How much is '5-a-day'? A qualitative investigation into consumer understanding of fruit and vegetable intake guidelines

Rooney, C., McKinley, M. C., Appleton, K. M., Young, I. S., McGrath, A. J., Draffin, C. R., Hamill, L. L., & Woodside, J. V. (2016). How much is '5-a-day'? A qualitative investigation into consumer understanding of fruit and vegetable intake guidelines. *Journal of human nutrition and dietetics : the official journal of the British Dietetic Association*. Advance online publication. https://doi.org/10.1111/jhn.12393

Published in:
Journal of human nutrition and dietetics : the official journal of the British Dietetic Association

Document Version:
Peer reviewed version

How much is '5-a-day'?: A qualitative investigation into consumer understanding of fruit and vegetable intake guidelines

Ciara Rooney[1], Michelle C McKinley[1], Katherine M Appleton[2], Ian S Young[1], Alanna J McGrath[1], Claire R Draffin[1], Lesley L Hamill[1] and Jayne V Woodside[1]

[1]Centre for Public Health, Institute of Clinical Sciences B, Grosvenor Road, Belfast BT12 6BJ, UK

[2]Department of Psychology, DEC, Bournemouth University, Poole House, Fern Barrow, Poole, Dorset BH12 5BB, UK

Corresponding author: Jayne Woodside, Centre for Public Health, Institute of Clinical Sciences B, Grosvenor Road, Belfast, BT12 6BJ UK, Tel: +44 (0)2890978942, Fax: +44 (0)2890235900, Email: j.woodside@qub.ac.uk

Authorship

CR contributed towards the design of the PS questionnaire, conducted qualitative data collection, carried out all analyses and drafted the manuscript. JVW designed the study and was Principal Investigator on the grant. ISY, MCMcK and KMA were co-investigators on the grant application, and MCMcK assisted with the analysis and interpretation of the qualitative data. KMA developed the first draft of the PS questionnaire and provided advice on its analysis. CRD, LLH and AJMcG were responsible for participant recruitment and completion of the study protocol. CRD and AJMcG also assisted with the FG discussions. All authors critically reviewed and approved the manuscript.

ACKNOWLEDGEMENTS

The authors declare that they have no conflicts of interest. Funding for the BIOFAV study was provided by the Medical Research Council (G0901793) to investigate the development of novel biomarkers of fruit and vegetable consumption. We also gratefully acknowledge the Centre of Excellence for Public Health Northern Ireland for providing the funding to write this manuscript. We are very grateful for the volunteers who took part in this research. Thanks also to the technical assistance of Drs Shrobona Bhattacharya and Sarah Gilchrist.

ABSTRACT

Background: Despite the known health benefits of fruit and vegetables (FV), population intakes remain low. One potential contributing factor may be a lack of understanding surrounding recommended intakes. This study aimed to explore understanding of FV intake guidelines among a sample of low FV consumers.

Methods: Six semi-structured focus groups were held with low FV consumers (n=28, age range 19-55 years). Focus groups were digitally recorded, transcribed verbatim, and analysed thematically using NVivo to manage the coded data. Participants also completed a short questionnaire assessing knowledge on FV intake guidelines. Descriptive statistics were used to analyse responses.

Results: Discussions highlighted that although participants were aware of FV intake guidelines, they lacked clarity with regards to the meaning of the '5-a-day' message, including what foods are included in the guideline, as well as what constitutes a portion of FV. There was also a sense of confusion surrounding the concept of achieving variety with regards to FV intake. The sample highlighted a lack of previous education on FV portion sizes, and put forward suggestions for improving knowledge, including increased information on food packaging, in supermarkets and through health campaigns. Questionnaire findings were generally congruent with the qualitative findings, showing high awareness of the '5-a-day' message, but a lack of knowledge surrounding FV portion sizes.

Conclusions: Future public health campaigns should consider how best to address the gaps in knowledge identified in this study, and incorporate evaluations that will allow the impact of future initiatives on knowledge, and ultimately behaviour, to be investigated.

INTRODUCTION

The World Health Organisation (WHO) set a minimum daily target of 400 g FV which has since been translated into the '5-a-day' public health message within the UK [1,2]. Despite these guidelines, current population intakes remain suboptimal [3].

Knowledge is potentially an important predictor of FV intake [4-7]. Few studies have investigated consumer understanding of the meaning of the '5-a-day' message, including which foods are included in the guidelines and what counts as a portion of FV. Greater awareness of the amounts and types of FV needed to achieve the recommended guidelines might promote better adherence and increased intake. For example, improved comprehension of what constitutes a portion of FV, may enhance consumers' capability and motivation to achieve the recommendations [8]. It might also help individuals to accurately assess their current FV intake and consequently plan dietary changes. Discordant findings between people's perception of their FV intake and their actual intake have been observed. For instance, one study [9] found that amongst 426 elderly participants, 83% were aware of FV intake guidelines, and 35% felt they were eating enough FV. However, a closer examination (using a dietary recall of typical FV intake) of the latter group showed that some individuals were consuming as little as two portions of FV per day. One explanation for this discrepancy might be that the individuals felt they were eating enough FV for their health personally, and so did not need to meet the intake guidelines [10]. However, another possibility is that participants did not understand how to quantify a portion of FV.

The few studies which have been conducted to date on consumer understanding of FV intake guidelines have primarily investigated knowledge amongst American [7, 11-14], Australian [8, 15-17], and New Zealand consumers [18]. Only two studies [19,20] have investigated knowledge within the UK, and these studies used samples of University students and socially-deprived individuals. Given that FV-based public health campaigns, intake recommendations and portion size (PS) guidance vary greatly between countries (see Supporting Information Table S1), the majority of evidence to date cannot necessarily be generalised to a UK context. Hence, the objective of the current paper was to explore awareness and understanding of FV intake guidelines, with a particular emphasis on sources of FV and FV portion sizes (PSs), within a sample of low FV consumers.

MATERIALS AND METHODS

Study Sample and Recruitment

The current sample comprised participants taking part in a pilot randomised controlled feeding study, entitled the Biomarkers of Fruit and Vegetable (BIOFAV) study. Full details of the pilot trial have been published elsewhere [21]. In brief, it was designed to investigate novel biomarkers of FV consumption amongst 32 healthy, low FV (≤ 2 portions) consumers. Participants were recruited through an intranet advertisement published within [University name removed for blinding purposes], and through word-of-mouth. The study was approved by the [removed for blinding purposes] research ethics committee of [removed for blinding purposes], and participants provided written informed consent.

Focus Group Discussions

Six focus groups (FGs) were conducted between August 2011 and May 2012, during the first week of the four week BIOFAV study. The FGs ranged in size between four and six participants. They lasted 45 to 60 minutes and were digitally recorded.

The FGs were moderated by CR, with assistance from another researcher (CRD/AJMcG). Moderators received formal training in conducting FGs. To ensure consistency, a semi-structured topic guide was developed based on a prior literature search. The guide was piloted on a group of four research students (aged between 20-30 years); sample questions are illustrated in Supporting Information Table S2. The co-moderator ensured all topic areas were covered within each session and volunteers were encouraged to fully express their views, provided the conversation was relevant to the aims of the research. At the end of each session, participants were asked if they had any other issues they would like to raise.

Questionnaire

Prior to the FGs, demographic information was collected on the sample. A questionnaire about the ‘5-a-day’ FV guideline was also administered. The purpose of the questionnaire was to provide some context on the sample, and to aid with the interpretation of participant responses during the qualitative discussions.

The questionnaire covered four areas; awareness of the ‘5-a-day’ message, knowledge on foods that are classified as a fruit or vegetable according to the ‘5-a-day’ message, PSs of commonly consumed FV and knowledge on portions provided by combinations of FV (to reflect normal dietary consumption patterns). Participants were firstly asked ‘Are you aware

of the ‘5-a-day’ message about FV consumption?’, to which they could answer ‘yes’, ‘no’ or ‘not sure’. Secondly, participants were given a categorisation task which required them to identify foods which counted as a fruit or vegetable according to the ‘5-a-day’ message from a list of 39 commonly consumed foods. A third question showed a list of 27 FV with specific quantities (e.g. four spears of broccoli) and asked participants to record how many portions of fruit or vegetables each would contribute towards the ‘5-a-day’ message (e.g. ½ portion). Finally, the questionnaire presented seven combinations of FV (e.g. one medium apple, one medium pear and two medium glasses of fruit juice) and asked participants to specify how many portions each set would equate to if eaten within the course of one day.

Statistical Analysis

FGs were transcribed verbatim by CR. Another study team member listened to the audio recordings and checked this against the transcripts. Data were analysed using Braun and Clarkes’ inductive thematic analysis framework [22]. This involved six steps i) familiarisation with data, ii) initial descriptive coding of data, iii) search for themes, iv) review of themes, v) naming and defining of themes and vi) writing up of results. CR carried out this process, and the transcripts were then read by MCMcK and the codes were checked and compared. Few between-researcher discrepancies were found and consensus was reached through discussion. QSR NVivo 8 was used to facilitate data coding and management.

Questionnaire responses were analysed using PASW (SPSS Inc, Chicago, IL). Descriptive statistics were used to describe the demographic profile of participants. Categorical data are presented as frequencies and percentages, while continuous data are shown as the median and interquartile range (IQR) (due to the small sample size). For questionnaire analysis, correct responses were given a score of one, whilst incorrect and ‘don’t know’ responses were given a score of zero, making a maximum possible score of 74. Percentage of correct responses was calculated for each participant for the questionnaire as a whole and for each of the four questionnaire domains. Descriptive statistics were used to report the frequency of correct and incorrect responses, and percentage knowledge scores for the sample are presented as the median and interquartile range (IQR). The small sample size did not permit statistical testing of responses by demographic variables.

RESULTS

Twenty-eight participants took part in the FGs (sample characteristics are shown in Table 1). The main themes which emerged from the analysis of the transcripts were: (i) knowledge; (ii)

education; and (iii) suggestions for improving FV PS knowledge (see Supporting Information Table S3 for a full list of themes, subthemes and quotations).

Knowledge

Whilst the majority of participants claimed to be aware of the '5-a-day' campaign, a lack of knowledge was evident regarding the specifics of the message (Quote 1, Table 2). For example, most participants were confused as to which foods counted as a fruit or vegetable according to the '5-a-day' message. Additionally, when prompted by the moderator, some expressed their surprise at foods such as tomato-based sauces, which they would not have previously classified as a fruit or vegetable (Quote 2, Table 2). Some participants also said they were unaware that potatoes were not classified as a vegetable according to the guidelines. Most ambiguity existed with regards to composite foods (e.g. spaghetti bolognaise and stew), with many participants stating they did not normally count these foods towards their FV intake (Quote 3, Table 2). One participant also indicated that they were uncertain about what conditions a food needed to satisfy to be classified as a fruit or vegetable (Quote 4, Table 2).

Most participants also expressed a lack of awareness surrounding PSs for FV, and this was the prevailing topic of conversation during the FG discussions about the '5-a-day' message. Respondents mentioned varieties they deemed particularly difficult, including lettuce, and the heterogeneity in PSs for different FV was highlighted as a factor which made it more difficult to identify a portion of FV (Quote 5, Table 2). When additional FV guideline rules were discussed, for example that fruit juices can only count as a maximum of one portion per day, some participants questioned the reasoning behind this rule (Quote 6, Table 2). Generally, it was suggested by participants that PSs for fruit were easier to establish than vegetables, with some mentioning fruit as *"more discrete"* (FG1, M, 19yrs) and the fact that you could *"use the whole thing"* (FG2, M, 20yrs). Most participants claimed that composite food dishes including FV (e.g. sandwiches, stew and soup) were particularly difficult to quantify in terms of the number of portions that were provided in one serving (Quote 7, Table 2).

Variety was a key concept discussed in multiple FGs. Firstly, some participants claimed that they had misinterpreted the '5-a-day' message as meaning five portions of fruit, plus five portions of vegetables a day (Quote 8, Table 2). Many participants also alluded to the fact that they were not previously aware that FV intake should ideally be comprised of a variety

of FV, and some thought eating five of the same type of fruit or vegetable would be sufficient to meet recommendations (Quote 9, Table 2).

Finally, in relation to their lack of knowledge of FV PS, some participants expressed that they had difficulty estimating their current intake of FV (Quote 10, Table 2; Quote 11, Table 2).

Education

Overall, findings from the FGs suggested that participants had received little or no information on what constituted a portion of FV according to intake guidelines. However, some sources of education mentioned included front-of-pack labelling, school and magazine articles (Quote 12 & 13, Table 2). There were mixed opinions with regards to the preferred unit of measurement for FV PSs. Some believed grams were superior as this is a universal measurement, and is used on packaging (Quote 14, Table 2). Others expressed concern that they were not familiar with grams as a form of measurement, it would be a hassle to weigh FV before eating, and there was no need to be so precise (Quote 15, Table 2). Tablespoons and handfuls were both generally perceived as more useful measures for FV PS (Quote 16, Table 2). However, some participants believed that handfuls could be confusing as the size of an individual's hands differ (Quote 17, Table 2). In two FGs, participants stated that they preferred to guess FV PSs based on the size of well-known FV such as an apple (Quote 18, Table 2).

On the whole, participants agreed that having more information on what constitutes a portion of FV would impact positively on their current FV consumption (Quote 19 & 20, Table 2). With increased information some said they would feel 'more informed' and 'more aware', and that the guidelines would seem 'more achievable'. However, others said they did not think about FV PS, instead preferring to eat depending on their appetite. Some participants also suggested that increased FV PS information would not overcome other barriers towards FV consumption, including routine and preparation (Quote 21 & 22, Table 2).

Suggestions for Improving Portion Size Knowledge

Suggestions for improved future communication of FV PS included increased information on packaging and displays in the FV produce section of supermarkets. Some participants said they would like personal assistance whilst shopping for FV (i.e. somebody to inform you of

how much you need to make up a portion of FV) (Quote 23, Table 2), although this idea was refuted by younger participants (Quote 24, Table 2).

Other proposals included increased FV PS information in eateries which could be used when ordering food, governmental campaigns and more promotional material, including leaflets or posters (Quote 25 & 26, Table 2). Assistance with meal planning and FV PS information in recipe books were also suggested as possible motivators for increasing FV intake (Quote 27 & 28, Table 2).

Questionnaire Results

A summary of the scores from each domain of the FV guidelines questionnaire are illustrated in Supporting Information Table S4. All participants were aware of the '5-a-day' FV guidelines and the majority were able to correctly identify foods which counted as a fruit or vegetable (median knowledge score 91%). Only 39.3% and 42.9% of participants correctly stated that jacket potatoes and potatoes respectively were not included in the FV count (Supporting Information Table S5).

The median knowledge score for identifying the portions provided by different amounts of individual types of FV was 37% (Supporting Information Table S6). For most foods (59%), less than half of the sample correctly answered the portions provided by the stated quantities of FV. More than 50% of participants correctly identified the portions provided by ten foods only. These were mostly in the form of one 'piece' of fruit or vegetable (e.g. one apple, one banana).

Apart from one combination of FV (1 apple, 1 banana, 1 glass of fruit juice), the majority of participants ($\geq$ 50%) incorrectly assessed the number of portions provided by different selections of FV (Supporting Information Table S7). The median knowledge score for this task was 21.4%.

DISCUSSION

Despite awareness of the UK government's '5-a-day' recommendation for FV, this study demonstrated a lack of knowledge with regards to the specifics of the message. Some mis-understandings of '5-a-day' exist, notably the belief that it recommends five fruit *and* five

vegetables per day, and not appreciating the importance of variety. There were also knowledge gaps regarding what is included in the FV recommendation, and a lack of knowledge about what constitutes a portion of FV, or how to actually achieve the recommended intake target.

Identification of FV within the Context of the '5-a-day' Guidelines

The FG discussions highlighted a lack of clarity with regards to which foods count as a fruit or vegetable according to the '5-a-day' message. Specifically, individuals illustrated a deficit of knowledge on whether certain composite foods counted towards FV guidelines. This is in line with findings from another study [(14)] which suggested that FV consumed in composite dishes were the most difficult to classify for American consumers. The exclusion of composite foods whilst assessing FV intake can have important implications in terms of the conclusions that are reached regarding current consumption. For example, a study [(23)] showed that excluding composite foods from FV estimates can misclassify participants as low/non-consumers of FV. Indeed, a possible explanation for the increase in FV consumption observed in UK adults in the National Diet and Nutrition Survey between 2002 [(24)] and 2012 [(4)] (2.8 portions FV/day versus 4.1 portions FV/day respectively) is that the most recent survey used disaggregated data for a wider range of composite dishes. Composite foods account for as much as 20-30% of vegetable intake and 10% of fruit intake, thus illustrating the need for consumers to be better informed of the value of FV-rich meals in relation to achieving FV guidelines [(25)]. Additionally, the public should be made aware of how to easily incorporate portions into commonly consumed meals. Such information could have a positive impact in terms of making the '5-a-day' target seem more achievable; a point which was strongly advocated in the FGs within this study.

Although the sample scored well in the questionnaire when asked to identify foods which are classified as a fruit or vegetable, as voiced in the FGs, there was some uncertainty in relation to potatoes, chickpeas and lentils. The international variation in the classification of potatoes, with some countries, such as the USA, including potatoes as a vegetable, and others, such as the UK, excluding potatoes from their FV guidelines (as per recommendations set by the WHO/FAO) may be confusing for individuals as indicated by the data gathered here. Regardless of the reason, this is an important finding as it highlights that some consumers may count potatoes towards their daily intake of FV, and thus they may be over-estimating

their consumption. Future education resources should endeavour to clarify this for the general public.

Understanding of FV Portion Sizes within the Context of the '5-a-day' Guidelines

Another key finding from the focus groups was that the majority of participants had trouble conceptualising a portion of different types of FV, which is a key skill required in understanding the '5-a-day' message. This finding is consistent with previous studies conducted in the area [8,12,14,15,18-20]. Participants generally found it more challenging to decipher the portions provided by FV which were not in the form of one whole food/piece, with some stating that this was the main reason why vegetables were often more difficult to determine in terms of portions in comparison to fruit. The questionnaire responses reinforced this finding, and also revealed that, when faced with a list of FV, most respondents were unable to tell how many portions the combination would provide. When translated into a normal day-to-day dietary context, this suggests that these consumers are unlikely to be able to accurately assess their own daily intake of FV, and this was acknowledged within the FGs. Hence, it is possible that this sample are making dietary choices regarding FV consumption based on ill-informed perceptions about their current intake. Another key finding was that some participants believed that the '5-a-day' guideline required consumption of five portions of fruit *in addition to* five portions of vegetables per day. This notion has been observed elsewhere [26], and could, potentially, be demotivating and thus might suggest a need for the refinement of '5-a-day' in order to facilitate better consumer understanding. There may be some merit, for example, in providing separate intake recommendations for FV, as is the case in Australia (Go for 2&5 campaign).

From a nutrition research perspective, the lack of PS knowledge presented within this study emphasises the complexities of measuring FV intake using self-report measures. Some measures of dietary intake, including FFQs, require respondents to report their frequency of consumption of FV based on an 'average portion'. As highlighted here, people are not necessarily aware of what a standard portion of FV equates to, and hence the validity of such data might be compromised. In terms of implications for the assessment of FV intake in the future, researchers should provide assistance to respondents when quantifying FV intake (e.g. through the use of a food PS atlas).

One of the key messages advocated by the '5-a-day' campaign is the importance of consuming a variety of FV, however, this work indicates that this message is not well understood. For example, during the FGs, a number of individuals indicated that they thought eating five of the same FV would suffice in terms of achieving the '5-a-day' guidelines. Similarly, Carter *et al.* [16] also found that a sample of Australian participants were unclear as to whether FV intake guidelines stipulated that five different FV needed to be consumed each day. These are again important findings in terms of the probability that people are misjudging the adequacy of their FV intake. Participants in the current study also conveyed the notion that eating five of the same FV was unappealing and an unrealistic target in relation to their satiety. Hence, education on consuming a variety of FV, particularly within meals, could make the guidelines more achievable.

In terms of why consumers lack understanding on FV intake guidelines including PSs, there are a number of proposed explanations. The first, and perhaps most obvious reason, could simply be a result of a lack of education. Within the current study, for example, the majority of participants claimed to have been exposed to limited information about FV PSs, except occasionally from packaged FV sources. A second potential reason, which was raised by participants, is the confusion generated by the substantial variation in the amounts of FV needed to achieve one portion.

In terms of the future, and how knowledge on achieving a portion of FV could be increased, the results from the FGs suggested a collaborative effort is required from the food industry (e.g. packaging), retailers (e.g. supermarket displays and eateries) and health promotion bodies (e.g. campaigns and promotional material) to address key misconceptions or deficits in knowledge. With regards to PS information on packaged FV, it is worth noting that, at present, no regulations exist within the UK in relation to making claims on the portions provided by FV products. Manufacturers are not obliged to display such details, and thus there is great inconsistency with regards to the level of information currently provided. Furthermore, there is variability in the methods used to communicate PS information to consumers (e.g. various logos have been employed).

What was ambiguous from the current study was how PS information would best be communicated in terms of grams/household measures. Future studies should seek to clarify this issue. Furthermore, public health campaigns should investigate not only whether increasing PS information can reduce confusion and increase understanding (knowledge), but

also whether it has the potential to facilitate long-term increases in FV consumption (behaviour), and overcome other barriers towards FV intake such as those mentioned in this study (appetite, routine, preparation).

Strengths and Limitations

This study provides some of the first evidence about consumer understanding of FV guidelines within the UK, including the novel topic area of FV PSs. However, the findings should be interpreted in light of some limitations. Firstly, the sample is comprised of a small number of mostly of well-educated young adults, with normal BMIs, thus the findings may not be generalisable to other groups in the population. However, this sample of low FV consumers represented an ideal opportunity to investigate understanding of intake guidelines. Secondly, whilst the FGs were held as close as possible to the start of the four week intervention, participants may have sought information on FV from the research team during prior feeding sessions which could have influenced their attitudes. Similarly, although the quantitative questionnaire was distributed at the beginning of the study, it is possible that participants may have acquired some information on FV at the screening visits. However, this was unavoidable as the questionnaire could not have been distributed before individuals were deemed eligible, and consented onto the study. Furthermore, the question assessing knowledge of the '5-a-day' message may have facilitated guessing which could have potentially inflated the accuracy score. Finally, the questionnaire was not validated nor formally piloted prior to use. Whilst one existing validated questionnaire contains questions on FV PS knowledge [20], it assessed knowledge on a limited number of foods and did not examine understanding of sources of FV, which was a key aspect of the current paper. In comparison to most previous studies assessing knowledge of FV intake guidelines, including FV sources and FV PS, the questionnaire used in the current study measured knowledge based on a greater number of items, making it one of the most comprehensive measures to date.

In conclusion, this study showed some mis-understanding surrounding the UK '5-a-day' message, including what foods are included within the guideline. It also emphasised a lack of knowledge with regards to FV PS. Future public health campaigns should attempt to address these mis-conceptions and gaps in knowledge, and incorporate evaluations that will allow the impact of future initiatives on knowledge, and ultimately behaviour, to be investigated.

ACKNOWLEDGEMENTS

The authors declare that they have no conflicts of interest. Funding for the BIOFAV study was provided by the [removed for blinding purposes] to investigate the development of novel biomarkers of fruit and vegetable consumption. We also gratefully acknowledge the [removed for blinding purposes] for providing the funding to write this manuscript. We are very grateful for the volunteers who took part in this research. Thanks also to the technical assistance of Drs [removed for blinding purposes] and [removed for blinding purposes].

TRANSPARENCY DECLARATION

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

REFERENCES

1. Food and Agriculture Organisation and World Health Organisation (2004) *Fruit and Vegetables for Health*. Available at: http://www.who.int/dietphysicalactivity/publications/fruit_vegetables_report.pdf (accessed September 2015).

2. National Health Service (2013) *5 A DAY - Live Well - NHS Choices.* Available at: http://www.nhs.uk/Livewell/5ADAY/Pages/5ADAYhome.aspx (accessed September 2015).

3. Bates B, Lennox A, Prentice A *et al.* (2014) *National Diet and Nutrition Survey: Results from Years 1-4 (combined) of the Rolling Programme (2008/2009-2011/12). Executive summary.* Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/310997/NDNS_Y1_to_4_UK_report_Executive_summary.pdf (accessed September 2015).

4. Shaikh AR, Yaroch AL, Nebeling L *et al.* (2008) Psychosocial predictors of fruit and vegetable consumption in adults a review of the literature. *Am J Prev Med* **34**, 535–543.

5. Spronk I, Kullen C, Burdon C *et al.* (2014) Relationship between nutrition knowledge and dietary intake. *Br J Nutr* **111**, 1713-1726.

6. Erinosho TO, Moser RP, Oh AY *et al.* (2012) Awareness of the Fruits and Veggies-More Matters campaign, knowledge of the fruit and vegetable recommendation, and fruit and vegetable intake of adults in the 2007 Food Attitudes and Behaviors (FAB) Survey. *Appetite* **59**, 155–160.

7. Wolf RL, Lepore SJ, Vandergrift JL *et al.* (2008) Knowledge, barriers, and stage of change as correlates of fruit and vegetable consumption among urban and mostly immigrant black men. *J Am Diet Assoc* **108**, 1315–1322.

8. Pollard CM, Daly AM & Binns CW (2009) Consumer perceptions of fruit and vegetables serving sizes. *Public Health Nutr* **12**, 637–643.

9. Appleton KM, McGill R, Neville C *et al.* (2010) Barriers to increasing fruit and vegetable intakes in the older population of Northern Ireland: low levels of liking and low awareness of current recommendations. *Public Health Nutr* **13**, 514–521.

10. Miles S & Scaife V (2003) Optimistic bias and food. *Nutr Res Rev* **16**, 3-19.

11. Young LR & Nestle M (1998) Variation in perceptions of a “medium” food portion: implications for dietary guidance. *J Am Diet Assoc* **98**, 458–459.

12. Britten P, Haven J & Davis C (2006) Consumer research for development of educational messages for the MyPyramid Food Guidance System. *J Nutr Educ Behav* **38**, S108–S123.

13. Shah M, Adams-Huet B, Elston E *et al.* (2010) Food serving size knowledge in African American women and the relationship with body mass index. *J Nutr Educ Behav* **42**, 99–105.

14. Thompson FE, Willis GB, Thompson OM *et al.* (2011) The meaning of 'fruits' and 'vegetables'. *Public Health Nutr* **14**, 1222–1228.

15. Glasson C, Chapman K & James E (2011) Fruit and vegetables should be targeted separately in health promotion programmes: differences in consumption levels, barriers, knowledge and stages of readiness for change. *Public Health Nutr* **14**, 694–701.

16. Carter OBJ, Pollard CM, Atkins JFP *et al.* (2011) 'We're not told why--we're just told': qualitative reflections about the Western Australian Go for 2&5® fruit and vegetable campaign. *Public Health Nutr* **14**, 982–988.

17. Kothe EJ & Mullan BA (2011) Perceptions of fruit and vegetable dietary guidelines among Australian young adults. *Nutr Diet* **68**, 262–266.

18. Ashfield-Watt PA (2006) Fruit and vegetables, 5+ a day: are we getting the message across? *Asia Pac J Clin Nutr* **15**, 245-252.

19. Herbert G, Butler L, Kennedy O *et al.* (2010) Young UK adults and the 5 A DAY campaign: perceived benefits and barriers of eating more fruits and vegetables. *Int J Consum Stud* **34**, 657–664.

20. Buyuktuncer Z, Kearney M, Ryan CL *et al.* (2014) Fruit and vegetables on prescription: a brief intervention in primary care. *J Hum Nutr Diet* **27**, 186–193.

21. McGrath AJ, Hamill LL, Cardwell CR *et al.* (2015) Combining vitamin C and carotenoid biomarkers better predicts fruit and vegetable intake than individual biomarkers in dietary intervention studies. *Eur J Nutr*, Epub Jun 17.

22. Braun V & Clarke V (2006) Using thematic analysis in psychology. *Qual Res Psychol* **3**, 77-101.

23. O'Brien MM, Kiely M, Galvin M *et al.* (2006) The importance of composite foods for estimates of vegetable and fruit intakes. *Public Health Nutr* **6**, 711–726.

24. Henderson L, Irving K, Gregory J *et al.* (2014) *The National Diet & Nutrition Survey: adults aged 19 to 64 years. Volume 1: Types and quantities of food consumed.* Available at: http://tna.europarchive.org/20110116113217/http:/www.food.gov.uk/multimedia/pdfs/ndnsfour.pdf (accessed September 2015).

25. Agudo A & Joint F (2005) *Measuring intake of fruit and vegetables*. Available at: http://www.who.int/dietphysicalactivity/publications/f&v_intake_measurement.pdf (accessed September 2015).

26. Booth AO, Lowis C, Dean M *et al.* (2013) Diet and physical activity in the self-management of type 2 diabetes: barriers and facilitators identified by patients and health professionals. *Prim Health Care Res Dev* **14**, 293–306.