------------------------------------------------|-----------------|-------------------|-------------|------------------|------------------|-----------------|-----------------|---------|
| Fibre-rich breakfast cereal like Weetabix, Fruit 'n Fibre, Porridge, Muesli    |                 |                   |             |                  |                  |                 |                 |         |
| Wholemeal bread or chapattis                                                  |                 |                   |             |                  |                  |                 |                 |         |
| Brown rice / bulgur wheat / quinoa                                             |                 |                   |             |                  |                  |                 |                 |         |
| Cheese / yoghurt                                                              |                 |                   |             |                  |                  |                 |                 |         |
| Crisps / savoury snacks                                                        |                 |                   |             |                  |                  |                 |                 |         |
| Sweet biscuits, cakes, chocolate, sweets                                       |                 |                   |             |                  |                  |                 |                 |         |
| Ice cream / cream                                                              |                 |                   |             |                  |                  |                 |                 |         |
| Non alcoholic fizzy drinks / pop (not sugar free or diet)                      |                 |                   |             |                  |                  |                 |                 |         |

Please tick how often you ate at least ONE portion of the following foods and drinks over the past month.

| Food Description                                                                 | Rarely or Never | Less than 1 a Week | Once a week | 2-3 times a week | 4-6 times a week | At least everyday |
|--------------------------------------------------------------------------------|-----------------|-------------------|-------------|------------------|------------------|-------------------|
| Beef, Lamb, Pork, Ham - steaks, roasts, joints,                                |                 |                   |             |                  |                  |                   |
### Mince or Chops

- Chicken or Turkey - steaks, roasts, joints, mince or portions (not in batter or breadcrumbs)
- Sausages, bacon, corned beef, meat pies/pasties, burgers
- Chicken/turkey nuggets, turkey burgers, chicken pies, or in batter or breadcrumbs
- White fish in batter or breadcrumbs - like fish 'n chips
- White fish not in batter or breadcrumbs
- Oily fish - like herrings, trout, salmon, sardines, mackerel, fresh tuna (not tinned tuna)

### What milk do you USUALLY use or drink, such as in hot & cold drinks or on cereal (including tea, coffee, hot milk, milkshakes, or on cereal)

- Whole / full-fat milk
- Semi-skimmed milk
- Skimmed Milk
- Rarely / never use milk

Other (please specify)
Appendix II: Screenshot of 24-Hour Dietary Recall (IN-TAKE24)
Appendix III: Food and Drink Items used in Food Frequency Questionnaire Nutrient Calculations

| Category       | Item                                                   |
|----------------|--------------------------------------------------------|
| Fruit          | Royal Gala Apples                                      |
| Fruit          | Fairtrade Bananas                                      |
| Fruit          | Easy Peeler Oranges                                    |
| Fruit          | Red Seedless Grapes                                    |
| Fruit          | Conference Pears                                       |
| Fruit          | Raspberries                                            |
| Fruit          | Strawberries                                           |
| Fruit          | Peaches                                                |
| Fruit          | Kiwi Fruit                                             |
| Fruit juice    | Smooth Orange Juice, Not from Concentrate              |
| Fruit juice    | Smooth Orange Juice, from Concentrate                  |
| Fruit juice    | Pressed Apple Juice, Not from Concentrate              |
| Fruit juice    | Apple Juice, From Concentrate                          |
| Fruit juice    | Orange Juice with Bits, Not From Concentrate           |
| Fruit juice    | Apple and Mango Juice, Not from Concentrate            |
| Fruit juice    | Mango and Passion Fruit Smoothie                       |
| Fruit juice    | Strawberry and Banana Smoothie                        |
| Salad          | Bistro Salad                                           |
| Salad          | Italian Style Salad                                    |
| Salad          | Mixed Leaf Salad                                       |
| Salad          | Sweet Leaf Salad                                       |
| Salad          | Babyleaf Salad                                         |
| Salad          | Crispy Salad                                           |
| Vegetables     | Cherry Tomatoes                                        |
| Vegetables     | Closed Cup White Mushrooms                             |
| Vegetables     | Mixed Peppers                                          |
| Vegetables     | Carrots                                                |
| Vegetables     | Onions                                                 |
| Vegetables     | Fine Beans                                             |
| Vegetables     | Broccoli                                               |
| Vegetables     | Sweetcorn                                              |
| Vegetables     | Cucumber                                               |
| Vegetables     | Red Onions                                             |
| Chips/fried potatoes | Homestyle Chips                           |
| Chips/fried potatoes | Straight Cut Chips                              |
| Chips/fried potatoes | French Fries                                     |
| Chips/fried potatoes | Oven Chips                                          |
| White rice or potatoes | Baked Potatoes                               |
| White rice or potatoes | Maris Piper Potatoes                                |
| White rice or potatoes | Baby Potatoes                                     |
| White rice or potatoes | Sweet Potatoes                                    |
| White rice or potatoes | Mashed Potatoes                                  |
| White rice or potatoes | Basmati Rice                                      |
| White rice or potatoes | Arborio Rice                                    |
| Beans or pulses | Baked Beans                                            |
| Beans or pulses | Baked Beans in Tomato Sauce                           |
| Beans or pulses | Green Lentils                                         |
| Beans or pulses | Red Lentils                                            |
| Beans or pulses | Chickpeas                                             |
| Category                              | Item                                      |
|---------------------------------------|-------------------------------------------|
| Tea or coffee sweetened               | Tea                                       |
| Tea or coffee sweetened               | Capuccino                                 |
| Tea or coffee sweetened               | Barista Coffee                            |
| Tea or coffee sweetened               | Weetabix                                  |
| Fibre-rich breakfast cereal           | Fruit and Fibre                           |
| Fibre-rich breakfast cereal           | Porridge                                  |
| Fibre-rich breakfast cereal           | Muesli                                    |
| Wholemeal bread or chapattis          | Wholemeal Bread                           |
| Brown rice/bulgur wheat/quinoa        | Brown Basmati Rice                        |
| Brown rice/bulgur wheat/quinoa        | Quinoa                                    |
| Brown rice/bulgur wheat/quinoa        | Bulgur Wheat                              |
| Cheese/yoghurt                       | Mature Cheddar                            |
| Cheese/yoghurt                       | Red Leicester                             |
| Cheese/yoghurt                       | Greek Style Yoghurt                       |
| Cheese/yoghurt                       | Natural Yoghurt                           |
| Crisps/savoury snacks                | Tortilla Crisps                           |
| Crisps/savoury snacks                | Cheese and Onion Crisps                   |
| Crisps/savoury snacks                | Salted Crisps                             |
| Crisps/savoury snacks                | Cashews                                   |
| Crisps/savoury snacks                | Peanuts                                   |
| Sweet biscuits, cakes, chocolate, sweets | Milk chocolate digestives               |
| Sweet biscuits, cakes, chocolate, sweets | Rich Tea Biscuits                     |
| Sweet biscuits, cakes, chocolate, sweets | Shortbread                               |
| Sweet biscuits, cakes, chocolate, sweets | Pain au Chocolat                        |
| Sweet biscuits, cakes, chocolate, sweets | Chocolate Cake                         |
| Sweet biscuits, cakes, chocolate, sweets | Milk Chocolate Fingers                |
| Sweet biscuits, cakes, chocolate, sweets | Chocolate Buttons                      |
| Sweet biscuits, cakes, chocolate, sweets | Fudge Chocolate Bar                     |
| Sweet biscuits, cakes, chocolate, sweets | Assorted Candy                         |
| Sweet biscuits, cakes, chocolate, sweets | Marshmallows                            |
| Sweet biscuits, cakes, chocolate, sweets | Vanilla Ice Cream                      |
| Ice cream/cream                       | Ice Cream Cone                            |
| Ice cream/cream                       | Whipped Cream                             |
| Ice cream/cream                       | Cola                                      |
| Ice cream/cream                       | Lemonade                                  |
| Ice cream/cream                       | Orange Ade                                |
| Ice cream/cream                       | Irn Bru                                   |
| Non alcoholic sugary fizzy drinks/pop | Beef Mince                                |
| Non alcoholic sugary fizzy drinks/pop | Honey Roast Ham                          |
| Non alcoholic sugary fizzy drinks/pop | Beef Joint                                |
| Beef, lamb, pork, ham                 | Beef Steak                                |
| Beef, lamb, pork, ham                 | Gammon Joint                              |
| Beef, lamb, pork, ham                 | Pork Loin                                 |
| Beef, lamb, pork, ham                 | Pork Chops                                |
| Beef, lamb, pork, ham                 | Lamb Mince                                |
| Beef, lamb, pork, ham                 | Lamb Leg                                  |
| Beef, lamb, pork, ham                 | Lamb Chops                                |
| Chicken or turkey                     | Chicken Breasts Fillets                   |
| Chicken or turkey                     | Chicken Thigh Fillets                     |
| Chicken or turkey                     | Whole Chicken                             |
| Chicken or turkey                     | Turkey Mince                              |
| Chicken or turkey                     | Turkey Breast Steaks                      |
| Chicken or turkey                     | Turkey Breast Fillets                     |
| Chicken or turkey                     | Unsmoked Bacon                            |
| Chicken or turkey                     | Pork Sausages                             |
| Chicken or turkey                     | Smoked Bacon                              |
| Chicken or turkey                     | Cumberland Sausages                       |
| Chicken or turkey                     | Beef Burgers                              |
| Chicken or turkey                     | Beef Meatballs                            |
| Category                                               | Item              |
|-------------------------------------------------------|-------------------|
| Sausages, bacon, meat pies, burgers                    | Pork Pie          |
| Sausages, bacon, meat pies, burgers                    | Steak Pie         |
| Chicken/turkey nuggets, burgers, pies                  | Chicken Kiev Garlic|
| Chicken/turkey nuggets, burgers, pies                  | Chicken Kiev Ham  |
| Chicken/turkey nuggets, burgers, pies                  | Chicken Nuggets   |
| Chicken/turkey nuggets, burgers, pies                  | Chicken Pie       |
| Chicken/turkey nuggets, burgers, pies                  | Turkey Escalope   |
| White fish in batter or breadcrumbs                   | Haddock Fishcakes |
| White fish in batter or breadcrumbs                   | Breaded Cod       |
| White fish in batter or breadcrumbs                   | Cod Fishcakes     |
| White fish in batter or breadcrumbs                   | Dusted Lemon Sole |
| White fish not in batter or breadcrumbs               | Cod Fillets       |
| White fish not in batter or breadcrumbs               | Sea Bass Fillets  |
| White fish not in batter or breadcrumbs               | Basa Fillets      |
| White fish not in batter or breadcrumbs               | Plaice Fillets    |
| Oily fish (not tinned)                                | Salmon Fillet     |
| Oily fish (not tinned)                                | Smoked Salmon Fillet|
| Oily fish (not tinned)                                | Trout Fillet      |
| Oily fish (not tinned)                                | Mackerel Fillets  |
| Category                                      | Calories | Fat  | Sat Fat | Carbohydrates | Sugar | Protein |
|----------------------------------------------|----------|------|---------|---------------|-------|---------|
| Fruit (tinned/fresh)                         | 49.444   | 0.433| 0.089   | 10.944        | 10.578| 0.878   |
| Fruit juice                                  | 44.750   | 4.688| 3.938   | 9.925         | 8.900 | 0.538   |
| Salad                                        | 20.667   | 0.467| 0.100   | 1.733         | 1.283 | 1.717   |
| Vegetables                                   | 45.100   | 0.630| 0.100   | 4.630         | 3.310 | 1.630   |
| Chips/fried potatoes                         | 199.500  | 5.975| 0.725   | 32.400        | 0.500 | 2.925   |
| White rice or potatoes                       | 109.714  | 1.157| 0.457   | 21.886        | 3.443 | 2.429   |
| Beans or pulses                              | 89.000   | 0.720| 0.140   | 12.400        | 2.200 | 5.920   |
| Tea or coffee sweetened                      | 19.333   | 0.433| 0.367   | 3.167         | 3.633 | 0.567   |
| Fibre-rich breakfast cereal                  | 369.750  | 5.100| 1.425   | 66.000        | 11.975| 10.650  |
| Wholemeal bread or chapattis                 | 221.000  | 1.800| 0.400   | 37.800        | 4.100 | 10.000  |
| Brown rice/bulgur wheat/quinoa               | 112.000  | 1.800| 0.500   | 19.033        | 0.400 | 3.700   |
| Cheese/yoghurt                               | 245.500  | 19.350| 12.575  | 3.200         | 3.150 | 14.925  |
| Crisps/savoury snacks                        | 555.000  | 38.520| 5.080   | 36.720        | 3.500 | 13.160  |
| Sweet biscuits, cakes, chocolate, sweets     | 445.700  | 18.310| 9.510   | 63.990        | 41.010| 5.440   |
| Ice cream/cream                              | 284.333  | 19.467| 14.233  | 24.100        | 17.767| 2.667   |
| Non alcoholic sugary fizzy drinks            | 35.250   | 0.000| 0.000   | 8.600         | 8.600 | 0.000   |
| Beef, lamb, pork, ham                        | 218.700  | 12.260| 5.230   | 0.970         | 0.590 | 26.200  |
| Chicken or turkey                            | 161.500  | 4.117| 1.083   | 0.500         | 0.500 | 30.583  |
| Sausages, bacon, meat pies, burgers          | 244.375  | 14.663| 5.638   | 9.075         | 1.350 | 18.550  |
| Chicken/turkey nuggets, burgers, pies        | 262.400  | 15.480| 3.980   | 17.040        | 1.260 | 13.140  |
| White fish in batter or breadcrumbs          | 191.500  | 8.475| 1.625   | 15.175        | 1.025 | 13.100  |
| White fish not in batter or breadcrumbs      | 129.000  | 4.200| 1.025   | 0.500         | 0.500 | 22.625  |
| Oily fish (not tinned)                       | 217.500  | 14.550| 3.075   | 0.675         | 0.500 | 21.150  |
# Appendix IV: List of Control Variables

| Variable Name | Description of Variable |
|---------------|--------------------------|
| Male          | Dummy denoting whether subject is male or not |
| Age           | Variable denoting the subject’s stated age |
| Employed      | Dummy denoting whether subject is currently gainfully-occupied |
| Unemployed    | Dummy denoting whether subject is currently unemployed and seeking work |
| Student       | Dummy denoting whether subject is currently a full-time student |
| Postgrad      | Dummy denoting whether subject’s highest level of education is a postgraduate degree |
| Undergrad     | Dummy denoting whether subject’s highest level of education is an undergraduate degree |
| A-level       | Dummy denoting whether subject’s highest level of education is an A-level certificate (or equivalent) |
| Income > £25000 | Dummy denoting whether subject’s annual household income is above £25,000 |
| Income £20000-£25000 | Dummy denoting whether subject’s annual household income is between £20,000 and £25,000 |
| Income £15000-£20000 | Dummy denoting whether subject’s annual household income is between £15,000 and £20,000 |
| Income £10000-£15000 | Dummy denoting whether subject’s annual household income is between £10,000 and £15,000 |
| Income £5000-£10000 | Dummy denoting whether subject’s annual household income is between £5,000 and £10,000 |
| White         | Dummy denoting whether subject’s race is Caucasian |
| Married       | Dummy denoting whether subject is currently married |
| Blood Sugar   | Dummy denoting whether subject has never been told that s/he has high blood pressure |
| Time 9.30am   | Dummy denoting whether subject attended a 9:30am experimental session |
| Time 11.30am  | Dummy denoting whether subject attended an 11:30am experimental session |
| Time 2.30pm   | Dummy denoting whether subject attended a 2:30pm experimental session |
| Mon           | Dummy denoting whether subject’s experimental session was on Monday |
| Tues          | Dummy denoting whether subject’s experimental session was on Tuesday |
| Wed           | Dummy denoting whether subject’s experimental session was on Wednesday |
| Variable Name | Description of Variable |
|---------------|-------------------------|
| Thurs         | Dummy denoting whether subject’s experimental session was on Thursday |