Final Report

Household food and drink waste: A people focus

This report explores the relationship between the level of avoidable food and drink waste from households in the UK and factors including socio-demographics, behaviours and others relating to food, such as healthy eating and time available for food-related activities. These insights will support WRAP and its partners to develop more effective ways to help people waste less food.

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We work with businesses, individuals and communities to help them reap the benefits of reducing waste, developing sustainable products and using resources in an efficient way.

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Front cover photography: Love Food Hate Waste

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Executive summary

In November 2013, WRAP published *Household Food and Drink Waste in the UK 2012*[1], which quantified the amounts, types and reasons for food and drink[2] being wasted from UK households. As part of that research, two datasets were collected that included details of what was wasted from individual households in addition to information from questionnaires relating to characteristics of those households. One dataset originated from diary-based research and the second from compositional analysis of household waste (conducted with informed consent).

Although a large amount of information was published in that previous report, there were additional analyses possible with these datasets to obtain information useful to those working to reduce household food waste[3]. In particular, the two studies provided a unique opportunity to compare levels of waste generated by households with different characteristics, including food-related behaviours they engage in such as shopping, storage and cooking. Additionally, in light of evidence from a number of small-scale, qualitative studies undertaken by WRAP and other researchers, which highlighted the importance of broader, contextual factors for household food waste generation (such as concerns over healthy eating, taking care of the family or availability of time), the analysis presented in this report aims to examine whether some of these more indirect relationships to food waste can be identified in a large, representative sample. Furthermore, the relationship between socio-demographics and food waste levels is examined.

This report presents statistical modelling using the two datasets to understand what factors are associated with different levels of avoidable food waste[4] from different households. Analysis of other data sources are used at times to provide additional insights.

Summary of results

Variation in avoidable food waste with household socio-demographics

Socio-demographic factors are unlikely to be a direct cause of food waste generation, but may be correlated with factors that do have a direct impact on waste levels (such as behaviours). Therefore, identifying differences between socio-demographic groups helps to understand the complexities of household food waste generation, related to how people act and which factors influence their behaviour. Exploring the differences between socio-demographic groups can also identify how to support different people to reduce their food waste. Household size, age of respondent and employment status of the main household earner were found to be correlated, to a greater or lesser extent, with levels of avoidable food waste.

Household size: The average amount of food waste increased with the number of occupants in a household. This in itself is not unexpected, as larger households will buy and prepare more food. However, the average amount of waste *per person* was highest for

[1] *A summary of all WRAP's research in this area can be accessed here: www.wrap.org.uk/waste-resource-listing*

[2] *Hereafter 'food waste' is used as shorthand for 'food and drink waste'.*

[3] *Alongside this report, a separate report – Household food and drink waste: a product focus – has been published that includes further descriptions of the types and state of food and drink thrown away, in addition to information on when and why this waste is discarded.*

[4] *Avoidable food waste comprises food thrown away that was, at some point prior to disposal, edible, e.g. milk, lettuce, fruit juice, meat (excluding bones, skin, etc.). It does not include inedible material such as egg shells, bones, and citrus peel. See glossary for further information.*

single occupancy households. Compared to larger households, a greater proportion of what was wasted by those in single occupancy households was due to food not being used in time. Other data indicates that those living alone buy more food (per person) than average, and throw away a greater proportion of what is bought.

The higher levels of waste (in comparison to larger households) do not appear to be associated with the food-related behaviours[5] that those in smaller households undertake or the types of people living in them. Other research[6] suggests that managing food in smaller households is more difficult than for larger households: for some products it can be difficult to obtain food in appropriate-sized packs, and where it is possible it can be more expensive (per kilogramme or per litre). Furthermore, day-to-day variations in the amount of food consumed, for example due to changes in circumstances or plans, are more likely to impact on waste levels in smaller households.

Age: Analysis reveals that – on average – lower levels of waste were generated in households containing older people compared to younger people, with those aged 18-34 wasting the most. Differences existed in the types of food wasted, although all age groups threw away similarly large amounts of fresh vegetables and salads. In general, younger people wasted more due to cooking, preparing and serving too much than older people, whilst older people had a higher proportion of food thrown away due to it not being used in time. The latter may be linked to the fact that many older people live alone (see the previous section), and are also less likely to use packaging to keep food fresher for longer. Older people tend to portion food more accurately, and are more inclined to use up leftovers.

Other WRAP research[7] has shown that younger people are more likely to report lower proficiency in some of the food management skills, which could help to explain why younger people are less likely to participate in some of the waste-prevention behaviours.

Further analysis suggests that at least some of this trend is explained by the employment status of the main income earner – older people being more likely to live in households where the main earner is retired. There is some evidence to suggest that this relationship could be linked to the availability of time. Older people were less likely to claim that their lives were so busy that they 'ate what they could while on the go', and agreeing with this statement was found to be correlated with higher levels of waste. Contrary to common assumptions, older people were not found to be more concerned over food waste than younger groups – but they may be better equipped in terms of skills and knowledge, and have more time, to act on these concerns.

Employment status: The analysis looked at differences between three broad groups: those in paid employment; those who were retired; and those not working for reasons other than retirement. Those households where the main earner was retired had the lowest average levels of food waste. Employment status was correlated with age (with older people more likely to be retired). However, in models controlling for age, employment status was still statistically significant. This means that some of the variation in waste levels linked to employment cannot be explained by age-related effects.

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[5] In this report, a behaviour is used to mean an activity; food-related behaviours include meal planning, use of the freezer and using up leftovers.

[6] e.g. one person household message testing: a summary brief, WRAP (2014) http://partners.wrap.org.uk/assets/9354/

[7] See page 21 of WRAP (2007) 'Food Behaviour Consumer Research. Quantitative Phase' at http://www.wrap.org.uk/sites/files/wrap/Food%20behaviour%20consumer%20research%20quantitative%20jun%202007.pdf

Additional analysis suggests that those households where the main earner was retired had higher levels of engagement in some of the waste prevention behaviours than other households. Specifically, those households where the main earner was retired were more likely to make a list, cook the right amount, and less likely to throw food away past the date on the packaging. In contrast, households where the main earner was retired were less likely to use the freezer. Furthermore, in those households where the main earner was retired, questionnaire respondents were less likely to cite time constraints as a hindrance to minimising waste.

Presence of children: A number of studies[8] have suggested that children could be influencing the amount of food waste generated in the home. Parents sometimes cite children being 'fussy' and leaving unfinished meals on their plates as a reason for throwing food away. Moreover, qualitative evidence suggests that some families regularly buy more than is needed in order to provide a wide selection of food for the children, even if it means that some of it may be wasted; others intentionally cook more than may be needed, so that second helpings are always available.

The analysis presented in this report suggests that families with children generated at least as much waste as all-adult households containing the same number of people. Taking into account the lower calorific needs of younger children, the fact that children were associated with the similar levels of waste as adults indicates that a higher proportion of food entering the home was wasted from families with children.

This additional analysis seems to support the popular view that waste can sometimes arise because children reject food or because parents cook or prepare more food than is required. There is also evidence to suggest that families with children might be paying greater attention to food safety, being more likely to throw away food because it has gone past the date on the packaging, which could (for products carrying a 'best before' date) lead to edible food being discarded. Families with children were also less likely to use their leftovers than households without children. On the other hand, households with children were more likely to be involved in two food-related behaviours than those without children – meal planning and use of freezer.

Variation in avoidable food and drink waste with food-related behaviours

The correlations found between certain food-related behaviours and avoidable food waste are consistent with the hypothesis that these behaviours help reduce food waste, although other explanations may explain the correlations. The following behaviours were found to be correlated with lower levels of avoidable food waste:

- **Strong evidence:** Using leftovers; throwing away fewer items because they have gone past their date label[9] (those throwing away fewer items generating less waste).
- **Moderate evidence:** Meal planning; list making; use of the fridge to store apples; cooking the right amount of rice and pasta; buying less of other items when purchasing special offers.

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[8] E.g. Cappellini, B., Parsons, E. (2013) 'Practising thrift at dinnertime: mealtime leftovers, sacrifice and family membership', The Sociological Review 60 (S2), pp. 121-134;

Evans, D. (2012) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology, 46 (1), pp. 41-56.

[9] 'Use by' dates refer to safety. Food can be eaten up to the end of this date but not after, even if it looks and smells fine. 'Best before' dates refer to quality. Foods will be safe to eat after the 'best before' date, but may not be at their best. The shelf life of many products (with either type of date) can be extended through the use of the freezer.

No correlation was found between some behaviours, such as checking cupboards and using the freezer, and avoidable food waste levels. This may be due to the fact that, by their nature, questionnaires are not able to capture the full richness in how activities are implemented within the home, and some behaviours may be more or less important to specific groups or circumstances. Therefore, this lack of correlation is not necessarily a reason to stop promoting them as strategies for food waste prevention.

The analysis also points to a complex relationship between behaviours and levels of avoidable food waste. This is likely to be because food can be wasted for a variety of reasons and the actions required to prevent different types of waste differ. In addition, qualitative research suggests that the generation of food waste is usually the result of the interplay between multiple behaviours. All of these points make detecting and quantifying the effects of single behaviours on food waste challenging. For this reason, it is difficult to determine which behaviours are most important for the population; for individual households, the behaviours that will help them reduce food waste will vary greatly depending on the reasons such waste is generated.

Indirect influences on food and drink waste

'Fussy eaters': Overall, the findings of this analysis provide support for the notion that personal preference, or more specifically 'fussy eating' (which was a term used in the questionnaires), contributes to higher levels of avoidable food waste. These results showed a correlation, rather than a causal relationship, between households with 'fussy eaters' and food waste levels; however, given the weight of evidence about this link, including householders themselves citing 'fussy eating' as a reason for food waste, it is likely that a small but substantial minority of avoidable food waste is related to 'fussy eating'. As a rough guide, this includes the 13% of avoidable food waste cited in the kitchen diaries as being connected to 'fussy eating'. 'Fussy eaters', as defined by the person responsible for the majority of the household shopping and cooking, tended to be concentrated in, but not limited to, those under the age of 24. The most 'fussy' group were children between the ages of 3 and 11.

Healthy eating: The link between healthy eating and food waste is complex. Whilst people generally do not want to waste food, sometimes other important considerations can override efforts to prevent waste occurring. In particular, there is some qualitative evidence[10] to suggest that concerns about obesity and healthy eating could be indirectly contributing to food waste in some households. For example, some people may buy large quantities of fruit and vegetables motivated by ideas of healthy eating, but for various reasons end up not eating all of what is bought. This may be exacerbated by the perishability of many fresh products, infrequent shopping trips for some households and the unpredictability of people's lives. Concerns about healthy eating are also linked to caring for children and other family members, with qualitative studies[11] finding that parents (particularly mothers) tend to prioritise children's health and nutrition over food waste concerns. In particular, ensuring that plenty of fresh fruit and vegetables are available is important, even if it means that some of them are not eaten and consequently thrown away.

Those who cited 'a need to buy a range of foods to ensure they can provide healthy food for their family' as a barrier to reducing waste (only around 5% of the sample) generated significantly more avoidable food waste than those that did not cite this reason. Similarly those that stated 'I don't want to compromise on the choice of fresh foods I have in my

[10] e.g. Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction, 20(2), pp. 1-25.

[11] e.g. Graham-Rowe, E., Jessop, D.C., Sparks, P. (2014) 'Identifying motivations and barriers to minimising household food waste', Resources, Conservation and Recycling (84), pp. 15-23.

fridge' as a barrier (around 4% or respondents) also generated more avoidable food waste than those who did not.

There was however some evidence to suggest that a healthy diet (self-reported) was associated with **lower** levels of avoidable food waste on average. This may not necessarily be a direct result of diet, but linked to other factors that may correlate with healthy eating, such as cooking skills, simply eating less food or managing food in the home more closely.

In summary, any link between healthy eating and waste is far from straightforward, and further research is needed to gain a better understanding of the complex relationships between healthy diets and impacts on food waste.

Time: A number of empirical studies[12] have pointed to the difficulties many people face in coordinating busy lives with household food provisioning, cooking and consumption. This analysis has further established a link between avoidable food waste and the amount of time available for food-related activities. The evidence suggests that those who quoted 'I don't have enough time' as a barrier to reducing food waste had higher levels of avoidable food waste (on average) than those who didn't cite this as a hindrance to minimising food waste. Those that agreed with the statement 'My life is so busy that I just eat what I can while I'm on the go' also had higher average levels of waste than those who disagreed with the statement.

Those who strongly agreed that their lives were busy were on average less engaged with many of the behaviours relevant to waste prevention than those who strongly disagreed with this statement. In particular, they were less likely to use leftovers, cook the right amount of food, and more likely to throw food away because it had gone past the date on its packaging.

Home composting: On average, home composters generated less avoidable food waste and were more engaged with various food-related behaviours than the rest of the population. Those who composted were more likely to plan their meals, make lists and use their leftovers, which could imply greater involvement in broader food-related practices. They also produced more unavoidable food waste on average, suggesting they cook more from scratch. This implies that the link between home composters and avoidable food waste is indirect (rather than causal), but *could* be linked to home composters being more likely to grow their own food.

Food waste collections: No significant correlation was found between levels of avoidable food waste and whether households used separate food waste collections (if available). This is consistent with WRAP's most recent research in this area[13].

Participation in the diary research: Analysis suggested that taking part in the diary exercise did not result in a big change of awareness of food waste generated in participants' homes. Around half of the sample already had accurate perceptions of the amount of food and drink they threw away prior to completing the diary. For the vast majority, the perceptions of waste levels stayed the same or altered only slightly. A small proportion of respondents (around 10%) admitted to have experienced a significant change in waste

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[12] *For example, see: Evans, D. (2012a) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology 46 (1), pp. 41-56.*

Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction 20(2), pp. 1-25.

[13] *See: http://www.wrap.org.uk/content/food-waste-messages-maximum-impact-uk*

awareness following diary completion, whilst 36% reported a slight change. This awareness change happened in both 'directions', i.e. some realized that they throw away more, and some that they throw away less, than they originally thought.

Those who originally underestimated their waste (around 18% of the sample) were also the ones who had the highest levels of waste reported in the diary. This is an important finding, as it implies that those throwing away the most food do not have an accurate perception of the amount they throw away. It seems, therefore, that diaries could be a useful method for improving waste awareness for those generating the most waste[14].

Participants who realized that they throw away more than expected were also the most willing to make efforts to reduce their waste. However, willingness to reduce waste – by itself – is not always enough to bring about change. Food waste generation is a complex issue, influenced by a variety of factors. It is relatively easy to declare an intention to reduce waste, but managing a household in a way that reduces waste is likely to be much more challenging.

Discussion

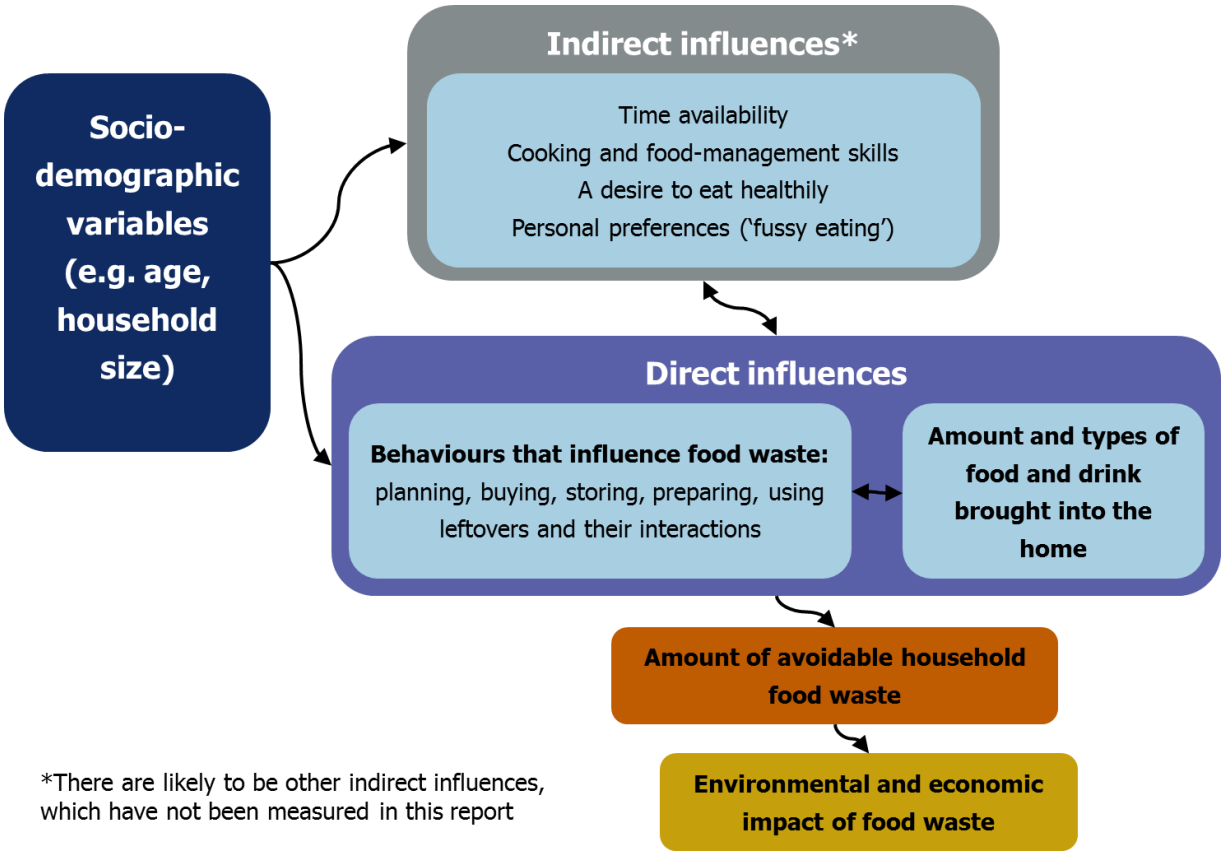
The analysis in this report has identified a number of socio-demographic, direct (behavioural), and indirect (contextual) factors that correlate with the amount of avoidable food waste generated by households.

A preliminary investigation was also conducted to explore the correlations between levels of waste and people's values (which were measured via questionnaires). This did not reveal significant correlations, which suggests that any relationship may be subtle, which is not to say that more detailed analysis would not reveal relationships. Further investigation in this area could generate useful findings.

The relationships between these different factors and avoidable food waste are likely to operate in different ways and one possible visual representation of these relationships is shown in Figure ES1. Logic would suggest that certain factors will have a more direct relationship with waste levels than other factors. In particular, food-related behaviours that influence food waste and the amount and type of food brought into the home are likely to be more direct influences than, for example, socio-demographic factors such as age. The correlations found between levels of food waste and factors such as age are likely to be due to the fact that age also correlates with the other relevant factors, such as availability of time, food-related skills and engagement with waste preventing behaviours.

[14] *LFHW provide a food waste diary for Partners and individuals to use, see: http://partners.wrap.org.uk/assets/3447*

Figure ES1: Visual representation of relationships found in the report



This report highlights that the link between direct food-related behaviours and food waste levels is difficult to identify as their effects are likely to differ between households. For example, for some households, planning meals ahead might be a good strategy to avoid waste; for others with more unpredictable lifestyles, a greater degree of flexibility might help keep food waste levels down. Moreover, a number of qualitative studies suggest that these direct food-related behaviours are not performed in a void, but are embedded in and influenced by numerous daily practices (e.g. having a family dinner, grocery shopping or socialising with friends). Whilst people have a degree of choice in what they do, their everyday practices are also influenced by social meanings, norms, conventions, available resources, infrastructure, socially learned skills as well as available time. This report found large-scale quantitative evidence for the influence of some of these broader, contextual factors on the amount of avoidable food waste.

The analyses suggest that there is a relatively strong degree of correlation between many of the variables describing the provisioning, preparation and consumption of food in the home. As food waste is determined by the interplay between these various factors, this explains why statistical modelling in this area is not straightforward, and the difficulties associated with presenting a 'simple' explanation as to why food is wasted.

Summary and conclusions

For developing interventions to prevent household food waste, understanding the wider context is obviously important, and a key challenge is determining how change can be affected despite the complexity and interaction with other food-related activities.

In light of the importance of contextual factors for household food waste generation, interventions need to be broadened beyond just trying to convince individual people to

change, by addressing or mitigating against some of the contextual factors. Examples already in action include WRAP's work with grocery retailers and food and drink manufacturers on changes to food product design, labelling and packaging[15]. Examples of the latter include clear and consistent date labelling and storage guidance, longer shelf-lives, improved freezing instructions and more appropriate pack sizes. All of these should make it easier for those facing time constraints or limited food knowledge to buy the right amount of food and use what is bought – other examples include tools (such as the Love Food Hate Waste (LFHW) App) that create shopping lists from recipes or that allow a running list of food to be kept that is accessible on-line.

Specific recommendations from the detailed analysis are highlighted below:

Differences in the causes of food waste, and the underlying reasons, mean that **messages, engagement and changes in products, packaging and labelling need to be developed with the specific needs of different groups in mind**. Those involved in developing such solutions also need to be cognisant of the constraints different groups of people might face, such as time availability and / or food-related skills.

More than 80% of household food waste is generated by **households containing more than one person**, and so these households should remain a key area of focus for prevention activity. Relevant recommendations can be found below, depending on whether these households have children at home, their employment status or other factors.

However, almost a fifth of food waste arises from **single-occupancy households**, with significantly more waste per person than larger households, and quite different contributing factors. Tailored messaging, engagement and product development should be considered to help people buy the right amounts of food for their needs, and store food to ensure that more of what is bought can be eaten (including use of the freezer; previous WRAP research found that single occupancy households had the largest unused freezer capacity[16]). It is important to recognise that there are large socio-demographic differences within this 'segment' of the population (e.g. from students and young professionals to those who are retired). WRAP has carried out more in-depth research into the motivations and barriers of different groups of people in single-occupancy households, which it will incorporate into the LFHW campaign, and information is available[17] for partners to use to support these different groups as well.

There are a number of measures that grocery retailers and food manufacturers could adopt – in addition to those mentioned above – that could support single-occupancy households: further optimisation of pack-sizes for smaller households, ensuring that these are widely available and that the difference in price, per kilogramme, is minimised between different pack sizes, since some smaller packs cost more per kg than larger sizes; an increase in the available shelf-life of perishable foods[18]; and consideration of how promotional strategies could impact on decisions made by those living alone. In the more specific WRAP research focusing on single occupancy households, many single occupancy households said that split packs, packaging that keeps products fresher for longer, re-sealable packaging and single serving packaging are innovations that they would find useful.

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[15] *See: http://www.wrap.org.uk/content/solutions-prevent-household-food-waste*

[16] *See: http://www.wrap.org.uk/content/understanding-consumer-use-freezer*

[17] *Love Food Hate Waste: one person household message testing: a summary brief,* WRAP (2014) *http://partners.wrap.org.uk/assets/9354/*

[18] *WRAP has developed a model, which suggests that – for milk – a small increase in shelf life could lead to considerable reductions in waste, see: http://www.wrap.org.uk/content/milk-model-simulating-food-waste-home-0*

On average, people of all ages are similarly concerned about food waste, and although there are age-related differences in the average amounts of food thrown away, all age groups can benefit from reducing food waste further.

Younger people state that their motivations for wasting less food are saving money and wanting to run an efficient home, similar to the rest of the population. However, there are differences in the factors that they feel hinder them from reducing food waste: this group are more likely (compared to the rest of the population) to cite time pressures, 'not knowing how to reduce food waste', and 'having more important things to worry about'. Therefore, younger people can be harder to reach on this issue as they feel they are busy and have other pressing concerns, but given their stated motivations there is an opportunity to engage them with money-saving benefits. Furthermore, if activities to reduce food waste can also save them time, this group would be more likely to take action. As with the rest of the population, raising awareness of the amount actually wasted, coupled with tips to reduce it (for example promoting the use of LFHW tools such as the meal planner) is likely to be of value to this group.

LFHW has been working with colleges and universities for a number of years, both directly and through its partners. Providing easy, simple recipes and tips for **students** at key moments in their lives – for example leaving home – can help **develop much wanted skills**, help save money and give greater independence to those involved. Likewise, LFHW has been developing and supporting cookery classes in the community to help raise people's **confidence in the kitchen**, helping them to increase their skills, waste less food and drink and save money. LFHW has also been piloting a new programme of work seeking to build kitchen skills for people who would like additional advice and support on budgeting and making the most of their food, but who are not seeking cookery classes. Following positive results, 'Love Food Hate Waste – Save More' will be rolled out across the UK in 2014-15 working in communities to help them save money[19].

There is scope for reducing the amount of food waste generated by **families with children**. Giving children the opportunity to serve themselves from a central serving dish, rather than other people serving them a plateful at the start of the meal, could help reduce the amount of plate-leftovers, which can be more difficult to use at a later date. Using leftovers for future meals – including using the freezer to extend the life of those leftovers – could form part of a family's strategy to reduce food waste. Freezing leftovers in individual portions that are clearly labelled can be an ideal way to ensure that a variety of quick and tasty home-made meals are available. Making date labelling on food products even clearer, and communicating what the two main date labels mean, could help parents in making decisions about when to eat rather than discard food, without compromising on safety. **Providing sound but reassuring advice for parents on food safety**, which relates to using leftovers, what food can be frozen and for how long and what dates mean, continues to be important to facilitating change.

Whilst **older people** waste less on average than other groups, there are areas where messages and innovations could help them reduce food waste further, particularly for fresh vegetables and salads, and food 'not used in time' more generally. Providing clear, evidence-based information on the benefits of food packaging for perishable foods which are not going to be used within a couple of days can help those who traditionally remove their food from its packaging at home[20]. Clear storage advice on-pack and highlighting in store when changes have been made to food packaging to improve its storage life would be beneficial.

[19] *See: http://england.lovefoodhatewaste.com/content/love-food-hate-waste-save-more-pack-run-sessions-your-community*

[20] *See: http://www.wrap.org.uk/fresherforlonger*

There is currently a significant gap between the average UK diet and recommendations for a healthy diet (e.g. the Eatwell plate). **Efforts to encourage and support people to make healthier choices need to be complemented by messages and initiatives to avoid the unintended consequences of a possible increase in food waste**. One example of this is the LFHW 'Eat well and waste less' guidance[21] which helps people to make the most of the good food that they buy.

One important area is efforts to increase fresh (and other) vegetable consumption by families (who currently buy less fresh vegetables than other types of household); these should be made in conjunction with support to ensure that extra purchases are consumed rather than wasted: good advice regarding storage location, use of packaging to prolong shelf life and inspiring and relevant recipes will be important, as will reinforcing that frozen and tinned vegetables also contribute to your '5-a-day'.

It is also important to ensure that, wherever possible, **communication with the public takes into account that different solutions are required to reduce food waste in different households**. For example:

- In households that have a lot of food that is not used before it goes off, focus may fall on planning (e.g. planning meals and making lists) and storage;
- Households in which too much food is served may focus more on meal times and serving the appropriate amount of foods for each individual in the household.

Every person and every household will have their own reasons as to why food is wasted in their home, which may change over time, and therefore a mix of advice, support and guidance is needed to address this. Whilst asking people to 'reduce food waste' is too broad a message, only focussing on one behaviour will not work for every person or household either. Helping people to identify why food is thrown away in their particular set of circumstances is therefore a key first step to allow them to pick solutions that will work for them.

It is important to take into account employment and other factors relating to **time constraints** in identifying the right tools and support to help people waste less. The majority of the population is in paid employment, and messages, engagement and innovations in products, packaging and labelling must be appropriate for those with busy lives and little time. Advice, support and tips which seek to help people reduce the amount of food and drink that is thrown away need to be grounded in the reality that some of the households producing the most waste afford a lower prioritisation to food-related activities due to competing pressures and time constraints. Therefore, solutions should, where possible, help households save time or, at the very least, be 'time neutral' and easy, for example:

- Making small simple changes in everyday behaviour, such as freezing leftovers to eat at a later date, thereby negating the need to cook for one meal in the future;
- Keeping apples in the fridge rather than the fruit bowl – it takes no longer to retrieve them, but they last much longer;
- The LFHW free App provides a simple way to check what food they have at home whilst in the supermarket, allowing people to squeeze a shop in between other activities and buy appropriate amounts of food;

[21] *See: http://england.lovefoodhatewaste.com/content/eat-well-and-waste-less*

- Making sure that at least one night a week involves eating from the freezer so if plans change unexpectedly that meal can be carried over to the following week rather than fresh food being wasted – this can be much quicker than cooking from scratch.

'Fussy eating' is likely to be one of the more difficult causes of food waste to address, however, options to explore could include:

- A greater involvement of children and other household members in food planning, shopping and preparation to ensure the food and drink that is bought and prepared is accepted by more people in the household;
- Using a different approach to serving food; for instance, giving children and others the opportunity to serve themselves from central bowls rather than other people serving full meals on their behalf. This has the dual benefit of less plate waste after serving and also any leftovers are likely to be easier to use later;
- Cooking and freezing individual portions of meals to allow for a wider variety of choice at meal times, to suit different members of the household;
- Mixing the use of fresh, tinned and frozen fruit and vegetables can provide a wide variety of choice but lead to less waste being generated.

For those **people particularly concerned about the freshness of their food**, guidance can be given on how to maintain this freshness for longer, for example through better storage and in-home use of food packaging.

The link between home composters and avoidable food waste may be indirect (rather than causal), but could be linked to home composters being more likely to grow their own food and possibly valuing their food to a greater extent because of this. This untested proposition could be investigated to see if **increasing people's awareness of the journey of food** (e.g. via growing their own) does indeed reduce food waste. If this is the case, it could mean that grow-your-own projects in schools and other community groups would be a good opportunity to promote food-waste prevention.

These insights will help WRAP and its partners develop more effective ways to help people waste less food. The report shows that – due to the complexity of waste generation – messages, engagement and changes in products, packaging and labelling need to be developed with the specific needs of different groups in mind.

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Glossary

- Avoidability of waste – a classification of the extent to which household food and drink waste could have been avoided[22]. Avoidable waste is the primary focus of this report.
  - **Avoidable waste:** food and drink thrown away that was, at some point prior to disposal, edible, e.g. milk, lettuce, fruit juice, meat (excluding bones, skin, etc.).
  - **Possibly avoidable waste**: food and drink thrown away that some people eat and others do not, e.g. bread crusts and potato skins.
  - **Unavoidable waste**: waste material generated from food and drink preparation that is not, and has not been, edible under normal circumstances, e.g. meat bones, egg shells, pineapple skin, tea bags.
- Behaviour – in this report, a behaviour is used to mean an activity, and the two words are used interchangeably.
- Defra – Department of Environment, Food and Rural Affairs.
- Disposal route[23] – the method by which household food and drink waste is collected or removed from the home; this term does not necessarily imply that the waste goes to landfill (see also local authority collected waste).
- Estimated marginal means – these are calculated as part of generalised linear modelling and represent the mean (average) value of the dependent variable (avoidable food and drink waste) for different levels of one of the explanatory variables (e.g. number of people in the household) when controlling for all other variables in the model.
- Food group – broad classification of food and drink (e.g. bakery, drink, fresh fruit).
- Food type – classification that subdivides each food group (e.g. fresh fruit is subdivided into types of fruit).
- Generalised linear modelling (GLM) – a method for statistical modelling used in this report. It allows identification and quantification of correlations between a) the amount of avoidable food and drink waste generated by a household and b) variables that might explain the differences between households, such as household size, age, availability of time for food preparation, etc.
- Kitchen diary research – research using diary keeping to record waste from all disposal routes from the home (including poured down the kitchen sink, home composted or fed to animals). Diary keepers also recorded why each item was thrown away. Fieldwork conducted during 2012. More details can be found in the *Methods used for Household Food and Drink Waste in the UK 2012*[24].
- Local authority collected waste – in this report, this refers to the household waste streams collected by, or on behalf of, the local authorities; these include kerbside residual waste (the 'general' bin), collections targeting food waste (either separate or mixed with garden waste), and minor contributions from residual waste from household waste recycling centres and contamination of kerbside dry recycling.
- Love Food Hate Waste (LFHW) – a campaign launched by WRAP in 2007, which helps UK households tackle food and drink waste. LFHW works with retailers and brands, local authorities, businesses, community and campaign groups.

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[22] *Further details of avoidability can be found in Household Food and Drink Waste in the UK 2012.*

[23] *The word 'disposal' is used here in its everyday sense (i.e. removal of food and drink from the kitchen / home), rather than the legal definition in Article 3 of the EU Waste Framework Directive (2008/98/EC).*

[24] *http://www.wrap.org.uk/sites/files/wrap/Methods%20Annex%20Report%20v2.pdf*

- Reasons for disposal – a classification of why food and drink and drink were thrown away, based on participants comments in the diary research[25]. Applied to avoidable food and drink waste only.
  - **Not used in time:** food that has been thrown away because it has gone off (mouldy, mushy or rotten) or because it has passed a date label (e.g. 'use by' or 'best before').
  - **Cooked, prepared or served too much:** food and drink that has been cooked, prepared or served in the home and subsequently disposed of. This category could also be referred to as 'leftovers'.
  - **Personal preference:** food and drink not eaten due to allergies, other health reasons, or simply not wanting to eat this particular food.
  - **Accidents:** food that has been contaminated, burnt or otherwise spoilt.
  - **All other reasons:** e.g. cupboard clear out, dregs at the bottom of a cup.
- Structural factors – variables used in the generalised linear modelling to control for effects known to influence levels of avoidable food and drink waste (e.g. number of people in the household), allowing effects of other variables to be explored. See §6.2 for more details).
- Waste compositional analysis (WCA) – research quantifying the weight and types of food and drink waste from approximately 1,800 consenting households (conducted in 2013). More details can be found in the *Methods used for Household Food and Drink Waste in the UK 2012*[26].
- WRAP's food waste tracker – WRAP's regular consumer survey on household food and drink waste. This is currently conducted using on-line panels with a sample that is representative of the UK.
- WRAP – Waste & Resources Action Programme.

[25] *Further details of reasons for disposal can be found in Household Food and Drink Waste in the UK 2012.*

[26] *http://www.wrap.org.uk/sites/files/wrap/Methods%20Annex%20Report%20v2.pdf*

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The authors also thank Sarah Clist and Andrew Davey (both WRc plc.) for their previous (unpublished) modelling on household food waste for WRAP. The current research has benefited greatly from that analysis.

Dedication

This report is dedicated to Roy Page of Exodus Research, who was instrumental not only in this research but also in many key pieces of the research about UK household food waste. In particular, Roy's energy and dedication helped ensure that the ground-breaking research in 2007 and 2008 – *The Food We Waste* – had the impact it did and put household food and drink waste on the agenda in the UK. His presence in this field will be sadly missed.

Roy Page
6th February 1969 – 2nd February 2014

Peer reviewer statement

An independent peer review was undertaken of *Household food and drink waste: A people focus*, with the goal of ensuring that the results stand up to technical scrutiny. Options for controlling for the effect of structural factors were discussed with WRAP during January and February 2014. WRc then reviewed a draft version of the final report (v3.1) on 21st May and a revised version (v4.1) on 28th May. Potential issues raised by the review were discussed with WRAP to identify and agree appropriate changes.

The main issues raised by the peer review process, and subsequently addressed by the report authors, are summarised below.

- Conceptual model – a clear conceptual model could be presented at the start of the report to explain the role of direct and indirect influences and to justify the choice of modelling approach.
- Terminology – the report should ensure that it clearly defines and then make consistent use of terms such as socio-demographic, structural, contextual and lifestyle factors.
- Choice of response variables – The report mainly considers food waste per household, but occasionally reverts to analysing food waste per person. Can the pros and cons of these two approaches be explained?
- Interactions – The GLMs rarely consider the possibility of interactions between explanatory factors. This approach should be discussed and justified by pointing out the difficulties of modelling interactions among factors with multiple levels.
- Presentation of results – It would be helpful to clarify the reporting of effect sizes for behavioural score variables.
- Model selection – The limitations of automatic stepwise selection should be mentioned and used to help explain the need to manually investigate model variants. A multi-model approach with model averaging could be a useful approach in future studies.
- Missing data – The existence of missing values for certain behavioural factors complicates the model selection process. This has been explored to some extent but alternative solutions could be explored in future analyses.

The authors appear to have taken great care to make best use of the available information and provide a clear, detailed and transparent justification for the methods used. Notably, attempts have been made to check the influence of outliers in the dataset and to explore the effect of correlated behaviours on the robustness of the model results. The final report is well structured, provides an accessible account of the study's findings, and the conclusions are supported by the available evidence.

In summary, I am satisfied that the research presented in this report provides sound evidence on the relationship between the level of avoidable food and drink waste and socio-demographic, behavioural and other food-related factors.

Dr Andrew Davey, WRc plc

Peer Reviewer, 30 May 2014

1.0 Introduction

1.1 Background to WRAP's work on household food and drink waste

Food is a valuable resource and yet UK households threw away 7.0 million tonnes in 2012, around 19% by weight of that purchased. At least 60% of this could have been avoided, including around 13 billion '5 a day' portions[27].

Over the last eight years WRAP has built up a comprehensive evidence base which has raised awareness of the issue, built a strong case for change and given focus to the areas where people need the most help, where business and local authorities can benefit, and where the biggest impacts can be made.

Recent WRAP research[28] revealed a substantial reduction (21%) in the amount of avoidable[29] household food and drink waste arising between 2007 and 2012 saving UK households almost £13 billion over the five years to 2012. However, the research also highlighted the scale of the opportunity remaining. The amount of avoidable food waste generated in 2012 was equivalent to six meals every week for the average UK household. Preventing this waste could save the average family £700 a year and deliver significant environmental benefits in terms of landfill avoidance and mitigating climate change.

In 2007, WRAP launched Love Food Hate Waste (LFHW) which helps UK households tackle food and drink waste. LFHW works with retailers and brands, local authorities, businesses, community and campaign groups to help promote the LFHW message by providing resources such as well-researched tips, advice, recipes, messages, creatives (e.g. leaflets and posters), an on-going campaign calendar and consumer insights. Love Food Hate Waste delivers a cascade training programme and kitchen skills advice working with groups across the UK to increase knowledge and skills on reducing food and drink waste in the home. The LFHW website, twitter, Facebook, App and PR campaigns all support people to reduce their food and drink waste.

WRAP also works with the grocery industry to make changes to the grocery retail environment that will make it easier for people to:

- buy the right amounts of food and drink, e.g. offering a range of pack sizes;
- keep what they buy at its best, e.g. giving clear storage and freezing guidance; and
- get the most out of what they buy, e.g. using consistent, clear date marks.

Food has been found to be wasted for a number of 'direct' reasons, which vary from household to household. These include buying more than is needed, not storing food in a way that would keep it at its best for longer, confusion around date labelling and what food can be frozen, incorrect portioning and discarding leftovers that could be saved and consumed later. There are also factors, which impact on food and drink waste generation in a less 'direct' way; these relate to the context in which the above behaviours take place, such as availability of time or wanting to eat a healthy diet. These various and complex behaviours, and broader factors, are the subject of the analyses found in this report.

[27] *Household Food and Drink Waste in the UK 2012, WRAP (2013)*

[28] *Household Food and Drink Waste in the UK 2012, WRAP (2013)*

[29] *For definitions around avoidability of food waste, please see the glossary.*

Alongside this report, a separate report – *Household food and drink waste: a product focus*[30] – has been published that includes further descriptions of the types and state of food and drink thrown away, in addition to information on when and why this waste is discarded. Together, these two reports provide information that will be extremely useful to organisations and people tackling household food and drink waste. These results have been used to inform a series of conclusions (found at the end of each section of results) to help maximise the impact of consumer engagement and innovation in food products, packaging and labelling. Insights such as those identified in this report will help refine existing solutions and the development of new ones.

1.2 Background to this research

In November 2013, WRAP published *Household Food and Drink Waste in the UK 2012*, which quantified the amounts, types and reasons for food being wasted from UK households. As part of that research, two datasets were collected that included details of what was wasted from individual households in addition to information from questionnaires relating to characteristics of those households. One dataset originated from diary-based research and the second from compositional analysis of household waste (conducted with informed consent). All the questionnaires that inform this work are published alongside this report.

Although a large amount of information was published in that previous report, there were additional analyses that were possible with these datasets to obtain information useful to those working to reduce household food and drink waste. In particular, the two studies provided a unique opportunity to compare levels of waste generated in the households with households' characteristics, including food-related behaviours they engage in such as shopping, storage and cooking. Additionally, in light of the recent evidence from a number of small-scale, qualitative studies[31], which highlighted the importance of broader, contextual factors for household food and drink waste generation (such as concerns over healthy eating, taking care of the family or availability of time), the analysis presented in this report aims to examine whether some of these more nuanced relationships can be identified in a large, representative sample.

Figure 1 illustrates a simplified diagram showing how the factors in this research are related to one another. Factors are split into three types: direct, indirect and socio-demographic[32]. Direct factors include food-related activities in the home that are likely to impact relatively straightforwardly on food waste levels; in addition, the amounts and types of food brought into the home can have a direct effect on food waste levels. These direct influences are affected by indirect influences – factors that don't in themselves lead to less food waste, but can impact food waste levels via more direct factors. For example, the availability of time for food preparation may influence direct factors such as the degree to which people plan meals and whether they use up leftovers.

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[30] http://www.wrap.org.uk/content/household-food-drink-waste-%E2%80%93-product-focus

[31] *For example: Cappellini, B., Parsons, E. (2013) 'Practising thrift at dinnertime: mealtime leftovers, sacrifice and family membership', The Sociological Review 60 (S2), pp. 121-134;*

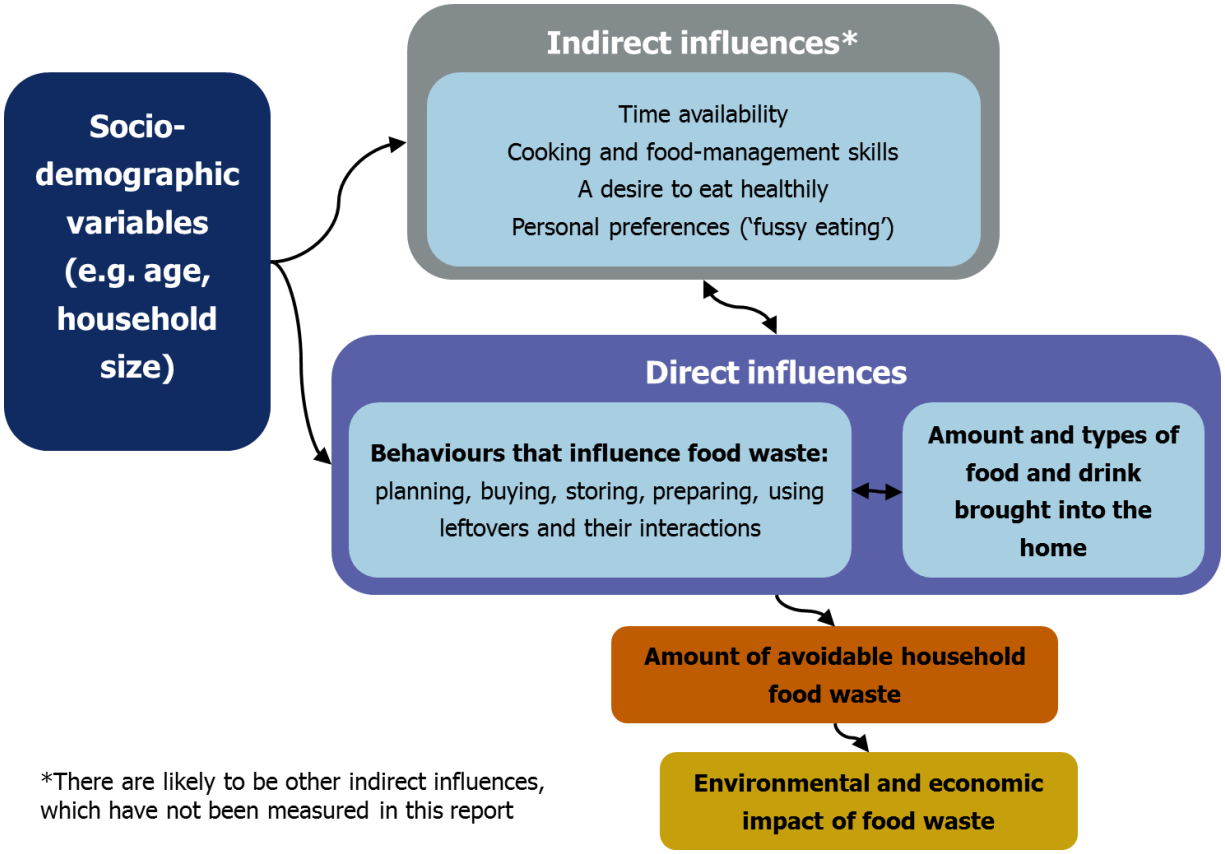
Evans, D. (2012) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology, 46 (1), pp. 41-56;

Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction, 20(2), pp. 1-25.

[32] *The distinction between direct and indirect factors is not always clear-cut; it is used here to distinguish activities that act on food in relation to waste and factors that relate to the context in which these activities are performed. Furthermore, the generation of avoidable food waste is usually the result of multiple, interacting factors.*

Direct and indirect factors correlate with socio-demographic factors. For instance, the presence of children in a household correlates with availability of time for food-related activities (an indirect effect) and meal planning (a direct effect).

Figure 1: Visual representation of relationships found in the report



This report presents statistical modelling using the two datasets to understand what factors are associated with different levels of food and drink waste from different households. Analysis of other data sources are used at times to provide additional insights (e.g. data from WRAP's regular consumer food waste questionnaire[33]). As can be seen from the results, a wide range of interrelated factors are found to be associated with high and low levels of food and drink waste, which highlights the complexity of its generation.

1.3 Research objective and methods

The objective of this research is to obtain insights into the levels of food and drink waste generated by different types of household in the UK, by exploring the relationships between household food and drink waste and factors relating to socio-demographics, specific food related activities, as contextual (or indirect factors), as described in the previous section. The analysis focuses on avoidable food and drink waste – the fraction that offers the greatest potential for waste prevention.

Generalised linear modelling (GLM) has been used as the method for statistical modelling in this report. This technique is similar to regression analysis: it identifies and quantifies

[33] *See* http://www.wrap.org.uk/sites/files/wrap/CFWPS_0.pdf

correlations between levels of avoidable food and drink waste and variables that might explain differences in the amount of waste generated, such as whether there were any children in the household or whether people in the household planned their meals in advance. The details of this approach can be found in §6.2.2.

Two types of analyses were performed for this report:

- Type 1 analyses explore the relationship between single household variables (e.g. age) and the level of food and drink waste. This determines whether the amount of food and drink waste varies with this characteristic (in this case, whether different levels of waste are generated by households containing younger people compared to older people). Where differences are found, these variables may not necessarily be directly influencing waste levels; instead, they may correlate with factors that do directly influence food and drink waste. Nevertheless, they provide information for understanding which parts of the population waste more than average and allow targeting of engagement activities. Further analysis and research has also been performed attempting to explain these differences.
- Type 2 analyses explore the relationships between food and drink waste levels and multiple household variables simultaneously. These help understand the factors that correlate with food and drink waste, whilst controlling for the other variables included in the model, thereby isolating the independent effect of each variable. For example, home ownership status has been found to correlate with food and drink waste levels, but, if age is controlled for, the relationship with home ownership becomes much weaker, suggesting that it was mostly the result of a correlation with age[34]. This gives a deeper understanding of the relationships seen.

Both types of analyses are presented in this report as each provides useful information and contributes to a greater level of understanding. In reality, each household variable correlates to some extent with most other variables, rendering the number of potential analyses very large, and reflecting the complexity of factors that relate to food and drink waste.

Additional analysis was also carried out in places to further explore the relationships found between levels of waste and explanatory factors. For example, it was discovered that older people generate less waste than other age groups, and additional analysis was performed in an attempt to explain this relationship, e.g. to see whether older people were engaged with different food-related activities compared to younger people or had different views about food waste.

1.4 Reporting results

In this report, results are referred to as 'significant' if the significance value (p), as determined in the generalised linear model (GLM), is below 0.05 for that variable. The p-value is the probability that we would observe relationships as big as those seen in the study if there were really no relationship between the variables; if p is below 0.05, the findings are unlikely to have arisen by chance and we are therefore reasonably certain in concluding that there is some relationship. A detailed description of the methodology is included in the Appendix in chapter 6.0.

[34] *When other socio-demographic factors are also included in the model, this relationship becomes more complex, due to a high level of correlation between many of the socio-demographic factors. See §.7.2 in the Appendix for more details.*

Some results are also reported where this threshold is not reached, typically where there are indications of a trend in both the diary and the waste compositional analysis but both fall just shy of this threshold. These results are reported alongside the *p* values, with an indication of the likelihood of any effect being real in the text.

Where significantly different levels of food and drink waste were found for different types of household or different responses to a question in the questionnaire, this shows a correlation. However, these relationships are not necessarily causal. For example, even though a relationship has been found between waste levels and age, it is not necessarily people's age that leads them to waste less; it could be that other factors (those classified as direct and indirect in Figure 1) correlate with age and it is these factors (and their interaction with each other) that are likely to be responsible for the difference in waste levels.

1.5 Report structure

This report aims to shed light on those complex relationships and is structured as follows:

- Chapter 2.0 explores the relationship between household socio-demographics and levels of avoidable food and drink waste, in order to find segments of the population that generate more or less waste. Where differences were found, further information has been presented to understand the likely reason for that difference.
- Chapter 3.0 examines the complex relationships between levels of food and drink waste and engagement in various food-related behaviours, such as shopping, cooking and storing food.
- Chapter 4.0 explores broader contextual factors that were found to be linked to household food and drink waste, such as availability of time or concerns over health.
- Chapter 5.0 summarises the results from the previous chapters and draws together findings.

In addition, the appendices to this report include methodological details (§6.0) and details of the statistical analysis that was carried out to inform each of the chapters (§7.0 & §8.0), as well as the analysis of the effectiveness of kitchen diaries as a research and behaviour change tool (§9.0).

2.0 Results: variation in avoidable food waste by household socio-demographics

2.1 Introduction

This chapter explores relationships between levels of avoidable food and drink waste and socio-demographic variables, as measured by questionnaires in the waste compositional analysis and the kitchen diary study. Socio-demographic factors are unlikely to be a direct cause of food waste generation, but may be correlated with factors that do have a direct impact on waste levels (such as behaviours) – see §1.2. Therefore, identifying differences between socio-demographic groups helps to understand the complexities of household food waste generation, related to how people act and which factors influence their behaviour. Exploring the differences between socio-demographic groups can also identify how to support different people to reduce their food waste.

This chapter discusses each of the socio-demographic characteristics measured in the study and presents results for the ones that were found to correlate relatively strongly with levels of avoidable food and drink waste (see §7.0 for more details). It also attempts to provide explanations, with additional analyses carried out – where possible – to test hypotheses. Overall, evidence was found to suggest that there are relationships between avoidable waste and household size, age and employment status[35]. These are examined in detail, exploring the potential underlying reasons for these correlations. As noted in §1.4, the findings presented in this chapter should be interpreted as *associations* between socio-demographic characteristics and levels of waste, rather than as causal relationships.

2.2 Socio-demographic variables

A number of socio-demographic characteristics were measured by questionnaires in both waste compositional and kitchen diary studies, with one exception – information about rural/urban area of residence was collected in the kitchen diary study only. Among all socio-demographic characteristics measured, three types can be distinguished: those related to the questionnaire respondent only; those related to the household as a whole; and those related to the main earner of the household (which may or may not have been the respondent).

Socio-demographic characteristics of the respondent:

- Age
- Gender

Socio-demographic characteristics of the household:

- Age structure, based on ages of all household members
- Household size (i.e. number of people in the household)
- Rural/urban area (kitchen diary only)
- Household composition, e.g. a couple, or family with young children
- Home ownership status, e.g. privately rented or owned with mortgage
- Type of residence, e.g. flat or terraced house
- Presence of children
- Social-economic status – calculated based on the characteristics of the main earner

Socio-demographic characteristics of the main earner:

- Employment status

[35] *Other socio-demographic characteristics were also explored; their relationship with avoidable food and drink waste was less straightforward and details can be found in the Appendix (§7.0).*

Even though information about the respondent does not fully represent the characteristics of the whole household (for households with more than one person), it provides useful insights, as the vast majority of questionnaire respondents were people responsible for at least half of the food-related household duties. 91% of respondents were responsible for at least half of food shopping in their home and 87% for at least half of food preparation and cooking (in both groups the vast majority had a main responsibility for these activities). Therefore, the analysis of this information provides an insight into the relationship between socio-demographic characteristics of the person taking care of food-related practices and levels of avoidable food and drink waste generated in the household.

It has to be borne in mind that all information gathered was based on questionnaire responses, and therefore represents the views and knowledge of the respondent only. This means that there is a probability that some information about other household members or the household as a whole was not fully accurate. However, considering that all respondents were adults, and at least partly responsible for shopping and cooking in the household, it is relatively safe to assume that in most cases they had an accurate perception of their household's socio-demographics (e.g. regarding home ownership status, or employment and age of other household members). Therefore, the level of accuracy of this socio-demographic data is likely to be high.

2.3 Household size

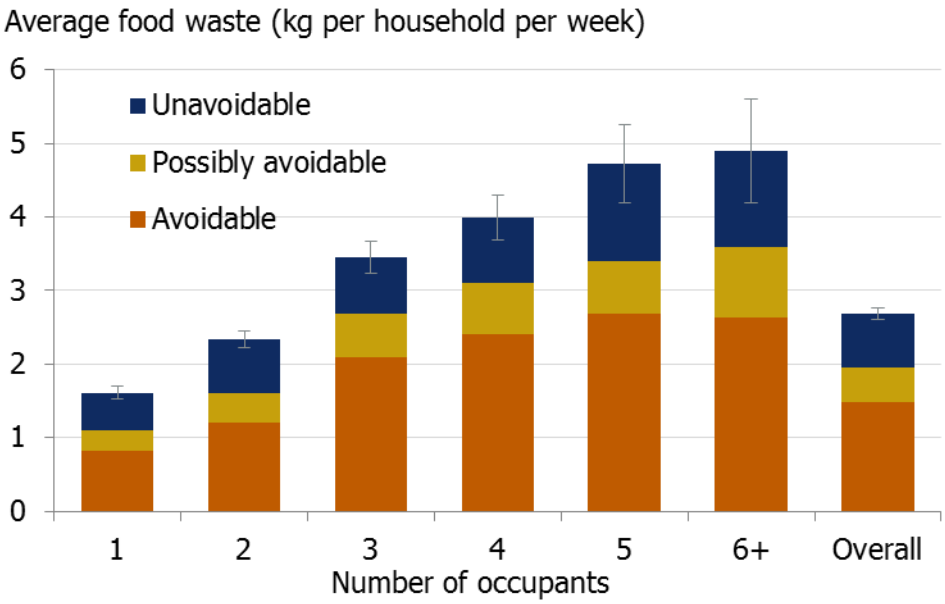
2.3.1 Household size and levels of avoidable food and drink waste

The number of people in the household was the variable explaining the most variation in the amount of avoidable food and drink waste generated per household. The average amount of household food and drink waste increases with the number of occupants of the household (Figure 2), which is unsurprising as the amount of food purchased and consumed within larger households will also increase with the number of occupants. However, the average amount of food and drink waste per person is not constant; single occupancy households generate considerably more food and drink waste per person than the rest of the population (Figure 3). For avoidable food and drink waste collected by local authorities, single occupancy households waste around 33% more per person than households containing more than one person[36].

This relationship has previously been reported in both the 2009 and 2012 *Household Food and Drink Waste in the UK* reports (sections 3.4 and 2.4 respectively). This relationship was consistently found for different elements of waste and from different data sources. The following section contains an exploration of the data to understand why these trends are seen, and, in particular, why households containing one person generate more food and drink waste per person on average.

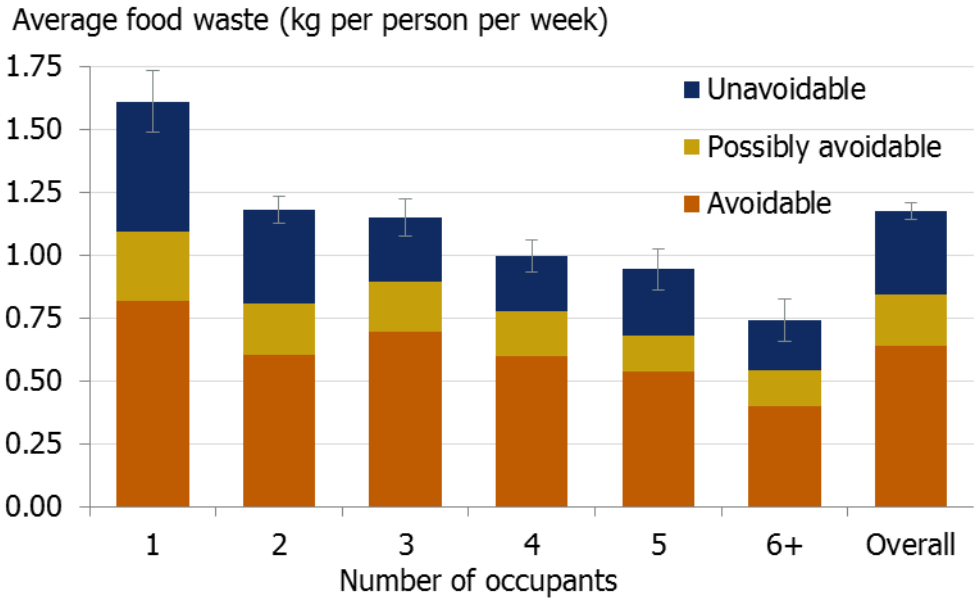
[36] *In Household Food and Drink Waste in the UK 2012, the increase in food waste per person for single occupancy households was quoted at 40%. The difference between this value and the 33% quoted here is due to different datasets contributing to the value in the previous research. In particular, contributions from waste streams not collected by local authorities were included in the previous estimate.*

Figure 2: Average amount of household food and drink waste **per household** for different household sizes by avoidability[37]



All waste collected by local authorities; 95% confidence intervals around mean value shown
Source: Waste compositional analysis data from 2012

Figure 3: Average amount of household food and drink waste **per person** for different household sizes by avoidability

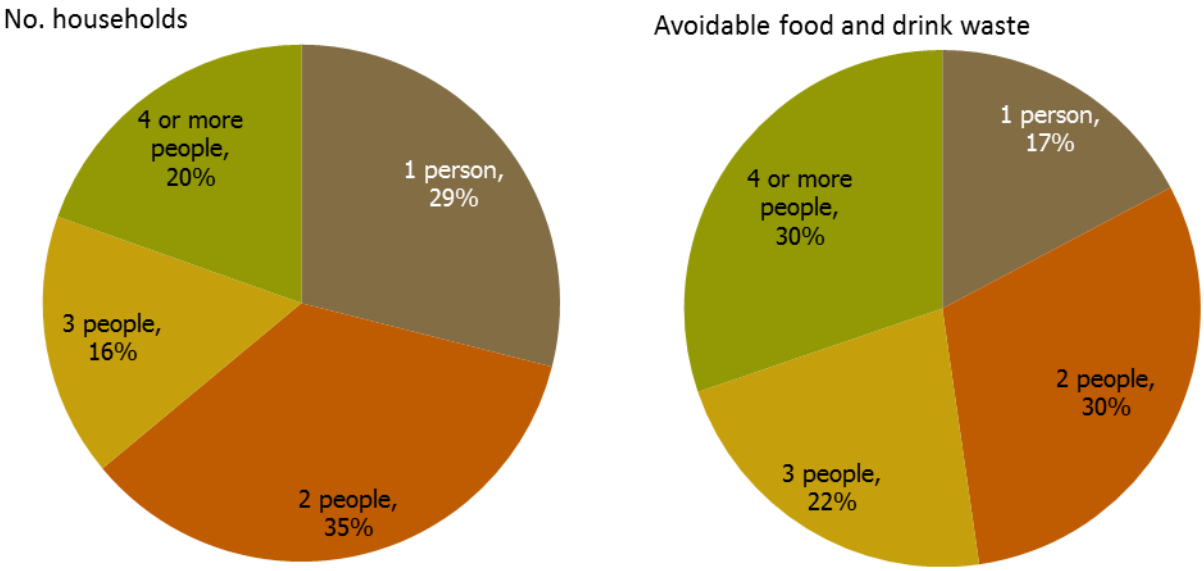


All waste collected by local authorities; 95% confidence intervals around mean value shown
Source: Waste compositional analysis data from 2012

[37] *The results present in this report have not been adjusted to bring them in line with the total amount of waste from the Synthesis of Waste Compositional Studies (2012), as per the methodology for the results in* Household Food and Drink Waste in the UK 2012. *Therefore, they are slightly lower than those previously reported. For more details, see §2 of the Methods used for Household Food and Drink Waste in the UK 2012.*

Figure 4 shows that 29% of households in the UK contained one person in 2012; however, as these households generate less waste per household, they only accounted for 17% of all avoidable waste in the UK. Although understanding and tackling household food and drink waste in single-occupancy households is important, a similar impact could be made through smaller percentage reductions in larger households, purely from the fact that more people reside in these households.

Figure 4: Left: proportion of households in the UK of different sizes. Right: proportion of avoidable food and drink waste from different household sizes.



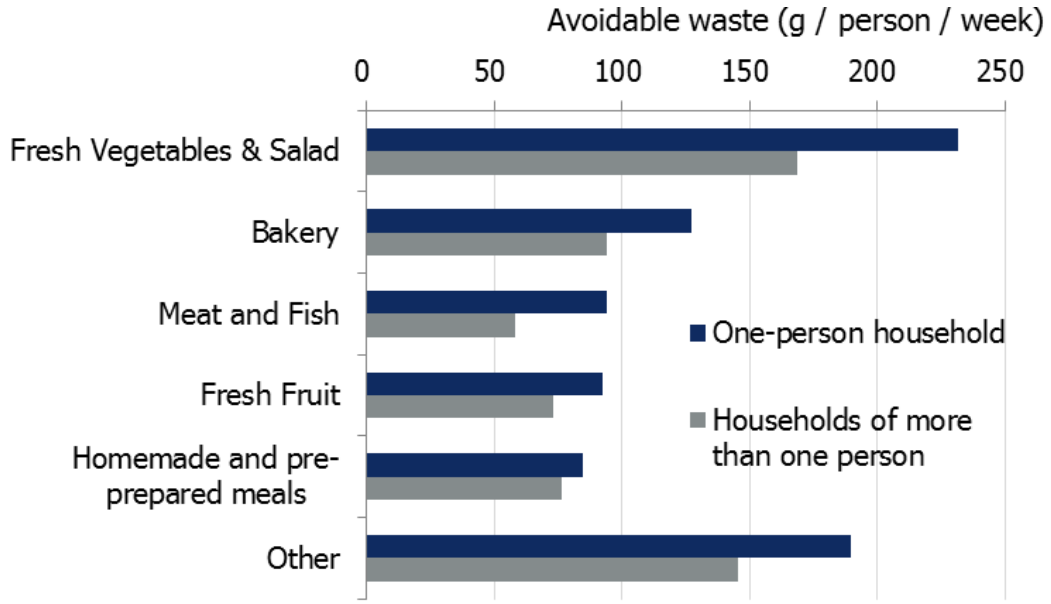
Sources: Left: Labour Force Survey; Right: Household Food and Drink Waste in the UK 2012

2.3.2 Household size and types of foods thrown away

This section looks at the types of foods thrown away by single occupancy households compared to the rest of the population. To allow comparison, the average amount of waste per person is calculated for the rest of the population.

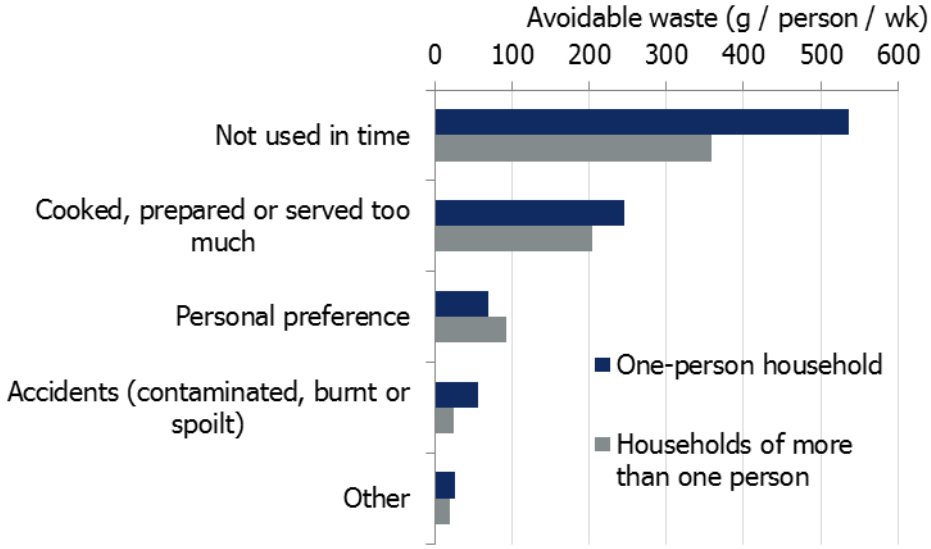
For the key food types contributing to avoidable food and drink waste, single occupancy households generate more food and drink waste per person than the rest of the population (**Figure 5**). The difference in waste appears higher for perishable products (fresh vegetables and fruit, meat and fish, bakery) and lowest for homemade and pre-prepared meals. This points towards a difference in the reasons why food is thrown away with more waste associated with food not being used in time. This is confirmed by analysis of the reasons for waste being produced given in the diaries: research participants in single occupancy households were more likely than the rest of the population to cite items not being used in time (Figure 6). Other major reasons for food being thrown away had similar levels of waste for single occupancy households and the rest of the population.

Figure 5: Food groups contributing to avoidable food and drink waste: comparison of single occupancy households and all other households[38]



Source: Waste compositional analysis data from 2012

Figure 6: Reasons for disposal contributing to avoidable food and drink waste: comparison of single occupancy households and all other households



Source: Kitchen diary data from 2012

The higher level of food and drink waste (per person) in single occupancy households is consistent with purchasing data of food and drink. Analysis for this report of Defra's Family Food Survey indicates that purchases of food per person per week were 15% higher by weight in single occupancy households compared to the general population[39].

[38] For graphs showing levels of waste by food group or reasons for disposal, the information is not the result of statistical modelling and therefore other factors have not been controlled for. Results are presented 'per person' to allow a reasonable comparison between groups.

[39] Some of this difference may be related to the fact that households with one person are only populated with adults; larger households will have combinations of adults and children, with children having different food and drink requirements

This means that the percentage of purchases that are wasted is higher for single occupancy households compared to the population as a whole. Table 1 indicates that 14.7% of food brought into single occupancy households becomes avoidable waste compared to 11.7% for all households.

Table 1: Percentage of food and drink purchases becoming waste in single occupancy households and all households (2012 data)

	Avoidable	Possibly avoidable	Unavoidable	Total
One person household	14.7%	4.3%	5.0%	24.0%
All households	11.7%	3.4%	3.4%	18.5%

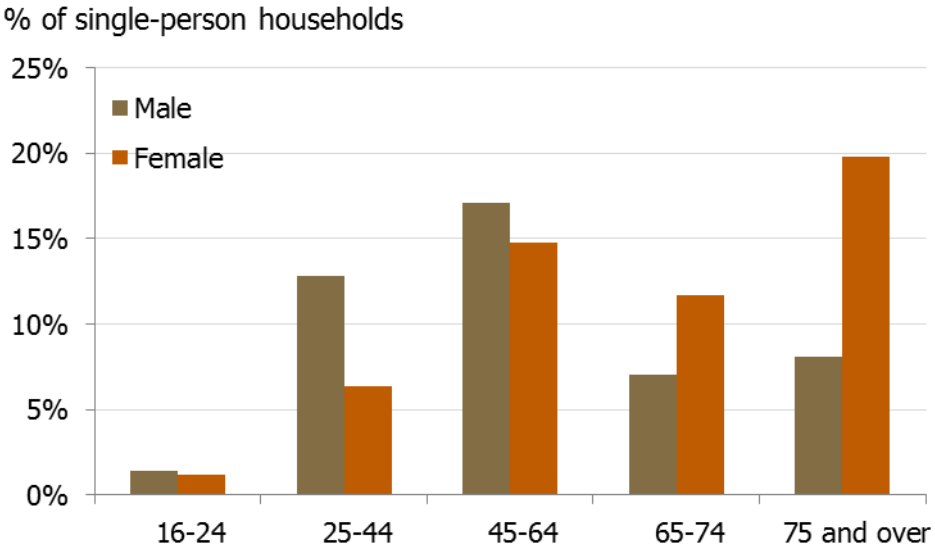
Source: WRAP analysis of Waste statistics and Family Food purchases dataset

2.3.3 Who lives in single occupancy households?

This section explores who lives in single occupancy households and whether this explains their higher (on average) levels of food and drink waste.

Firstly, single occupancy households do not contain children; they are exclusively composed of adults. This, in itself, does not explain the higher levels of food and drink waste; analysis of the 2012 waste compositional analysis dataset (*Household Food and Drink Waste in the UK 2012*, table 6 and §2.6 of the current report) found that adults and children were associated with similar levels of waste.

Figure 7: Percentage of single occupancy households by age and gender



Source: Labour Force Survey 2013

(potentially much lower levels for younger children). Further analysis still revealed a higher level of purchases for single occupancy households compared to households containing two or more adults.

According to the Labour Force Survey, 47% of single occupancy households were made up of people 65 or over in 2013[40]. This compares to 16% of the overall population being over 65[41]. A higher proportion of the over 65s in single-households were female, while more under 65 households were male (Figure 7). None of these factors appears to explain the higher levels of waste in single occupancy households: older people generate less food and drink waste on average (§2.4), and no significant effect between waste levels and gender has been picked up from the waste compositional analysis (§7.3.3).

Given the distribution of ages of people living in single occupancy households and the impact of age on food and drink waste levels, single occupancy households should not be treated as a single entity. Many differences were found in recent qualitative research[42] between younger and older people living by themselves.

Few other national statistics were available on the correlation between single occupancy households and other socio-demographic variables.

2.3.4 Food related behaviours and household size

Another possible reason for the increased level of food and drink waste from single occupancy households is the food-related behaviours they are engaged with[43]. The level of engagement with nine key behaviours has been measured by WRAP since 2010 via WRAP's food waste tracker – a regular questionnaire survey on household food waste. Information is presented in this section from the autumn 2013 wave of the survey (the most recent at the time of writing)[44].

The regular questionnaire results indicate that single occupancy household respondents are more likely to portion food when cooking. However, they are significantly less likely to plan meals, make shopping lists, or use a freezer for storing foods. They also indicate that they throw away less food because it has gone past a date label on the packaging (Figure 8).

These differences are not necessarily the result of living in a one person household. Some of the differences may reflect the fact that older people are more likely to live alone, and older people have different food-related behaviours, in particular a higher level of measuring food before cooking and throwing away less food because it has gone past a date label. Similarly, many of the differences seen may reflect an absence of children in these households. For instance, people without children are less likely to plan meals in advance or use their freezer, but more likely to measure food before cooking.

Previous research by WRAP compared waste levels generated between those under and over 65, living alone or in two-person households[45]. For both age groups higher levels of food and drink waste per person were seen in single occupancy households.

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[40] http://www.ons.gov.uk/ons/dcp171778_332633.pdf

[41] *As measured in the 2011 census:* http://www.ons.gov.uk/ons/dcp171778_292378.pdf

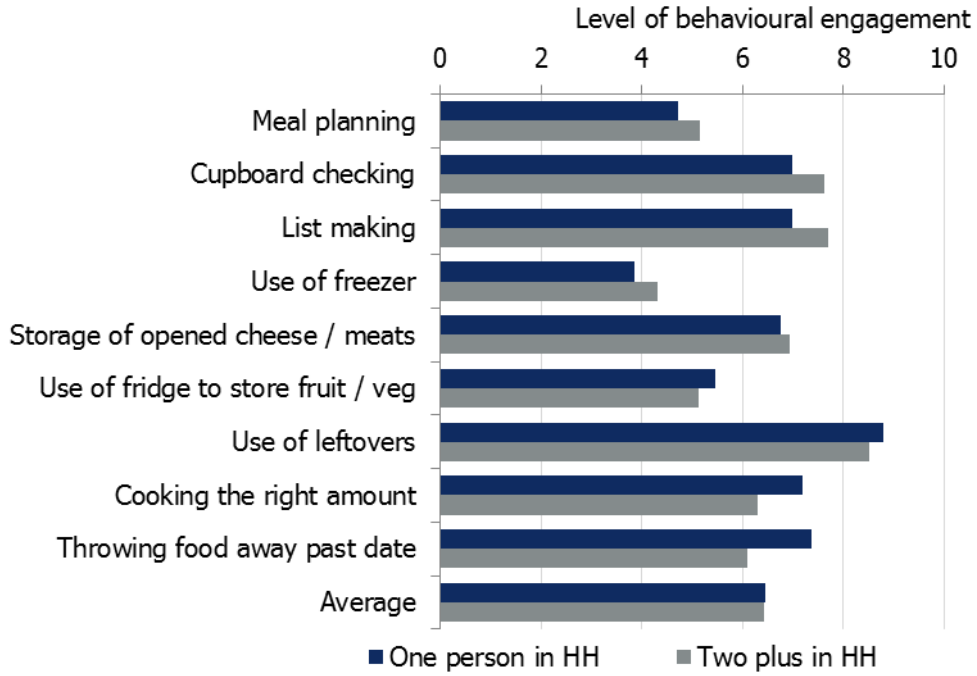
[42] *Love Food Hate Waste: one person household message testing: a summary brief,* WRAP (2014) http://partners.wrap.org.uk/assets/9354/

[43] *More details of the link between behaviours and waste levels can be found in §3.0.*

[44] *For more details of the scorecard method used, see this document. Also, see* http://www.wrap.org.uk/sites/files/wrap/CFWPS_0.pdf

[45] *See Quested et al. (2013) 'Spaghetti soup: The complex world of food waste behaviours', Resources, Conservation and Recycling 79, pp. 43-51*

Figure 8: Comparison of single occupancy households to the rest of the population for engagement in food-related behaviours



Source: WRAP's food waste tracker, UK data, Autumn 2013

However, the differences between the single occupancy households and the rest of the population in terms of food related behaviours are not particularly large; furthermore, for some behaviours there are higher levels of engagement with activities associated with less food waste and, for other behaviours, lower levels of engagement. Therefore, this is unlikely to explain why single occupancy households generate more waste on average.

2.3.5 Other factors associated with single occupancy households

Various pieces of past research have provided potential explanations for why single occupancy households have higher levels of waste. These include:

- Difficulties in buying amounts of food appropriate for small households[46]: for example, food may not be available in a pack size that could be easily eaten by a one person household before going off.
- Pricing of food: in many cases, food sold in smaller quantities costs more per kilogram or litre[47]. In addition, some promotional offers are of a format that requires multiple items to be purchased (e.g. 3 for £2). Both these factors make it relatively cheaper to purchase larger quantities of food, (i.e. per kilogramme or litre); if these lead to people purchasing more food than is necessary and they do not have knowledge about how to store the

[46] *E.g.* Research into consumer behaviour in relation to food dates and portion sizes, WRAP (2008): http://www.wrap.org.uk/sites/files/wrap/Consumer%20behaviour%20food%20dates%2C%20portion%20sizes%20report%20july%202008.pdf

[47] *The report* Helping Consumers Reduce Food Waste – A Retail Survey 2011, WRAP (2012) *indicates that strong price gradients are present for many products across many different categories, including bread, potatoes, orange juice, and bagged salads. However, some categories did not have steep gradients.* http://www.wrap.org.uk/sites/files/wrap/240412%20Retailer%20review%202011.pdf

extra food in the best way or do not have the storage capacity, for example within a small or ice-box style freezer, this could contribute to larger levels of waste in smaller households[48].

- Variation in consumption over time: in many large households, the variation in the amount of a given food eaten each day is averaged out by the presence of many people. In contrast, single occupancy households can experience greater variation in how much of given food is required each day: e.g. if a person unexpectedly eats out for a given meal – for instance, due to a social engagement – this represents 100% of the household being absent. This higher level of variability in demand for food within a household can be an important factor in waste production[49].

Given that there is little evidence to suggest that socio-demographic or behavioural factors explain the increased levels of household food and drink waste in single occupancy households, it is likely that at least some of the explanation lies with the above points. All of these reasons are associated with food not being used in time (rather than preparing or serving too much), and this is consistent with the increased level of waste in one person households associated with this reason (Figure 6).

It is interesting to note that previous WRAP research exploring consumer use of the freezer found that single occupancy households had the largest unused freezer capacity; only 25% said they're full to capacity after the main shop, compared to 38% for couples[50].

Summary: Variation in food and drink waste by household size

Evidence presented in this section shows that the average amount of avoidable food and drink waste increased with the number of occupants in a household. This in itself is not unexpected, as larger households will buy and prepare more food. However, the average amount of waste per person was highest for single occupancy households. A greater proportion of what was wasted by those in single occupancy households was due to it not being used in time, compared to larger households. Other data indicates that those living alone buy more food (per person) than average, and throw away a greater proportion of what is bought.

The higher levels of waste do not appear to be related to the behaviours that smaller households undertake (in comparison to larger households) or the types of people living in them. Other research suggests that managing food in smaller households is more difficult than for larger households: for some products it can be difficult to obtain food in appropriate-sized packs, and where it is possible it can be more expensive (per kilogramme or per litre). Furthermore, day-to-day variations in the amount of food consumed, for example due to changes in circumstances or plans, are more likely to impact on waste levels in smaller households.

[48] *Previous research couldn't establish a quantitative link between promotions and food waste, although this research did not focus on single person households. This absence of evidence may be linked to the complexity of food waste generation rather than there being no link. For more details, see:* http://www.wrap.org.uk/content/investigation-possible-impact-promotions-food-waste-0

[49] *As demonstrated by* The Milk Model: Simulating Food Waste in the Home, WRAP (2013).

[50] http://www.wrap.org.uk/content/understanding-consumer-use-freezer

Conclusions:

More than 80% of household food and drink waste is generated by households containing more than one person, and so these households should remain a key area of focus for prevention activity (see other sections for relevant conclusions).

However, almost a fifth of food and drink waste arises from single-occupancy households, with significantly more waste per person than larger households, and quite different contributing factors. Tailored messaging and engagement should be considered to help people buy the right amounts of food for their needs, and store food to ensure that more of what is bought can be eaten (including use of the freezer). It is important to recognise that there are large socio-demographic differences within this 'segment' of the population (e.g. from students and young professionals to those who are retired), and LFHW has carried out more in-depth research[51] into the motivations and barriers of different groups of people in single occupancy households, and has produced information for partners to use to support these different groups as well as incorporating it into the LFHW campaign itself.

Confirming WRAP's previous research around the 'Fresher for Longer' initiative[52], the recent LFHW research demonstrated considerable demand among retailers' customers for further innovations in packaging. Significant proportions of single occupancy households said that split packs, packaging that keeps products fresher for longer, re-sealable packaging and single serving packaging are innovations that they would personally find useful. Focus groups demonstrate that such innovations, when they are noticed by people, are positively received.

As evidenced in this report, it is intrinsically more difficult to manage food in single-occupancy households. There are a number of measures that grocery retailers and food manufacturers could adopt – in addition to those mentioned above – that could support single-occupancy households in this respect: further optimisation of pack-sizes for smaller households and ensuring that these are widely available and that the difference in price, per kilogramme, is minimised between different pack sizes, since some smaller packs cost more per kg than larger sizes; an increase in the available shelf-life of perishable foods; and consideration of how promotional strategies could impact on decisions made by those living alone.

2.4 Results: variation in food and drink waste by age

Age has been found to correlate strongly with levels of avoidable food and drink waste in the waste compositional analysis study, and a similar pattern (although not statistically significant) was found in the kitchen diary study. This section aims to explore and discuss this relationship in greater depth. §2.4.1 examines variation in waste levels among different age groups (also considering other socio-demographic characteristics); §2.4.2 looks at engagement in waste-prevention behaviours by age; whilst §2.4.3 examines broader differences between age groups, including contextual factors that could indirectly influence the amount of food and drink waste generated.

[51] *Love Food Hate Waste: one person household message testing: a summary brief,* WRAP (2014) http://partners.wrap.org.uk/assets/9354/

[52] *See:* www.wrap.org.uk/fresherforlonger

2.4.1 Age and levels of avoidable food and drink waste

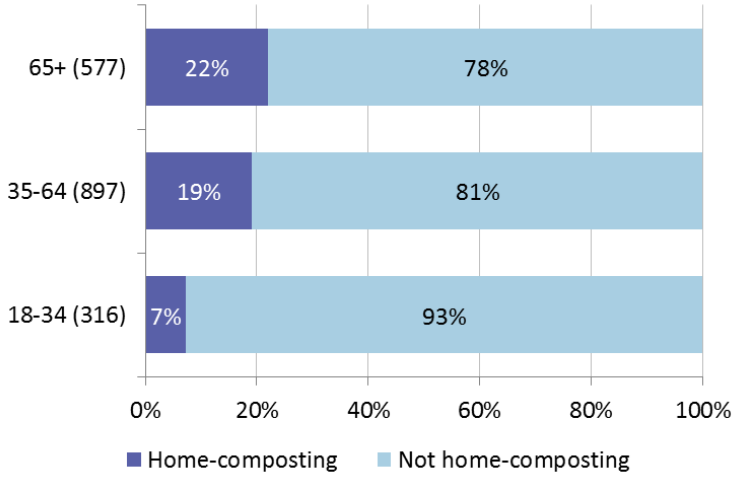
§6.0 includes an in-depth discussion about the choice of modelling method and the need to account for household size and home-composting when analysing household waste levels for different age groups.

To reiterate, household size has a double-effect on food and drink waste levels. Even though, as could be expected, larger households generate more waste *per household*, it is smaller households that generate more waste *per person*. Simply comparing waste levels, either per household or per person, would fail to account for these relationships between household size and food and drink waste. This was particularly important when examining variation in the amounts of waste between different age groups, as older people tend to live in smaller households.

Moreover, in the waste compositional analysis study, it was important to account for whether people home composted or not. The study only analysed waste from waste streams collected by local authorities[53], so those actively home-composting were expected to have lower levels of food and drink waste in their local authority-collected waste streams, as some of their waste was diverted to home composting. This was again particularly important when exploring relationships between age and waste, as it was found that older people were significantly more likely to home compost (see Figure 9). 22% of households where the survey respondent was aged 65 or over were home-composting, as compared to only 7% of those aged 18-34.

Therefore, a model was built to explore the relationship between age and levels of avoidable waste, which accounted for both these structural factors (i.e. household-size and home-composting).

Figure 9: Home-composting by age of survey respondent (number of cases in brackets)



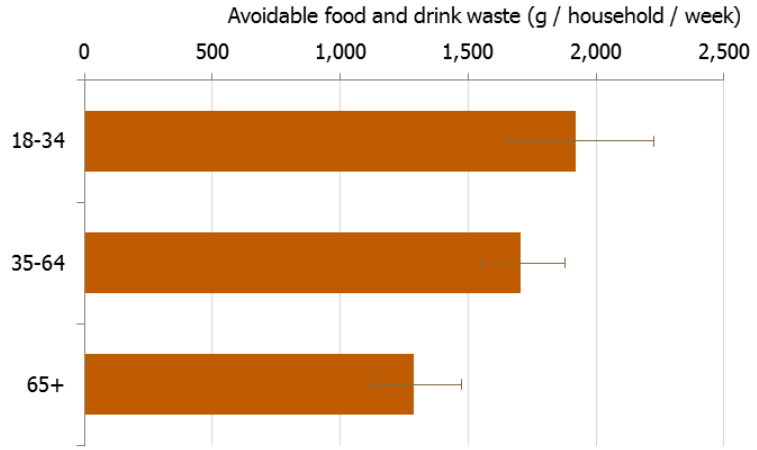
Source: Waste compositional analysis study 2012

Figure 10 shows the variation in waste by age of respondent in the waste compositional analysis study. As mentioned before, all respondents were at least partly responsible for cooking and shopping in the household, with the majority responsible for 'most' or 'around

[53] *The residual (or general) bin, and any collections targeting food waste*

half' of these activities. Therefore, these results provide an insight into the relationship between the age of the person taking care of food-related practices and levels of avoidable food and drink waste generated in the household. Those aged 65 and over generated less avoidable food and drink waste than any other age group, once household size and home-composting were controlled for, with those aged 18-34 generating the most. Households where the age of the respondent was between 18-34 generated, on average, 49% (±28%[54]) more avoidable food and drink waste than over 65s, whilst those aged 35-64 generated 33% (±19%) more waste than over 65s.

Figure 10: Variation in avoidable food and drink waste level by age of respondent, controlling for household size and home-composting



Estimated marginal means shown[55]; error bars show 95% confidence intervals
Source: Waste composition analysis study 2012

A similar trend in results was found in the kitchen diary study; however this was not statistically significant (p = 0.139), which could have been due to a smaller sample size and the fact that there was a lower proportion of participants aged 65 and over in that study.

These results are also in line with a previous waste compositional analysis carried out by WRAP in 2007, which also found older people generating less waste than other age groups, when household size was controlled for[56].

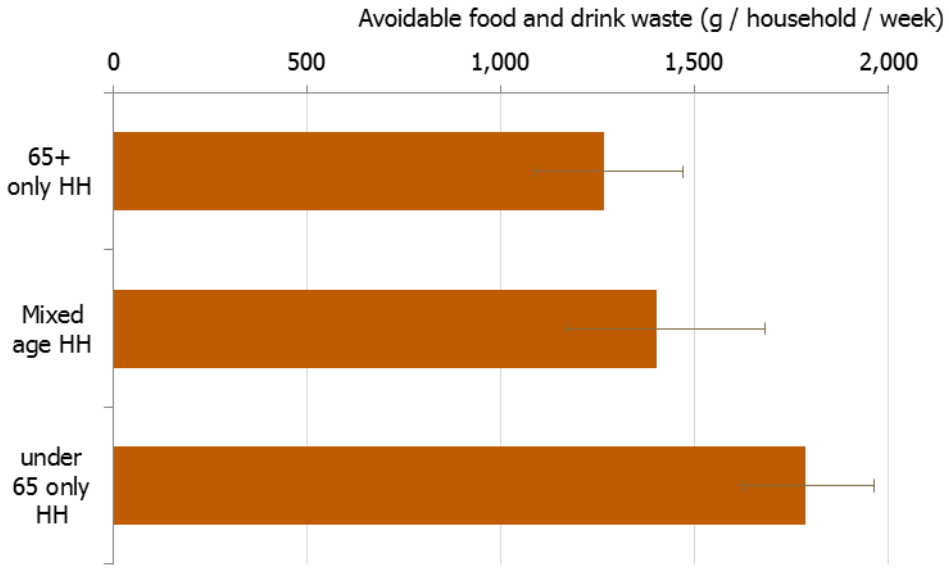
To complement these results, the relationship between waste and households' age structure was explored using the waste compositional analysis dataset. Three age categories were created based on the ages of all household members: first, households where all members were under 65 years old; second, households that included both over and under 65 year olds; and, finally, households that included people aged 65 and over only. The results (Figure 11) further support the findings that older people generate the least avoidable food and drink waste, whilst households including younger people only – the most. Households consisting of only those under 65 generated 41% (±22%) more waste on average than those where all household members were over 65 years old. Mixed age households generated 11% more waste than those consisting of over 65s only.

[54] *95% confidence intervals quoted.*

[55] *Estimated marginal means are the average values when controlling for all other variables in the model. In this case, they show the average levels of avoidable food and drink waste for different ages of the respondent, whilst controlling for household size and home composting.*

[56] *See Quested et al. (2013) 'Spaghetti soup: The complex world of food waste behaviours', Resources, Conservation and Recycling 79, pp. 43-51*

Figure 11: Variation in avoidable food and drink waste level by household's age structure, controlling for household size and home-composting



Estimated marginal means shown; error bars show 95% confidence intervals
Source: Waste composition analysis study 2012

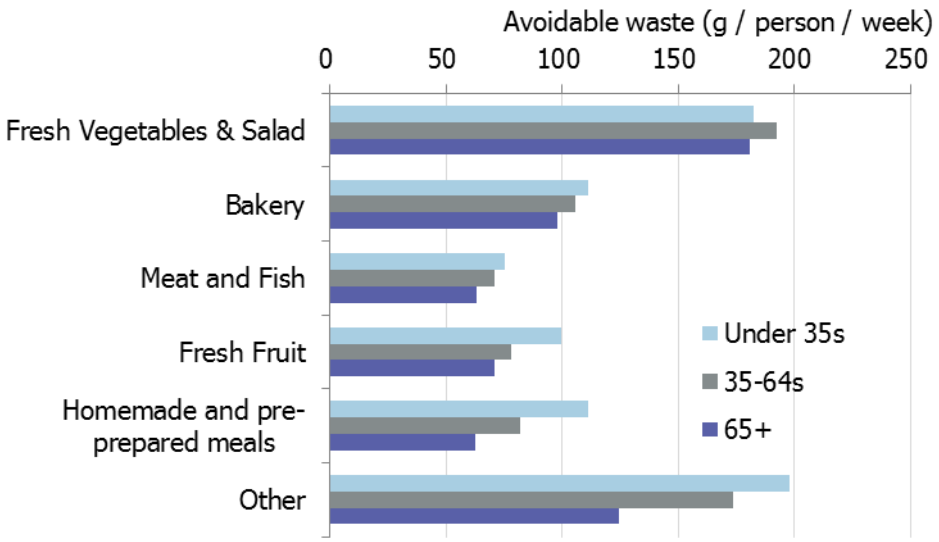
Subsequently, other socio-demographic factors were included in the model, to examine whether the effect of age could be explained by other household characteristics. For example, it could be hypothesised that older people waste less because they are less likely to have children living with them, or that a different gender composition among older groups is the real driving factor for the effect of age. However, the only socio-demographic characteristic that was affecting the significance of age as a factor was employment status of the main earner. When employment was included in the final model for waste compositional analysis, age fell just short of statistical significance at $p = 0.067$ (§7.2).

This suggests that whilst the differences in waste levels between age groups are not driven by the presence of children or gender (which is in itself an interesting finding), they seem to be at least partly explained by the fact that older people are not in employment, and younger groups are more likely to work. Possible underlying reasons for this are explored in greater depth in the employment section (§2.5), e.g. older people might be wasting less food because they have more time to engage in waste prevention behaviours. However, age is still very close to statistical significance even when employment is included in the model – this suggests that the relationship between age and waste is not entirely explained by differences in employment status between different age groups (although this should be treated with caution, as the significance falls just under the threshold).

Another interesting area to explore was whether there were any differences in *types* of waste generated by the three age groups. Figure 12 shows that over 65s generated less waste in all categories of food, with the exception of fresh vegetables and salad. The largest differences between age groups were found for homemade and pre-prepared meals and 'other' types of food and drink waste. People aged 65 and over had significantly lower levels of waste from meals than other age groups. This could imply a more efficient use of leftovers or better portioning and cooking the right amount of food. This could be indirectly caused by the fact that older people tend to live in smaller households which might make it easier for them to account and plan meals for all household members. Figure 13 seems to support this hypothesis, showing that older people were less likely to throw away food because they cooked, prepared or served too much. However, they were also more likely to

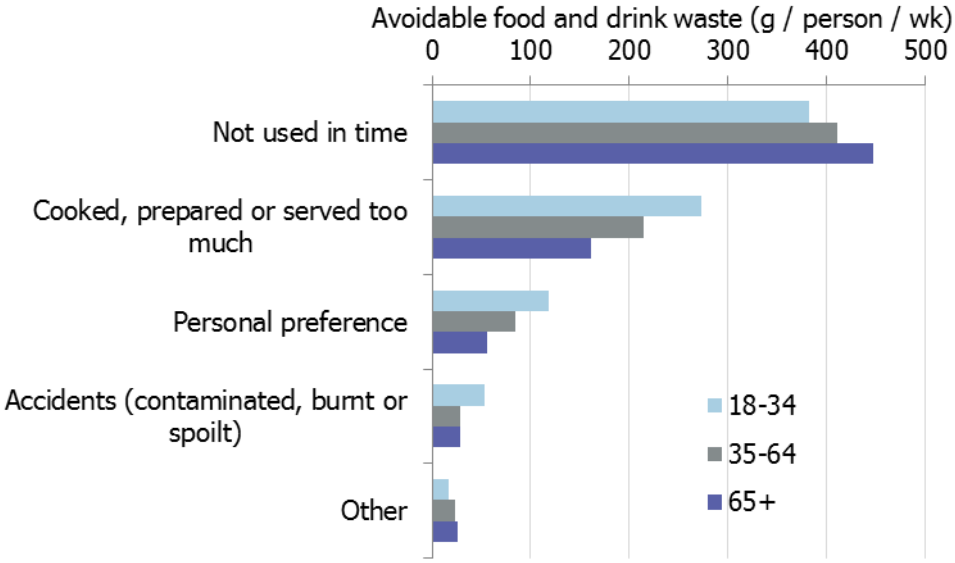
cite 'not used in time' as a reason for disposing of food, which could also be linked to them being more likely to live alone (see §2.3.2).

Figure 12: Types of avoidable food and drink waste by age of respondent



'Other' includes all other types of food and drink not covered in the other categories
Source: Waste compositional analysis 2012

Figure 13: Amount of avoidable food and drink waste for different reasons for disposal by age of respondent



Source: Kitchen diary research 2012

The above results show that older people generate less waste, when controlling for household size and home composting, which has potentially important implications for waste prevention strategies and targeting. However, it is unlikely that age itself is a causal factor[57]. More likely, the lower levels of waste are connected to different levels of engagement with

[57] *Although the physiological effects of age cannot be excluded, as old age is sometimes associated with lower energy needs – less waste might therefore be associated to an extent with less food being purchased; this issue was beyond the scope of this study but could be explored with further research.*

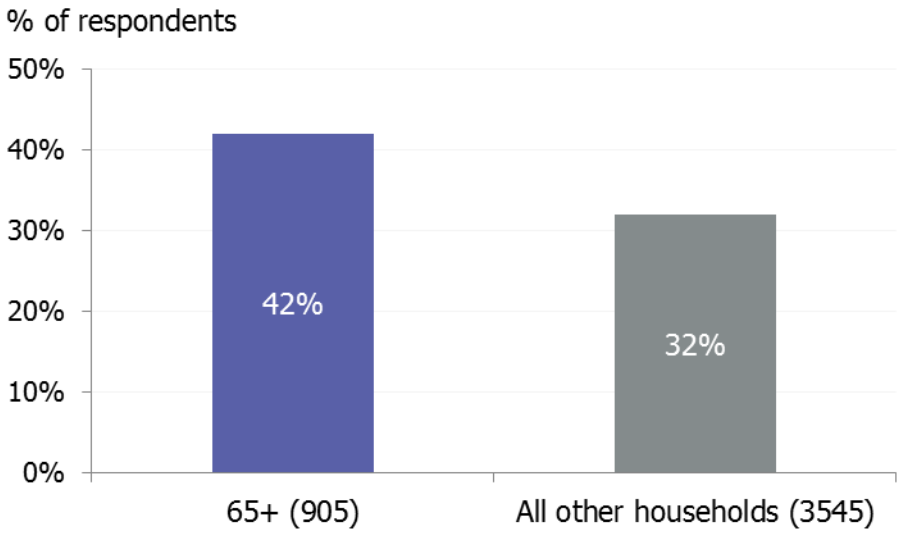
waste-preventing activities. The questions of *what* it is that older people do differently (e.g. shopping, cooking or planning) and, most importantly, *why* (e.g. more time available due to not being employed) are explored in the remaining parts of this section.

2.4.2 Food-related behaviours and age

Research studies into household food and drink waste reveal the complexity of factors that influence its generation. Actions that lead to edible food being generated often happen a long time in advance of the act of throwing food away. Among these, WRAP identified specific behaviours that are likely to help prevent waste, such as making shopping lists, buying the right quantities of food or measuring the correct amount of rice and pasta to be cooked. These behaviours (self-reported) were measured in both the waste compositional analysis and kitchen diary studies, and are also tracked over time through an online survey conducted twice a year (WRAP's food waste tracker). The analysis of these data sources reveals that participation in some of the waste prevention behaviours varies by age. Moreover, the compositional analysis study provided the first opportunity to compare reported behaviours with the actual levels of food and drink waste. It was found that the relationship between them is not straightforward, with only some of the behaviours directly correlated with waste levels (Chapter 3.0). Nonetheless, different age groups engaged with these behaviours to a varying extent, which is in itself an interesting finding.

Figure 14 shows that keeping a running shopping list was more common among those aged 65 and over. This could be due to older people having better food management skills, acquired either over time through managing their home for many years, or as a result of different educational experiences and/or skills or attitudes passed on from parents who would have experienced food shortages in the war and post-war era. There are, of course, different motivations for this behaviour, such as making sure that nothing is forgotten, reducing the possibility of buying more than is needed and wanting to avoid wasting food. In contrast, other shopping-related behaviours such as planning meals and checking cupboards were not found to be age-related.

Figure 14: Percentage of respondents keeping a running list during the week of the things they need to buy (number of cases in brackets)

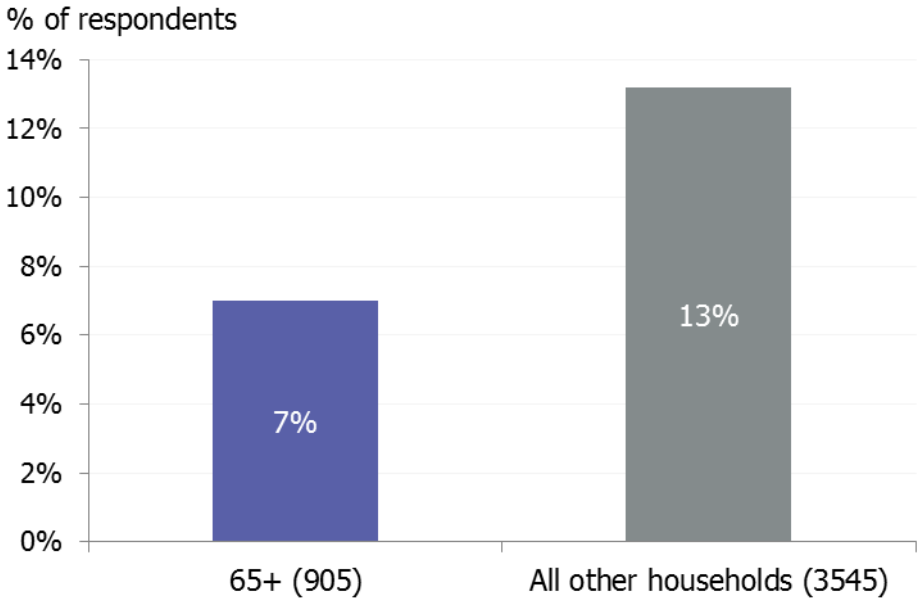


Source: WRAP's food waste tracker, UK data, Autumn 2013

Those aged 65 and over were also less likely to throw away leftover food than the rest of the population, as shown in Figure 15. This both supports and could partly explain the previous

finding that older people threw away less homemade and pre-prepared meals (see Figure 12). It is possible that older people have more skills and knowledge on how to re-use leftover ingredients or meals. Research suggests that such knowledge was more common in the past, for instance most of the pre-war English-language cookery books included sections on using up leftovers and managing the home efficiently, whilst these concerns almost completely disappeared in the post-war era of rising incomes and falling food prices[58]. Moreover, it is possible that older people (on average) have less busy lifestyles, due to fewer being in full-time paid employment, which means that it might be easier for them to plan how they will use the ingredients they purchased and stick to the plans they make. Additional analysis related to lifestyles and broader contexts, such as employment, can be found in §2.4.3, §2.5 and §4.3.

Figure 15: Percentage of respondents who said that last time they had leftovers they didn't get used and were thrown away (number of cases in brackets)



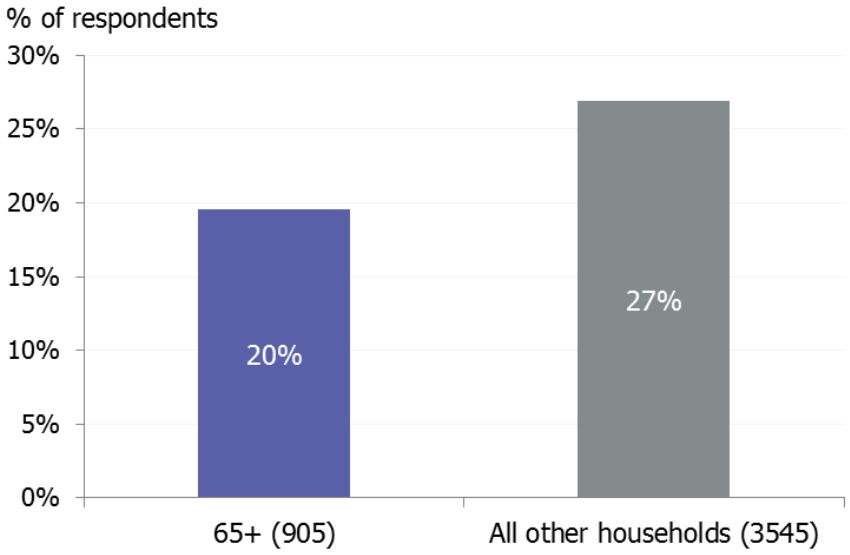
Source: WRAP's food waste tracker, UK data, Autumn 2013

Figure 16 shows that older people were also less likely than other age groups to cook too much pasta or rice by mistake. This could again be due to having better food management skills acquired through life experience or training in their formative years, but also to the fact that older people are more likely to live in smaller households, which can make it easier to consistently assess the amount of food that needs to be cooked. Research suggests that coordinating daily practices, including food consumption, with other household members can be a challenging task, particularly taking into account increasingly variable working hours[59].

[58] *Evans, D., Campbell, H. and Murcott, A. (2013) 'A brief pre-history of food waste and the social sciences', The Sociological Review, 60 (S2), pp. 5-26*

[59] *See for example Southerton, D., Diaz-Mendez, C. and Warde, A.(2012) 'Behavioural Change and the Temporal Ordering of Eating Practices: A UK-Spain Comparison' International Journal of Sociology of Agriculture and Food, 19(1) pp.19-36*

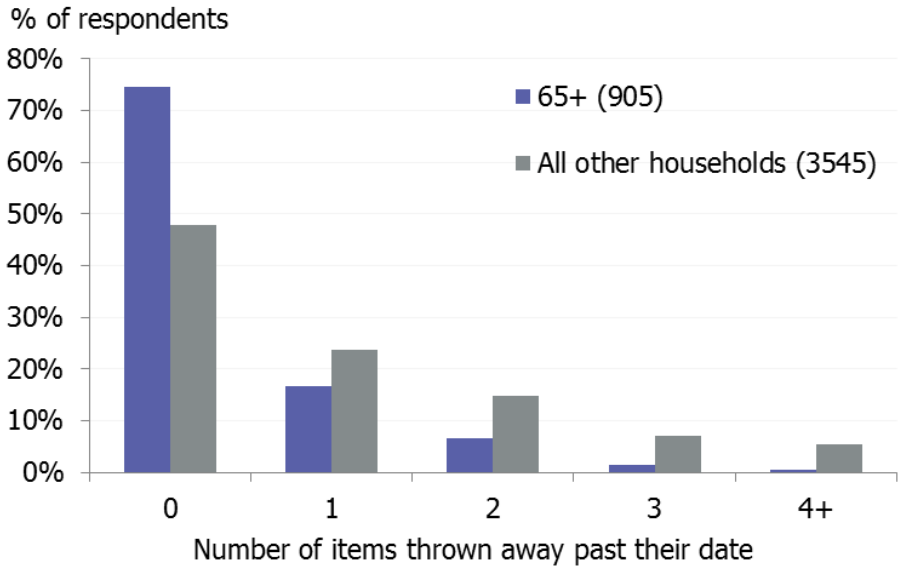
Figure 16: Percentage of respondents who cooked too much pasta or rice by mistake last time they had a meal based on those ingredients (number of cases in brackets)



Source: WRAP's food waste tracker, UK data, Autumn 2013

Finally, older respondents were found to be less likely to throw food away because it has gone past the date on the packaging (Figure 17). Consuming food after a 'best before' date should not present any issues with regards to food safety, although the quality of the food may not be at its best. However, eating food after the 'use by' date is not advisable. Also, it has to be borne in mind that this behaviour was likely to be associated with other food-related behaviours, including how much was bought and using the freezer for example (i.e. which all can influence whether food is used before it reaches its expiry date).

Figure 17: Number of items thrown away because they have gone past the date on the packaging in the past week, comparison of over 65s and rest of the population (number of cases in brackets)



Source: WRAP's food waste tracker, UK data, Autumn 2013

Other behaviours, such as planning meals, checking cupboards before shopping, storing fruit and vegetables in the fridge, correct storage of opened cheese and meats and efficient use of freezer were not found to be correlated with age.

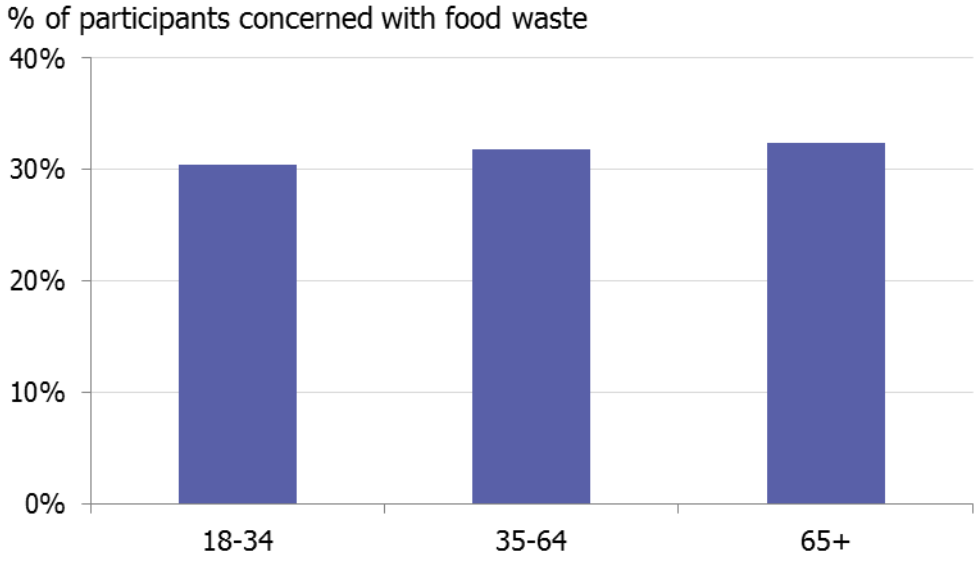
Previous WRAP research on attitudes towards and behaviours around packaging[60] found that older people are more likely to think that packaging is a serious environmental problem and less likely to acknowledge any positive role that packaging can play. In particular, they are most likely to think that storing food in the original packaging causes it to sweat and spoil quicker. Therefore, they might be more likely to unpack food before storing, which in some cases can shorten its shelf life. Younger people, by contrast, are more likely to recognise the benefits of packaging – in particular, its role in keeping products fresher for longer. This does not explain the trend seen in the data (that older people have less waste), but adds to the understanding of the potential reasons behind waste generation in older households.

2.4.3 Other age-related factors: attitudes to waste and lifestyle

There are a number of other potential reasons for the variation in waste levels between age groups, some of them indirectly influencing participation in behaviours described above, others related to broader differences between the groups.

It is often assumed that older people have different attitudes to food waste, caused by war and post-war experiences of food shortages in their formative years, or those of their parents, and as such are more reluctant to throw away good food. However, when asked about food concerns in the survey accompanying the waste compositional analysis, all age groups were equally likely to cite 'food waste' as one of their concerns (around 30% for each age group; Figure 18), which can suggest that lower levels of food and drink waste among older groups are not due to their higher concern with this issue. The marginal differences in food waste concerns between the groups that can be seen in the graph were not statistically significant. However, it has to be borne in mind that these responses might not necessarily reflect levels of effort to prevent food waste, or actions that could influence food waste.

Figure 18: Food waste concerns by age of respondent. Percentage of respondents citing 'food waste' as one of their food concerns.



[60] http://www.wrap.org.uk/fresherforlonger

Source: Waste compositional analysis 2012

It has also been suggested that older people might shop more frequently, which could explain why they generate less waste. However, a preliminary analysis didn't reveal important differences in the frequency of shopping between age groups.

Analysis of data from WRAP's food waste tracker suggests that for younger people (18-34 year olds) the stated motivations to waste less food are similar to the rest of the population – saving money and wanting to run an efficient home are the most cited reasons; environmental reasons are not cited as frequently for the whole of the population. However, there are some differences in factors that hinder people from reducing food and drink waste: younger people are more likely (compared to the rest of the population) to cite time pressures, not knowing how to reduce food waste, and having more important things to worry about.

This research has already suggested that part of the explanation for the differences in avoidable waste generated by different age groups is related to differences in lifestyles, and as a result different ways in which they engage with shopping, cooking and eating practices. Employment has been shown to explain at least part of the 'age effect' in statistical modelling (see §2.5.2 and §7.2 for details)[61].

Another aspect of age-related lifestyle (which can also be linked to employment) is how busy people are, and the consequent effects on food practices. This was measured in the kitchen diary study by the level of agreement with the statement 'My life is so busy that I just eat when I can while I'm on the go'. Those who agreed with this statement had significantly higher levels of waste than those who disagreed (see §4.3 for a related discussion on the availability of time). The 'Food and You' Survey of over 3,000 people conducted in 2010 by the Food Standards Agency (FSA) also included this question, and found a relationship between age and respondents' answers. 35% of 16-24s agreed that 'their life was so busy that they just eat when they can while they're on the go', decreasing to only 7% of those aged over 60.[62]

The availability of time and the frequency of other daily engagements can have an impact on when, where and how food is prepared and eaten. This is likely to include not only 'eating on the go', but also shopping (e.g. if shopping is 'squeezed' between many other daily activities, it might not always be possible to check what is already at home), planning meals (busy lifestyles are likely to interfere with plans) and potentially other behaviours. These issues are described in greater depth in §4.0.

Other WRAP research has shown younger people to report lower proficiency in some of the food management skills[63] and to have lower levels of motivation to tackle food and drink waste. Lower levels of skills can help to explain why younger people are less likely to participate in some of the waste-prevention behaviours discussed in the previous section.

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[61] *It should be remembered that employment status was measured for the main income earner, whilst age for the study participant (i.e. an adult member of the household at least partly responsible for shopping and cooking). Whilst 56% of participants in waste compositional study identified themselves as main income earners, in other cases age brackets might not have been the same for the respondent and the main earner. This does not negate the analysis, as the employment status of the main earner is likely to have an influence on the whole household.*

[62] *Prior, G., Hall, L., Morris, S. and Draper, A., (2011), Exploring Food Attitudes and Behaviours: Findings from the Food and You Survey 2010, London: FSA.*

[63] *See page 21 of WRAP (2007) 'Food Behaviour Consumer Research. Quantitative Phase' at* http://www.wrap.org.uk/sites/files/wrap/Food%20behaviour%20consumer%20research%20quantitative%20jun%202007.pdf

Summary: Variation in food and drink waste by age

Analysis in this chapter reveals that – on average – lower levels of waste were generated in households containing older people compared to younger people, with those aged 18-34 wasting the most. Differences existed in the types of food wasted, although all age groups threw away similarly large amounts of fresh vegetables and salads. In general, younger people wasted more due to cooking, preparing and serving too much than older people, whilst older people had a higher proportion of food thrown away due to it not being used in time. The latter may be linked to the fact that many older people live alone (see the previous section), and are also less likely to use packaging to keep food fresher for longer. Older people tend to portion more accurately, and are more inclined to use up leftovers.

Other WRAP research has shown younger people are more likely to report lower proficiency in some of the food management skills, which could help to explain why younger people are less likely to participate in some of the waste-prevention behaviours.

Further analysis suggests that at least some of this trend is explained by the employment status of the main earner – older people being more likely to live in households where the main earner is retired. There is some evidence to suggest that this relationship could be linked to the availability of time. Older people were less likely to claim that their lives were so busy that they 'ate what they could while on the go', and agreeing with this statement was found to be correlated with higher levels of waste. Contrary to common assumptions, older people were not found to be more concerned over food waste than younger groups – but they may be better equipped in terms of skills and knowledge, and have more time, to act on these concerns.

Conclusions:

People of all ages are similarly concerned about food waste, and although there are age-related differences in the average amounts of food thrown away, all age groups can benefit from reducing food and drink waste further. Differences in the causes of food and drink waste, and the underlying reasons, mean that messages, engagement and changes in products, packaging and labelling need to be developed with the specific needs of different groups in mind. Those involved in developing such solutions also need to be cognisant of the constraints different groups of people might face, such as time availability.

Younger people state that their motivations for wasting less food are saving money and wanting to run an efficient home, similar to the rest of the population. However, there are some differences in factors that they feel hinder them from reducing food and drink waste: this group are more likely (compared to the rest of the population) to cite time pressures, 'not knowing how to reduce food and drink waste', and 'having more important things to worry about'. Therefore, younger people can be harder to reach on this issue as they feel they are busy and have other pressing concerns, but given their stated motivations there is an opportunity to engage them with money-saving benefits. Furthermore, if activities to reduce food waste will also save them time, this group would be more likely to take action. As with the rest of the population, raising awareness of the amount actually wasted, coupled with tips to reduce it (for example promoting the use of the Love Food Hate Waste tools such as the meal planner) is likely to be of value to this group.

Providing clear, evidence-based information on the benefits of food packaging for perishable foods which are not going to be used within a couple of days can help those people who traditionally would remove their food from its packaging at home, which previous WRAP research suggests are more likely to be older people. Clear storage advice on-pack and highlighting in store when changes have been made to food packaging to improve its storage life would also be beneficial.

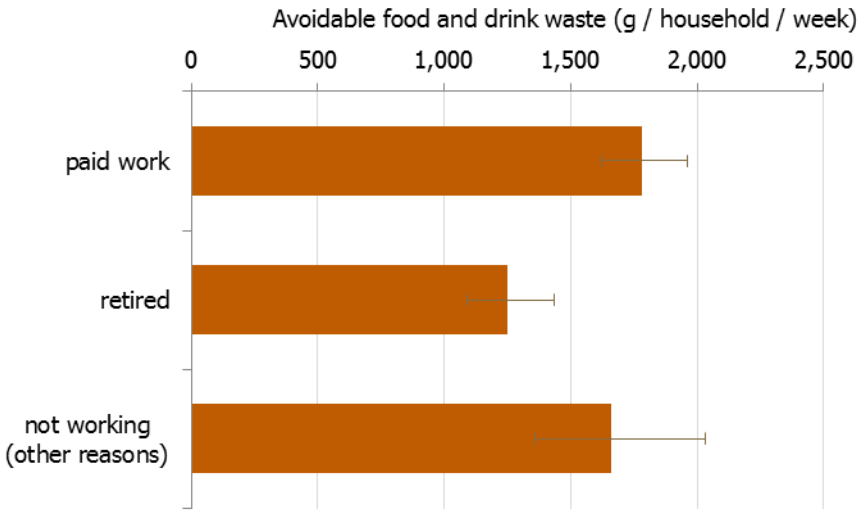
2.5 Results: Employment status

2.5.1 Employment status and levels of avoidable food and drink waste

The employment status of the main earner was calculated on the basis of respondents' answers to Q34d in the survey accompanying the waste compositional analysis and Q9 in the recruitment questionnaire of the kitchen diary study. Due to a high level of detail, and low number of cases in some of the categories, responses to these questions were then recoded into the following three broad categories to simplify the analysis and allow for identifying differences between the groups: in paid employment; retired; and not working for reasons other than retirement (e.g. unemployed, suffering from long term sickness, students, etc.).

The employment status of the main earner was found to be statistically significant in the waste compositional analysis study controlling for household size and home-composting. Those households where the main earner was retired were found to have, on average, the lowest levels of waste compared to either those in paid work or those not in paid work (for reasons other than retirement); these latter two groups generated similar levels of waste to one another (Figure 19).

Figure 19: Variation in avoidable food waste level, by employment status of main earner, controlling for household size and home-composting



Estimated marginal means shown; error bars show 95% confidence intervals
Source: Waste composition analysis study 2012

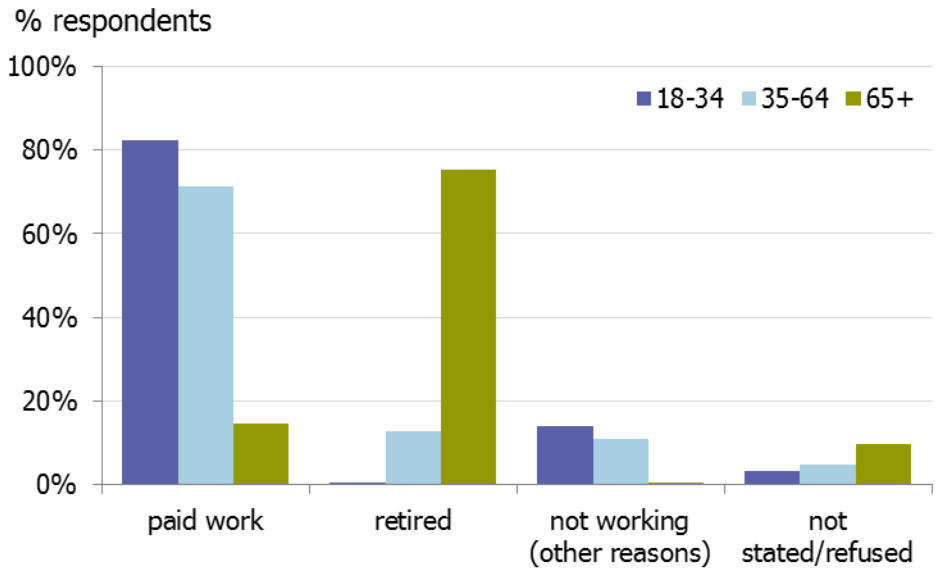
The employment status of the main earner was also close to being significant in the analysis of the kitchen diary data when included in the simple model (i.e. including employment of the main earner and household size as the structural factor), at $p = 0.060$. Again, those who were retired were again seen to generate the lowest amount of waste.

Even though employment status of the main earner was strongly correlated with age of respondent, employment status was still statistically significant when both variables were included in the model (see §7.2). In fact, adding employment of the main earner to the model, decreased statistical significance of age of respondent to $p = 0.067$ (from $p < 0.0005$), which implies that at least some of the effect of age is explained by employment status, as discussed in the age section (§2.4). However, as both variables were still significant or close to significance in the final socio-demographic models, it implies that there are some additional effects for each of the factors, which cannot be explained by the other factor. This means that some of the variation in waste levels caused by employment of

the main earner cannot be explained by age of respondent, and equally that there is likely to be some variation caused by age which cannot be explained by differences in employment status between age groups (although the latter should be treated with caution, as the significance of age falls just below the threshold of statistical significance when employment is included in the model). Figure 20 shows how the two variables were correlated.

The following sections explore potential explanations for the differences in avoidable waste levels between different employment groups, focusing on households where the main income earner was retired compared to other households, as this is where a consistent difference in levels of avoidable food and drink waste was observed. Furthermore, the group 'not working for reasons other than retirement' included many different groups of people: the unemployed, those suffering from long-term sickness, students, people living off private means and those receiving maintenance from an ex-spouse.

Figure 20: Relationship between age of respondent and employment of main earner in waste compositional analysis study



Source: Waste compositional analysis study 2012

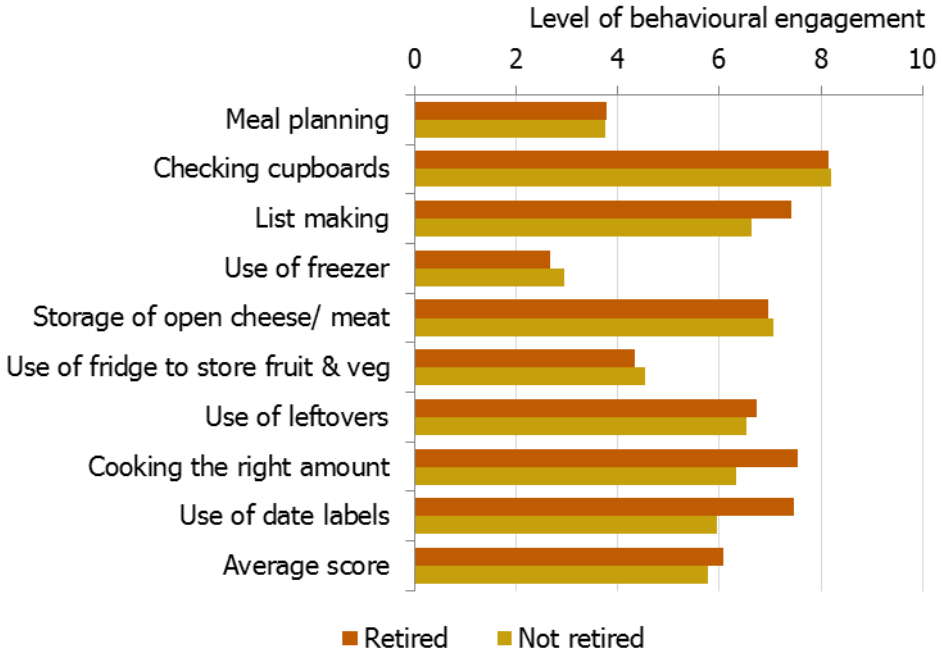
2.5.2 Food-related behaviours and employment status

One potential explanation for the difference in food and drink waste levels between households where the main income earner was retired and other households was different levels of engagement with some of the behaviours identified by WRAP as contributing to waste generation in the home (as discussed in §3.0).

Figure 21 shows differences in levels of behavioural engagement by the employment status of the main earner. Significant differences between households where the main earner was retired (compared to other households) were found for the following behaviours: list making, use of the freezer, cooking the right amount, throwing food away because it has gone past the date on the packaging, and average level of behavioural engagement. The level of engagement was calculated for each of the behaviours, measured by questionnaire responses, with 10 representing strong engagement with the behaviour and 0 the lowest level of engagement (or no engagement) – see §3.1 for more details.

The results show that those households where the main earner was retired were significantly more engaged than other households with three of the four behaviours where differences were seen: list making, cooking the right amount and throwing food away past date on the packaging (in addition to the average level of behavioural engagement). There was evidence of a relationship with levels of avoidable food and drink waste for all these behaviours, as discussed in §3.0. In contrast to other behaviours, households where the main income earner was retired were significantly less likely to use the freezer than the households. However, the use of freezer was not found to be significantly correlated with levels of avoidable food and drink waste, see §3.2. Therefore, this suggests that at least some of the differences in levels of avoidable food and drink waste between households where the main earner is retired and other households are explained by engagement with key behaviours.

Figure 21: Comparison of households where the main earner was retired and the rest of the population for engagement in food-related behaviours[64]



Source: Waste compositional analysis study 2012

It has to be borne in mind that, although the results above show a correlation between employment status (specifically whether the main income earner was retired) and behaviour, it is not necessarily the case that retirement causes these differences directly. These differences may be the result of other factors, which correlate with whether someone is retired (such as time available for food preparation). It should also be noted that the employment status related to the main earner of the household whilst behaviours were measured via answers provided by study participant (with 56% of respondents identifying themselves as main earners).

[64] *For more details of the behavioural scorecard, see this document.*

2.5.3 Other explanations

Many qualitative studies have pointed to the difficulties faced by many people in coordinating their busy working lives with household food provisioning, cooking and consumption, including some of the behaviours described in the previous section.

For example, being tired and hungry after work can lead to purchasing additional, easy-to-prepare food items, instead of cooking meals with ingredients already at home, but requiring more time and effort to cook. Similarly, making shopping lists and checking what was in the fridge might not always be possible, when shopping is performed in a hurry, for example, on the way back from work or train station[65].

The waste compositional analysis study included only one question related to time – whether respondents saw time as a hindrance to minimising waste (Q21_1). Not many people chose this option, perhaps because the link between time and food and drink waste is not direct, and therefore not usually reflected on (time is discussed in greater depth in §4.3). Answers to this question were, however, strongly correlated with the employment status of the main earner, with respondents from the households where the main earner was employed being much more likely to cite time as a barrier to minimising waste than those where the main earner was retired or not working for other reasons.

Summary: Variation in food and drink waste by employment status

This chapter shows the relationship between the employment status of the main income earner and levels of avoidable food and drink waste generated in the household. Those households where the main earner was retired had the lowest levels of waste. Employment status was correlated with age (with older people more likely to be retired). However, in models controlling for age, employment status was still statistically significant. This means that some of the variation in waste levels linked to retirement cannot be explained by age-related effects.

Additional analysis suggests that those households where the main earner was retired had higher levels of engagement in some of the waste prevention behaviours than other households. Specifically, those households where the main earner was retired were more likely to make a list, cook the right amount, and less likely to throw food away past the date on the packaging. In contrast, households where the main income earner was retired were less likely to use the freezer. Furthermore, in those households where the main earner was retired, questionnaire respondents were less likely to cite time constraints as a hindrance to minimising waste.

[65] *See for example: Evans, D. (2012a) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology 46 (1), pp. 41-56*

Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction 20(2), pp. 1-25

Conclusions:

This evidence reinforces the importance of taking into account employment and other factors relating to time constraints in identifying the right tools and support to help people waste less (§4.3). The majority of the population is in paid employment, and messages, engagement and innovations in products, packaging and labelling must be appropriate for those with busy lives and little time.

For those not in paid work, but not retired, other routes need to be developed. For students, LFHW has been working with colleges and universities for a number of years, both directly and through its partners. Providing easy, simple recipes and tips for students at key moments in their lives – for example leaving home – can help develop much wanted skills, help save money and give greater independence to those involved. Likewise, LFHW has been developing and supporting LFHW cookery classes in the community to help raise people's confidence in the kitchen, helping them to increase their skills, waste less food and drink and save money.

In 2013/14 LFHW has been piloting a new programme seeking to build kitchen skills for people who would like additional advice and support on budgeting and making the most of their food, but who are not seeking cookery classes. Following great results, 'Love Food Hate Waste – Save More'[66] will be rolled out across the UK in 2014-15 working in communities to help them save money.

2.6 Presence of children

2.6.1 Presence of children and levels of avoidable food and drink waste

A number of studies suggest that children could be influencing the amount of food and drink waste generated in the home. Parents sometimes cite children being 'fussy' and leaving unfinished meals on their plates as a reason for throwing food away[67]. Moreover, qualitative evidence suggests that some families regularly buy more than is needed in order to provide a wide selection of food for the children, even if it means that some of it will inevitably be wasted; others intentionally cook more than may be needed, so that second helpings are always available[68].

However, the waste compositional analysis found no evidence of a relationship between presence of children and overall levels of avoidable food and drink waste when controlling for the number of occupants in a household and home composting. This is consistent with analysis previously reported[69], which showed that there was no difference in waste levels between same size households with and without children for three- and four-people households (implying that the presence of a child does not contribute to any more waste

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[66] See this link for more details: http://partners.wrap.org.uk/assets/4224/

[67] See §4.1 for more discussions on fussy eating, including related literature and further analysis.

[68] See for example: Evans, D. (2012) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology 46 (1), pp. 41-56

Graham-Rowe, E., Jessop, D.C., Sparks, P. (2014) 'Identifying motivations and barriers to minimising household food waste', Resources, Conservation and Recycling (84), pp. 15-23

[69] See section 2.4 in Household Food and Drink Waste in the UK 2012, WRAP (2013).

than the presence of an adult). However, taking into account lower calorific needs of younger children and therefore lower amounts of food required to meet their needs, it seems that there is some scope for reducing waste levels for families with children below that of all-adult households of a similar size.

Moreover, in the kitchen diary study, households with children had in fact more avoidable food and drink waste recorded than those without. There are a few potential explanations why this relationship was not found in the waste compositional analysis dataset. The kitchen diary gathered information about waste from all disposal routes – it is possible that some types of food and drink wasted more by children (particularly liquids) are more likely to be disposed of down the drain or through other routes not accounted for in waste compositional analysis. This would mean that data from kitchen diaries may be more complete, as the waste compositional analysis only measured waste collected by local authorities. However, the difference between the two datasets could also be due to the possibility that families with children engaged in the diary exercise in a different way than those without children. For example, it is possible that children helped with filling in the diary, thus contributing to it being more complete. Another explanation could be that for households with children, the person filling in the diary (probably a parent in most cases) had more control and awareness of what other household members were eating and throwing away, thus being able to record it more diligently than a survey respondent responsible for recording waste of adult members of the household.

In summary, evidence presented in this section shows that households with children generate at least as much waste as all-adult households with the same number of occupants. Moreover, there is weak evidence from the kitchen diary study that children are associated with more waste than adults, although this finding should be treated with caution, as it might not reflect the real differences in waste levels, but could be caused by households with children submitting more completed diaries.

2.6.2 How do children affect waste generation in the home?

As noted above, the main way in which the presence of children was thought to be potentially contributing to waste generation in the home related to the rejection of food and being 'fussy', together with parents' strategies to ensure that children get the right nutrition, such as over purchasing and cooking more than may be required (and then not re-using leftovers). Whilst these complex relationships revealed by qualitative research were difficult to capture through a questionnaire, questionnaires in both studies attempted to examine whether some of these patterns could be identified in a large, representative sample.

In the pre-diary questionnaire, participants were asked about reasons that hindered them from trying to minimise the amount of food that their household throws away (Q23). They were given an option to choose any number of reasons from ten provided in the questionnaire, specify any other reason, or state that none of them were a barrier for them. Those who provided 'children don't always finish their food' as a barrier to minimising waste had 43% (±31%) more avoidable food and drink waste than those that did not cite this reason, controlling for household size.

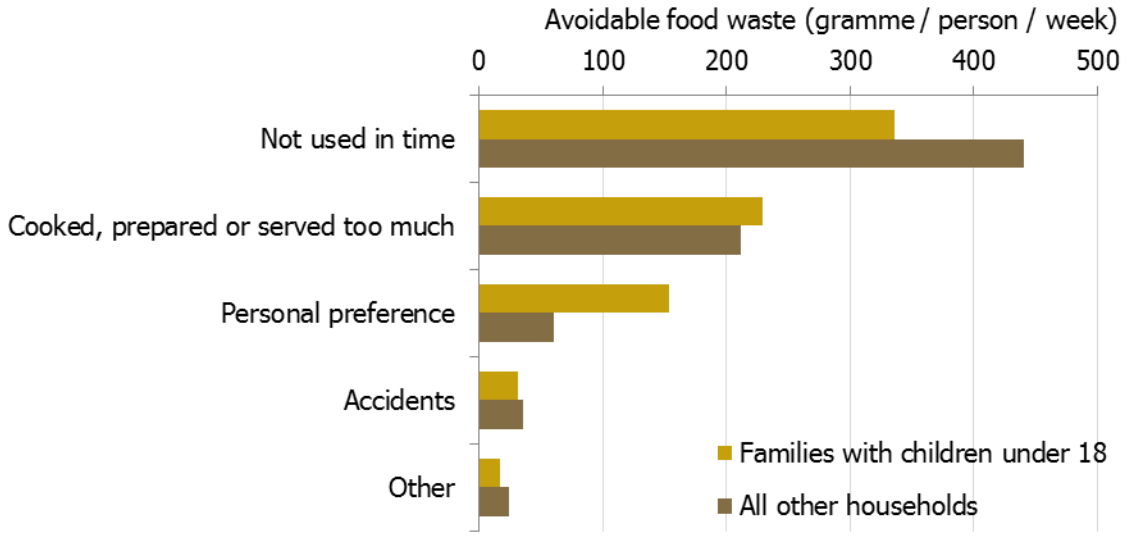
This question was also asked in the waste compositional analysis research, but no significant relationship was found between waste levels and responses to this question. This means that the results from the diary research should be interpreted with a degree of caution as they were not replicated in both data sources. As noted previously, the difference between these two datasets could be due to the level of completeness of diary keepers or due to the fact

that the kitchen diary recorded waste from all disposal routes (including liquid waste disposed of down the drain).

Figure 22 shows that families with children were in fact more likely than other households to record 'personal preference' as a reason for disposal, which further supports the hypothesis that children might be more likely to reject food. It is also possible that the presence of children could be an underlying cause for some of the other major reasons provided by participants in that study, in particular 'served too much'. This was because study participants could record whichever reason for disposal they felt was best, and this was largely a subjective decision – leftovers after dinner could be associated by some as resulting from serving or preparing too much, and by others as being rejected by family members, and therefore recorded as 'personal preference'.

It has to be borne in mind that 'fussy eating' is not limited to children only. §4.1 further explores this phenomenon.

Figure 22: Reasons for disposal by presence of children



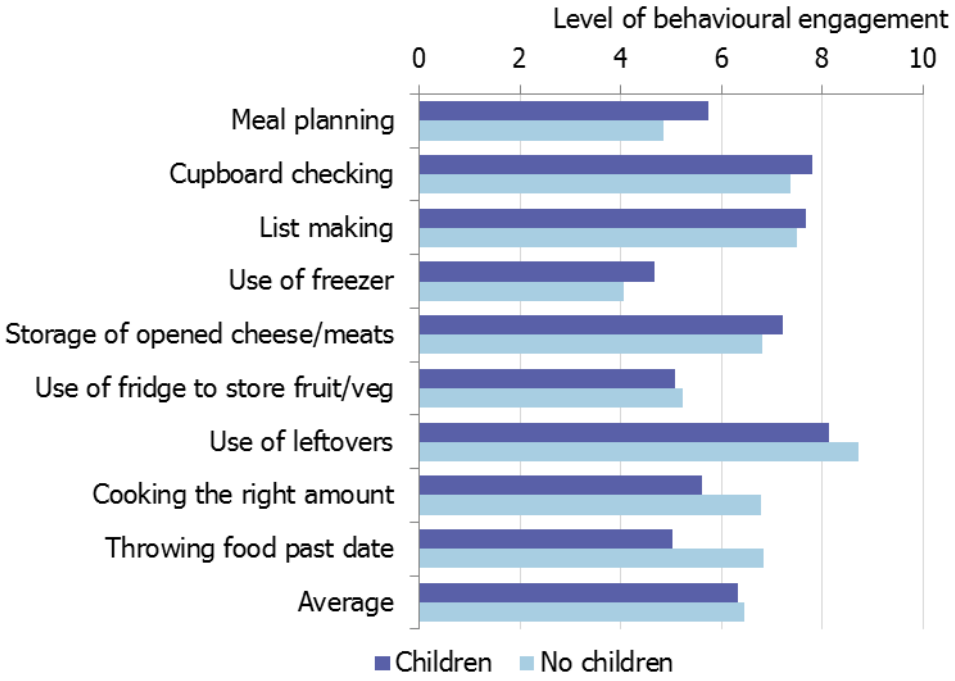
Source: Kitchen diary study 2012

Figure 23 illustrates the differences between households with and without children in terms of the various food-related behaviours they engage in. The level of engagement was calculated for each of the behaviours, measured by questionnaire responses, with 10 representing strong engagement with the behaviour and 0 the lowest level of engagement (or no engagement) – see §3.1 for more details.

It was found that families with children were significantly less likely to cook the right amount of food and use their leftovers than households without children. This finding seems to support the view that the presence of children in the household might make it more difficult to prepare the right amount of food.

Families with children were also more likely to throw food away because it has gone past the date on the packaging, which could imply a higher concern over food safety in those households. On the other hand, households with children were significantly more likely to be involved in two food-related behaviours than those without children – meal planning and use of freezer, both of which could be associated with the challenge of provisioning larger households.

Figure 23: Comparison of households with and without children for engagement in food-related behaviours[70]



Source: WRAP's food waste tracker, UK data, Autumn 2013 wave

2.6.3 Variation in food and drink waste types by presence of children

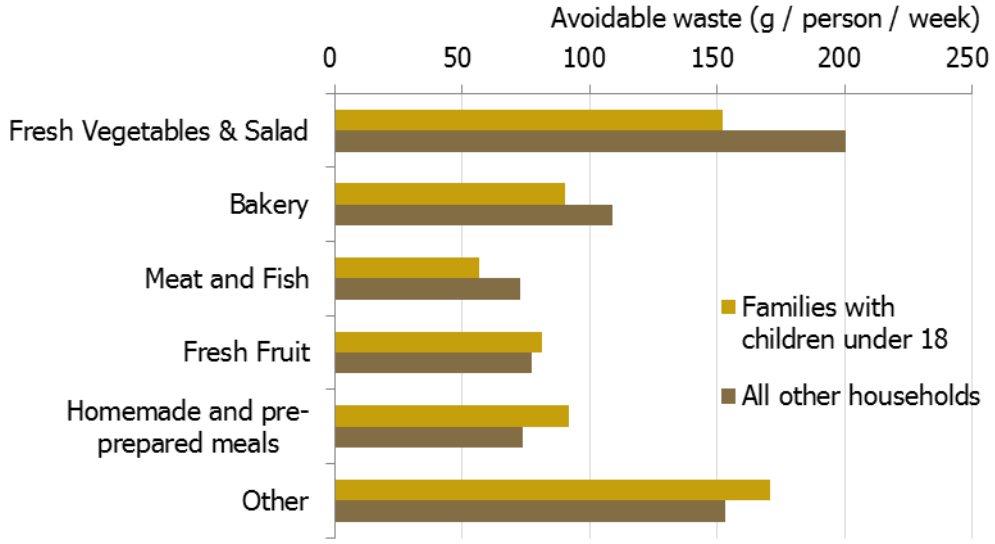
Figure 24 shows that in, the waste compositional analysis, families without children generated higher levels of avoidable waste from fresh vegetables and salad; households with children wasting substantially less. One explanation could be that families with children simply purchase fewer vegetables, which would explain lower levels of such waste. This seems to be supported by purchasing data from Family Food survey (Defra) where households with children were shown to purchase fewer fresh and processed vegetables (excluding potatoes) than same size households without children.

In contrast, families with children generated slightly higher levels of waste from homemade and pre-prepared meals, which further supports the hypothesis that some food and drink waste in such households might be caused by children rejecting food or by cooking or serving overly large portions and not re-using leftovers.

Further analysis will be needed to compare these results to purchasing data related to other products; this was outside of the scope of the current study. A contribution may also be the fact that households with children tend to be larger, and, as demonstrated earlier in Figure 5, managing fresh vegetables and salad seems to be more difficult for small households. Therefore the relationship found might not be entirely due to the presence of children, but related to household size.

[70] *For more details of the scorecard, see this document.*

Figure 24: Types of avoidable food and drink waste generated by presence of children



'Other' includes all other types of food and drink not covered in the other categories
Source: Waste compositional analysis 2012

Summary: Presence of children

This section shows the relevance of the presence of children for levels of avoidable food and drink waste generated in the home. The evidence suggests that families with children generated at least as much waste as all-adult households of the same size. Taking into account the lower calorific needs of younger children, the fact that children were associated with similar levels of waste as adults indicates that a higher proportion of food entering the home was wasted from families with children.

Additional analysis seems to support the popular view that waste can sometimes arise because children reject food or because parents cook or prepare more food than is required (which as other studies suggest could be a conscious practice, to ensure a wide selection of food for the children or to ensure that second helpings are available). There is also evidence to suggest that families with children might be paying greater attention to food safety, being more likely to throw away food because it has gone past the date on the packaging, which could (for products carrying a 'best before' date) lead to edible food being discarded. Families with children were also less likely to use their leftovers than households without children. On the other hand, households with children were more likely to be involved in two food-related behaviours than those without children – meal planning and use of freezer.

Conclusions:

The conclusions in this section relate to households with children. For conclusions for households without children, please see the conclusions in other sections, including §2.4, §2.5 and those in Chapter 4.0.

In light of this evidence, there is scope for reducing the amount of food and drink waste generated by families with children. Allowing children to help themselves to food from a central serving dish, rather than other people serving it for them, could help reduce the amount of plate-leftovers, which can be more difficult to use at a later date. However, strategies need to take into account qualitative evidence from other studies, which suggest that some parents may knowingly cook too much to ensure that enough food is available. In such circumstances, using leftovers for future meals – including using the freezer to extend the life of those leftovers – could form part of a family's strategy to reduce food and drink waste. Freezing leftovers in individual portions that are clearly labelled can be an ideal way to ensure that a variety of quick and tasty home-made meals are available.

Also, making date labelling on food products even clearer, and communicating what the two main date labels mean, could help parents in making decisions about when to discard food, without compromising on safety.

It is also important that efforts to increase vegetable consumption by families (who currently buy less fresh vegetables than other types of household) are made in conjunction with support to ensure that extra purchases are consumed rather than wasted: good advice regarding storage location, use of packaging to prolong shelf life and inspiring and relevant recipes will be important, as will reinforcing guidance that frozen and tinned vegetables also contribute to your '5-a-day'.

2.7 Household socio-demographics: Summary and conclusions

The analysis of relationships between avoidable waste and socio-demographic factors revealed a complexity of correlations between them. Overall, three socio-demographic characteristics were found to be strongly correlated with levels of avoidable waste in the waste compositional analysis study: household size, the age of respondent and employment status of the main earner. These results were more or less supported by results from the kitchen diary: household size being strongly correlated with waste; age of respondent not being significant, but the same pattern identified in the data; and employment showing a similar effect in a simple model, but was not significant in the final model[71] (which could be caused by the inclusion of other variables that correlate with employment).

Therefore, there is enough evidence derived from both studies to suggest a relationship between household size, age of respondent and employment status of the main earner with avoidable food and drink waste.

Additionally, the kitchen diary study found relationships between waste and gender, and presence of children, which were significant both in isolation and after controlling for other demographic factors. These relationships are harder to explain due to a lack of consistency with the waste compositional data. It is possible that some of these effects were not caused by differences in the actual amount of food and drink waste generated, but could be due to different socio-demographic groups engaging with the diary exercise in different ways. More

[71] *See §7.0 for details of statistical modelling.*

research would be needed to understand these findings. This was beyond the scope of the present study, and as such these variables are not analysed further.

Summary: Variation in food and drink waste by household socio-demographics

Evidence presented in this chapter suggests that household size, age of respondent and employment status of the main household earner were correlated to a higher or lower extent with levels of avoidable food and drink waste. Those aged 18-34, those where the main income earner was not retired and single occupancy households generated the highest levels of avoidable waste on average. Households with children were found to have similar levels of avoidable food and drink waste on average as all-adult households with the same number of occupants.

3.0 Results: variation in avoidable food waste by food-related behaviours

3.1 Behaviours: background

For levels of food and drink waste to be reduced, one of the main options is for people to change what they do in relation to food in the home. These changes could include changes to shopping, food preparation and storage, meal patterns, communication between household members about food, or changes to the food brought into the home.

This is not to say that other household attributes are unimportant – attitudes, awareness, socio-demographic factors, cooking skills or confidence in the kitchen; some of these have been investigated in other chapters within this report and shown to be correlated with levels of avoidable food waste. However, their relationship with food and drink waste is likely to be indirect, acting through what people actually do, as discussed in §1.2.

Given their importance, food-related activities form the focus of this chapter, specifically to identify correlations between levels of avoidable food and drink waste and responses to questions focused on food-related activities that could impact waste, as asked in the questionnaires accompanying the waste compositional analysis and kitchen diaries[72].

WRAP had previously developed a series of questions to assess the extent to which various behaviours are being performed in the UK. The behaviours that were chosen were hypothesised to have some impact on at least one element of household food and drink waste, relevant to large parts of the UK population, and be the type of behaviour that should be included in a campaign aimed at reducing household food and drink waste, such as Love Food Hate Waste (LFHW).

The behaviours chosen (Table 2) were not designed to be exhaustive; there are likely to be dozens of different activities that could influence food and drink waste levels in different contexts. The chosen behaviours cover a range of types of activities, including planning, shopping, storage, cooking and use of food in the home. Some of the behaviours were chosen as they may have been wider proxies for other behaviours – for instance, storing apples in the fridge could be a wider proxy for storing other fruit in the fridge.

Other behaviours and behavioural proxies were also included in this analysis where questions were present in the questionnaire:

- A question (Q28) asking the research participant to rate how 'fussy' the people in their household has been used to estimate the proportion of 'fussy eaters' in each household[73]. Although the responses are subjective (i.e. the opinion of the person responding to the questionnaire) and they are not strictly a behaviour, they are likely correlated to the act of rejecting food and, for this reason, have been included in this analysis. [This question was asked in the waste compositional analysis research, but not in the kitchen diary research.]
- In the kitchen diary, a question was asked about whether people bought special offers (pre-diary questionnaire, Q9); this was not found to be correlated with waste levels and most people did buy food on special offer. However, the follow up question (Q10) asked

[72] *In this chapter, these activities have been referred to as behaviours as the questions largely reflect single activities, rather than a group of activities and their surrounding context (practices). This should not be taken to imply that social practices perspective are not useful in understanding food waste (quite the opposite is argued in §5.0), only that questions relating to specific activities are explored in this chapter.*

[73] *The topic of fussy eating is explored in more detail in §4.1.*

what occurred when they bought special offers and one of the options ('I buy less of something else') describes a behaviour centred around using offers intelligently. For this reason it was included in the analysis. [This question was not asked in the waste compositional analysis research].

Table 2: Behaviours included in the behavioural scorecard

Behaviour	Question number	
	Waste compositional analysis	Pre-diary questionnaire
Meal planning	Q3	Q5
Cupboard checking	Q4	Q6
List making	Q5	Q7
Use of freezer	Q7	Q11
Storage of cheese & meats after opening	Q8a, Q8b	Q12a, Q12b
Use of the fridge to store apples & carrots	Q9a, Q9b	Q13, Q14
Using leftovers	Q11	Q16
Cooking the right amount of rice & pasta	Q12, Q13	Q17, Q18
Throwing away items because they have gone past their date label	Q14	Q19

The analysis details are described in §7.0. In short, correlations were investigated between behavioural factors and the amount of avoidable food and drink waste generated from households, controlling for structural factors (such as household size). To explore these correlations, a number of different models were used, drawing on both the waste compositional dataset and that from the kitchen diaries. The following section presents a summary of the results; more detailed results can be found in §8.0.

3.2 Behaviours: results summary

The appendix on statistical analysis of behaviours and food and drink waste levels (§8.0) contains details of the many models used to explore the relationships between behaviours and levels of avoidable food and drink waste. Table 3 summaries the results of these models, showing the evidence of correlations found.

Table 3: Summary of behavioural variables and their correlation with avoidable food and drink waste levels for different models in this chapter

Type of waste / Behaviour	Avoidable waste: Waste compositional analysis	Avoidable waste: Kitchen diary	'Not used in time'	'Cooked, prepared or served too much'	Avoidable apple & carrot
Meal planning	✓	✓	✓✓		Not included in models
Cupboard checking					
List making		✓✓		✓✓	
Use of freezer					
Storage of cheese and meats after opening					
Use of the fridge to store apples and carrots					✓ apples only
Using leftovers	✓✓	✓✓		✓✓	Not included in models
Cooking the right amount of rice and pasta		✓✓		✓✓	
Throwing away items because they have gone past their date label	✓✓	✓✓	Not included in models (see comments)		
Fussy eating	✓✓	Not measured			
Buying less of other items when purchasing special offers	Not measured	✓	✓		

✓✓ = clear relationship – similar relationships in all models, most (or all) being significant
✓ = moderately clear relationship – significant relationships found in only some of the models

The strength of evidence for correlations between each behaviour and food and drink waste levels can be found below.

Strong evidence

- **Using leftovers**: strong correlations were found for both datasets with those using up leftovers generating less avoidable food and drink waste.

- **Fussy eating**: strong correlation found in the waste compositional analysis dataset (not asked in kitchen diary research); households with more fussy eaters were generating more avoidable food and drink waste.
- **Throwing away items because they have gone past their date label**: strong correlations were found in both datasets with those throwing away fewer items generating less waste. As noted in the technical results section, this measure is not, strictly speaking, a behaviour but the result of other behaviours that lead to waste.

Moderate evidence

- **Buying less of other items when purchasing special offers**: strong correlation in some of the variants of the kitchen diary models; those who adjust their purchases when buying special offers generated less avoidable food and drink waste.
- **Meal planning**: significant in one variant of the waste compositional analysis, and as a single variable in the kitchen diary analysis; significant when analysing amount of food 'not used in time' in the kitchen diary. The fact that meal planning was significant in a model with no other behavioural variables but not in multi-behavioural models suggests that either a) the relationship seen is not causal but is the result of another behaviour that meal planning correlates with (e.g. list making) or b) this variable affects food and drink waste levels in combination with other variables.
- **List making**: significant in the kitchen diary, but not in the waste compositional analysis.
- **Cooking the right amount of rice and pasta**: significant in the kitchen diary, but not in the waste compositional analysis.
- **Use of the fridge to store apples and carrots**: relationship found between the level of avoidable apple waste and storing apples in the fridge. No analogous relationship was found for carrots.

For the behaviours mentioned above, the evidence in this chapter does not prove that performing these behaviours leads to less waste, only that households that do perform them waste less. This distinction is important, as the effects seen could be the result of other actions which are also performed by those households. For instance, 'buying less of other items when purchasing special offers' might be related to other purchasing decisions that also lead to people buying the right amount of food and drink for their needs. The intelligent use of offers, as implied by the behaviour, may only represent a small part of the correlation with avoidable food and drink waste levels seen in the analysis. However, with the data available, it is not possible to partition the effect further.

For all of these relationships however, a relatively direct mechanism of action between the behaviour and the amount of waste is highly plausible. Therefore, the correlative evidence presented in this report is consistent with that mechanism being present and strong enough to measure. However, the authors suggest that the information in this report is not used to compare the size of effects of different behaviours, given that a) the strength of relationship between behavioural factors and waste levels varies depending on the other variables included in the model, and b) these correlations are not necessarily describing causal mechanisms.

No evidence

The fact that no correlation was found between some behaviours and avoidable food and drink waste levels is not necessarily a reason to stop promoting them as strategies for food

and drink waste reduction. As mentioned in §6.3, there are a number of reasons why no correlation has been found. Specific points for each of these three behaviours include:

- **Cupboard checking**: if people in some households only add food to a shopping list as it runs out, there would be no need to check cupboards. Similarly, for products with long shelf lives, the effect on waste would be minimal if purchases are made when there is already some in the cupboards. In contrast, for other combinations of households and products, checking cupboards may be an important step to reducing food and drink waste.
- **Using the freezer**: the freezer can be a very convenient method of extending the shelf life of products. It can be especially useful if plans change rendering it difficult to consume items before they go off. As it currently stands, the question about freezers is focused on the number of different types of food that are frozen. As such, it misses information on food coming back out of the freezer (and being eaten) or people's confidence in using up items from the freezer. Therefore, future WRAP questionnaires will attempt to capture a greater range of freezer-related behaviour in questions on this topic in the questionnaires.
- **Storage of cheese and meats after opening**: Since this question was drafted, a higher proportion of these products have re-closable (often referred to as re-sealable) packaging. This means that storing items in their original packaging includes some items that are protected from rapid deterioration (re-closable) and some which are not. Furthermore, very few people respond to the question stating they leave items unwrapped, suggesting that this behaviour may not be causing much waste amongst the population[74]. Alongside the relatively small amounts of cheese and sliced meats wasted as a proportion of the total avoidable food and drink waste, these factors may explain why no correlation was found with this question.

As only a subset of these factors are picked up in questionnaires and, by their nature, questionnaires are not able to capture the full richness in how activities are implemented within the home, it is not surprising that only some behaviours are found to be significant in the models.

The interrelation of various behaviours and the context in which they are performed are also likely to be important in determining food and drink waste levels. For instance, checking cupboards might only be relevant for those who shop relatively rarely, and not make any difference for those who shop every day, as they might have a better idea of what is already in the house. Qualitative research suggests that it is not any single behaviour that determines food and drink waste levels, but combinations of behaviours and their interplay that are important.

Given this, exploring statistical interactions between explanatory factors in the current analysis should be useful: for example, that meal planning only has an effect if, say, a list is also made. However, preliminary explorations to this effect did not reveal any significant relationships. This is likely to be due to the variability in the data available precluding these subtle effects being picked up. In particular, the analysis is not helped by the week-to-week variation in the amount of waste generated (adding variability around the long-term average

[74] *Or there is a bias towards socially desirable responses from research participants.*

waste level of each household) and the number of potential factors influencing food and drink waste.

Therefore, from the evidence in this chapter, it is hard to determine which behaviours are *most* important in reducing household food and drink waste for the population. On a household level, this information might not be very useful as waste generation appears to be highly context dependent and therefore what might reduce food and drink waste in one household (e.g. ensuring that the right amount of food is brought into the home to reduce the amount of food that is not used in time) may not reduce food and drink waste in another home (where, for instance, there is a high level of food being rejected).

Summary: Behaviours

This chapter presents results from statistical models demonstrating a correlation between a number of food-related activities (behaviours) and the level of avoidable food and drink waste generated by a household. These correlations are consistent with the hypothesis that these behaviours help reduce food and drink waste, although other explanations may explain the correlations.

The following behaviours are associated with lower levels of avoidable food and drink waste:

Strong evidence: Using leftovers; throwing away fewer items because they have gone past their date label[75].

Moderate evidence: Meal planning; list making; use of the fridge to store apples; cooking the right amount of rice and pasta; buying less of other items when purchasing special offers.

In addition, the higher the proportion of fussy eaters in a household the more waste generated.

This is the first time (to the authors' knowledge) that quantitative relationships between actual waste levels and a wide range of behaviours have been identified.

The analysis also points to a complex relationship between behaviours and levels of avoidable food and drink waste. This is likely to be because food can be wasted for a variety of reasons and the activities required to prevent different types of waste differ. In addition, qualitative research suggests that the generation of food and drink waste is usually the result of the interplay between multiple behaviours. All of these points make detecting and quantifying the effects of single behaviours on food and drink waste challenging. For this reason, it is difficult to determine which behaviours are more important for the population; for individual households, the behaviours that will help them reduce food and drink waste will vary greatly depending on the reasons such waste is generated.

[75] *'Use by' dates refer to safety. Food can be eaten up to the end of this date but not after, even if it looks and smells fine. 'Best before' dates refer to quality. Foods will be safe to eat after the 'best before' date, but may not be at their best. The shelf life of many products (with either type of date) can be extended through the use of the freezer.*

Conclusions:

It is important to ensure that, wherever possible, communication with the public takes into account that different solutions are required to reduce food waste in different households. For example:

- In households that have a lot of food that is not used before it goes off, focus may fall on planning (e.g. planning meals and making lists) and storage;
- Households in which too much food is served may focus more on meal times and serving the appropriate amount of foods for each individual in the household.

Every person and every household will have their own reasons as to why food is wasted in their home and therefore a mix of advice, support and guidance is needed to address this. Whilst asking people to 'reduce food waste' is too broad a message, only focussing on one behaviour will not work for every person or household either. Helping people to identify why food is thrown away in their particular set of circumstances is therefore a key first step to allow them to pick solutions that will work for them.

4.0 Results: Indirect influences on food and drink waste

This section explores factors that are likely to have an indirect influence on avoidable food waste levels, as discussed in §1.2. There is investigation of fussy eating (§4.1), healthy eating (§4.2), availability of time (§4.3), home composting (§4.4) and presence of food waste collections (§4.5).

4.1 Personal preference or 'Fussy eating'

4.1.1 Background

Eating habits and preferences of all household members can have a significant impact on a number of interrelated everyday practices, such as planning meals, shopping, cooking and eating, and therefore on the amount of food and drink waste generated. In order to successfully address household food and drink waste, it is important to understand whether, and to what extent, eating habits influence food disposal.

There are a number of qualitative studies suggesting that eating habits can indeed have an impact on household food and drink waste generation, particularly in relation to 'fussy children' rejecting food on a regular basis. For instance, families participating in the *Food Waste Challenge*[76], a waste-prevention competition in Leicestershire, provided 'children's leftovers' as a reason for throwing food away. An ethnographic study conducted by David Evans in Manchester[77], found that over-purchasing can be a regular and planned practice – a way of ensuring that 'fussy children' have a choice of food to choose from, even if that means that some of it may get thrown away.

It is important to note that studies suggest that fussiness is not limited to children, with adults also sometimes refusing to eat meals prepared for them by other household members (typically by a spouse or partner)[78]. Accounting for food preferences and habits of children and other household members can be a challenging task; particularly taking into account that, despite the growing number of partners sharing grocery shopping and cooking responsibilities, these tasks are still typically performed by a sole care-provider, usually a woman[79].

So far, it has been difficult to assess to what extent fussiness impacts on household food and drink waste generation, due to a lack of quantitative evidence. In the recent *Household Food and Drink Waste in the UK 2012* report[80], personal preferences accounted for 14% of avoidable food and drink waste (self-reported); in *Household Food and Drink Waste: A Product Focus*[81], this reason for disposal has been further split so that fussy eating has now been separated out. This suggests that the vast majority of 'personal preference' was related

[76] http://www.lesswaste.org.uk/food_waste_challenge

[77] *Evans, D. (2012) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology 46 (1), pp. 41-56*

[78] *See for example: Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction 20(2), pp. 1-25*

[79] *See for example: Lake, A.A., Hyland, R.M., Mathers, J.C., Rugg-Gunn, A.J., Wood, C.E., Adamson, A. J. (2006) 'Food shopping and preparation among the 30-somethings: whose job is it? (The ASH30 study)', British Food Journal, 106(6), pp. 475-486*

[80] *See section 2 of Household Food and Drink Waste in the UK 2012, WRAP (2013)*

[81] *http://www.wrap.org.uk/sites/files/wrap/Product-focused%20report%20v5_3.pdf, section 2.3*

to fussy eating (with the remainder of personal preference covering other 'rejection' of food: for example, relating to allergies).

4.1.2 Results

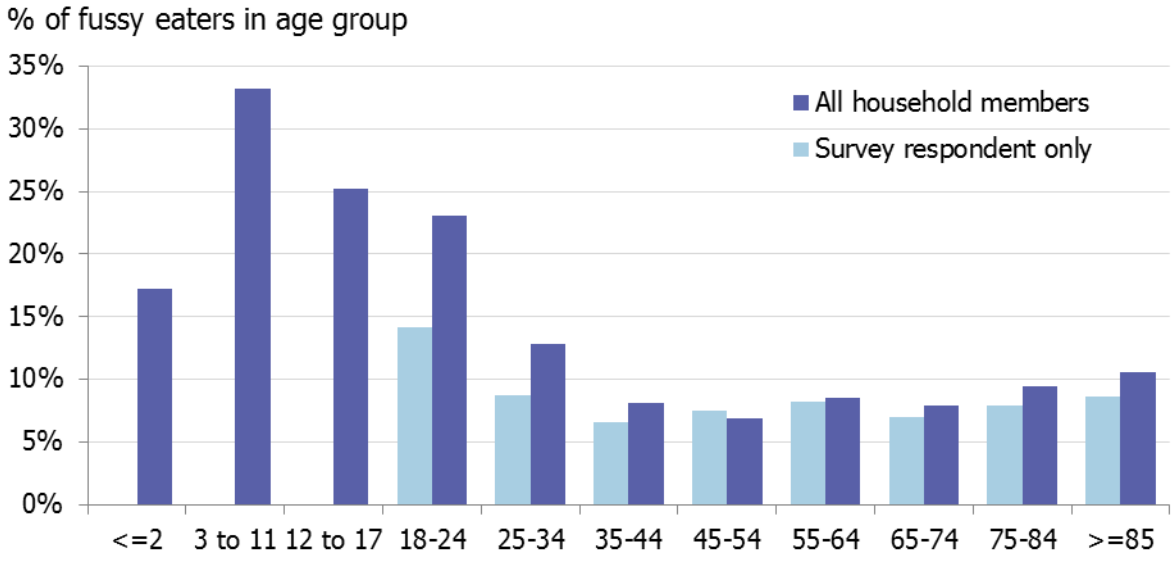
In the waste compositional analysis (question 28), participants were asked to describe the eating habits of each of the household members, by choosing one of the following options:

- fussy eater;
- stick to known and trusted meals;
- happy to try new things; and
- happy to eat whatever is prepared.

A 'don't know' answer was also provided. The number of fussy eaters in each household was then calculated, based on respondents' answers.

The dark-blue bars in Figure 25 show the relationship between 'fussy eating' and age. 'Fussy eaters' tended to be concentrated in, but not limited to, those under the age of 24. The most 'fussy' group were children between the ages of 3 and 11.

Figure 25: Proportion of fussy eaters by age



Source: Waste compositional analysis study 2012

The age relationship was somewhat less striking for self-reported 'fussiness' of the survey respondents only (light-blue bars in Figure 25). (Survey respondents had to be at least 18, hence there is a lack of self-reported data for children.) On average, survey respondents had lower level of 'fussiness' than all household members, and this might be explained by the fact that the majority of survey respondents (89%) were responsible for at least half of the cooking and food preparation within their households and therefore less likely to be fussy over food they prepared themselves. Alternatively, it could be that respondents were happier to classify other household members as fussy.

It was found that the presence of 'fussy eater(s)' in the household was associated with higher levels of avoidable food and drink waste. To highlight the relationship between 'fussy eating' and the amount of waste generated, households were divided into three groups: those without 'fussy eaters'; those where less than 35% of the household were 'fussy

eaters'; and those where more than 35% were 'fussy eaters' – and the levels of avoidable food and drink waste for each group were compared.

Figure 26 shows the variation in avoidable food and drink waste levels for UK households. Households with over 35% 'fussy eaters' generated the most avoidable food and drink waste, whilst households that did not include 'fussy eaters' generated the least. The results control for household size and home-composting in order to allow for a meaningful comparison between the groups. This result points to a clear trend of households containing more 'fussy eaters' generating more food and drink waste.

Figure 26: Variation in levels of avoidable food and drink waste by proportion of 'fussy eaters' in the household, controlling for household size and home composting

Estimated marginal means shown[82]; error bars show 95% confidence intervals
Source: Waste composition analysis study 2012

However, even in households with no fussy eaters, there was still plenty of avoidable food waste, suggesting that other reasons are also important in the generation of food waste. This is consistent with the findings in *Household Food and Drink Waste: a product focus*, which suggests that around 13% of avoidable food and drink waste was associated with rejection of food. This figure is broadly consistent with the level of waste in this section if it assumed that the difference in food waste between households with fussy eaters (compared to those without) is due to fussy eating.

[82] *Estimated marginal means are the average values when controlling for all other variables in the model.*

Summary: 'Fussy eating'

Overall, the findings in this section provide support for the notion that personal preference, or more specifically 'fussy eating' (which was a term used in the questionnaires), contributes to higher levels of avoidable food waste. These results showed a correlation, rather than a causal relationship, between households with 'fussy eaters' and food and drink waste levels; however, given the weight of evidence about this link, including householders themselves citing 'fussy eating' as a reason for food and drink waste, it is likely that a small but substantial minority of avoidable food and drink waste is related to 'fussy eating'. As a rough guide, this includes the 13% of avoidable food and drink waste cited in the kitchen diaries as being connected to 'fussy eating'[83].

'Fussy eaters', as defined by the person responsible for the majority of the household shopping and cooking, tended to be concentrated in, but not limited to, those under the age of 24. The most 'fussy' group were children between the ages of 3 and 11.

Conclusions

This is likely to be one of the more difficult causes of food and drink waste to address; however, options to explore could include:

- A greater involvement of children and other household members in food planning shopping and preparation to ensure the food and drink that is prepared is accepted by more people in the household;
- Using a different approach to serving food; for instance, giving children and others the opportunity to serve themselves from central bowls rather than other people serving meals on their behalf. This has the dual benefit of less waste after serving and also any leftovers are likely to be easier to use later;
- Cooking and freezing individual portions of meals to allow for a wider variety of choice at meal times, to suit different members of the household;
- Mixing the use of fresh, tinned and frozen fruit and vegetables can provide a wide variety of choice for the different members of the household, including 'fussy eaters', whilst giving more control of the amounts that need to be prepared, leading to less waste being generated.

4.2 Healthy eating

4.2.1 Background

The link between healthy eating and food waste is complex. Whilst people generally do not want to waste food, sometimes other important considerations can override efforts to prevent waste occurring. In particular, there is some qualitative evidence to suggest that concerns about obesity and healthy eating, which has attracted a lot of public and policy attention in recent years, could be indirectly contributing to food and drink waste generation in some households. The idea of what types of food *should* be purchased and consumed do

[83] *Household food and drink waste: a product focus: see section 2.3.*

not always correspond to the reality in which people's lives are lived[84]. For example, some people may buy large quantities of fruit and vegetables motivated by ideas of healthy eating. However, when decisions are being made as to which foods to prepare and eat, the fruit and vegetables may be eschewed in favour of other foods. This may be exacerbated by the perishability of many fresh food products, infrequent shopping trips for some households and the unpredictability of people's lives.

Concerns about healthy eating are also linked to caring for children and other family members, with qualitative studies finding that parents (particularly mothers) tend to prioritise children's health and nutrition over food waste concerns[85]. In particular, ensuring that plenty of fresh fruit and vegetables are available is important, even if it means that some of them are not eaten and consequently thrown away.

4.2.2 Results

Whilst these complex issues are difficult to measure through a questionnaire, analysis of the kitchen diary research and waste compositional analysis suggests that those people who considered it challenging to reconcile efforts to provide healthy, fresh foods for themselves and their family with efforts to reduce food waste, had higher than average levels of avoidable food and drink waste.

Participants in both studies were asked about the reasons that hinder them from trying to minimise the amount of food[86] that their household throws away (question 21 waste compositional; question 23 pre-diary questionnaire; question 14 post-diary questionnaire). In the waste compositional analysis, those who cited 'a need to buy a range of foods to ensure they can provide healthy food for their family' as a reason (only around 5% of the sample) generated 31% more avoidable food and drink waste than those that did not cite this reason (controlling for household size and home composting).

A significant result in the same direction was found in the post-diary questionnaire (although the difference between the two groups was smaller, at around 20%), but not in the pre-diary questionnaire – the result was in the same direction but was not statistically significant (p = 0.482). These results seem to support the view that in some cases trying to ensure that the family eats healthy food can be a barrier to reducing food waste.

Another option in the same question was 'I don't want to compromise on the choice of fresh foods I have in my fridge'. In the waste compositional analysis, those who provided this as a reason generated 30% more avoidable food and drink waste than those who did not (compared to around 20% difference between the groups in the questionnaire following the kitchen diary study; no relationship was found in the pre-diary questionnaire). The level of food and drink waste associated with the different responses was close to being significant in

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[84] See, for example: Evans, D. (2012) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology 46 (1), pp. 41-56;

Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction 20(2), pp. 1-25

[85] See, for example: Graham-Rowe, E., Jessop, D.C., Sparks, P. (2014) 'Identifying motivations and barriers to minimising household food waste', Resources, Conservation and Recycling (84), pp. 15-23

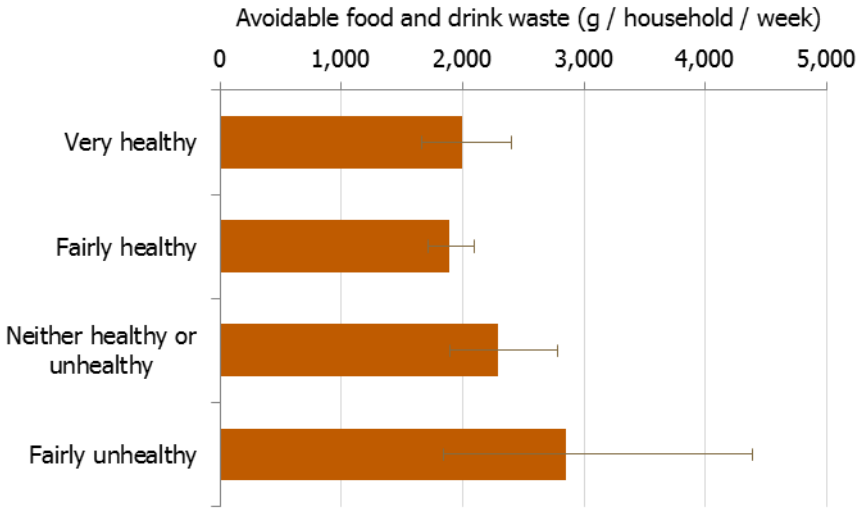
[86] The question asked about FOOD only, but as the studies covered food and drink waste and didn't make a distinction between the two (for example with 'milk and fruit juices' being listed as a type of food waste in Q20 in pre-diary questionnaire), it is assumed that 'food waste' covers both food and drink. There is, however, a small possibility that when answering to this question, participants themselves made the distinction between the two and provided reasons that hindered them from throwing away food only, rather than food and drink.

waste compositional analysis (p = 0.073) and was significant in post-diary questionnaire (p = 0.034)[87]. Whilst there might be other reasons for preferring fresh foods than health concerns (such as personal taste and preference), this is nonetheless an interesting finding, further supporting the view that other priorities can hinder people from reducing their waste.

What these results do imply is that those who see either health concerns or having a range of fresh foods as a *barrier* to reducing food waste, do have higher levels of avoidable food and drink waste than those who don't (i.e. those who either do not worry about providing healthy food for the family, or don't see it as a barrier).

A further question was asked in the kitchen diary research about how 'healthy' research participants rated their own diet. Those who claimed that what they generally eat is 'very' or 'fairly healthy' generated less avoidable food and drink waste compared to those who said that their diet is 'neither healthy nor unhealthy' (in kitchen diary study, see Figure 27). This relationship was close to significant (p = 0.076)[88].

Figure 27: Variation in levels of avoidable food and drink waste by self-reported 'healthiness' of diet, controlling for household size[89]



Estimated marginal means shown; error bars show 95% confidence intervals
Source: Kitchen diary study 2012, pre-diary questionnaire

The results in this section, taken together, provide some evidence that those stating their diet is healthy generate less avoidable food and drink waste than the rest of the population. This needs to be interpreted with caution because, firstly, the significance of this result was slightly above the threshold set and therefore there is a slightly higher probability that the trend seen is the result of chance, and secondly, the level of healthiness given in the questionnaire is a self-assessment by the participant and should be viewed as such (rather than an objective assessment of the healthiness of his or her diet).

[87] *Only a small number of people gave a positive response to this question in the waste compositional analysis questionnaire, which is one reason why this relationship may not have been significant.*

[88] *Variable modelled as a covariate rather than categorical data to take into account the trend seen in the data.*

[89] *Only one respondent said that 'It varies too much to say' in response to this question, and nobody stated that their diet was 'Very unhealthy', therefore these are excluded from the graph.*

This lower level of food and drink waste associated with healthier diets (as stated by participants) may not necessarily be a result of their diet, but other factors that correlate with healthy eating. For instance, there may be a correlation between healthy eating and cooking skills, with the latter being the reason why food and drink waste levels are lower. It is also possible that healthy eating is, in many cases, associated with simply eating less food or thinking more about food, and therefore the difference in waste levels could simply reflect less food being brought into the home. More research is needed to examine the underlying reasons for these relationships.

However, there is a small group of the population that sees provisioning of a range of healthy, fresh foods as a barrier to reducing food waste and this group does waste more than the rest of the population.

In summary, any link between healthy eating and waste levels is far from straightforward, and further research is needed to gain a better understanding of the complex relationships between healthy diets and impacts on food and drink waste.

Summary: Healthy eating

This section explores the relationship between healthy eating and levels of avoidable food and drink waste. There is some evidence to suggest that a healthy diet (self-reported) was associated with lower levels of avoidable food and drink waste. This may not necessarily be a direct result of diet, but linked to other factors that may correlate with healthy eating, such as cooking skills, simply eating less food or thinking more about food.

In contrast those who cited 'a need to buy a range of foods to ensure they can provide healthy food for their family' as a barrier to reducing waste (only around 5% of the sample) generated more avoidable food and drink waste than those that did not cite this reason.

Similarly those that stated 'I don't want to compromise on the choice of fresh foods I have in my fridge' as a barrier (around 4% or respondents) also generated more avoidable food and drink waste than those who did not.

In summary, any link between healthy eating and waste levels is far from straightforward, and further research is needed to gain a better understanding of the complex relationships between healthy diets and impacts on food and drink waste.

Conclusions:

There is currently a significant gap between the average UK diet and recommendations for a healthy diet (e.g. the Eatwell plate). Efforts to encourage and support people to make healthier choices need to be complemented by messages and initiatives to avoid the unintended consequences of a possible increase in food and drink waste. One example of this is the LFHW 'Eat well and waste less' guidance[90] which helps people to make the most of the good food that they buy.

For those people particularly concerned about the freshness of their food, guidance can be given on how to maintain this freshness for longer, for example through better storage and in-home use of food packaging.

[90] http://lovefoodhatewaste.com/content/eat-well-and-waste-less

4.3 Time

4.3.1 Background

In the field of food waste, a number of empirical studies have pointed to the difficulties many people face in coordinating their busy lives with household food provisioning, cooking and consumption. Increasingly flexible and unpredictable patterns of work and social life mean that products purchased or meals planned in advance are not cooked or eaten in time, sometimes due to lack of energy or time at the end of the day, or because of unplanned meals out with friends or colleagues. Coordinating daily practices with other, often equally busy, household members, and accounting for their needs and daily schedules when making purchases and planning meals, can also be challenging[91].

Therefore, time constraints have the potential to hinder participation in many waste prevention behaviours in complex and not necessarily direct ways. Previous sections investigating the relationship between age (§2.4) and food and drink waste, and employment status and waste (§2.5) have already referred to the potential role that available time, or lack of it, could play. This is explored further within the following section.

4.3.2 Results

Complex relationships between the availability of time and waste levels are difficult to account for in quantitative research. However, both the kitchen diary research and the waste compositional analysis included a few questions designed to shed light on these relationships, and found that 'less time' was correlated with higher levels of avoidable food and drink waste.

When asked directly about the reasons that hinder them from minimising the amount of food waste generated in their households, those who quoted 'I don't have enough time' were found to have higher levels of avoidable food and drink waste than those who didn't provide this as a hindrance to minimising food waste.

This relationship was significant when answers to this question in the post-diary questionnaire were compared to levels of waste. Those citing time as a barrier to food waste prevention wasted 38% (±28%) more than those who did not. The relationship was close to significant in the pre-diary questionnaire (p = 0.064) and not significant in the waste compositional analysis (p =0.288) although a relationship was visible (i.e. those with less time had more waste in all three surveys).

Lack of statistical significance in pre-diary and waste compositional questionnaires was likely to be due to the fact that not many people cited this as a hindrance – perhaps because the link between time and food waste is often indirect. The number of people who answered the question in this way in the post-diary study increased slightly in comparison to pre-diary answers, perhaps as more people reflected on the underlying reasons for household food waste as a result of taking part in the diary exercise.

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[91] *See for example: Evans, D. (2012) 'Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste', Sociology 46 (1), pp. 41-56*

Southerton, D., Diaz-Mendez, C. and Warde, A.(2012) 'Behavioural Change and the Temporal Ordering of Eating Practices: A UK-Spain Comparison' International Journal of Sociology of Agriculture and Food, 19(1) pp.19-36

The pre-diary questionnaire also included another question related to 'busyness' of participants' lives. They were asked to state the extent to which they agree with the following statement 'My life is so busy that I just eat what I can while I'm on the go' on a 5 point scale varying from 'Definitely agree' to 'Definitely disagree'. It was found that those agreeing with this statement had higher levels of waste than those who disagreed (Figure 28).

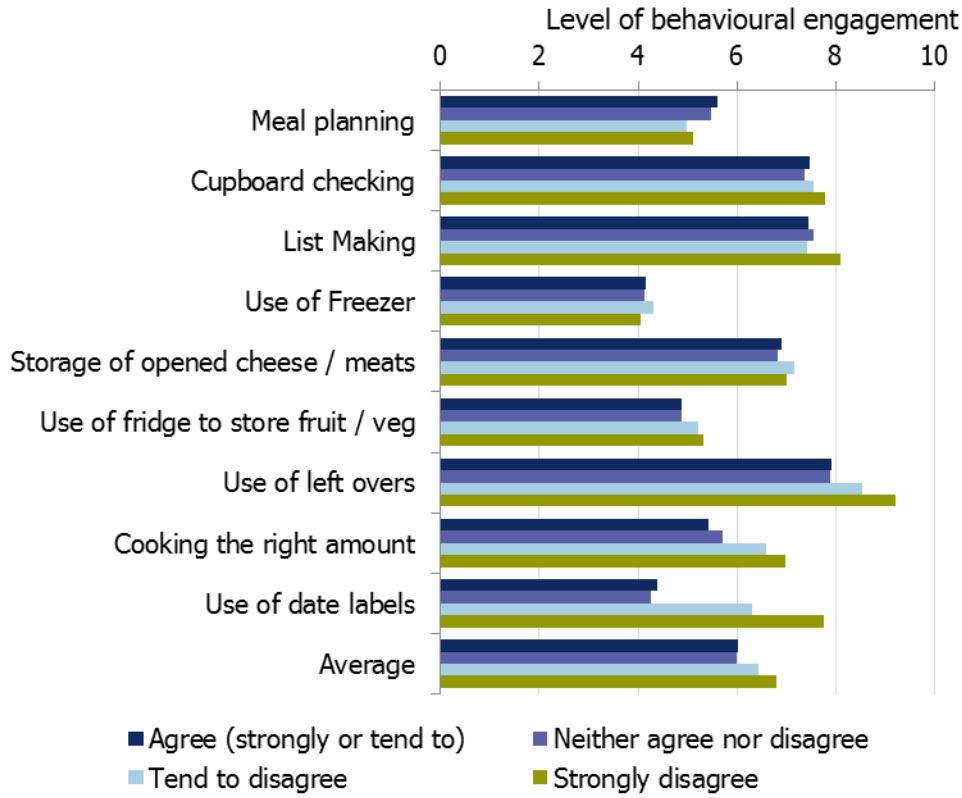
Figure 28: Variation in levels of avoidable food and drink waste by extent of agreement with the following statement 'My life is so busy that I just eat what I can while I'm on the go', controlling for household size

Estimated marginal means shown; error bars show 95% confidence intervals
Source: Kitchen diary study 2012, pre-diary questionnaire

This seems to support findings from qualitative research that lack of time often prevents people from acting to avoid wasting food. Further analysis revealed that those people who said that their lives are 'so busy that they just eat what they can while they're on the go', also had a lower level of engagement in most waste prevention behaviours identified by WRAP and discussed in §3.0. This seems to support the hypothesis that availability of time can be an important factor influencing participation in those behaviours (although it is important to stress that the findings merely show a relationship between the two, which in itself does not prove a causal link). Figure 29 shows that those who strongly agreed that their lives were busy had lower levels of behavioural engagement for most of the behaviours than those who strongly disagreed with this statement[92]. In particular, they were less likely to use their leftovers, cook the right amount of food, and more likely to throw food away because it had gone passed the date on its packaging ('use of date labels', which could be interpreted as a proxy for 'not eating food in time').

[92] *The most recent wave of WRAP's regular questionnaire survey has been used as this provides a larger sample size with fewer sampling biases compared to the kitchen diary and waste compositional analysis datasets.*

Figure 29: Comparison of behavioural engagement by level of agreement with the following statement: 'My life is so busy that I just eat what I can while I'm on the go'[93]



Source: WRAP's food waste tracker, UK data, Autumn 2013 wave

Summary: Time

This section has further established a link between avoidable food and drink waste and the amount of time available for food-related activities. The evidence suggests that those who quoted 'I don't have enough time', as a barrier to reducing food waste, have higher levels of avoidable food and drink waste than those who didn't provide this as a hindrance to minimising food waste. Those that agreed with the statement 'My life is so busy that I just eat what I can while I'm on the go' also had higher levels of waste than those who disagreed with the statement.

Those who strongly agreed that their lives were busy had lower levels of engagement with many of the behaviours relevant to waste prevention compared to those who disagreed with this statement. In particular, they were less likely to use leftovers, cook the right amount of food, and more likely to throw food away because it had gone past the date on its packaging.

[93] *For more details of the scorecard, see this document.*

Conclusions:

Advice, support and tips which seek to help people reduce the amount of food and drink that is thrown away need to be grounded in the reality that some of the households producing the most waste afford a lower prioritisation to food-related activities due to competing pressures. Many of us also feel as though we are time-poor in our lives. Therefore, solutions should, where possible, help households **save** time or, at the very least, be 'time neutral' and easy, for example:

- Making small simple changes in everyday behaviour, such as freezing leftovers to eat at a later date, thereby negating the need to cook for one meal in the future;
- Keeping apples in the fridge rather than the fruit bowl – it takes no longer to retrieve them, but they last much longer;
- The Love Food Hate Waste free App provides a simple way to check stocks whilst in the supermarket, allowing people to squeeze a shop in between other activities and buy appropriate amounts of food;
- Making sure that at least one night a week involves eating from the freezer so if plans change unexpectedly that meal can be carried over to the following week rather than fresh food being wasted – this can be much quicker than cooking from scratch;
- Making more use of technology to help people manage their busy lives with food consumption in the home (e.g. FridgeCam for checking cupboards from PCs and mobile devices)[94].

4.4 Home composting

As discussed in the methodology section, composting food waste at home was affecting the amount of food and drink waste found in waste streams collected by local authorities (the residual (or general) bin, and any collections targeting food waste) in the waste compositional analysis. It was found that those home composting had 24% less avoidable waste in bins collected by their local authority than those who didn't home compost, presumably as the 'missing' food waste was diverted to home composting. For this reason, home-composting was one of the factors controlled for in all subsequent analyses of waste compositional analysis dataset.

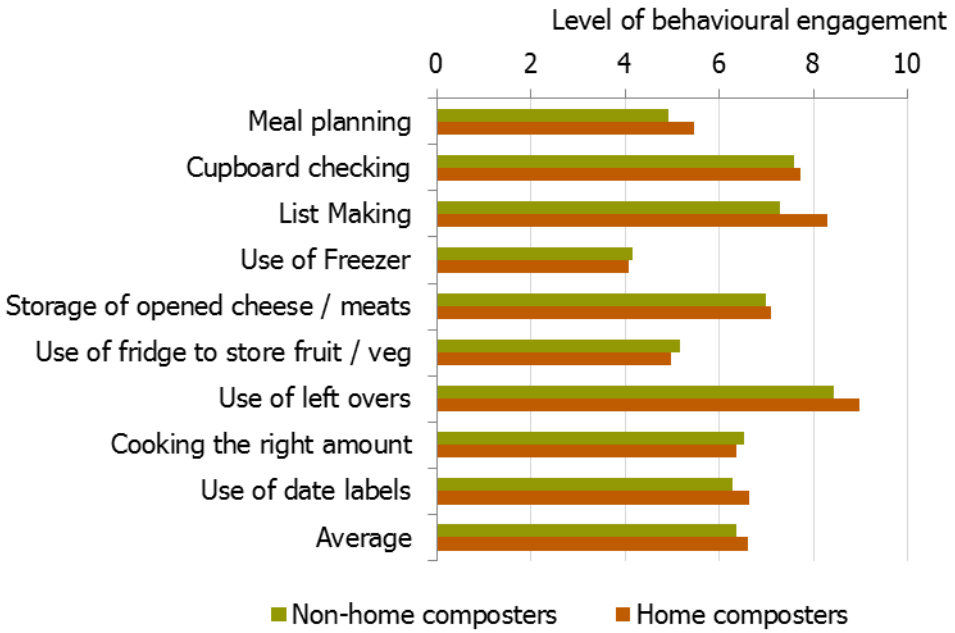
However, a relationship was also found between home composting and levels of avoidable food and drink waste in the kitchen diary study, even though the diary allowed for recording waste disposed through all possible routes, including home composting. Those who used any form of home composting generated around 22% (±13%) less avoidable food and drink waste than those who didn't, whilst controlling for household size.

It could be argued that some of this difference could be attributed to age, as those aged 65 and over were more likely to home compost than other age groups, both in the kitchen diary and in waste compositional analysis study (see Figure 9 in §2.4 for results in waste compositional study). However, this relationship between home composting and age provides only a partial explanation for the correlation between levels of avoidable food and drink waste and home composting.

[94] *See the following study for the details of this innovative technology: Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction 20(2), pp. 1-25*

The reasons why home composters generated less avoidable waste are likely to be linked to broader differences in behaviours between the two groups. WRAP's food waste tracker found that those who home composted were more engaged with some of the nine key waste prevention behaviours identified by WRAP. Figure 30 shows the difference in levels of behavioural engagement for both groups (on a 10 point scale, with 10 representing the highest level of engagement).

Figure 30: Comparison of engagement in food-related behaviours for households that composting food at home with all other households[95]



Source: WRAP's food waste tracker, UK data, Autumn 2013 wave

In particular, those who composted were more likely to plan their meals, make lists and use their leftovers, which could imply their greater involvement in broader food practices. This hypothesis is supported by a difference in the level of **unavoidable** waste between those who composted their food waste and those who didn't[96]. Much higher amounts of unavoidable waste (such as bones, citrus peels, apple cores, inedible vegetable peeling and egg shells) were found in those households that home composted, which implies that they cook more food from scratch and purchase different kinds of products to those who don't home compost.

[95] *For more details of the scorecard, see this document.*

[96] *However, considering all avoidabilities of waste, those households home composting food waste generated similar levels of food waste than those who did not home compost.*

Summary: Home composting

On average, home composters generated less avoidable food and drink waste and were more engaged with various food-related behaviours. Those who composted were more likely to plan their meals, make lists and use their leftovers, which could imply their greater involvement in broader food-related practices. They also produced more **un**avoidable food and drink waste, suggesting they cook more from scratch. This implies that the link between home composters and avoidable food and drink waste is indirect (rather than causal), but, we speculate that it could be linked to home composters being more likely to grow their own food and possibly valuing their food to a greater extent because of this. This untested proposition could be investigated to see if increasing people's awareness of the journey of food (e.g. via growing their own) does indeed reduce food and drink waste. If this is the case, it could mean that grow-your-own projects in schools and other community groups would be a good opportunity to promote food-waste prevention.

Conclusions:

More research is needed to provide detailed recommendations, particularly to investigate further whether home composters have a different relationship with food, and whether this is linked to growing their own food.

However, a number of grow-your-own projects and local-food projects are being run across the UK and food waste prevention information is often a core focus of these projects.

4.5 Food waste collections

Many local authorities in the UK now provide collections that target food waste, either separately or mixed with garden waste. This reduces the amount of food (and garden) waste going to landfill. Instead it is sent to either industrial composting or anaerobic digestion – both better options environmentally than sending the material to landfill[97].

It is possible that participating in local authority food collection schemes *could* affect the amount of food and drink waste generated in people's homes. These potential effects were discussed in detail in two WRAP reports[98]. On the one hand, those who have a separate bin for food waste collections might be more aware of how much food they throw away, as having a separate container could make such waste more visible and bring it to people's attention. This could then result in making more effort to reduce it, resulting in less waste (i.e. a 'prevention effect'). On the other hand, food waste collection schemes could lead to more waste via a 'legitimisation effect'. As collected food waste is targeted by the local authority and it might therefore no longer be perceived as 'waste' by the householders. This could lead to a decrease in any efforts to avoid it.

[97] *As pointed out in, for example Quested et al. Food and Drink Waste from Households in the UK, Nutrition Bulletin, 36: 460–467 and in keeping with the waste hierarchy, preventing food and drink from being wasted has a greater environmental benefit than diverting it to treatment routes such as composting and anaerobic digestion.*

[98] *Literature Review - Relationship between Household Food Waste Collection and Food Waste Prevention, WRAP (2011) and Effect of food waste collections on arisings: recent evidence, WRAP (2013)*

In this study, the waste compositional analysis research found no relationship between participating in food waste collections and levels of avoidable waste, whilst controlling for structural factors (household size and home composting). The amount of waste generated by those who disposed of uneaten food in food waste collection bins was very similar to those who didn't use it for any reason (including not having access to it) and any difference was not statistically significant. Similar results were obtained from the kitchen diary study. This could imply either that the 'prevention' and 'legitimisation' effects mentioned above are both of small magnitude and therefore not detectable in this analysis or that the two effects exist but counteract one another (i.e. some people throw away less because of participating in food collection schemes, whilst others throw away more). This lack of evidence for an effect of collections on waste levels is in line with WRAP's most recent research in this area[99].

To further explore this issue, respondents in both studies were asked whether they feel that they don't need to reduce their waste because they use a local authority collection for their food waste. No significant relationship was found between answers to this question and levels of avoidable food and drink waste, further supporting the view that participating in food waste collections does not have a sizeable impact on the amount of avoidable food and drink waste generated.

Summary: Food waste collections

No significant correlation was found between levels of avoidable food and drink waste and whether households used food waste collections (if available). This is consistent with WRAP's most recent research in this area.

Conclusions:

Through previous WRAP research[100], we know one of the main barriers to people taking action to reduce their food waste, or to effectively participate in their collection service, is a lack of awareness that we waste food, how much we waste and the benefits of reducing and recycling it.

It has been found that the act of introducing a food waste collection alone is very unlikely to reduce food waste generated as a whole.

In order to avoid confusion and maximise both the prevention and recycling of food waste, there is a clear case for joining up messaging. WRAP has designed an easy to use tool, based on feedback from the public, to help deliver this joined up communication on food. Guidance on communicating about both prevention and recycling was published by WRAP in 2013 (see previous footnote).

[99] *Effect of food waste collections on arisings: recent evidence, WRAP (2013)*

[100] *http://www.wrap.org.uk/content/food-waste-messages-maximum-impact-uk*

5.0 Summary and concluding discussion

The analysis in this report has identified a number of socio-demographic, direct (behavioural), and indirect (contextual) factors that correlate with the amount of avoidable food waste generated by households. In §2.0, various socio-demographic factors were found to correlate with levels of waste, including number of occupants in a household, age & employment status. On average, higher levels of waste were associated with larger households (although smaller households generate more per person), households containing younger people and households where the main earner was not retired.

In addition, a number of food-related activities were also found to correlate with food and drink waste levels (§3.0). These are:

- Using leftovers
- Fussy eating
- Throwing away items because they have gone past their date label
- List making
- Cooking the right amount of rice and pasta
- Buying less of other items when purchasing special offers
- Meal planning
- Use of the fridge to store apples and carrots (apples only)

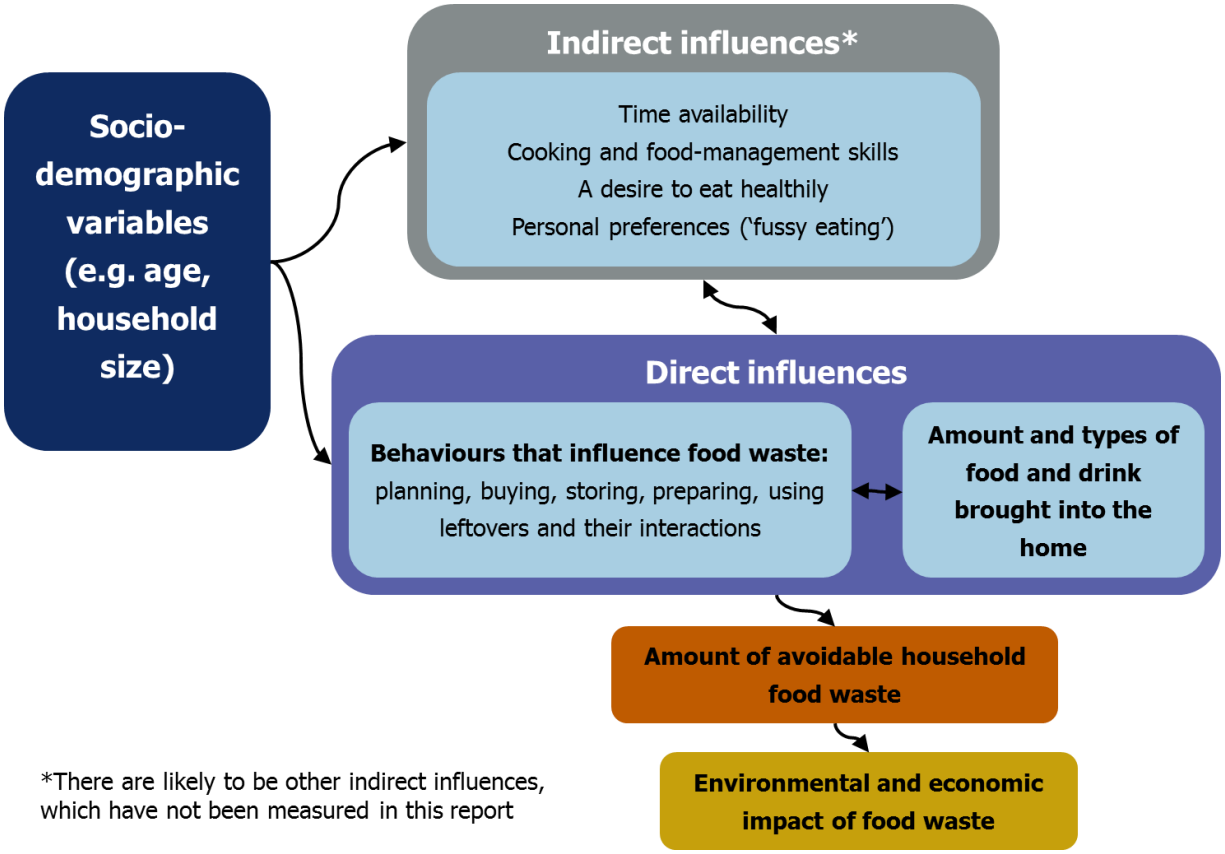
With the exception of fussy eating and throwing away items because they had gone past their date label, all these activities were associated with lower levels of avoidable food and drink waste. Larger amounts of waste were associated with a high proportion of individuals in the home classified by the questionnaire participant as fussy eaters. Greater numbers of items thrown away because they have gone past their date label were also associated with higher waste levels.

Contextual factors, for which a relationship with avoidable food and drink waste were found in §4.0, include (self-reported) healthiness of diet and time available for food-related activities. Higher levels of waste were, on average, associated with less time available for food-related activities. There was a less straightforward relationship between waste levels and health: although those with less healthy diets (as reported in the questionnaire) were found to have higher levels of waste, other people cited eating a healthy diet as a barrier to reducing food waste.

A preliminary investigation (not included in the report) was also conducted to explore the correlations between levels of waste and people's values (which were measured via questionnaires). This did not reveal significant correlations. This suggests that any relationship may be subtle, which is not to say that more detailed analysis would not reveal relationships. Further investigation in this area could generate useful findings. In addition, all other questions in the questionnaires were analysed and those not included in this report either did not show significant correlations with avoidable food and drink waste levels or did not show correlations that added insight to the topic of food waste.

The relationships between these different factors and avoidable food and drink waste are likely to operate in different ways and one possible visual representation of these relationships is shown in Figure 31. Logic would suggest that certain factors will have a more direct relationship with waste levels than others. In particular, food-related activities that influence food and drink waste and the amount and type of food brought into the home are likely to be more direct influences than, for example, socio-demographic factors such as age.

Figure 31: Visual representation of relationships found in the report



This report highlighted that the link between these direct food-related behaviours and food and drink waste levels is difficult to identify as their effects are likely to differ between households. For example, for some households planning meals ahead might be a good strategy to avoid waste; for others with more unpredictable lifestyles, a greater degree of flexibility might help keep food and drink waste levels down. Moreover, a number of qualitative studies suggested that these direct food-related activities are not performed in a void, but are embedded in and influenced by numerous daily practices (e.g. having a family dinner, grocery shopping or socialising with friends). Whilst people have a degree of choice on what they do, their everyday practices are influenced by social meanings, norms, conventions, available resources, infrastructure, socially learned skills as well as available time. This report found large-scale quantitative evidence for the influence of some of these broader, contextual factors on the amount of avoidable food and drink waste.

Moreover, this report found that some of the socio-demographic characteristics were strongly associated with both the direct food-related behaviours and contextual factors. Whilst socio-demographics are unlikely to be causal factors by themselves, they can be indirectly correlated with levels of food waste. Identifying the groups generating (on average) the most and the least amounts of waste in the population can help in understanding the complexities of household food waste management and identify groups with greatest potential to reduce food waste. This report has found that younger people and those not retired generated higher levels of avoidable food and drink waste on average. In addition, those in small households generated more waste per person on average.

Both direct and indirect effects correlate with socio-demographic factors and it is likely that this is how relationships between socio-demographic factors and avoidable food and drink waste levels operate. For instance, the number of people in a household strongly correlates with the amount of food brought into the home, which in turn influences food and drink waste levels. The number of people in a household will also correlate more weakly with other factors such as meal planning, which again have a direct influence on food and drink waste levels.

The analyses suggest that there is a relatively strong degree of correlation between many of the variables describing the provisioning, preparation and consumption of food in the home. As food and drink waste is determined by the interplay between these various factors[101], this explains why statistical modelling in this area is not straightforward.

The strength of the relationship between any given variable and avoidable food and drink waste levels is not necessarily related to the directness of its impact. For instance, some socio-demographic variables (e.g. age and household size) have a strong correlation with food and drink waste levels. In the case of household size, this is likely to be mainly mediated through a strong relationship with the amount of food brought into the home, which, in turn correlates strongly with waste levels. In contrast, age appears to be correlated with a larger number of food-related activities in the home (such as using up leftovers) and contextual factors, such as availability of time to prepare food.

This report has shown that some ideas discussed in the literature – many of which have a social-practices perspective – can be identified by linking the questionnaire information with measured levels of waste. Given this, there is a strong case for using research methods grounded in the social practices approach – where individual behaviours are not considered in isolation but as part of a series of practices relating to food (and other activities that intersect with food and provisioning, such as paid employment). It also suggests that analysis techniques that can model these practices (for example, taking into account interactions between behaviours) and the movement of food within the home (such as discrete event simulation as deployed in the Milk Model[102]) have a strong case for obtaining robust and useful results.

For developing interventions to prevent household food and drink waste, understanding the wider context – other activities, meanings, associated materials and competencies – of important behaviours could be beneficial[103]. Social-practice approaches are good at understanding an issue within the context in which they are performed: in this particular context, understanding why food gets wasted in light of broader food-related activities. When developing interventions, a key challenge is determining how change could be affected despite the complexity and interaction with other food-related activities – i.e. not accepting that waste is inevitable, even though it is a result of the way provisioning, preparation and consumption of food in the home is negotiated in modern life.

In light of the importance of contextual factors for household food and drink waste generation, interventions could be broadened beyond just trying to convince individual people to change (although addressing norms and meanings are also likely to be important),

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[101] *e.g. see The Milk Model: Simulating Food Waste in the Home, WRAP (2013)*

[102] *As discussed, for instance in: The Milk Model: Simulating Food Waste in the Home, WRAP (2013) and Quested et al. (2013) 'Spaghetti soup: The complex world of food waste behaviours', Resources, Conservation and Recycling 79, pp. 43-51*

[103] *For example, through the application of tools such as that described in Darnton, A. and Evans, D. 2013. Influencing Behaviours: A Technical Guide to the ISM tool. Edinburgh: Scottish Government.*

to addressing some of the contextual factors. Examples already in action include WRAP's work with grocery retailers and food and drink manufacturers on storage guidance, advice around date labels and pack sizes. Other potential interventions could, for example, address time constraints on food provisioning and preparation – for instance, use of devices such as FridgeCam, which takes pictures of the contents of your fridge and allows these pictures to be viewed whilst on the go[104]. Other examples include tools (such as the Love Food Hate Waste App) that create shopping lists from recipes and applications that allow a running list of food to be kept that is accessible on-line.

Psychological factors are also likely to be important in determining people's propensity for change and the importance they place on food waste prevention – although, as this report highlighted, food and drink waste should not be understood as solely a matter of individual choice.

This analysis also suggests that in-depth social research methods should be adopted to understand these complexities and intricacies (which can be supplemented with more quantitative methods, but where those quantitative methods are informed strongly by the in-depth research). Given the connection between food and drink waste and other food-related practices, this argument can be extended to the examination of other food-related topics.

More specific recommendations that result from the research and analysis in this report can be found at the end of the results sections and in the Executive Summary.

[104] *Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) 'Negotiating Food Waste: Using a Practice Lens to Inform Design', ACM Transaction on Computer-Human Interaction 20(2), pp. 1-25*

6.0 Appendix: Methodology for analysis

This chapter includes general information on the methodology used for this report. The data sources are discussed in §6.1, the analysis methods in §6.2, and the challenges using the methods adopted in this report in §6.3.

6.1 Data sources used

The results in this report are derived from a number of different data sources. Two of these – the waste compositional analysis and the kitchen diaries – underpinned the recent report *Household Food and Drink Waste in the UK 2012*. Extensive details of the research methods used to obtain these datasets can be found in the *Methods used for Household Food and Drink Waste in the UK 2012*[105].

Both of these pieces of research have an estimate of the amount of waste produced by a household. For the waste compositional analysis, this entailed direct measurement of food and drink in waste streams collected by local authorities from participating households (each of which gave informed consent to have their waste analysed). For the kitchen diary research, information was recorded by participants in a week-long diary.

In addition, both pieces of research were accompanied by questionnaires that were asked to someone in the household responsible for at least some cooking and some food shopping. Some questions were common to each study, but others were only asked in one piece of research. More questions were asked in the diary research as there were both pre-diary and post-diary questionnaires, whereas the waste compositional analysis only had one questionnaire, conducted prior to the analysis of waste. The questionnaires can be found as an appendix to this report, giving the questions asked and the options available for closed questions. The questionnaire interviews for the diary were conducted over the phone; the waste compositional analysis questionnaire was conducted face-to-face.

Table 4 compares the two data sources: for the purposes of the analysis in this report, each has advantages over the other. For example, the waste compositional analysis had a larger sample size and is likely to be a more reliable measurement of waste levels, but omitted any information on the reasons why food was thrown away and only covered waste streams collected by local authorities. In contrast, the kitchen diary research included all waste streams, and contains detailed information about why food was thrown away, but had a smaller sample size and measured waste levels were self-reported.

The third source of information is WRAP's food waste tracker – a regular household questionnaire survey run twice a year. This is currently conducted using on-line panels with a sample that is representative of the UK population. Information has been used from this where no estimate of waste levels is required and has the advantages of few biases in the sample and larger sample sizes. Information is also available for a number of waves in the past.

Reasons are given in the text to explain why each data source has been used for a given piece of analysis. Where the same questions have been asked in both datasets, results are usually given for both.

[105] *Methods used for Household Food and Drink Waste in the UK 2012, WRAP (2013)*

Table 4: Comparison of pros and cons of waste compositional analysis and kitchen diaries

	Waste compositional analysis	Kitchen diaries
Interview method	Face-to-face	Telephone
Sample size with waste measurement	1799	948
Sample biases	Flats under-represented due to difficulties linking waste to households Only households giving consent for waste analysis included	Only households willing to complete a week-long diary included
Reliability of waste measurement	Small chance that questionnaire affects behaviour around food and drink waste	Self-completed diaries that could a) be incomplete (not all waste reported) and / or b) lead to change in behaviour affecting food and drink waste levels
Waste streams included	Only waste in local authority waste streams: residual, separate food waste collections (if any), mixed food and garden collections (if any)	Local authority waste streams, sewer, home composting, fed to animals, other
Information included on waste (where the same in each source)	'Avoidability' of the waste, waste stream in which waste disposed, food group and food type	
Information included on waste (where different from the other source)	Information on presence of packaging (and information from packaging)	Reason for disposal, size of waste instance, day of week, meal occasion

6.2 Analysis methods

This section describes the method for comparing levels of household food and drink waste for different groups of households, as determined by their responses to questionnaires. The analysis methods used are very similar for the waste compositional analysis and the kitchen-diary datasets; however, there are some differences in the variables that are controlled for, as discussed below.

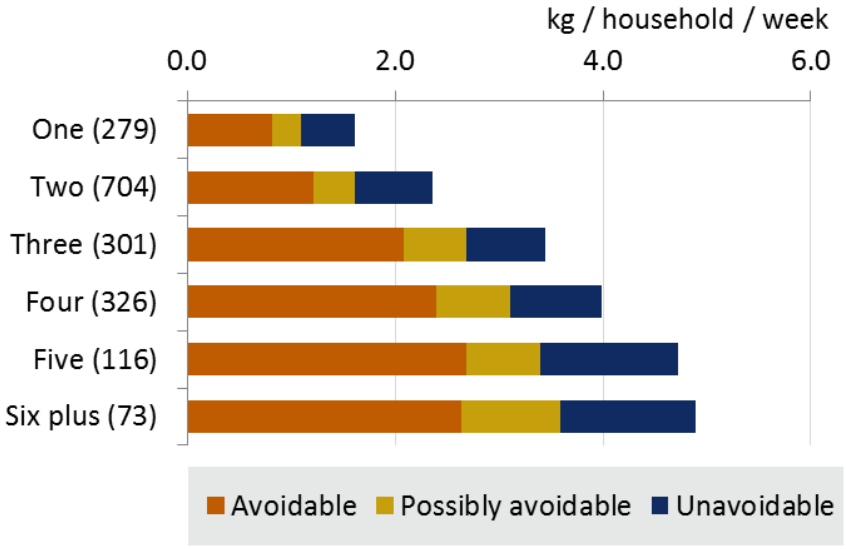
The main objective is to control for 'structural' factors in the analysis. In this context, structural factors are those that influence household food and drink waste levels and are either associated with the household structure (e.g. the number of people in the household) or issues that will affect the measurement of household food and drink waste (e.g. home composting will influence levels of food and drink waste collected by local authorities via a diversion effect).

By controlling for structural factors, it is possible to determine the other factors above and beyond them. This is illustrated in the following section.

6.2.1 Background to the issue

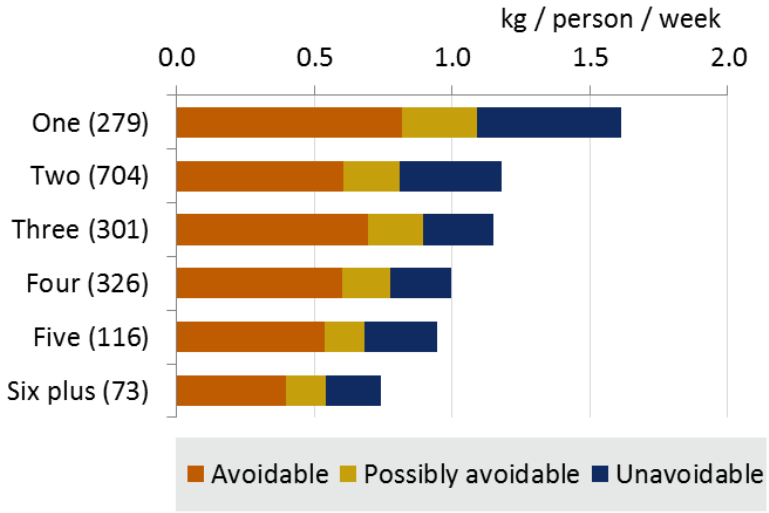
The basic issue to be addressed is that there are factors that are known to influence household food and drink waste levels that it would be useful to control for in the analysis. This allows the influence of these known factors to be removed and the remaining impact to be quantified. The most obvious example of a known factor influencing food and drink waste levels is the number of people in the household (referred to as household size): the more people in the household, the higher the level of food and drink waste per household (Figure 32) but the lower the amount of food and drink waste per person (Figure 33).

Figure 32: Average amount of food and drink waste **per household** by household size in waste compositional analysis study (base size in brackets)



Source: Waste compositional analysis data from 2012

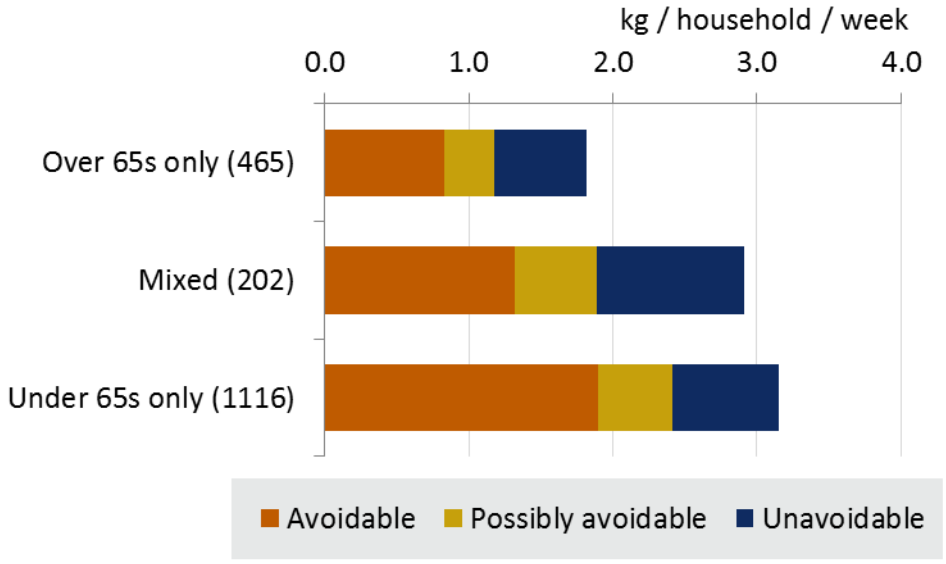
Figure 33: Average amount of food and drink waste **per person** by household size in waste compositional analysis study (base size in brackets)



Source: Waste compositional analysis data from 2012

Therefore, if there is a difference in household size between groups of a second variable (e.g. age), this could lead to different conclusions being drawn depending on whether the data is being analysed per household or per person. This is illustrated for the age of people in a household in Figure 34, which shows that the amount of waste **per household** for those households where all people living in the household are 65 or over is much lower compared to other households.

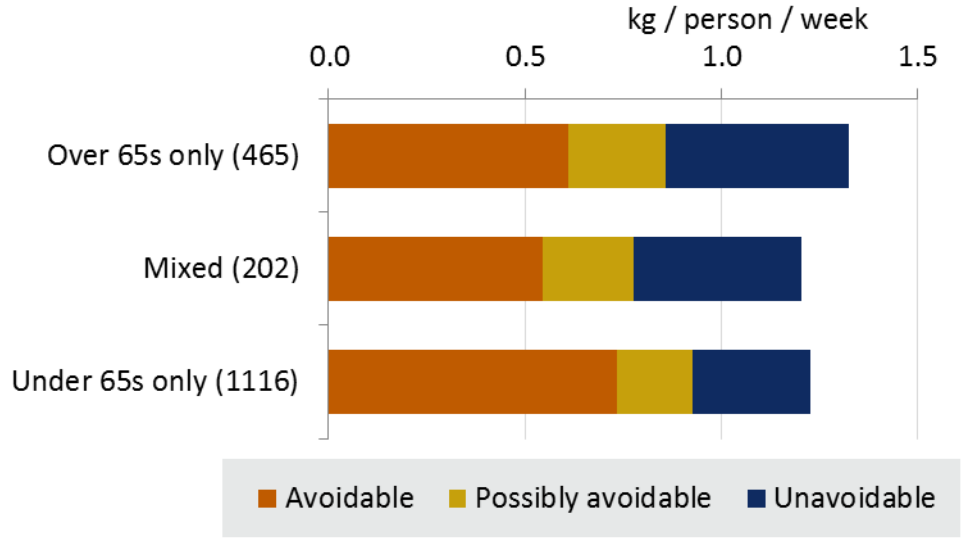
Figure 34: Average amount of food and drink waste **per household** for different age groups in waste compositional analysis study (base size in brackets)



Source: Waste compositional analysis data from 2012

However, the average household size for the 65+ group is also much smaller (1.6 people per household, compared to 3.2 for 'under 65s only' and 2.6 for 'mixed' households). Restating the results per person (Figure 35) appears to remove any large differences between these groups.

Figure 35: Average amount of food and drink waste **per person** for different age groups in waste compositional analysis study (base size in brackets)



Source: Waste compositional analysis data from 2012

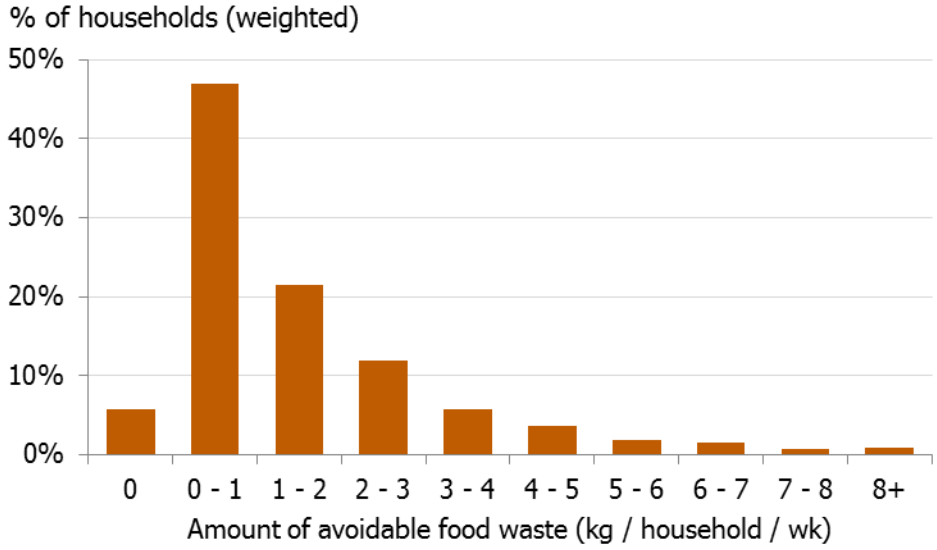
Although waste level per person appears to be a fairer metric for comparison, it fails to take into account that smaller households generate proportionately more waste (Figure 33). Given that smaller household are more likely to be in the 'over 65s only' group, the number of people in the household needs to be controlled for to understand the role of age (or any other variable of interest) – see §2.4 for more information on the effect of age on food waste.

6.2.2 Analysis method – generalised linear modelling

To control for the effects of 'structural' factors on food and drink waste, generalised linear modelling (GLM) has been used. This approach is an extension of standard linear regression modelling and consists of using explanatory (or independent) variables to explain the variation in a dependent variable. The advantages of generalised linear modelling are that:

- The explanatory variables can be categorical (i.e. where households are placed into separate groups, such as home ownership status) or continuous (varying on a scale, such as age, although this variable is usually grouped into categories);
- The distribution of the dependent variable need not be normal. This is the case for the distribution of the amount of food and drink waste from households, which is skewed (Figure 36).

Figure 36: Histogram of amount of food and drink waste from individual households in waste compositional analysis



Source: Waste compositional analysis data from 2012

It was decided to use the amount of avoidable food and drink waste as the dependent variable for the majority of models. This was for a number of reasons; firstly, it was useful to have one key metric to reduce the number of comparisons, reducing the amount of analysis to manageable levels and to decrease the number of false positives in the results (i.e. where the analysis suggests a significant effect where none actually exists).

The decision to use avoidable food and drink waste was that this is the category of waste with the largest potential for waste reduction, as the majority of the food could have been

eaten had it been better managed in the home[106]. It also aligns closely with communications by WRAP on household food and drink waste – for example, those delivered via the *Love Food Hate Waste* campaign.

Some analysis has also been performed on the possibly avoidable and unavoidable fractions of waste as secondary metrics of interest. This was because preliminary analysis revealed some interesting correlations that warranted further exploration and reporting.

GLM was performed in SPSS Statistics (version 22). It was modelled assuming a Gamma error distribution, which most closely fitted the distribution of avoidable food and drink waste. The calculations also used a log-link function which means that the model assumed that, where more than one explanatory variable was used in the model, the relationships between each explanatory variable and the level of avoidable food and drink waste were multiplicative, rather than additive. This means that the effect of each variable is modelled as a difference in avoidable waste represented by a constant percentage, irrespective of the value of other variables. This appears to be a better approximation to the data than the alternative, in which the difference relating to a variable is modelled as a constant difference in the weight of avoidable waste generated per household.

A small increment (1 gramme) was added to the amount of avoidable food and drink waste to allow the analysis to be performed. This avoided values of zero waste in the dependent variable, which, for Gamma distributions, SPSS would otherwise have excluded from the model[107]. Various increments were tried (1 g, 3 g, 10 g and 30 g): 1 gramme had minimal impact on the results and meant that there was only a small change to the dataset.

It was decided that the dependent variable for the modelling was avoidable food and drink waste **per household**. The choice of this variable over the alternative – the amount of waste per person – was not clear cut. However, as much waste is generated by activities that are on a household basis (e.g. for households with more than one occupant, grocery shopping is more frequently performed for the whole household, rather than individual members of that household), there is a rationale for explicitly exploring the amount of waste for that household, rather than generating a variable that implies an equal division of that waste between people. Furthermore, the relationship between number of occupants and waste levels is not proportional; using waste levels per person would still require the inclusion of a household size variable to control for effects of single person households.

Explanatory variables were screened to identify very strong correlations that could make model results unstable.

6.2.3 Alternative method considered: Normalisation

To compare households in one group with households of the same size in another group, a normalisation method was also considered (but not used). This involved:

- Calculating the average amount of waste for each household size
- For each household, calculating the amount of waste relative to the average for the relevant number of people in that household; this gives the normalised waste level

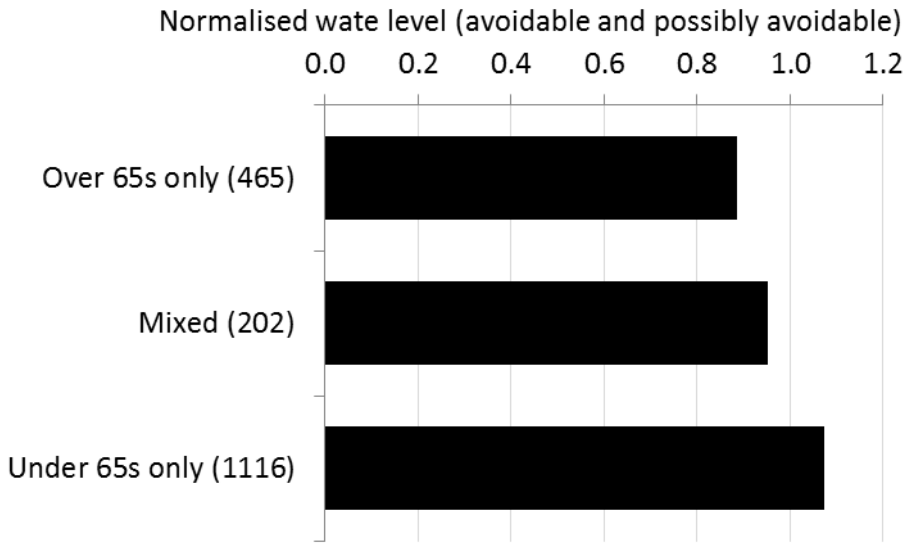
*[106] An example of food waste that would be classified as avoidable which could **not** have been eaten if better managed in the home is when products are brought into the home that have already gone off (e.g. due to a production fault). These would appear as avoidable waste if disposed of in the household waste streams.*

[107] It is a valid approach to include cases with zero values of the dependent variable generalised linear modelling using a Gamma distribution. This 'work around' was necessary due to limitations of SPSS.

- For each group, calculating the average normalised waste level.

The normalised results for the age categories explored above (Figure 37) shows that, once household size is controlled for, households containing only people over 65 waste less than the rest of the population (but not as much as the per household figures imply).

Figure 37: Amount of food and drink waste for different age groups in waste compositional analysis study, normalised by household size (based size in brackets)



Source: Waste compositional analysis data from 2012

Generalised linear modelling (GLM) was favoured over normalisation for the analysis in this report. Although both methods take into account structural factors, GLM can better apportion differences between structural factors and other factors of interest. For instance, if the difference in waste related to household size was partially due to a difference in those households relating to, say, meal planning, the GLM model would apportion differences in the amount of food and drink waste between household size and meal planning. In this hypothetical example, the inclusion of meal planning in the GLM model would reduce the coefficients in the results associated with household size, with some of these differences reassigned to meal planning. Normalisation would not fully take these differences into account.

Another advantage of GLM is that it is relatively straight-forward to change the factors being controlled for. For instance, it is of interest that there is a difference between households with different aged residents. However, it would be useful to understand if this difference is driven by other socio-demographic factors (e.g. employment status, socio-economic group) or behavioural factors (e.g. meal planning). It is possible to explore any differences in waste levels relating to a given factor (e.g. age) by including other factors (e.g. other socio-demographic factors, responses to questionnaire questions) to see if these explain the differences seen.

In addition, GLM allows interactions between terms to be investigated. The use of this functionality in this project is discussed in §6.3.

6.2.4 Structural factors to include in the generalised linear model

As has been demonstrated above, it is necessary to account for differences in household size using a GLM model to allow meaningful comparisons between groups. This section looks at other factors that potentially need to be taken into account.

For the waste compositional analysis, candidate factors included whether households divert food away from local-authority collections, for example via home composting or feeding animals with wasted food. Controlling for this type of factor is necessary as the waste compositional analysis only measures food in local-authority waste streams; therefore if material is diverted to, say, home composting, it could influence the results (the same is not true of the kitchen diaries, which measured all waste streams). The options in the questionnaire accompanying the waste compositional analysis (where people can state where they dispose of food and drink waste) are given below, alongside the percentage of sample who had their bins analysed who gave this response:

- General waste bin†, 48%
- Council food waste collection†, 44%
- Feed to animals (e. g. pets, birds)‡, 25%
- Home compost bin‡, 18%
- Down the sink/drain, 2%
- Food waste digester, 1.2%
- In home wormery, 0.4%
- Other, 2%

Aside from the general waste bin and the council food waste collection (marked †), all the other options represent a potential diversion from local-authority collections. Of these, the only two options that had substantial percentages of participants choosing them were 'home compost bin' and 'feed to animals' (marked ‡).

Households that home composted had substantially lower levels of avoidable food and drink waste in local authority collections (24% lower; $p < 0.0005$) than those that did not home compost, after controlling for household size. For feeding to animals, the difference between those who fed food waste to animals and those who did not was smaller (11%) and not statistically significant ($p = 0.053$). The larger difference associated with home composting (compared to feeding to animals) is consistent with diary research which suggests that the average amount of waste home composted by those who do home compost is higher than the average amount of waste fed to animals (by those who feed food to animals).

Given the above, for the generalised linear modelling based on the waste compositional data, it was decided to control for both household size and whether a household home composts, but not include whether a household feeds food to animals, as the effect associated with this diversion mechanism was much smaller and did not quite reach statistical significance at the 5% level. The decision to exclude this variable was also made to keep the models as simple as possible (i.e. to include as few variables). The exclusion of feeding food to animals did not appear to impact on the results where comparisons were made.

The above discussion is focused on the waste compositional analysis dataset. When developing a GLM model for the avoidable food and drink waste as recorded in the kitchen diary research, it was not necessary to include whether a household home composts (or uses

other waste streams) because waste disposed to these streams was recorded in the diary. The effects associated with households that home compost are described in §4.4.

For the kitchen diary research, it was also considered whether to include, as a structural factor, a question asked to research participants about whether the information recorded in their diary was broadly typical for their household (question 9 in the post-diary research). This question was significant as an explanatory variable, but the level of waste did not vary with the question options in an intuitive way (i.e. waste levels increasing across the question options), and could be the result of subjectivity associated with the question (e.g. the assessment of whether a week is 'typical' depends on the respondent being aware of their household's previous waste levels). Therefore, the variation associated with this question may be a reflection of other factors that correlate with their response to this question and this question was not used as a structural factor for waste compositional analysis, although this decision is not clear cut.

By including the above factors in GLM models, structural elements of a household that were demonstrated to influence food and drink waste were taken into account. However, stated behaviours, attitudes and values were not controlled for – largely because these factors were the focus of the main analyses and to control for them would make any differences invisible in the main analysis.

6.3 Challenges with modelling

There are a number of challenges associated with modelling the levels of avoidable food and drink waste via regression or generalised linear models, as presented in this report.

Firstly, the generation of food and drink waste within a household is complex, and depends on many interrelating factors. At its simplest, food and drink waste generation can be seen as a consequence of the interplay between food-related activities (such as cooking too much, incorrect storage of food or not using up leftovers), the context in which they are performed and the food that is brought into the home.

Given this, there are likely to be few factors that will correlate with food and drink waste levels in all circumstances. In many cases, it is the combination of activities, decisions and attributes of food (such as shelf-life) that lead to waste[108]. This suggests that it is the interactions between variables, as well as the variables themselves that would correlate with food and drink waste levels. However, due to the issues highlighted below, it was hard to isolate the effect of these interactions. This was also made difficult by many of the categorical variables having multiple responses, which means that interaction terms create a large number of new levels in explanatory variables.

The reasons that food is wasted vary between households (e.g. some households may generate a lot of food due to buying too much; others may have regular accidents in the kitchen). These reasons do not always correlate with one another, meaning that there may be a large 'averaging' effect – households generating food and drink waste for one reason may not generate much for other reasons. This makes the task of finding correlations between food and drink waste and information about the household problematic. The analyses in §8.3 attempt to circumvent this issue by exploring specific fractions of waste that may be less susceptible to these averaging effects.

[108] *This is discussed with simulated examples in §3.5 of The Milk Model: Simulating Food Waste in the Home, WRAP (2013)*

The questionnaires contain a range of questions. Some relate to a specific time (e.g. about the last grocery shop), whilst others are more general (such as number of people in the household). The questions with a specific time frame will not have been asked about the week or fortnight in which the measurement of food and drink waste was made (either via the kitchen diary or waste compositional analysis) because the questionnaire fieldwork was generally a few weeks before the compositional analysis. Therefore, relationships between these questions and the level of food and drink waste will only be found where people's activities are similar over time (i.e. activities as indicated in the questionnaires are also present, to some extent in the measurement week). As discussed in other research[109], activities associated with food have a strong habitual element, so there is likely to be a high degree of similarity in food-related activities over time; nevertheless, this effect still limits the ability of responses to these questionnaires in explaining food and drink waste levels. For questions without a temporal framing, this effect is not likely to have a large impact.

This effect is only an issue because the amount of food and drink waste generated by a single household is not a constant and varies over time. Indeed, of the limited information available, there is a suggestion that much of the variation seen between households in surveys is due to week-to-week variation of individual households, rather than differences in the long-term average between households[110].

This effect limits the amount of variability between households that can be explained via this type of modelling approach (given the relatively short sampling periods in both the waste compositional analysis and kitchen diary). Because of this week-to-week variation, not much can be said of the (long-term) average waste levels of a single household from the data available (i.e. whether an individual household is of low or high waste levels in general), only what was measured during that measurement period. It is only by grouping together households with similar characteristics that relationships with explanatory variables can be observed. Even so, factors causing small (but important) differences in levels of food and drink waste may not be detected.

The questionnaires were also asked to one person in a household. In both pieces of research, an attempt was made to conduct the interview with the person with most responsibility for shopping and cooking and all interviews were conducted with someone who has at least some responsibility for both of these activities. However, the responses of one person may not be fully representative of the whole household, except in the case of single-occupancy households. In households with more than one occupant, there will be a degree of divergence between the activities, attitudes and views expressed in the questionnaire and those of the household in general. Where members of a household cook and prepare food as a unit – which is found in most households in the sample – this divergence may be small, but this will not be the case for all households. In these latter cases this, again, limits the ability of questionnaire data to explain household food and drink waste levels.

Despite all of the above, the fact that correlations have been found in this report and that these correlations are in keeping with other pieces of research demonstrates that these challenges have not been so great to mask all effects in the analysis. It is likely that only the effects that have a relatively strong correlation with waste have been picked up in this modelling – there may be other, more subtle effects that it is simply not possible to detect given the points in the discussion above. Nevertheless, the findings of this research suggest

[109] *e.g. Habits, Routines and Sustainable Lifestyles, Defra (2011)*

[110] *For further discussion on this point, see Appendix A of The Milk Model: Simulating Food Waste in the Home, WRAP (2013)*

that the approach used in this report can add to the findings coming from other fields of research about household food and drink waste.

7.0 Appendix – Statistical analysis for socio-demographics chapter

This chapter presents the methodology and detailed statistical results behind the chapter on socio-demographics (§2.0).

7.1 Results: Individual socio-demographic factors and avoidable waste

Each of the socio-demographic factors was examined separately for relationships with levels of avoidable food and drink waste in the household, controlling for household size (in waste compositional analysis and kitchen diary studies) and home composting (waste compositional analysis study only), as discussed in §6.2.4. Table 5 shows the results of a number of generalised linear models built with each of the socio-demographic factors in waste compositional analysis as explanatory variables, controlling for household size and home-composting where appropriate (also as explanatory variables). Table 6 shows corresponding results for the kitchen diary study. The dependent variable was the amount of avoidable food and drink waste (expressed per household per week); for the waste compositional analysis, this was all avoidable waste collected by local authorities (residual (general) waste and any collections targeting food waste) and for the kitchen diary this was avoidable waste from all waste streams.

Out of all socio-demographic variables in the waste compositional analysis study, household size[111], age of respondent, household's age structure, home ownership and employment status of the main earner were found to correlate with avoidable food and drink waste. Higher levels of waste were associated with larger households, younger households, those renting and those where the main earner was not retired. Ethnicity was excluded from the analysis, as only a small proportion of respondents were not white British and these other households were split across a range of diverse groups that it would not make intuitive sense to combine.

Interestingly, the kitchen diary provided somewhat different results. Consistent with the waste compositional analysis study, household size was found to be strongly correlated with levels of avoidable food and drink waste. Furthermore, employment status of the main earner was close to being significant. Age of respondent was not found to be significantly correlated with levels of avoidable food and drink waste in the kitchen diary study; however the same trend as the waste compositional analysis model was observed – higher levels of waste for younger respondents – despite not being significant. No relationship was found between home ownership and waste. Additionally, the following socio-demographic characteristics were found to be significant in the kitchen diary study, but not in waste compositional analysis: gender; urban/rural area; household composition; presence of children; and socio-economic grouping. These results and the differences between the two datasets are discussed in the next section.

It has to be borne in mind that information presented in both tables shows relationships for each of the socio-demographic factors *separately*, controlling for household size and home-composting where appropriate. Due to a high degree of correlation between some socio-demographics (e.g. older people being more likely to live in smaller households and own their homes; or women more likely to live with children), when all were included in a single model, many were no longer significant (see §7.2). Moreover, it is possible that some of the differences between findings in the two studies could be due to very different research designs and the influence of various socio-demographic factors on the accuracy of self-

[111] *As mentioned before, household size is one of the structural factors controlled for in all other analysis, but as it is also a socio-demographic characteristic, it is included in this list.*

reporting in the kitchen diary. These issues are also discussed in greater depth in the next section.

Table 5: Results of generalised linear models with each of the socio-demographic factors in waste compositional analysis, controlling for household size and home-composting

Variable	*p* value	Relationship with avoidable food and drink waste
Age (respondent)	<0.0005	Modelled as three age categories. Those aged over 65 waste the least (20% less than average), whilst 18-34 the most (19% more than average); §2.4.
Age structure (household)	<0.0005	Modelled as three age categories. Households composed solely of people aged over 65 waste the least (around 21% less than average), those including under 65s only 11% more than average.
Gender (respondent)	0.983	No relationship with avoidable food and drink waste (levels of waste similar for men and women)
Household size*	<0.0005	One of the structural factors controlled for in all other analysis. Smaller households generated less waste overall, but more waste per person; §2.3.
Household composition	0.715	Not statistically significant, no clear relationship (although single occupancy seem to have the highest levels of waste). Highly correlated with HH size, became significant when HH size was removed from the model
Home ownership status	0.002	Home owners (no mortgage) had the lowest levels of waste, whilst those renting (either privately or from the council or housing association) had the highest.
Type of residence	0.151	Not statistically significant, no clear relationship (a small amount of people living in flats included in the sample)
Presence of children (QC)	0.222	Not statistically significant, but those without children had slightly less waste
Socio-economic grouping (Q35)	0.189	Not statistically significant, but those in middle groups (C and D) seem to have had the most waste, with the top and bottom groups having the least waste
Employment (main earner)	<0.0005	Those in paid work waste the most (19% above average), followed by those not in employment (11% more than average), with retired wasting the least (17% below average); §2.5.

*controlling for home-composting only

Table 6: Results of generalised linear models with each of the socio-demographic factors in kitchen diary study, controlling for household size

Variable	*p* value	Relationship with avoidable food and drink waste
Age (respondent)	0.139	Not statistically significant, but the same pattern observed as in waste compositional analysis. Those aged 65 and over wasted the least, and those aged 18-34 the most
Age structure (household)	0.127	Not statistically significant, but a broadly similar pattern observed as in waste compositional analysis. The majority of households (n=707) didn't include any people aged 65 or over
Gender (respondent)	0.006	Households with female respondents generated 22% more waste than those with male respondents
Rural/urban area	0.009	Those living in rural areas generated the lowest levels of waste (30% less than those living in urban areas). The third category 'Town and fringe' was intermediate between the other two.
Household size*	<0.0005	One of the structural factors controlled for in all other analysis. Smaller households generate less waste overall, but more waste per person.
Household composition	0.028	Single occupancy households wasted the most (38% more than average), followed by families with children, with couples wasting the least (32% less than average).
Home ownership status	0.187	Not statistically significant, no clear relationship
Type of residence	0.232	Not statistically significant, no clear relationship
Presence of children	0.001	Those without children had 29% less waste than those with children
Socio-economic grouping	0.037	Those in group C2 generated the most waste (17% above average), ABs the least, and C1, D and E intermediate values.
Employment (main earner)	0.060	Close to statistical significance. Those who were retired wasted the least (11% below average).

*model with household size as a sole factor

7.2 Results: Full socio-demographic models

The previous section explored the effects of each of the socio-demographic variables separately. However, as mentioned before, some of the socio-demographics were strongly correlated with each other (e.g. age was correlated with employment, with older people more likely to be retired and younger people to have paid jobs). In order to determine the strength of the correlation of each variable with avoidable food and drink waste, relative to other socio-demographic factors, all socio-demographic and structural factors were included in a single model (one for each study). In both studies, the main models started with all socio-demographic variables included, as listed in the previous section. Variables were then removed step-wise, starting with the least significant until only those that were statistically significant ($p < 0.05$) remained. In some cases variables close to statistical significance were also included, and this is highlighted and discussed where relevant. Where variables were identified as strongly correlated, variables that were previously excluded were reintroduced to the model to check whether they were significantly correlated in a more parsimonious model. This helped ensure that the final multivariate models were robust to the order in which variables were excluded.

As a result, some of the socio-demographics significant in 'simple models' (i.e. including one explanatory variable at a time) ceased to be significant in the main model, which implies that their individual effects shown in the previous section could in fact be explained by other related socio-demographic factors. As expected, age structure was strongly correlated with age of respondent, and as such both could not be meaningfully included in one model. Including one or the other was producing broadly similar results in waste compositional analysis (both were not significant in kitchen diary study), therefore only one of them – age of respondent – is presented here.

Table 7: Results of main generalised linear model of socio-demographic variables using waste compositional dataset

Variable	*p* value	Relationship with avoidable food and drink waste
Household size	<0.0005	Structural factor controlled for in all other analysis. Smaller households generate less waste overall, but more waste per person.
Home composting	0.001	Structural factor diverting waste away from local authority bins; thus those home composting had lower waste levels
Employment of main earner	0.035	Results broadly consistent with those in the simple model (see Table 5)
Age of respondent	0.067	Results broadly consistent with those in the simple model (see Table 5)

In the waste compositional analysis study, the final model included household size, home composting (i.e. 'structural factors', as discussed in the §6.2.4), employment of main earner and age of respondent, even though age of respondent fell just short of being significant (see Table 7). Age of respondent was strongly correlated with home ownership, and therefore only one of them could have been meaningfully included in the model. Table 7

shows the results of the main model where age of respondent was deliberately kept in (i.e. rather than precisely following the step-wise exclusion method, other variables, including home ownership, were removed, to ensure that 'age of respondent' was kept in the final model). Table 8 shows the alternative model where step-wise exclusion was strictly followed, which resulted in home ownership replacing age of respondent.[112]

Table 8: Results of an alternative generalised linear model of socio-demographic variables using waste compositional dataset

Variable	*p* value	Relationship with avoidable food and drink waste
Household size	<0.0005	Structural factor controlled for in all other analysis. Smaller households generate less waste overall, but more waste per person.
Home composting	0.002	Structural factor diverting waste away from local authority bins; thus those home composting had lower waste levels
Employment of main earner	<0.0005	Results broadly consistent with those in the simple model (see Table 5)
Home ownership	0.023	Results broadly consistent with those in the simple model (see Table 5)

Table 9: Results of main generalised linear model of socio-demographic variables using kitchen diary dataset – household size included; household composition excluded

Variable	*p* value	Relationship with avoidable food and drink waste
Household size	<0.0005	Structural factor controlled for in all other analysis. Smaller households generate less waste overall, but more waste per person.
Presence of children	0.010	Those without children had around 25% less waste than those with children
Gender	0.013	Households with female respondents generated 20% more waste than those with male respondents
Rural/urban area	0.011	Those living in rural areas generated the lowest levels of waste (30% less than those living in urban areas). The third category 'Town and fringe' was intermediate between the other two.

Table 9 shows variables included in the final socio-demographic model using the kitchen diary dataset. Including all variables in one model resulted in employment of the main earner

[112] *The relationship between home ownership and age is not therefore straightforward. Because the two socio-demographic factors are strongly correlated with one another, unpicking which is in fact driving the correlation with levels of waste proves difficult. In this case, two alternative models are possible – one including home ownership instead of age, and the other one including age instead of home-ownership. The decision about which model provides a better picture is therefore to a large extent subjective. Both are discussed in different places in the report.*

and socio-economic groupings no longer being statistically significant. Household composition and household size were both highly significant, however due to a high correlation between them they could not be included in one model (e.g. the 'couple' category in household composition variable corresponded to two occupants in household size variable). Household size was decided to be left in the main model as a preferred variable out of the two alternatives, as it was also consistent with findings from waste compositional analysis and easier to interpret.

Table 10 shows the alternative model with household composition included in place of household size. The quantified effects of each of the factors differ depending on which other variables are included in the model; this is why figures for, for example, the effects relating to 'presence of children' are different in the two models (i.e. results in Table 10 and Table 9). The relationships between socio-demographic factors and levels of avoidable waste are therefore best understood in qualitative terms (e.g. that those household without children had less waste), rather than making definite quantitative statements about the strength of that relationship.

Table 10: Results of alternative generalised linear model of socio-demographic variables using kitchen diary dataset – household size excluded; household composition included

Variable	*p* value	Relationship with avoidable food and drink waste
Household composition	<0.0005	Pattern seems to correspond to household size, i.e. single occupancy households wasting the least, followed by couples, then families with young children, and families with adult children
Presence of children	0.001	Those without children had around 39% less waste than those with children
Gender	0.026	Households with female respondents generated 18% more waste than those with male respondents
Rural/urban area	0.021	Those living in rural areas generated the lowest levels of waste (28% less than those living in urban areas). The third category 'Town and fringe' was intermediate between the other two.

7.3 Results: Other socio-demographic variables

This section is dedicated to examining those socio-demographic factors that were not included in the main body of the report, but which were also found to correlate with levels of avoidable food and drink waste to a higher or lower extent. They are discussed separately, because their relationship with food and drink waste was not straightforward and/or because they were highly correlated with other socio-demographic variables (see statistical modelling presented in the previous section for details).

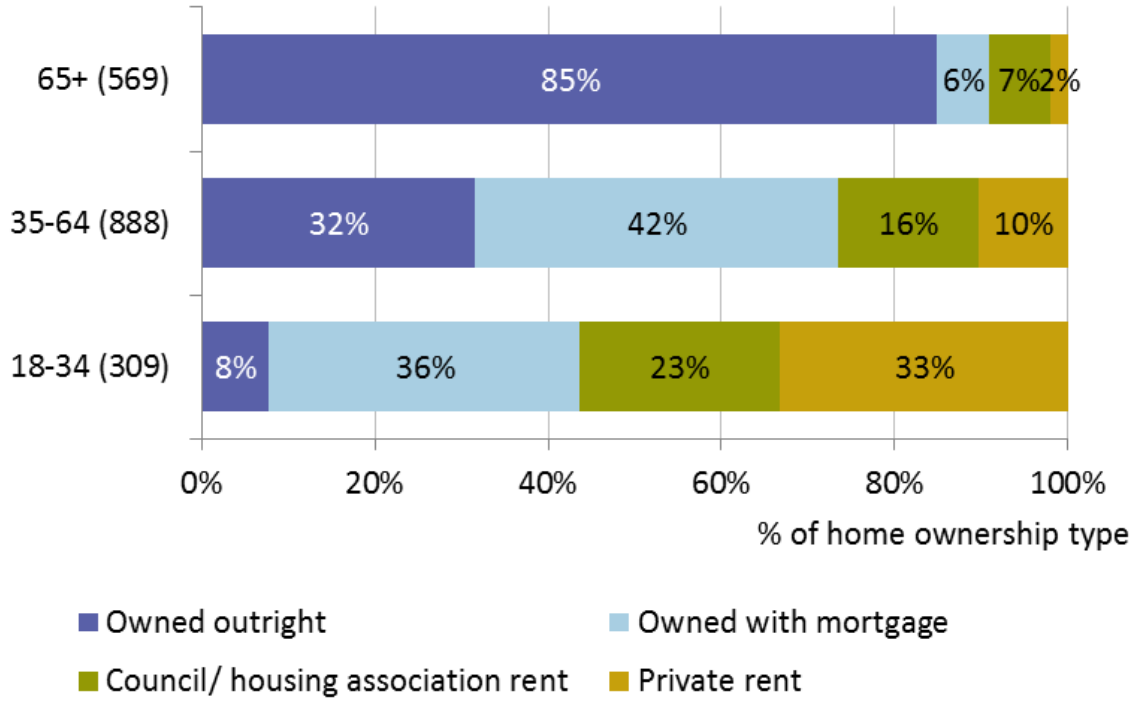
7.3.1 Home ownership

In waste compositional analysis, home ownership was significantly correlated with levels of avoidable food and drink waste. In the questionnaire, respondents were asked to describe

their home ownership status by choosing one of the following answers: owned outright; owned with mortgage; council / housing association rented; private rented; and other.

In the waste compositional analysis study, home owners (owned outright) were found to waste less than other groups. However, there was a strong correlation between age and home ownership, with the over 65s more likely to be outright home owners (Figure 38).

Figure 38: Home ownership status by age of survey respondent, number of cases in brackets



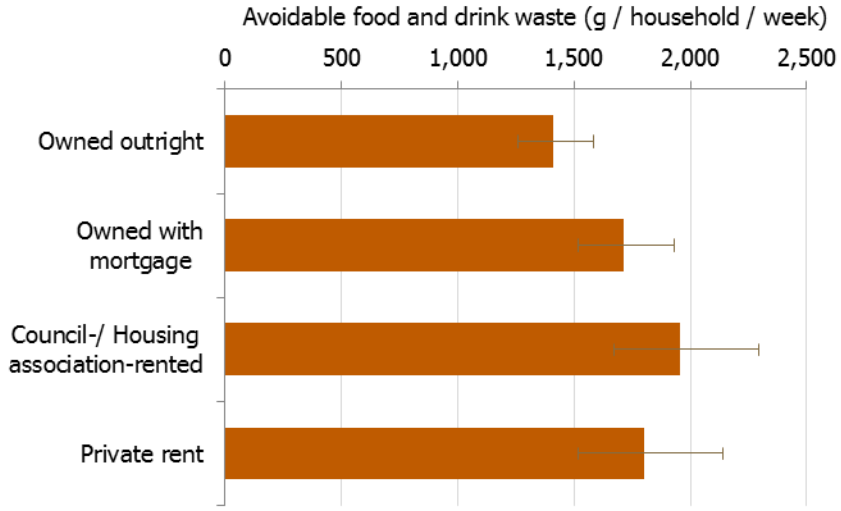
Source: Waste compositional analysis study 2012

When age and home-ownership were both included in the model, home ownership was no longer significant, which means that most of the effect of home-ownership on waste levels was in fact due to age[113].

Figure 39 shows the relationship between home-ownership and waste levels when age is not accounted for. No significant relationship was found between home ownership and levels of avoidable waste in the kitchen diary study, possibly due to a smaller sample and because there were fewer older people in that study – i.e. the same reasons that could explain why age is not correlated with levels of waste in the kitchen diary study.

[113] *The relationship between the two variables becomes more complex when other socio-demographics are included in the full model, see §.7.2 for details.*

Figure 39: Variation in levels of avoidable food and drink waste by home ownership status, controlling for household size and home composting



Estimated marginal means shown; error bars show 95% confidence intervals
Source: Waste compositional analysis study 2012

7.3.2 Household composition

The household composition variable was calculated in both studies on the basis of respondents' answers to the following question: 'which of the following best describes your household composition?', with seven options: single occupancy; couple/ husband & wife; family with at least one children under 18; family with children (all 18 years or over); family with three or more generations; multiple families; unrelated individuals.

This variable was found to be significant in the kitchen diary, but not waste compositional analysis study, controlling for household size and/or home-composting. This was due to its high correlation with household size (with some categories corresponding directly to those in 'household size' variable, e.g. couple = two occupants), which meant that including both variables in the statistical models resulted in only one of them appearing as significant (which in the kitchen diary was household composition, whilst in the waste compositional analysis – household size). Only one of them could be therefore meaningfully included in the model. Household size was a preferred variable for further analysis, as household composition in fact measured many factors at the same time, including household size, presence of children and the type of relationship between household members, which made the interpretation of the findings more difficult. The effect of presence of children is discussed in §2.6.

7.3.3 Gender

There was no relationship between the gender of the respondent and levels of waste in the waste compositional analysis dataset. However, it was found that households with female respondents to the survey had around 22% more avoidable food and drink waste than male respondents in the kitchen diary study. It is unclear why there is a difference between the two datasets, but it is possible that it was due to different ways in which men and women completed the diaries. Women might have been more diligent in filling them in or more aware of the food and drink being thrown away in the household, thus having higher recorded levels of waste than men.

As a difference in waste levels by gender was only found in the kitchen diary model, and that most households have occupants of both genders, this result should be treated with caution.

8.0 Appendix: Statistical analysis for behavioural chapter

This chapter presents the methodology and detailed statistical results behind the chapter on food-related behaviours (§3.0).

As described in §6.2.2, generalised linear modelling (GLM) was used to understand the relationship between the explanatory variables (in this section, questions related to behaviours) and the amount of avoidable food and drink waste expressed per household per week. For the waste compositional analysis, this is all avoidable waste collected by local authorities: residual (general) waste and any collections targeting food waste, including separate food waste collections and mixed food and garden waste collections. For the kitchen diaries this is avoidable waste from all waste streams: residual (general) waste, local authority collections that target food waste, sewer, home composting and fed to animals.

For some of the later models in this section, some subsets of avoidable food and drink waste have been used as the dependent variable – only including avoidable food and drink waste associated with certain reasons for disposal or specific food types.

The explanatory variables were related to behavioural questions, as described in §8.1. For these questions, the wording was designed to capture whether the behaviour occurred, rather than the reason why it was performed. For example, the question on storage of apples in the fridge does not distinguish between those people who store apples in the fridge motivated to prolong the apples' life (possibly with food-waste prevention in mind) from those who store them in the fridge for other reasons (for instance, because they don't have any other storage location). In some cases the question also captured the extent to which the behaviour was performed.

When these questions were developed (during 2010), they were designed to be used in an on-line survey. Small modifications were necessary for them to be used in the current research (telephone interviews for the kitchen diary research, face-to-face for the waste compositional analysis). The exact wording and response options can be found in the appendix of questionnaires published alongside this report.

At the time of development, there was no opportunity to test whether there were correlations between the questionnaire responses and actual levels of waste. This research into household food and drink waste levels during 2012 and 2013 represents the first opportunity to explore the relationship between these questions and waste levels.

The questions have been used to track behavioural change in the UK. To condense a large amount of information from multiple responses of questions, a 'scorecard' method was developed, which assigned a score to questionnaire responses: ten was assigned to the response most likely to be associated with low levels of food and drink waste and zero to the response most likely to be associated with high levels of food and drink waste. For intermediate responses, the score reflects WRAP's judgement as to the degree to which a response would prevent food and drink waste[114].

[114] *Full details of the behavioural scorecard can be found in this document.*

The fact that scores have been applied to different behaviours should **not** be viewed as implying that engagement with these behaviours is 'good' or disengagement with these behaviours is 'bad'. It merely provides a quantitative assessment of whether a person or a household is engaged with that behaviour. There will be situations in which households generate low levels of food and drink waste although they are not engaged with these nine behaviours; qualitative research suggests that there are a large number of strategies for reducing food and drink waste in the home, of which only some will be captured by the behavioural scorecard. This is one reason why actual measurement of food and drink waste levels is a key part of monitoring efforts in the UK, rather than relying on behavioural information from questionnaires.

In some cases the behavioural scores were used within the modelling, as these condense information from a number of response options into a single score ranging from zero to ten, which helps to develop a manageable model[115]. Where this has occurred, the score is entered into the model as a covariate – i.e. the model takes into account that the score is on a continuous scale. In other cases, the response options have been entered into the model as categorical factors. This is the case where there is not necessarily a trend between response options (such as storage location for apples). Occasionally similar responses have been combined to ensure sufficient responses in each level, without which the GLM results would not be robust.

Alongside the behavioural variables, structural variables (see §6.2.1) have also been included as explanatory variables. These structural variables are factors about a household that are known to influence waste levels and which we wish to control for. For the waste compositional dataset, these are number of occupants in a household (household size) and diversion of food and drink waste to home composting[116]; for the diary research, there is just one: household size[117].

As discussed in §1.4, different types of model have been constructed. Some contain structural factors and one other variable, which help understand whether households in which a behaviour is performed generate more or less avoidable food and drink waste compared to other households. Further modelling was performed in which multiple behavioural variables were included as explanatory variables; the results from these models can thus be understood as helping to understand which variables are more likely to be having a direct effect. For instance, meal planning and using a shopping list are correlated with one another; by placing both as explanatory variables in a model, the model can understand the effect of each on food waste levels whilst controlling for the other, thus understanding which one is likely to be responsible for any effect.

In the next section (§8.1), results from the waste compositional analysis dataset are presented; §8.2 includes results from the kitchen diaries dataset. For each of these a main model has been developed, but variants of these main models were also tested to explore the robustness of the model to which explanatory variables were included.

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[115] If too many variables (and response options within those variables) are included, the GLM accounts for a spuriously high level of variability in the dependent variable and consequentially the results become difficult to interpret.

[116] For the waste compositional analysis, a variable describing what proportion of possible collections has been used by a household in the collection cycle during which waste was being collected and analysed was also explored as a possible structural factor. This was included in the 'main model' in §8.1, but its omission from other models did not have a large impact on the results. This takes into account those who were away of otherwise did not set out waste on all opportunities during the collection cycle, potentially distorting results.

[117] Similarly, a question in the post-diary questionnaire asking about how the information in the diary related to a 'typical' week for that household was explored as a potential additional structural factor. This can be found as a model variant in §8.2 and, again, has little impact on the results.

8.1 Behaviours: results – modelling using waste compositional analysis dataset

8.1.1 WCA models with single behavioural factors

In this section, results of generalised linear modelling from the waste compositional analysis (WCA) dataset are presented. The dependent variable is the amount of avoidable food and drink waste in waste streams collected by the local authority (expressed per household per week) and the explanatory variables were behaviour-related questions in the accompanying questionnaire. Each model contained structural factors (as listed below) and one behavioural factor. As stated above, this gives information on whether a household giving a certain response to a questionnaire generates more or less food than households that give a different response.

Structural factors:

- Number of people in the household (recoded into 1, 2, 3, 4, 5 or '6 or more' people)
- Whether or not the household stated that they home composted (Q19, option 2)
- Extent to which householders set out waste streams included in the study (from records collected during waste compositional analysis; see footnote in §8.0 for more details)

Variables from the behavioural scorecard:

- The extent of meal planning (Q3)
- Behaviour scores associated with:
    - Cupboard checking (Q4)
    - List making (Q5)
    - Use of freezer (Q7)
    - Storage of cheese and meats after opening (Q8)
    - Use of the fridge to store apples and carrots (Q9)
    - Using leftovers (Q11)
    - Cooking the right amount of rice (Q12) and pasta (Q13)
    - Throwing away items because they have gone past their date label (Q14)

Other behavioural variables:

- Type of shopping trips made (recoded from Q1)
- Frequency of main shopping trip (Q2)
- Proportion of occupants of the household classed by the survey respondent to be fussy eaters (recoded from Q28 into following categories: 0%, between 1% and 35%, 35%+; see §4.1 for more details)

The results for these models are presented in Table 11. Only three behaviours were significantly correlated with levels of avoidable food and drink waste: using leftovers, throwing away items because they have gone past their date label and fussy eating. In addition, list making and meal planning (when modelled as a covariate) were only marginally non-significant. None of the other behaviours was significant, and variables relating to

shopping frequency and type of shopping were not either. The next section explores the effect of multiple behavioural factors in the same model.

Table 11: Results of individual GLMs using waste compositional analysis dataset: dependent variable = avoidable food and drink waste; controlling for household size, home composting, and extent to which householders set out waste streams during the study

Variable	*p* value	Relationship with avoidable food and drink waste
Meal planning (behavioural score used as a covariate)	0.695	No significant relationship found
Meal planning (responses used as categorical data)	0.150	This method allows for a non-linear trend in waste levels with response options. However, the effect on avoidable food waste was still not significant
Cupboard checking	0.345	No significant relationship found
List making	0.174	No significant relationship found
Freezer use	0.872	No significant relationship found
Storage of cheese & meats after opening	0.436	No significant relationship found
Use of the fridge to store apples & carrots	0.664	No significant relationship found – modelling of this behavioural variable for apple and carrot waste only is found in §8.3.3.1 and §8.3.3.2.
Using leftovers	0.004	1.8% (±1.2%[118]) decrease in waste level with each unit of behavioural score – i.e. those using up leftovers waste 16% less (±10%) compared to those who waste them.
Cooking the right amount of rice & pasta	0.270	No significant relationship found
Throwing away items because they have gone past their date label	<0.0005	4.4% (±1.3%) decrease in waste level with each unit of behavioural score
Fussy eating (modelled as a covariate)	0.015	An increase of 10% (±8%) in waste levels between each fussy eater category (10% increase from no fussy eaters in a household to those with 1%-35% fussy eaters and the same increase from 1-35% to 35%+ fussy eaters)
Type of shops (recoded into either 'almost all my food in a main shop' and 'other')	0.172	No significant relationship found
Frequency of shopping	0.742	No significant relationship found

[118] *Approximate 95% confidence intervals around the mean presented. Most confidence intervals are slightly asymmetric; those presented here are the average of the upper and lower confidence intervals.*

8.1.2 WCA model with multiple behavioural factors

In this section, results of generalised linear modelling from the waste compositional analysis (WCA) dataset are presented. The model started with the explanatory variables listed below and variables were removed step-wise, starting with the least significant until only those that were statistically significant at the 5% level ($p < 0.05$) remained. The resulting model is referred to as the 'pared-down' model. As with §8.1.1, the dependent variable is the amount of avoidable food and drink waste in waste streams collected by the local authority (per household per week) and the explanatory variables were behaviour-related questions in the accompanying questionnaire.

Where variables were identified as strongly correlated, variables that were previously excluded were reintroduced to the model to check whether they were significantly correlated in a more parsimonious model. This helped ensure that the final multivariate models were robust to the order in which variables were excluded.

Structural factors:

- Number of people in the household (recoded into 1, 2, 3, 4, 5 or '6 or more' people)
- Whether the household stated that they home composted (Q19, option 2)
- Extent to which householders set out waste streams included in the study (from records collected during waste compositional analysis; see footnote in §8.0 for more details)

Variables from the behavioural scorecard:

- The extent of meal planning (categorical information from Q3)
- Behaviour scores associated with:
    - Cupboard checking (Q4)
    - List making (Q5)
    - Use of freezer (Q7)
    - Storage of cheese and meats after opening (Q8)
    - Use of the fridge to store apples and carrots (Q9)
    - Using leftovers (Q11)
    - Cooking the right amount of rice (Q12) and pasta (Q13)

Other behavioural variables:

- Type of shopping trips made (recoded from Q1)
- Frequency of main shopping trip (Q2)
- Proportion of occupants of the household classed by the survey respondent to be fussy eaters (recoded from Q28 into following categories: 0%, between 1% and 35%, 35%+; see §4.1 for more details)

As noted in the previous section, the proportion of occupants of the household classed as fussy eaters is not strictly a behavioural variable, but included as a proxy for frequency of food being rejected (which is a behaviour). In addition, this model omitted behavioural scores associated with throwing away items because they have gone past their date label. This is because it is not, strictly speaking, a behaviour: it is the result of other behaviours that lead to waste. As such, it correlates relatively strongly with waste levels and could be

masking the effect of other behaviours that lead to people throwing away food that has gone past a date label (e.g. low levels of planning or poor storage of items). The omission of this variable is explored in variant 1 below.

The results for this model are given in Table 12 for the variables that were statistically significant in a final, pared-down model. These show that only two variables, out of the list shown above, were statistical significant, when controlling for the other variable and structural factors. The other behavioural factors were all eliminated from the model due to being non-significant (with the lowest significance value being $p = 0.28$ – i.e. not very close to the threshold for inclusion).

Table 12: Results of main 'pared-down' generalised linear model using waste compositional analysis dataset: dependent variable = avoidable food and drink waste; controlling for household size, home composting, and extent to which householders set out waste streams during the study

Variable	*p* value	Relationship with avoidable food and drink waste
Using leftovers	<0.0005	Those using leftovers generated 16% (±11%) less than those who wasted leftovers
Fussy eating (modelled as a covariate)	0.049	An increase of 9% (±9%) in waste levels between each fussy eater category (9% increase from no fussy eaters in a household to those with 1%-35% fussy eaters and the same increase from 1-35% to 35%+ fussy eaters)

The behavioural variables included in the model move in a direction consistent with expectations: using up leftovers is associated with lower levels of avoidable food and drink waste; fussy eating is associated with higher levels. Given that this model is examining correlations between variables, the results in Table 12 do not prove causation, but they are consistent with notion that a) using up leftovers reduces waste and b) the presence of fussy eaters in a household increases the level of waste (although other explanations could account for the trends seen).

Three variants on the final model were run to examine how correlation among the explanatory variables influenced the results.

Variant 1: This variant includes the behavioural score associated with throwing away items because they have gone past their date label (Q14). The main model omitted behavioural scores associated with throwing away items because they have gone past their date label. This is because it is not, strictly speaking, a behaviour and could be masking the effect of other behaviours that lead to people throwing away food that has gone past a date label (e.g. low levels of planning or poor storage of items). However, to check whether its omission had a large impact on the results, the modelling was repeated with this variable included.

The variable around use of date labels was significant in the model ($p = 0.001$, 3.2% (±1.8%) increase in waste level for each additional point on the 10-point behavioural scale). Its inclusion did not alter the fact that leftover use was a significant variable, although the strength of its correlation with waste levels did increase on inclusion of the date labels question, suggesting that there is a correlation between these two variables (Table 13).

The inclusion of the date-labels variable did affect the results relating to the proportion of fussy eaters in the household. In particular, the relationship between fussy eating and avoidable food waste was now marginally non-significant (p = 0.069). However, the size of the relationship between fussy eating and avoidable food and drink waste was estimated to be similar to before (but the confidence interval around this estimate had increased). Therefore, the decision of whether to include the 'date labels' behavioural score did not impact greatly on the conclusions drawn.

Table 13: Results of 'variant 1' generalised linear model using waste compositional analysis dataset: dependent variable = avoidable food and drink waste; controlling for household size, home composting, and extent to which householders set out waste streams during the study

Variable	*p* value	Relationship with avoidable food and drink waste
Using leftovers	<0.0005	Those using leftovers generated 28% (±11%) less than those who wasted leftovers.
Throwing away items because they have gone past their date label	0.001	3.2% (±1.8%) increase in waste level for each additional point on the behavioural score
Fussy eating (modelled as a covariate)	0.069	9% (±11%) increase between households with 0% fussy eaters to those with 1%-35% and the same increase from 1-35% to 35%+ fussy eaters

Variant 2: Omission of the behavioural score relating to using leftovers. This variant was used because the 'using leftovers' variable led to the omission of many households who were still storing their leftovers, don't know what happened to their leftovers, or don't generate leftovers. In these cases, no behavioural score was allocated to the household, so these cases were omitted from the main model. However, omitting the 'using leftovers' variable (and therefore including these previously excluded households) had no impact on the other variables that were found to be significant in the model (i.e. fussy eating was still found to be significant, with a similar strength of relationship).

Table 14: Results of 'variant 2' generalised linear model using waste compositional analysis dataset: dependent variable = avoidable food and drink waste; controlling for household size, home composting, and extent to which householders set out waste streams during the study

Variable	*p* value	Relationship with avoidable food and drink waste
Fussy eating (modelled as a covariate)	0.015	An increase of 10% (±8%) in waste levels between each fussy eater category (10% increase from no fussy eaters in a household to those with 1%-35% fussy eaters and the same increase from 1-35% to 35%+ fussy eaters)

Variant 3: Omission of cases with a high influence on the modelling results. This analysis aimed at identifying if households with extreme values of explanatory or dependent variables were unduly influencing the model. Cook's scores were calculated for each case as a measure of how much they influenced the output parameters of the model. Cases with a Cook's score in the initial model (i.e. with all variables present) greater than 4 / n[119] (where n = the number of cases) were excluded from the rest of the model (61 out of 1,232 cases[120]). With these cases excluded, the proportion of a household classified as fussy was no longer significant (p = 0.22 when excluded), but meal planning (Q3) was significant. In the main version of the model, meal planning was the last variable to be excluded with a significance value of p = 0.28. However, the results do not suggest a straight-forward decrease in food and drink waste levels with increased planning; rather the lowest levels of waste are associated with the categories relating to moderate levels of planning. This result should be compared to that in §8.3.1 where only food and drink waste classified as 'not used in time' is analysed, suggesting that waste generated for other reasons may be obscuring a relationship in this case.

Table 15: Results of 'variant 3' generalised linear model using waste compositional analysis dataset: dependent variable = avoidable food and drink waste; controlling for household size, home composting, and extent to which householders set out waste streams during the study

Variable	*p* value	Relationship with avoidable food and drink waste
Meal planning (modelled as a categorical variable)	0.030	Those planned meals for 'most' or 'a few' meals for the week ahead wasted the least; those deciding on the day wasted a bit more, with knew almost all of their meals wasted the most.
Use of leftovers	<0.0005	Those using leftovers generated 24% (±10%) less than those who wasted leftovers.

Variant 3 suggests that a small number of households have a moderate effect on the final model results. Most of these households generated higher than average levels of avoidable food and drink waste. However, it is not clear-cut whether these households should be included in the model or not – there is no information to suggest that the measurements were suspect and therefore exclusion from the model should only be if their influence on the results is disproportionate. For this reason, the main 'pared down' model is likely to be a more robust model than variant 3.

In conclusion, this section presents evidence that using up leftovers and fussy eating correlate with levels of avoidable food and drink waste generated, when controlling for important structural factors relating to a household. Furthermore, the scorecard question on throwing away food because it has passed its date was significant if included, but may be more a marker of waste awareness, rather than a behaviour in its own right. There is also some (weaker) evidence for meal planning correlating with waste levels.

[119] *This criterion is relatively stringent; other criteria include where Cook's score is greater than one: it this had been applied, no cases would have been omitted.*

[120] *The number of cases in the model prior to the omission of cases with high Cook's score is lower than the total number of cases with food waste (1,799) as many households did not have behavioural scores due to them not being applicable to these households (for example, see the previous bullet point about leftovers).*

8.2 Behaviours: results – model using kitchen diary dataset

Modelling similar to that in the previous section was performed using the kitchen diary dataset. As discussed in §6.1, there are a number of differences between the two datasets, and greater understanding of food waste generation may be obtained by analysing both. One key difference between the two is that the dependent variable in the models developed for the kitchen diary represents avoidable food and drink waste in all waste streams[121], not just those collected by local authorities. Therefore, it allows analysis of households' total waste generated, not just that collected by local authorities. It also includes properties that are flats which were mainly omitted from the waste compositional dataset. However, levels of waste in the kitchen diary are self-reported and rely on accurate completion of the diaries.

8.2.1 Kitchen diary models with single behavioural factors

In this section, results of generalised linear modelling from the kitchen diary dataset are presented. The dependent variable is the amount of avoidable food and drink waste in all household waste streams (expressed per household per week) and the explanatory variables were behaviour-related questions from the pre-diary questionnaires. Each model contained structural factors (listed below) and one behavioural factor. As stated above, this gives information on whether a household giving a certain response to a questionnaire generates more or less food than households that give a different response.

Structural factors:

- Number of people in the household (recoded into 1, 2, 3, 4, 5 or '6 or more' people)

Variables from the behavioural scorecard:

- The extent of meal planning (Q5)
- Behaviour scores associated with:
    - Cupboard checking (Q6)
    - List making (Q7)
    - Use of freezer (Q11)
    - Storage of cheese and meats after opening (Q12)
    - Use of the fridge to store apples (Q13) and carrots (Q14)
    - Using leftovers (Q16)
    - Cooking the right amount of rice (Q17) and pasta (Q18)
    - Throwing away items because they have gone past their date label (Q19)

Other behavioural variables:

- When special offers are purchased, whether less of other items are purchased in response (Q10, option D)
- Type of shopping trips made (Q3)
- Frequency of main shopping trip (Q4)

[121] *Residual (general) waste, local authority collections that target food waste, sewer, home composting and fed to animals.*

Structural factors around whether a household home composted and the extent to which householders set out waste streams included in the study were not required here, as they are specific to waste compositional analysis (§6.2.4). In addition, there were no questions about fussy eating in the kitchen diary – hence their absence from the variables listed above.

Table 16: Results of individual generalised linear models using the kitchen diary dataset: dependent variable = avoidable food and drink waste; controlling for household size

Variable	*p* value	Relationship with avoidable food and drink waste
Meal planning (behavioural score used as a covariate)	0.001	3.0% (±1.8%) decrease in waste level with each unit of behavioural score
Meal planning (responses used as categorical data)	0.001	See Figure 40
Cupboard checking	0.598	No significant relationship found
List making	0.006	3.2% (±2.2%) decrease in waste level with each unit of behavioural score
Freezer use	0.313	No significant relationship found
Storage of cheese & meats after opening	0.124	No significant relationship found
Use of the fridge to store apples & carrots	0.564	No significant relationship found
Using leftovers	<0.0005	4.2% (±1.6%) decrease in waste level with each unit of behavioural score – i.e. those using up leftovers waste 35% less (±11%) compared to those who waste them.
Cooking the right amount of rice & pasta	0.001	2.7% (±1.6%) decrease in waste level with each unit of behavioural score
Throwing away items because they have gone past their date label	<0.0005	4.7% (±1.6%) decrease in waste level with each unit of behavioural score
When special offers are purchased, whether less of other items are purchased in response	0.091	No significant relationship found
Type of shops	0.525	No significant relationship found
Frequency of shopping	0.751	No significant relationship found

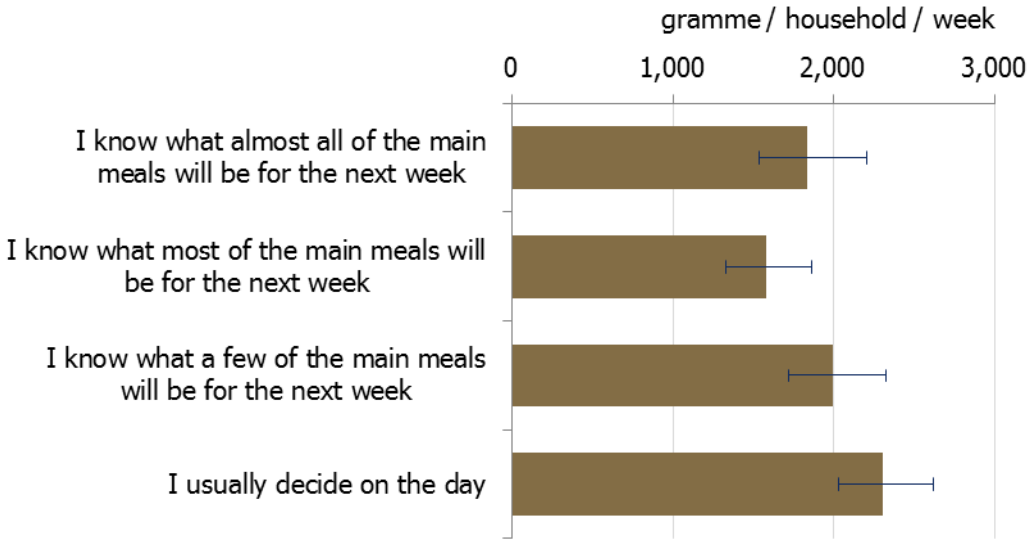
The variable relating to whether less of other items are purchased in response to purchasing special offers is included as a proxy for making intelligent decisions around (and taking

advantage of) special offers. This question was not asked in the waste compositional analysis (hence its omission from that analysis).

The results for these models are presented in Table 16. These show significant correlations with avoidable food and drink waste levels for a wider range of behavioural questions than the previous analysis using waste compositional analysis data: meal planning, list making, using leftovers, cooking the right amount of rice & pasta and throwing away items because they have gone past their date label. In addition, 'when special offers are purchased, less of other items are purchased in response' was marginally non-significant (p = 0.091).

The next section looks at models containing multiple factors to see if similar relationships are also found.

Figure 40: Amount of avoidable food and drink waste by responses to Q5 on meal planning



Estimated marginal means[122] shown; error bars represent 95% confidence intervals around the mean
Source: kitchen diary 2012 study

8.2.2 Kitchen diary model with multiple behavioural factors

In this section, results of generalised linear modelling from the kitchen diary dataset are presented. As with §8.2.1, the dependent variable is the amount of avoidable food and drink waste in all household waste streams and the explanatory variables were behaviour-related questions in the accompanying questionnaire. The main model started with the explanatory variables listed below and variables were removed step-wise, starting with the least significant until only those that were statistically significant at the 5% level (p < 0.05) remained. The resulting model is referred to as the 'pared-down' model.

Structural factors:

- Number of people in the household (recoded into 1, 2, 3, 4, 5 or '6 or more' people)

Variables from the behavioural scorecard:

- The extent of meal planning (categorical information from Q5)

[122] *Estimated marginal means are the average values when controlling for all other variables in the model.*

- Behaviour scores associated with:
    - Cupboard checking (Q6)
    - List making (Q7)
    - Use of freezer (Q11)
    - Storage of cheese and meats after opening (Q12)
    - Use of the fridge to store apples (Q13) and carrots (Q14)
    - Using leftovers (Q16)
    - Cooking the right amount of rice (Q17) and pasta (Q18)

Other behavioural variables:

- When special offers are purchased, whether less of other items are purchased in response (Q10, option D)
- Type of shopping trips made (Q3)
- Frequency of main shopping trip (Q4)

As with the model in the previous section, this model also omitted the behavioural score associated with throwing away items because they have gone past their date label (Q19). This was for the same reasons and, as before, a variant of the model was developed with the behavioural score associated with date labels included.

The results for this model are given in Table 17 for the variables that were statistically significant in the 'pared-down' model. This shows that three behavioural variables were statistically significant – list making, using leftovers and cooking the right amount of rice and pasta. In addition, buying less of other items when purchasing special offers was very close to statistical significance.

Table 17: Results of main 'pared-down' generalised linear model using kitchen diary dataset: dependent variable = avoidable food and drink waste

Variable	*p* value	Relationship with avoidable food and drink waste
List making	0.002	3.6% (±2.3%) decrease in waste level with each unit of behavioural score
Using leftovers	<0.0005	4.1% (±1.6%) decrease in waste level with each unit of behavioural score. Those using leftovers generated 34% (±11%) less than those who wasted leftovers
Cooking the right amount of rice and pasta	0.011	2.2% (±1.7%) decrease in waste level with each unit of behavioural score
Buying less of other items when purchasing special offers	0.067	Not quite statistically significant at the 5% level, but indicative of c. 19% lower levels of waste for those who picked this option.

These variables are all correlated with avoidable food and drink waste in a direction consistent with expectations: list making, using up leftovers, cooking the right amount of rice and pasta and buying less of other items when purchasing special offers were all associated with lower levels of avoidable food and drink waste. These results are consistent with the notion that these behaviours contribute to food and drink waste (although this analysis does not prove this).

There are differences between this set of behaviours and those presented in the previous section (Table 16, i.e. models only containing one behavioural variable). In particular, meal planning is not included in the 'pared-down' model in this section. This is likely due to correlations with other behaviours (in particular list making), suggesting that the relationship seen in the previous section may not be direct, but due to other factors that correlate with meal planning.

Two variants around the main model were examined to check that the main model was not unduly influenced by the way it was constructed.

Variant 1: Including the behavioural score associated with throwing away items because they have gone past their date label (pre-diary Q19). As discussed previously, this variable could be considered a measure of waste generated, rather than a behavioural measure. However, to check whether its omission had a large impact on the results, the modelling was repeated with this variable.

The variable around use of date labels was significant in the model ($p < 0.0005$, 4.0% (±1.9%) increase in waste level for each additional type of item thrown away). Its inclusion made two change to the variables included in the final, pared-down model: a) the variable about cooking the right amount was no longer significant ($p = 0.117$), but b) the variable about buying less of other items when purchasing special offers was now significant ($p = 0.003$, 35% less waste generated by those who selected this option). This result is broadly similar to the main kitchen diary model, but the inclusion of the variable on date labels subtly altered some of the quantitative results.

Table 18: Results of 'variant 1' model using kitchen diary dataset: dependent variable = avoidable food and drink waste; controlling for household size

Variable	*p* value	Relationship with avoidable food and drink waste
List making	0.002	3.5% (±2.5%) decrease in waste level with each unit of behavioural score
Using leftovers	<0.0005	3.2% (±1.7%) decrease in waste level with each unit of behavioural score. Those using leftovers generated 28% (±13%) less than those who wasted leftovers
Throwing away items because they have gone past their date label	<0.0005	4.0% (±1.9%) decrease in waste level with each unit of behavioural score
Buying less of other items when purchasing special offers	0.003	Those who chose this option generated 35% (±19%) less waste than those who did not

Variant 2: Inclusion of the question on whether the research participant thought the level of food and drink waste recorded in the diary was typical of a week (post-diary Q9). This variable was included to see if the variability was the result of the diary not being typical (due to difficulties recording all waste or the week's waste not being typical). This question was recoded to ensure sufficient respondents in each level[123].

Table 19: Results of 'variant 2' model using kitchen diary dataset: dependent variable = avoidable food and drink waste; controlling for household size and level of food and drink waste in diary relative to a typical week

Variable	*p* value	Relationship with avoidable food and drink waste
List making	0.002	3.9% (±2.5%) decrease in waste level with each unit of behavioural score
Using leftovers	<0.0005	3.6% (±1.7%) decrease in waste level with each unit of behavioural score. Those using leftovers generated 31% (±12%) less than those who wasted leftovers
Cooking the right amount of rice and pasta	0.049	1.8% (±1.8%) decrease in waste level with each unit of behavioural score
Buying less of other items when purchasing special offers	<0.0005	Those who chose this option generated 40% (±17%) less waste than those who did not

This variable was not quite significant in the final model (p = 0.077), but was left in to explore its effect. The other variables in the final model were the same as in the main model, with the variable about buying less of other items when purchasing special offers now significant (p = <0.0005, 40% ±17% less waste generated by those selecting this option; Table 19).

In conclusion, the modelling of the total avoidable food waste in the kitchen diary presented in this section provides further evidence that households that use up leftovers generate lower levels of food and drink waste. However, the central estimate is different for each dataset (and is different again for each variant of the model). This suggests that providing a precise estimate of the degree to which households that use up leftovers produce less waste compared to those that do not is problematic for this type of research.

In addition to using up leftovers, this section provides evidence that four other behaviours from the scorecard are correlated with food and drink waste levels: meal planning, making a shopping list, cooking the right amount of pasta and rice and throwing away food past its date label. The evidence for the first three should be considered less strong than for using up leftovers, in light of them not being significant in the waste compositional analysis modelling. The fact that they were found to be significant in one model but not the other is likely linked to differences between the datasets, for instance reflecting differences in the

[123] *The four recoded options were, compared to a typical week, the diary contained about 'half or less', 'about three quarters', 'the same' or 'more' waste.*

makeup of the sample, the waste streams sampled or the self-completion element of the kitchen diary.

Buying less of other items when purchasing special offers was also found to be correlated with avoidable food waste levels in the variants of this model. In preliminary investigations it was found that whether a household buys food on special offer (irrespective of other associated actions, such as buying less of something else) was not correlated with waste levels. Taking these two pieces of information together suggests that buying food on special offer need not necessarily lead to more waste, but it takes additional actions on the part of householders (e.g. buying less of something else) to ensure that the right amount of food is brought into the home for the householder's needs.

8.3 Behaviours: results – specific fractions of waste

In the previous two sections, no significant correlation was found between levels of avoidable food and drink waste for four of the behaviours in the scorecard:

- Checking cupboards
- Use of freezer
- Storage of cheese and meats after opening
- Use of the fridge to store apples and carrots

The fact that a correlation was not found for these behaviours could be for a variety of reasons:

- There might be no correlation
- The correlation could be too small to be seen given the variability in the data
- The correlation is 'masked' by other factors included in the model which correlate with the behaviour of interest
- The behaviour only influences food and drink waste levels in certain circumstances (e.g. meal planning may only be important where shopping is infrequent)
- Any correlation is only with a particular fraction of waste

As an example of the last explanation, cupboard checking and freezer use would, if effective, affect the level of food and drink waste that has 'not been used in time' (i.e. before it has gone off or passed a date label), but is unlikely to be directly associated with leftovers that are thrown away or food rejected due to personal preference (although there may be indirect effects).

In this section, models are presented which look at the correlation in waste levels between behaviours and specific waste streams for which, ahead of the analysis, a possible link was hypothesised.

8.3.1 Behaviours: results – 'not used in time'

In this section, the dependent variable in the modelling was avoidable waste that was 'not used in time'. This information comes from the kitchen diaries and involves information as to why food and drink was thrown away supplied by the research participants for each item of waste. [No information on the reasons why food and drink were disposed was recorded in the waste compositional analysis research as it is difficult to ascertain in most cases from examining the waste.]

The explanatory variables considered are listed below and focus on bringing the right amount of food and drink into the home and storing food to maximise the shelf life. Questions about shopping are also included in case they have an influence on the results.

Structural factors:

- Number of people in the household (recoded into 1, 2, 3, 4, 5 or '6 or more' people)

Variables from the behavioural scorecard:

- The extent of meal planning (categorical information from Q5)
- Behaviour scores associated with:
    - Cupboard checking (Q6)
    - List making (Q7)
    - Use of freezer (Q11)
    - Storage of cheese and meats after opening (Q12)
    - Use of the fridge to store apples (Q13) and carrots (Q14)

Other behavioural variables:

- When special offers are purchased, whether less of other items are purchased in response (Q10, option D)
- Type of shopping trips made (Q3)
- Frequency of main shopping trip (Q4)

The results for this model are given in Table 20 for the variables that were statistically significant in the final, pared-down model. This shows that meal planning (Q5) was statistically significant. In addition, buying less of other items when purchasing special offers was marginally significant ($p = 0.114$).

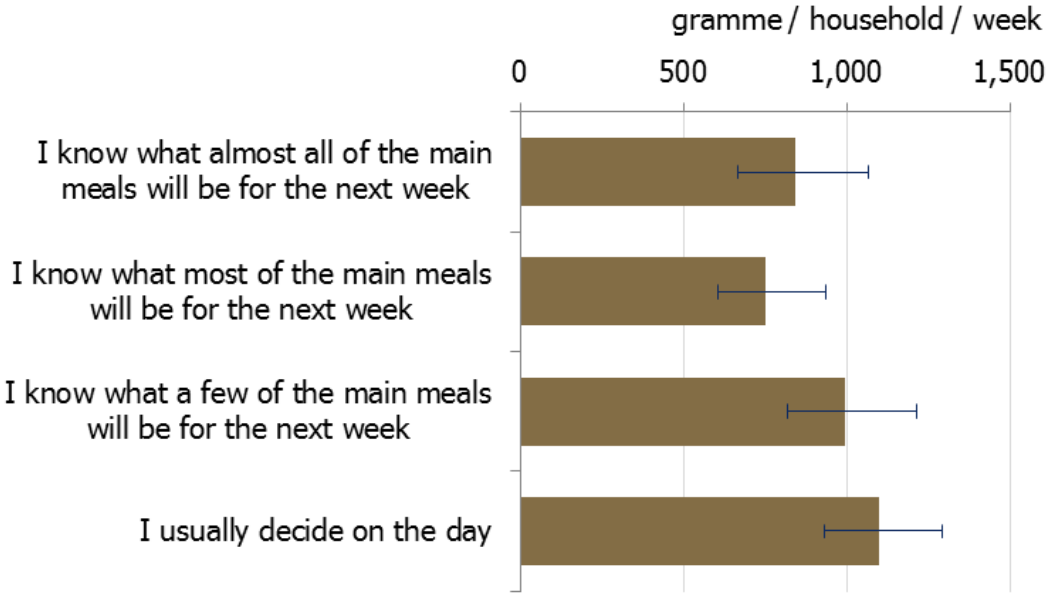
In addition, the frequency of main shopping trips (Q4) was found to be significant ($p = 0.049$) alongside household size and meal planning. However, the variation with frequency of shopping trips had no a clear trend and this variable correlated with household size (for instance, households with four or more people were more likely to do a weekly shop). This correlation appeared to be destabilising the model and therefore Q4 was omitted from the model presented.

Table 20: Results of main 'pared-down' generalised linear model using kitchen diary dataset: dependent variable = avoidable food and drink waste 'not used in time'

Variable	*p* value	Relationship with avoidable food and drink waste 'not used in time'
Meal planning	0.018	See Figure 41

The variation in avoidable food and drink waste 'not used in time' with responses to the meal planning question, whilst controlling for household size can be seen in question Figure 41. The direction of these differences in levels are broadly in line with expectations – most waste is associated with those who 'decide what to eat on the day' and lower levels of waste with those who plan 'most' or 'nearly all' meals for the week ahead.

Figure 41: Amount of avoidable food and drink waste that was 'not used in time' by responses to Q5 on meal planning



Estimated marginal means[124] shown; error bars represent 95% confidence intervals around the mean
Source: kitchen diary 2012 study

8.3.2 Behaviours: results – 'cooked, prepared or served too much'

A model was also constructed with the explanatory variable equal to the amount of avoidable food and drink waste classified as 'cooked, prepared or served too much' by diary respondents. This information comes from the kitchen diaries and involves information as to why food and drink was thrown away supplied by the research participants for each item of waste. [No information on the reasons why food and drink were disposed were recorded in the waste compositional analysis research as it is difficult to ascertain in most cases from examining the waste.]

The explanatory variables considered are listed below and all behavioural indicators[125] were included in case of correlations (even though the focus of this investigation was on preparing the right amount of food and using up leftovers which are generated). Questions about shopping are also included in case they have an influence on the results.

Structural factors:

- Number of people in the household (recoded into 1, 2, 3, 4, 5 or '6 or more' people)

Variables from the behavioural scorecard:

- The extent of meal planning (categorical information from Q5)
- Behaviour scores associated with:
    - Cupboard checking (Q6)

[124] *Estimated marginal means are the average values when controlling for all other variables in the model.*

[125] *Except for the behavioural score about throwing away food past its date label; see previous sections for discussion about the exclusion of this variable.*

- List making (Q7)
- Use of freezer (Q11)
- Storage of cheese and meats after opening (Q12)
- Use of the fridge to store apples (Q13) and carrots (Q14)
- Using leftovers (Q16)
- Cooking the right amount of rice (Q17) and pasta (Q18)

Other behavioural variables:

- When special offers are purchased, whether less of other items are purchased in response (Q10, option D)
- Type of shopping trips made (Q3)
- Frequency of main shopping trip (Q4)

The results for this model are given in Table 21 for the variables that were statistically significant in the pared-down model. This shows that three variables were statistically significant: using leftovers (Q16), cooking the right amount of rice (Q17) and pasta (Q18) and list making.

Table 21: Results of main 'pared-down' generalised linear model using kitchen diary dataset: dependent variable = avoidable food and drink waste 'cooked, prepared or served too much'

Variable	*p* value	Relationship with avoidable food and drink waste 'cooked, prepared or served too much'
List making	0.005	5.1% (±2.1%) decrease in food and drink waste with each additional point
Using leftovers	<0.0005	4.6% (±3.1%) decrease in food and drink waste with each additional point (or 41% (±20%) less waste generated by those who use up leftovers compared to those who throw them away)
Cooking the right amount of rice and pasta	0.013	2.9% (±2.3%) decrease in food and drink waste with each additional point

These statistically significant factors are the same as the model including all avoidable food and drink waste in the kitchen diary as the explanatory variable (presented in §8.2), suggesting that variation in 'cooked, prepared or served too much' waste was correlated to similar factors to all avoidable food and drink.

The inclusions of using leftovers and cooking the right amount of rice and pasta is not too surprising, given that both, logically, could impact on leftovers recorded in the 'cooked, prepared or served too much'. However, the fact that list making is statistically significant is interesting, given that the relationship between list making and food and drink waste relating to too much being cooked, prepared or served is likely to be less direct than the other behaviours found to be significant. A potential explanation for this is that households that

buy the right amount through list making are also more likely to cook the right amount a range of foods (not just those picked up by Q17 & Q18 relating to rice and pasta).

8.3.3 Behaviours: results – avoidable waste of specific food types

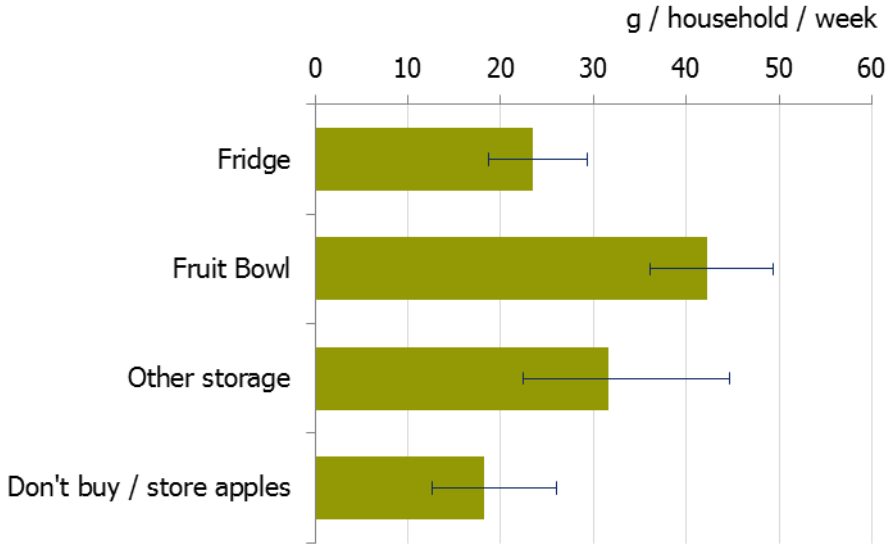
This section looks at the correlations between where people store their apples and carrots and the waste associated with these two types of food. The waste compositional analysis dataset is used as this provides a larger sample size. As before, structural factors are controlled for. In each case, the relevant storage question was recoded to avoid too few responses in any category. These recoded questions were then used as the explanatory variable in a model to explain avoidable apple or carrot waste.

It was also intended to investigate the correlation between responses to the question on wrapping opened cheese and sliced meats and waste of these particular food items. Exploratory analysis did not reveal any meaningful correlations, which is probably due to the low number of people responding that they did not wrap these items and the ambiguity associated with items stored in their original packaging (some of which is re-sealable). For these reasons, results are not presented in this report.

8.3.3.1 Apples

The relationship between avoidable apple waste and the storage options used for apples (as stated in question 9a) is shown in Figure 42. This shows that those storing apples in the fridge had lower levels of waste compared to those who stored them in a fruit bowl. The differences between these responses to question 9a were significant ($p < 0.0005$). A similar trend was seen in the kitchen diary research (results not shown here), suggesting this result is robust.

Figure 42: Average level of avoidable apple waste by apple storage method stated in the questionnaire, controlling for household size and whether household home composts



Estimated marginal means shown; error bars represent 95% confidence intervals around the mean
Source: Waste compositional analysis from 2012

The lowest levels of apple waste were for those who claimed not to buy or store apples, although these households did generate apple waste, presumably as the response to the

questionnaire for a small number of households was not truly representative of their purchasing habits, or it included home-grown apples.

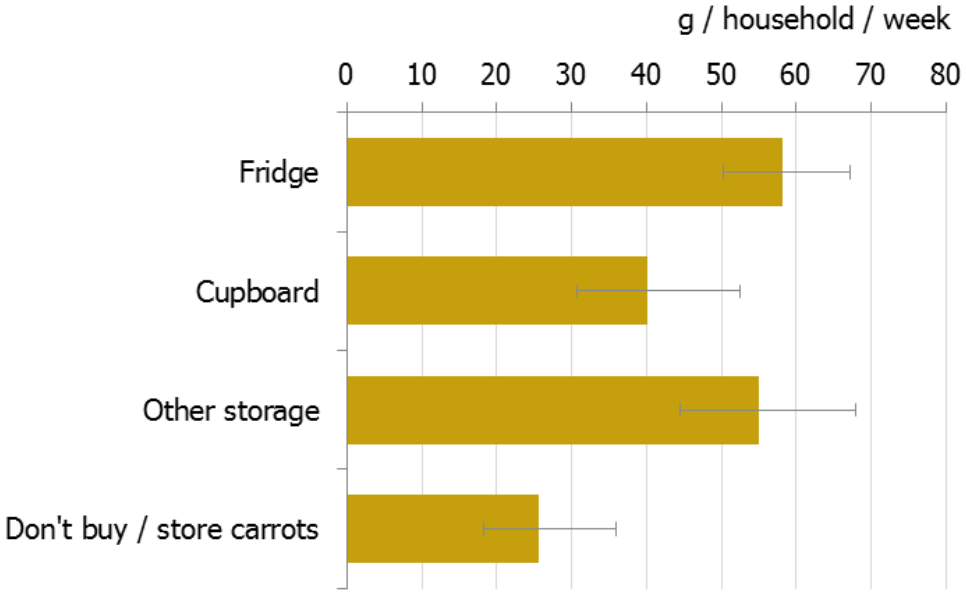
The correlation shown in Figure 42 is consistent with the idea that storing apples in the fridge extends their shelf life and reduces avoidable apple waste[126]. This appears to outweigh other impacts of apples being stored in the fridge, such as them being less visible and therefore less likely to be eaten.

It is interesting to compare this result to the fact that the behavioural score around apple and carrot storage does not correlate with the total amount of avoidable food and drink waste in either the waste compositional analysis or the kitchen diary. Nor does the behavioural score correlate with the amount of avoidable waste 'not used in time' in the kitchen diary. This suggests that storing apples in the fridge is not a wider proxy for storing other items correctly – at least not at a level that can be detected in this analysis.

8.3.3.2 Carrots

The relationship between avoidable carrot waste and the storage locations for carrots as – stated in question 9b – is shown in Figure 43. In contrast to apple storage, this shows that those storing carrots in the fridge (the majority of the population) had higher levels of waste compared to those who stored them in a cupboard. A similar trend was seen in the kitchen diary research. Again, the lowest levels of waste were found for those not buying or storing carrots. The differences between these responses to question 9b were significant ($p <$ 0.0005).

Figure 43: Average level of avoidable carrot waste by carrot storage method stated in the questionnaire, controlling for household size and whether household home composts



Error bars represent 95% confidence intervals around the mean
Source: Waste compositional analysis from 2012

[126] *Although, as with all correlations in this report, this is not proof of a causal relationship and other explanations may exist that explain this correlation.*

The fact that those storing carrots in the fridge were not found to waste less – indeed were found to waste more than other storage options – could be explained by the amount of carrots being purchased by different households (for which we don't have household-specific data), i.e. those placing them in the fridge may have bought and wasted more.

8.4 Summary

The findings from this chapter are summarised in §3.2 in the main body of the report. This summary shows that the level of evidence for relationships between behavioural variables and levels of avoidable food and drink waste varies from strong evidence to no evidence found.

In this chapter, uncertainties (95% confidence intervals) have been presented for parameters describing the correlation between explanatory variables and the level of avoidable food and drink waste. These show that, where there is a significant correlation with waste levels, there is a high degree of uncertainty around the strength of the correlation. Therefore, we are relatively certain that the correlation exists, but not very certain of its strength. For this reason, the chapter in the main report presents qualitative information about the results.

9.0 Appendix – Diary research: effect of diary keeping on waste levels

Diaries are not only frequently used as a method of data collection, but they can also be employed as a behaviour change tool to encourage people's reflections of their various habitual, routine activities (such as work, diet or everyday travel). In the food waste area, diaries were successfully employed during the Food Waste Challenge competition[127] (alongside storing waste in a clear plastic box) and allowed participating families to identify patterns of behaviour that generated waste and decide on the appropriate actions to prevent this waste.

It was therefore possible that taking part in the kitchen diary study could increase participants' awareness of the amount of food and drink they throw away, and there was a potential that this could also affect their behaviour (although it is crucial to note that awareness change does not necessarily lead to behaviour change).

This has potentially significant consequences for drawing conclusions from the data, as it is necessary that research tools have only a negligible impact on the phenomena they are designed to examine. It was therefore important to explore whether taking part in the diary affected participants' awareness of food and drink waste, in order to highlight potential problems related to the reliability and validity of the findings, and to assess the usefulness of food waste diaries as a research tool more generally. This was also to determine whether diaries could be an effective method for raising awareness of food and drink waste. Questionnaires (conducted before and after the diary exercise) were designed to capture this potential change in awareness.

This chapter explores the above issues and is structured as follows: §9.1 examines changes in awareness of overall food waste following diary completion; §9.2 looks at awareness change for various food and drink types; whilst §9.3 explores the willingness to take action. Summary points and conclusions are included in §9.4.

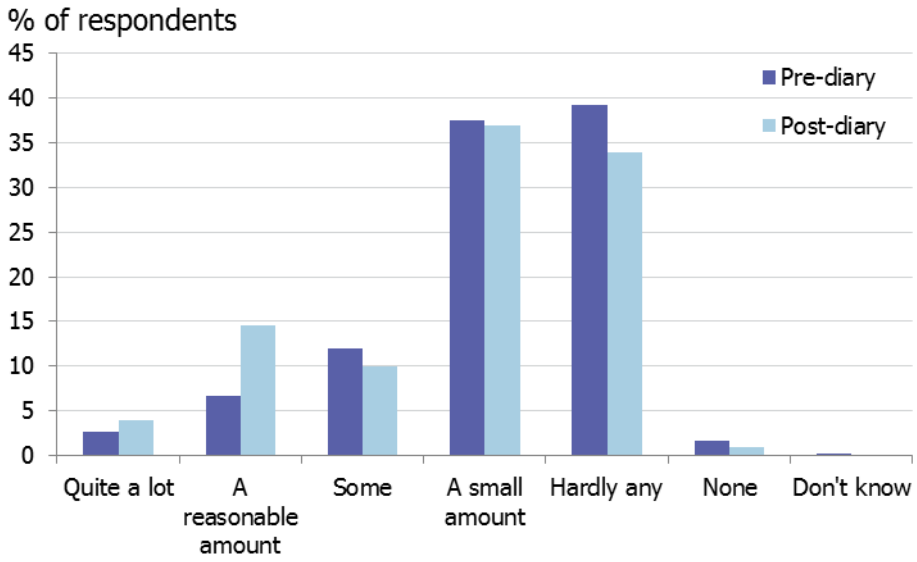
9.1 Change in awareness of overall food waste levels

In both questionnaires (pre- and post-diary), participants were asked to assess the amount of uneaten food and drink that they generally throw away by choosing one of the following answers: 'Quite a lot', 'A reasonable amount', 'Some', 'A small amount', 'Hardly any, 'None' and 'Don't know'.

There was an increase in the number of participants choosing the top two answers ('Quite a lot' and 'A reasonable amount') and a decrease in all the other answers following the diary exercise (Figure 44). In particular, the percentage of those saying that they throw away 'a reasonable amount' increased from 6.6% to 14.5%, whilst those throwing away 'Quite a lot' increased from 2.7% to 3.9%. Conversely, the percentage of those who said they threw away 'some', 'a small amount' or 'hardly any' decreased (from 11.9% to 9.9%; from 37.6% to 36.9%; and from 39.3% to 33.9% respectively). The percentage of those who said that no food gets thrown away in their household nearly halved, from 1.7 % to 0.9%. The largest changes were for 'A reasonable amount' and 'Hardly any', both of which were significant.

[127] http://www.lesswaste.org.uk/food_waste_challenge

Figure 44: How much uneaten food generally gets thrown away in your household? Comparison of pre- and post-diary questionnaire answers (in percent)

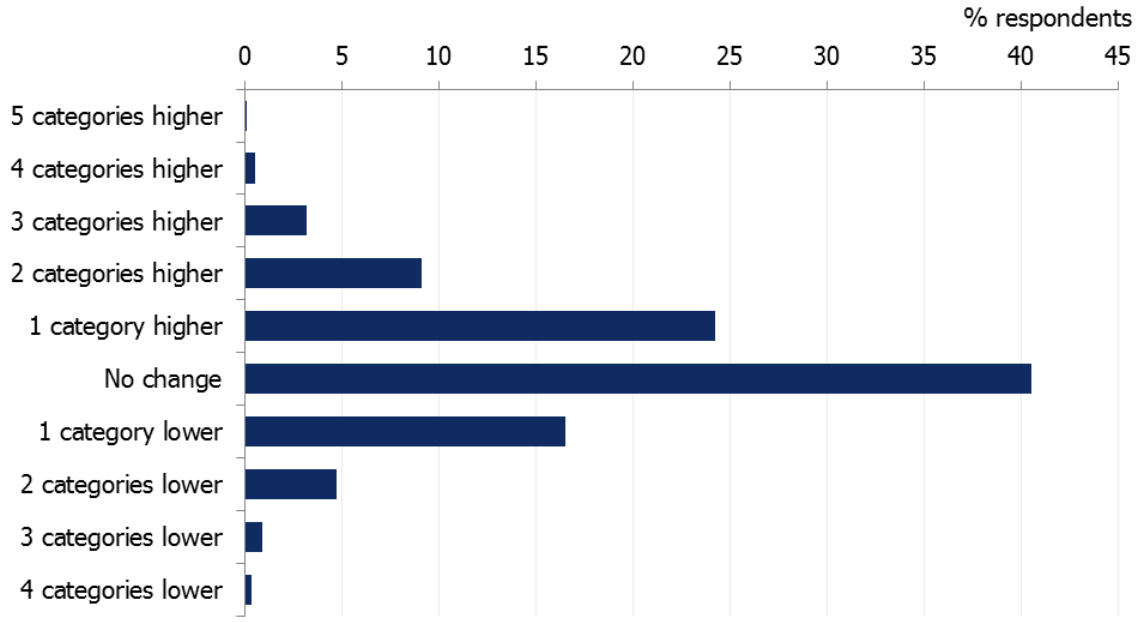


Source: Kitchen diary study 2012

Figure 45 further illustrates how answers to this question differed before and after the diary, by comparing answers for individual participants. 40.5% participants answered the question in exactly the same way in both questionnaires – it seems that this group was already quite aware of their waste levels prior to the diary exercise. However, 37.1% assessed their food waste at a higher level than in the pre-diary questionnaire (24.2% by one category, 9.1% by two categories higher), whilst 22.4% assessed their food waste at a lower level than in the pre-diary questionnaire. (One category difference means, for example, a change from 'Some' to 'A reasonable amount'.)

This representation of the data is consistent with the findings in Figure 44, which illustrates that, following completion of the diaries, the top categories were chosen more frequently and the bottom ones less frequently. However, the vast majority responded to the question either in exactly the same way as in the pre-diary questionnaire, or by one category higher/lower (81.2% of the sample). Taking into account the relatively ambiguous and subjective differences between categories, (for example, between 'A small amount' and 'Hardly any') some of the differences in responses might not necessarily signify a change in awareness, but could be caused by respondents' interpretation of the question varying between the questionnaires. Moreover, waste levels vary to some extent from week to week, and this could be reflected in participants' answers (even though the question asked about the amount of food thrown away *in general*, responses could be affected by, for example, having a particularly wasteful week prior to completing the questionnaire). There were also a small number of cases in which a different person from the household completed the post-diary questionnaire; the latter respondent's opinion of waste levels in their household may have been different from the initial respondent's.

Figure 45: Change in self-categorization on the waste-scale between post- and pre-diary questionnaires (in per-cent)

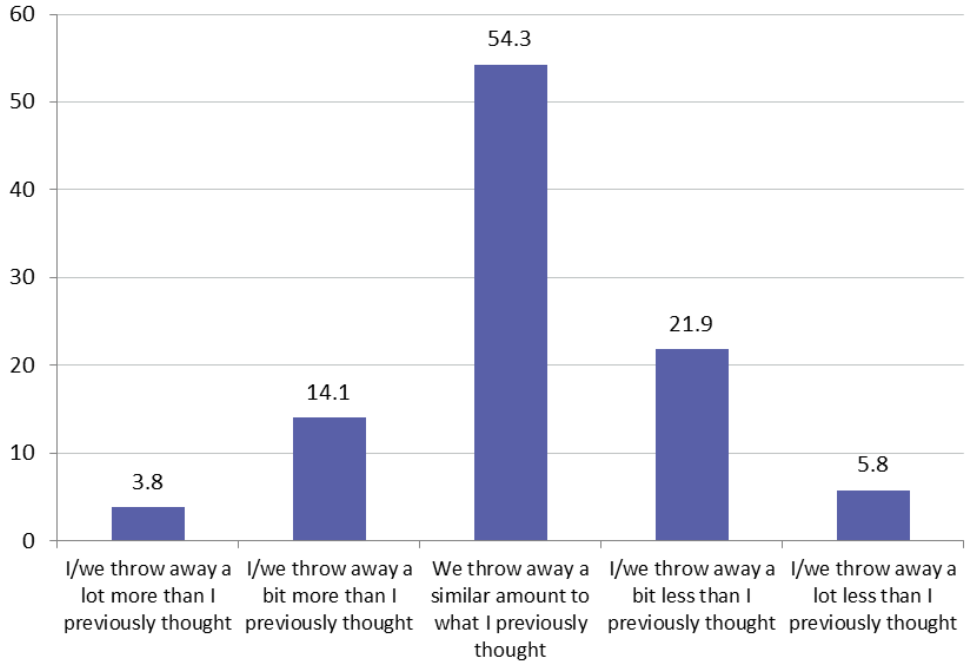


However, when asked directly whether completing the diary affected their awareness of food and drink waste[128] generated in their households, some participants acknowledged that there had been change. Figure 46 presents this self-reported shift in awareness. 54% said that they throw away a similar amount of food to what they previously thought, compared to around 28% throwing away less and 18% more than they previously thought. Therefore, contrary to the findings discussed above, self-assessed awareness change seems to suggest that there were more people overestimating than underestimating their waste before the diary. This difference could be due to the ways in which both questions were phrased and the issues described above (related to the relative ambiguity of categories in the previous question).

These results indicate that – when asked directly – around half of the sample did not think that the diary exercise had changed their estimate of the amount of food they threw away, with the other half either overestimating or underestimating their waste previously. Therefore, taking part in the diary exercise brought food waste to people's attention and in some cases led to a re-evaluation of the initial waste level estimates. However, when asked to describe the levels of waste on a scale, most people gave consistent answers between the two waves, suggesting that changes in awareness associated with participating in the diary research were slight. Overall, such high level of consistency between pre- and post-diary responses implies that the diary exercise did not have a significant impact on waste awareness for the majority of participants. These results may not be fully representative of the wider population as there is the possibility that people who are more engaged with household food waste at the outset of the study were more likely to take part in the diary research.

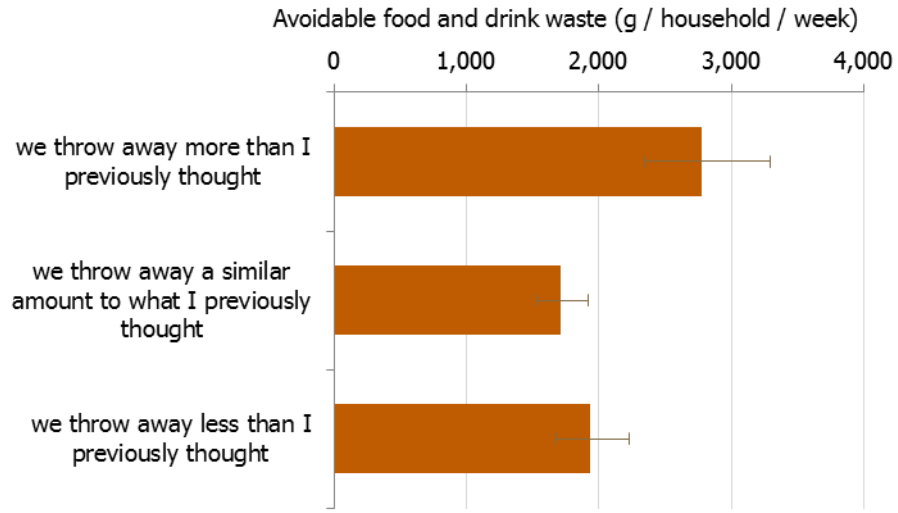
[128] *Note that the previous 'awareness change' question asked participants to assess the amount of uneaten FOOD thrown away, whilst this one inquired about change of awareness of both food and drink waste. There is a very small likelihood that this influenced participants answers, as 'food waste' and 'food and drink waste' were referred to interchangeably in the study and no distinction was made between the two (e.g. milk and fruit juices were sometimes referred to as a type of food waste). However, there is a small possibility that the slight difference in the answers between the two 'awareness change questions' was due to the fact that one referred to food, whilst the other one to food and drink waste.*

Figure 46: Since diary completion how awareness of food/drink thrown away has changed



Moreover, even though the group that originally underestimated their waste levels and ended up saying that they throw away either 'a bit' or 'a lot' more than expected was relatively small (around 18%), it was also a group that generated more waste than others, as Figure 47 illustrates. The group could therefore be a potential target for waste prevention strategies.

Figure 47: Variation in levels of avoidable food and drink waste, by self-assessed change in awareness of food/drink waste following diary completion[129]



Estimated marginal means shown; error bars show 95% confidence intervals
Source: Kitchen diary study 2012

[129] *The new category 'I/we throw away MORE than I previously thought' refers to those responding 'A lot more' and 'A bit more' in the questionnaire. Similarly, the category 'I/we throw away LESS than I previously thought' consists of 'A lot less' and 'A bit less' groups combined.*

It has to be remembered, however, that these results – by themselves – do not imply causation, i.e. it does not necessarily mean that an increase in waste awareness would lead to a decrease in waste. There are other potential explanations for this correlation. For example, it is possible that those generating high levels of waste avoided reflecting on the amount of food they throw away, given the social stigma and feelings of guilt sometimes associated with wasting food. Conversely, those who waste less might be more willing to reflect on their behaviour, or even take pride in their thrifty practices – thus having a much better understanding of how much food gets thrown away in their households. Higher awareness could therefore be a result, rather than a cause, of having low levels of waste. Another possible explanation could be that people who waste a lot of food simply do not have time to keep track of what is thrown away in the house, and this lack of time could also be causing higher food and drink waste levels. Time has been shown to be a potentially important influence on levels of waste (see §4.3). In that case, increasing people's awareness of food and drink waste could lead to the feelings of guilt and even willingness to take action, but this in itself might not be enough to instigate change.

More research is therefore needed in order to determine whether increased awareness of food and drink waste would lead to reductions in waste levels. In particular, taking a longitudinal approach could help assess the effectiveness of awareness raising strategies on the actual behaviour. The results described above indicate a relationship between awareness of food waste and food and drink waste levels, but there is more than one way in which this relationship could be interpreted.

9.2 Change in awareness of food and drink waste, by waste type

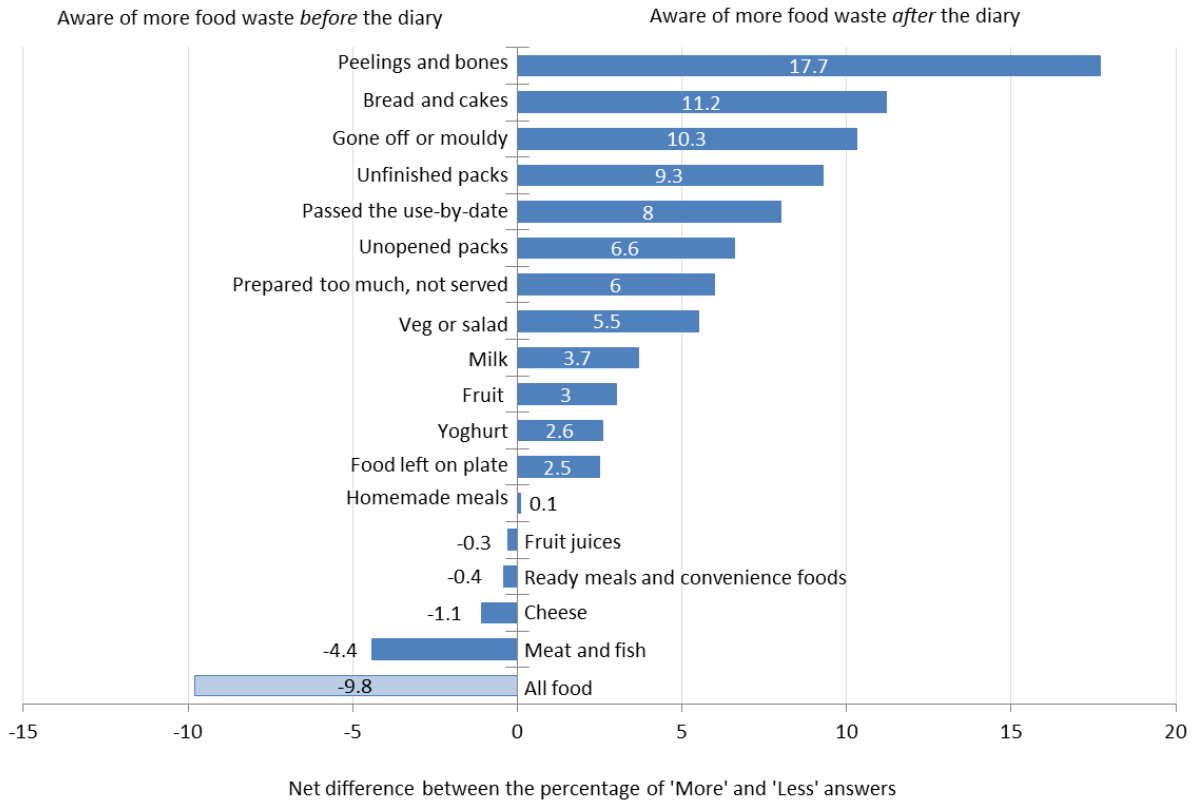
This section explores this change in awareness for different types of food and drink waste following completion of the diary. In the post-diary questionnaire, participants were asked to assess the amount of food and drink waste generated in their households compared to what they originally thought, first in general (as reported in Figure 46), and then split by seventeen different types of waste by choosing one of the following answers: 'A lot more', 'A bit more', 'No change', 'A bit less', 'A lot less' or 'Not applicable'.

To highlight these results, Figure 48 shows differences between the percentage of those who originally underestimated and those who overestimated their waste (i.e. the difference between those who answered 'A lot more' or 'A bit more' and those who answered 'A lot less' or 'A bit less'). Although this report mainly focuses on avoidable food waste, this question also asked about inedible parts of food (unavoidable waste – peelings & bones). This type of waste was most frequently underestimated, alongside bread/cake products. The reason for this might be that inedible parts of food are not normally considered as 'waste', and are thrown away automatically, without conscious consideration or feelings of guilt. Having to record this waste over the diary period may have brought this otherwise 'unconscious' practice to people's attention. For bread and cake, on the other hand, it is possible that a lot of waste goes unnoticed during everyday consumption, as bread is a basic, daily product, relatively cheap and likely to be used (and discarded) by all household members. This might have made the accurate assessment of bread waste prior to the diary exercise more difficult.

Other types of food and drink waste that were underestimated much more frequently than overestimated include: food that's gone off or mouldy, unfinished packs and food passed the use by date. This set of 'waste types' relates to the reason for disposal rather than product type. This could signify that some people do not normally reflect on the reasons *why* food gets thrown away, and that a food waste diary could be a useful tool for encouraging such reflections and bringing reasons for disposal to people's attention.

By contrast to other food and drink waste types, meat and fish (and to a lesser extent cheese, ready meals and fruit juices) were slightly more frequently overestimated, and completing the diary exercise made respondents realize that they throw away less than they originally thought. This could be due to the relatively high price of these products – throwing them away is likely to register more strongly than other types of waste, as the financial loss is likely to be experienced more acutely. This could lead to the perception that meat and fish (and possibly some other products) are thrown away more frequently than in reality, and again a diary serves as a tool to correct those false assumptions.

Figure 48: Change in awareness of different types of food and drink waste following diary completion. Difference between the percentage of those who threw away more and those who threw away less than they originally thought (self-assessed, by product type)



The results discussed above show that more types of food and drink waste were under-estimated prior to the diary exercise (bars on the right-hand side of the chart) than over-estimated (bars on the left-hand side of the chart). Therefore, there was an apparent discrepancy between how the *overall* waste levels were perceived (more frequently overestimated prior to the diary, as represented by the bottom bar and shown in Figure 46) and how *specific* food and drink waste types were seen. It is difficult to assess why this was the case. It may suggest that questions related to food waste need to focus on specifics (e.g. types of food) in order to get an accurate reflection of waste levels; generalities may lead to vaguer (and less accurate) responses.

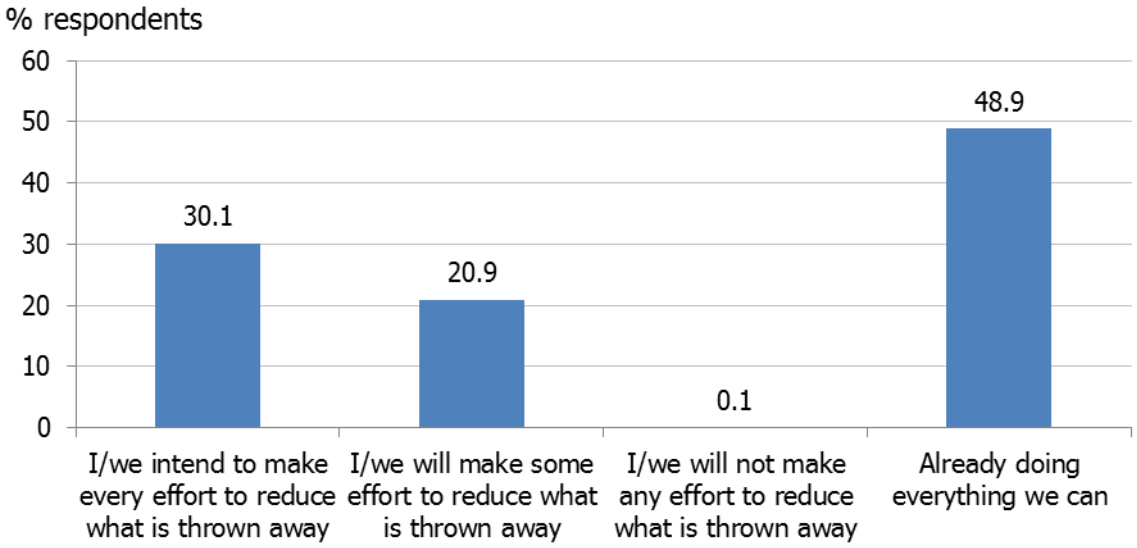
9.3 Willingness to take action against food and drink waste following diary completion

This section explores the willingness to take action against food and drink waste, following diary completion. Questions related to this issue were included in the post-diary

questionnaire only, so it is not possible to assess whether taking part in the study changed people's readiness to act. Nonetheless, some interesting results have been found.

Almost half of the participants felt that they were already doing everything they could to avoid waste, with the other half willing to make some or every effort to reduce their food and drink waste levels, as illustrated by Figure 49.

Figure 49: Willingness to take action to reduce food and drink waste, following diary completion (in percent)



Source: Kitchen diary study 2012

Most importantly, those who were willing to make every effort to reduce what is thrown away in their households, were also the ones who had the highest levels of avoidable waste, as shown in Figure 50. This finding is of high significance for behaviour change strategies, suggesting that the group generating the most waste already has a high willingness to change. However, we cannot exclude the possibility that those participants who generated most waste could have been inclined to answer this question in the most socially desirable way, perhaps driven by feelings of guilt associated with the waste they generate.

In addition to social-desirability bias, willingness to take action does not always result in actions being taken – the gap between actual behaviour and stated values and attitudes is a well-documented phenomenon in social sciences. A desired behaviour change might be difficult to introduce in practice, particularly taking into account a variety of factors that influence food and drink waste generation (some beyond the power of an individual, such as available pack sizes) and other priorities that might come in the way of good intentions (such as time, convenience, wanting to provide a choice of healthy food for the children, etc.). These and other factors were a focus of a number of academic studies in this field[130] and

[130] For example: *Evans, D. (2012)* Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste, *Sociology, 46 (1), pp. 41-56;*

Ganglbauer, E., Fitzpatrick, G., Comber, R. (2013) Negotiating Food Waste: Using a Practice Lens to Inform Design, *ACM Transaction on Computer-Human Interaction, 20(2), pp. 1-25;*

Watson, M. and Meah, A. (2013) Food, waste and safety: negotiating conflicting social anxieties into the practices of domestic provisioning, *The Sociological Review, 60:S2, pp. 102–120.*

were also shown to be important in the current research (see §4.0). It is therefore difficult to assess how close to action the groups shown in Figure 49 are.

Figure 50: Variation in levels of avoidable food and drink waste by willingness to make effort to reduce food and drink waste following diary completion

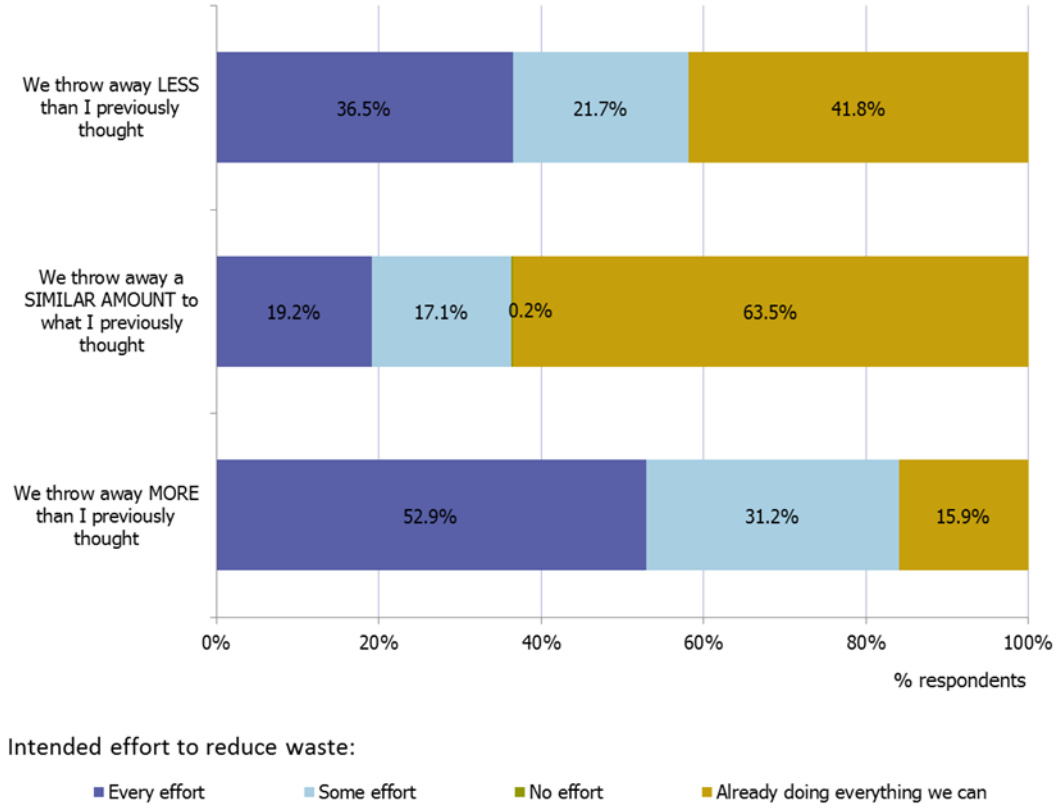
Estimated marginal means shown; error bars show 95% confidence intervals
Source: Kitchen diary study 2012

Those who initially underestimated their food waste levels and realized that they throw away more than they previously thought, were also, perhaps unsurprisingly, the most willing to take action and least likely to feel that they were already doing everything they could. This is illustrated by Figure 51. However, those initially **overestimating** their waste were also more likely to make every effort than those who felt they had a reasonable initial estimate of their waste levels.

As discussed above, it is important to note that even the best intentions do not always lead to behaviour change, with other factors influencing food and drink waste generation.

Williams, H., Wikstrom, F., Otterbring, T., Lofgren, M. and Gustafsson, A. (2012), Reasons for household food waste with special attention to packaging*, Journal of Cleaner Production, 24,pp. 141-148*

Figure 51: Intended effort to reduce waste by change in awareness of food waste following diary completion (in percent)



Source: Kitchen diary study 2012

9.4 Conclusions

Findings presented in this chapter show that taking part in the diary exercise did not result in a big change of awareness of food waste generated in participants' homes. Around half of the sample already had accurate perceptions of the amount of food and drink they throw away prior to completing the diary. For the vast majority (between c. 80%-90%), the perceptions of waste levels stayed the same or altered slightly, with participants realising that they throw away 'a bit more' or 'a bit less' than they originally thought. The exact figures vary slightly for individual food and drink waste types. Overall, this implies that diaries can be a useful tool to study people's waste behaviour, as they are unlikely to influence it in a significant way and impact on research results. However, there is also evidence to suggest that diaries can make people think about food and drink waste in a different way, which could be utilised more in food waste prevention initiatives.

At the same time, a small proportion of respondents (around 9.6%) admitted to having experienced a significant change in waste awareness following diary completion, whilst 36% reported a slight change (see Figure 46). This awareness change happened in both 'directions', i.e. some realized that they throw away more and some that they throw away less than they originally thought.

Those who originally underestimated their waste, either 'a bit' or 'a lot' (around 18% of the sample), were also the ones who had the highest levels of waste reported in the diary. This is an important finding for behaviour change strategies, as it implies that those people generating the most waste do not have an accurate perception of the amount of food they

throw away. It seems, therefore, that diaries could be a useful method for improving waste awareness for those generating the most waste. It needs to be borne in mind, however, that improving awareness might not in itself be a sufficient measure for changing people's behaviour, with many other factors influencing food and drink waste generation, although it may be an important step in the process of reducing food and drink waste.

Participants who realized that they throw away more than expected were also the most willing to make an effort to reduce their waste, although it is difficult to assess with certainty whether this willingness was a result of taking part in the diary exercise and increased awareness of food and drink waste, as this question was not asked in the pre-diary questionnaire. Nonetheless, this is an important finding, suggesting that those who waste the most are also the most willing to reduce their waste, at least when they are aware of that waste. This is in line with findings from other studies by WRAP and others, which suggest that people generally do not want to throw away food. However, willingness to reduce waste – by itself – is not always enough to bring about change. Food and drink waste generation is a complex issue, influenced by a variety of factors. It is relatively easy to declare an intention to reduce waste in a questionnaire, but managing a household in a way that reduces waste is likely to be much more challenging.

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