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Towards a multi-level framework of household food waste and consumer behaviour: Untangling spaghetti soup

Mark Boulet^{a,*}, Annet C. Hoek^b, Rob Raven^c

^a BehaviourWorks Australia, Monash University, 8 Scenic Drive, Clayton Vic, 3800, Australia

^b The George Institute for Global Health, PO Box M201, Missenden Rd, NSW, 2050, Australia

^c Monash Sustainable Development Institute, Monash University, 8 Scenic Drive, Clayton Vic, 3800, Australia

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ABSTRACT

Changing the everyday food-related behaviours of consumers is a critical part of tackling the global food waste challenge. Comprehensive frameworks of household food waste and consumer behavior are needed to guide the development of targeted interventions and future research agendas. This study systematically reviews food waste and behaviour studies from developed nations to provide an overview of the current research field. It uses a multi-level perspective to organise the various factors influencing food-related behaviour and proposes a new, multi-level, framework of consumer behaviour and household food waste. A novel addition to the field, the framework gathers factors at micro (individual), meso (household), and macro (external to the household) levels and argues that behaviour and food waste emerge from their interactions. Our review also reveals a research domain with disciplinary and methodological ‘blind spots’ and an over-emphasis on individual level factors. A multi-level research agenda focusing on under-explored factors and interactions between factors across levels is presented, and consideration given to multi-level interventions that support consumer behaviour change to reduce household food waste.

1. Introduction

Each year, up to one third of food produced world-wide (over one billion tonnes) is estimated to be spoiled, lost, or discarded uneaten (HLPE, 2014; Thyberg & Tonjes, 2016). Wasted food has significant sustainability implications that cut across a number of human and planetary health issues. It contributes to global warming and land degradation, reduces food availability and affordability, represents unsustainable resource use, and threatens the long-term viability of global and local food systems (HLPE, 2014; Neff, Kanter, & Vandevijvere, 2015; Thyberg & Tonjes, 2016; Willett et al., 2019).

In the Global South, the primary sources of food waste are at production, harvest and transportation stages; while in wealthier, industrialised nations, the most significant volumes occur during consumption, particularly in domestic households (Baker, Fear, & Dennis, 2009; Parfitt, Barthel, & Macnaughton, 2010; Stancu, Haugaard, & Lahteenmaki, 2016). Here, food waste emerges, in part, from consumers’ daily behaviours, such as buying more food than required; preparing too much at meal times; and not re-using leftovers (Evans, 2012a; Parizeau, von Massow, & Martin, 2015; Quedsted, Marsh, Stunell,

& Parry, 2013). Stenmarck et al., (2016, p. 31032016) estimate that households in the European Union (EU) contribute 53% (92 kg per capita) of total food waste, compared to 12% (21 kg per capita) from the hospitality and food services, and to 30% (51 kg per capita) from food production and processing sectors. Changing the everyday food-related behaviours of consumers therefore represents a critical element in tackling the global food waste challenge (Doorn, 2016; Neff, Kanter, & Vandevijvere, 2015; Parfitt et al., 2010).

Research attention to household food waste and consumer behaviour has grown substantially since 2010 and a number of reviews have attempted to synthesise the current evidence base (for e.g. Hebrok & Boks, 2017; Roodhuyzen, Luning, Fogliano, & Steenbekkers, 2017; Principato, 2018; Schanes, Dobernig, & Gözet, 2018; Stangherlin & Barcellos, 2018). Three themes are evident:

1. A spectrum of food related behaviours by consumers is associated with household food waste (Schanes et al., 2018). Some behaviours lead to relatively higher amounts of waste (such as exclusively shopping in large supermarkets), while others lead to lower amounts (such as the use of meal plans and shopping lists) (Stangherlin & de

* Corresponding author.

E-mail addresses: mark.boulet@monash.edu (M. Boulet), ahoek@georgeinstitute.org.au (A.C. Hoek), rob.raven@monash.edu (R. Raven).

- Barcellos, 2018). These behaviours are part of broader household food provisioning practices related to planning, purchasing, storage, preparation, consumption and disposal (Roodhuyzen et al., 2017).
- In turn, a range of factors influence food-related behaviours (Schanes et al., 2018). These can be categorised as internal (such as attitudes, values, knowledge, habits and skills) or external (such as social norms, product characteristics, regulatory frameworks and retail environments) to the individual consumer (Secondi, Principato, & Laureti, 2015). Notable here is the large and diverse number of factors that have been identified. In their systematic review, Roodhuyzen et al. (2017) collate over 90 different factors associated with household food waste.
 - Quested et al. (2013) coined the term *spaghetti soup* to represent the complex web of potential interactions that exist between consumer food-related behaviours and influencing factors. Food waste emerges as the final outcome of these interactions and follows a variety of potential pathways (Hebrok & Boks, 2017). Factors that predict food waste in one particular context, and for one particular type of consumer, are irrelevant in other contexts with other consumers (Parizeau et al., 2015; Quested & Luzecka, 2014). Factors can also interact with each other and influence behaviour through a combined effect (Roodhuyzen et al., 2017).

Despite a growing appreciation of the complex relationship between food waste and behavior, the majority of studies focus narrowly on particular behavioural or factorial subsets and do not place these into more comprehensive perspectives (Roodhuyzen et al., 2017). This leads to 'shopping lists' of possible behaviours and factors that influence household food waste, but with no indication of which might be prioritized in different contexts or of their possible mutual influences. Policy makers and practitioners are left to cherry-pick potential leverage points and have limited opportunity to tailor food waste interventions to specific audiences (Parizeau et al., 2015; Quested & Luzecka, 2014).

Few comprehensive frameworks of household food waste and consumer behavior are available to assist the development of targeted interventions and to guide further research. Roodhuyzen et al. (2017) synthesized the range of behavioural and personal factors associated with household food waste and pioneered an integral framework of food waste and behavior. It gives detailed consideration to the potential relationships between factors and behaviours, as well as the different pathways from which food waste emerges. The framework is however more limited in its conceptualization of factors beyond the individual consumer. These are presented as a list of societal factors, and their potential interactions are largely ignored. Closer attention to the relative placement of factors in *both* internal and external contexts to the consumer, and to their collective influence on behaviour and food waste, is needed (Sallis, Owen, & Fisher, 2008; Story, Robinson-O'Brien, & Glanz, 2008).

We address this gap by systematically reviewing the food waste research field from a *multi-level perspective*. This review will provide a critical overview of what is known (and not known) about consumer behaviour in relation to household food waste, and, at the same time, use a multi-level framework to organise influencing factors at different contexts relative to the individual.

The application of a multi-level perspective is novel for the food waste research field. Common in public health, social and organisational science as *ecological, or socio-ecological models*, the approach gives explicit recognition to influencing factors at multiple levels, to their potential interplay, and to their collective effect on an individual's behaviours (see for e.g. Bronfenbrenner, 1994; Cohen, Scribner, & Farley, 2000; Stokols, 1992; Story, K., Robinson-O'Brien, & Glanz, 2008). While reviews of household food waste such as Aschemann-Witzel, de Hooge, and Normann (2016) and Principato (2018) recognise factors at levels beyond the individual, they do not organise them into different levels or propose multi-level models to explain consumer food waste related behaviour and household food waste.

Hence, the research question we ask in this paper is: What insights can a multi-level perspective provide the field of household food waste and consumer behaviour, and what do these mean for new research agendas and behaviour change interventions that aim to reduce food waste?

The next section describes the guiding elements of a multi-level perspective and our systematic review methodology. The review results are presented, followed by a discussion of key themes and our proposed multi-level framework of household food waste and consumer behaviour. We conclude with a future multi-level research agenda and sketch out implications for practitioners.

2. Methodology

This review is informed by a mixed-methods, configurative, review methodology (Gough, 2015; Gough, Thomas, & Oliver, 2012). We use a multi-level perspective as the conceptual framework to organise the findings of a range of methodologically diverse primary studies (Sandelowski, Voils, Leeman, & Crandell, 2012). The multi-level perspective is described in this section, followed by the review's data collection, screening and analysis processes.

2.1. A multi-level perspective – defining the levels

The term multi-level perspective is used in this paper to denote an ontology that describes, explores and analyses a system at multiple levels (Hackman, 2003; McIntyre, 2017; Penner, Dovidio, Piliavin, & Schroeder, 2005). This approach should not be confused with Multi-Level Perspectives (MLP). Based on similar foundations, MLP is a framework on the interactions between three specific level (niches, regimes and landscapes) relevant to transitions in sociotechnical systems (Geels, 2010, 2011). The multi-level perspective referred to in this paper is more general in its treatment of levels and focuses on their interaction and combined influence on behaviour and food waste, rather than on transitions (see Fig. 1).

Two principles are important the multi-level perspective in Fig. 1. The first is that a system can be organised into levels of increasing heterogeneity and complexity. Three levels are commonly referred to; the micro, the meso and the macro (Hitt, Beamish, Jackson, & Mathieu, 2007). These are differentiated by researchers based on their complexity, the characteristics of their constituent units, and by the processes and structures that characterise these units (Rousseau, 1985). For a multi-level perspective on household food waste and consumer behaviour, we follow Reid, Sutton, and Hunter (2010) by allocating the physical and social unit of *the household* to the meso level. This is used as the point of contrast to define the bracketing micro and macro levels, namely:

- **The micro (individual):** The focal entity here is the individual. A common categorisation across a range of disciplines, individuals are a social system's building blocks and they have different internal factors, such as attitudes, knowledge, skills, life experiences and financial resources, that influence their behaviours (Penner et al., 2005; Sallis et al., 2008; Story et al., 2008).
- **The meso (household):** The social unit (i.e. the group) within the physical setting of a household is this level's focus (Reid et al., 2010; Scott, Oates, & Young, 2015). The social unit is often a biological family, but can be any other collection of people that live together in the same house. The household is not just an aggregation of individuals and their characteristics, it is also defined by their interactions (Reid et al., 2010; Schenk, Moll, & Schoot Uiterkamp, 2007). Influencing factors include group-level characteristics, such as composition, cohesion, structure and interdependence, as well as the physical attributes of the house itself (Forsyth, 2010).
- **The macro (external to household):** The focal entities here are the physical and social settings external to the household. This level

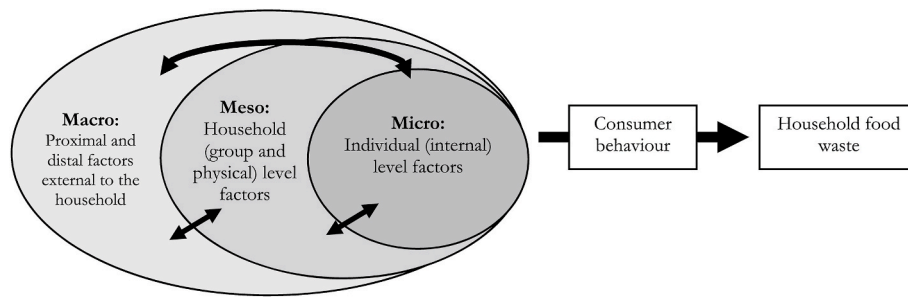


Fig. 1. Multi-level perspective of household food waste and consumer behaviour.

could potentially be endless and we draw on [Story et al. \(2008\)](#) to categorise *proximal* influences from external physical settings (such as workplaces, schools, supermarkets) and social networks (such as friends, family, neighbours) with which individuals in the household frequently interact. Beyond this, we cluster the more *distal*, and sometimes indirect, influences of factors such as social values, regulatory frameworks, average-income, commercial markets and climatic conditions ([Roodhuyzen et al., 2017](#); [Story et al., 2008](#)).

The second principle is that lower, less complex, levels are nested within higher, more complex, ones. In these nested hierarchies, relationships exist within, and between, the levels ([Hitt et al., 2007](#); [Mathieu & Chen, 2011](#); [Rousseau, 1985](#)). Entities or factors relevant to one level can influence those within other levels (and vice-versa), as well being part of interplays on the same level. For example, the density and location of food retail outlets (a macro level feature) may influence how much food is stock-piled in a household, while the food management skills of individuals (micro) influence how well that food is stored, and the dynamics between householders (meso) then determines what is actually eaten. Different behaviours, and household food waste, emerge from these interactions.

2.2. Data collection and screening

In May 2019, the databases Scopus, PsycINFO and CAB Abstracts were searched for relevant studies between 2008 and May 2019. These databases were chosen based on their size, coverage and relevance to the topic (see Supplementary Materials for data-base search strategies).

Studies were included if they were: i) peer-reviewed primary studies; ii) empirical investigations of factors that predict, influence or determine the existence, nature or generation of household food waste; iii) based on consumers in regions where food waste at the consumption stage is higher than in other food chain stages (namely Europe, Japan, the Republic of Korea, China, North America, and Australia/New Zealand ([HLPE, 2014](#))); and iv) written in English.

Studies were excluded if they were: i) conference proceedings or reviews; ii) based on food waste in settings outside of the household; iii) based on consumers in regions where food waste at the consumption stage is lower than in other food chain stages (namely Latin America, Africa and the remainder of Asia ([HLPE, 2014](#))); and iv) not written in English.

After an initial yield of 3180 papers across all three data-bases, two authors (MB and AH) co-screened a sample of 309 eligible papers at title and abstract level and achieved 94% agreement on inclusion or exclusion. Following resolution of screening conflicts, MB continued screening the remaining papers at title and abstract level, and then conducted full-text screening based on the above inclusion/exclusion criteria (see Supplementary Materials for a summary of the review process).

2.3. Data extraction and collation

Data extraction of selected studies had two main phases. The first extracted and collated general information, such as the date of publication, geographical location, and the research designs and methods utilized in each study.

The second phase identified the particular factors that were empirically investigated in each study and which, based on their findings, the authors claimed to have an effect on household food waste and/or consumer behaviour. Based on the level definitions from section 2.1, each factor was assigned to the micro, meso or macro level. Assignment was typically based on the entity that the study associated with a particular factor. For example, if the attitudes or skills of an individual were found to have an effect on food waste (for e.g. [de Hooge et al., 2017](#); [Gojard & Véron, 2018](#)), these were classified as micro level factors. If family dynamics were described as influencing food waste (for e.g. [Andrews, Kerr, Pearson, & Miroso, 2018](#); [Devaney & Davies, 2017](#)), these were classified as meso level factors.

Two authors (MB and AH) each independently extracted factors from thirteen randomly selected studies and assigned them to different levels. Upon comparison, any discrepancies or differences were resolved through discussion and MB then completed the extraction process with the remaining studies. A data extraction table was developed that collated factors identified in each study and their designated level. Broader factor categories were then inductively developed to group similar or overlapping factors.

3. Results

3.1. General overview

118 studies conducted between 2000 and 2019 on household food waste and consumer behaviour were selected as relevant to this review. [Fig. 2](#) shows that since 2105 there has been a substantial increase in relevant studies. The number of papers for 2019 only includes those published up to May 2019. Based on the trend evident in [Fig. 2](#), we would expect this number to be much higher by the end of the year.

There is a clear predominance of European based studies ($n = 90$ studies), with those from Italy ($n = 19$ studies) and Great Britain ($n = 17$ studies) the most common. North American ($n = 14$ studies) and Australian/New Zealand ($n = 7$ studies) based studies are the next most common (see graph illustrating these concentrations in the Supplementary Materials). While these results may have been partially influenced by our search for papers only written in English, the high number of Italian studies suggests that this possible bias may be negligible and the trend is more reflective of overall food waste research activity in different countries.

Apparent also is the methodological dominance of surveys in the research field (see graph illustrating these findings in the Supplementary Materials). 56% of collated studies only used this methodology (for e.g. [Abeliotis, Lasaridi, & Chroni, 2016](#); [Chen, 2018](#); [Silvennoinen, Katajajuuri, Hartikainen, Heikkilä, & Reinikainen, 2014](#); [Stefan, Herpen,](#)

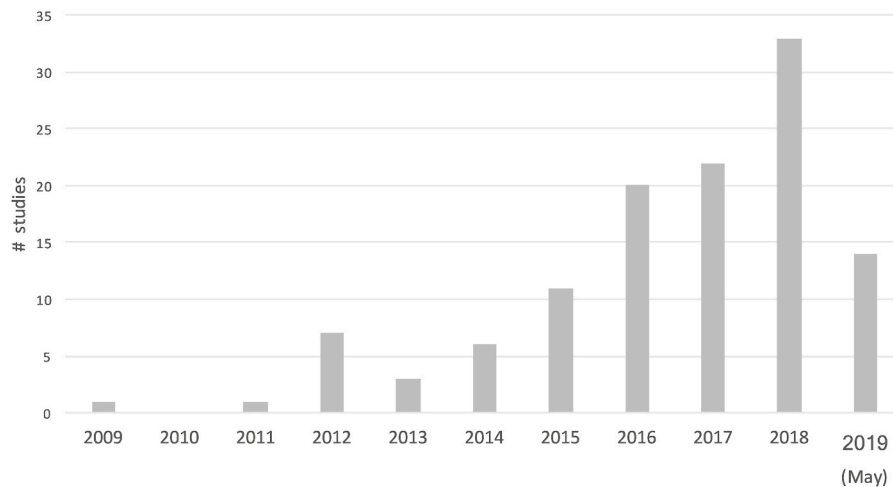


Fig. 2. Relevant household food waste and consumer behaviour studies published (2009–May 2019) $n = 118$ studies.

Tudoran, & Lähtenmäki, 2013), while 25% used a combination of methods, often a mix of observations and in-depth interviews as favoured by ethnographic research (for e.g. Cappellini, 2009; Ganglbauer, Fitzpatrick, & Comber, 2013; Mattila, Mesiranta, Närvänen, Koskinen, & Sutinen, 2018; Sosna, Brunclíková, & Galeta, 2019). Only 12% used an experimental method or tested an intervention focused on reducing household food waste (for e.g. de Hooge et al., 2017; Graham-Rowe, Jessop, & Sparks, 2019; Schmidt, 2016; Young, Russell, Robinson, & Chintakayala, 2018).

85 studies featured a primarily quantitative analysis, while 25 were qualitative. Only eight studies used both quantitative and qualitative data, and these were either surveys which included open ended questions (for e.g. Lanfranchi, Calabrò, De Pascale, Fazio, & Giannetto, 2016; Petrescu-Mag, Petrescu, & Robinson, 2019) or were mixed interview and survey methods (for e.g. Aschemann-Witzel et al., 2016; Romani, Grappi, Bagozzi, & Barone, 2018).

85 studies did not use, or make explicit, an underlying theoretical framework. Of the 33 studies that did explicitly use theory, the majority were either based on social practice theory ($n = 10$ studies) (for e.g. Hebrok & Heidenstrøm, 2019; Revilla & Salet, 2018; Watson & Meah, 2012) or a behavioural theory ($n = 16$ studies) (for e.g. Farr-Wharton, Foth, & Choi, 2014; Fiore, Pellegrini, La Sala, Conte, & Liu, 2017; Mondejar-Jimenez, Ferrari, Secondi, & Principato, 2016). The Theory of Planned Behaviour (TPB) ($n = 9$ studies) was the most common of behavioural theories, with some studies utilising an extended version with additional variables based on their particular focus (for e.g. Hoek, Pearson, James, Lawrence, & Friel, 2017; Setti, Banchelli, Falasconi, Segrè, & Vittuari, 2018; Visschers, Wickli, & Siegrist, 2016).

3.2. Influencing factors of household food waste organised with a multi-level perspective

All studies included in this review empirically investigated one or more factors that might influence household food waste and/or food waste related behaviours. Relevant factors were typically identified in quantitative studies by correlating with measures of household food waste, for example the positive association with household size as found by Koivupuro et al. (2012) or the negative association with consumer's education levels found by Fonseca (2013). Qualitative studies described and coded relevant factors as salient themes, such as a fear of children being bored with leftover food (Evans, 2012b) or the influence of personal ideologies (Blichfeldt, Mikkelsen, & Gram, 2015). We only extracted factors from studies if an association with food waste was identified either statistically or descriptively.

We have already commented on the well-established association

between different behaviours and food waste. A large range of studies in this review ($n = 59$) identified relationships between food waste and general provisioning practices (such as planning, shopping, storage, cooking and consumption) or between food waste and more specific behaviours. Practices, which we consider as bundles of different behaviours (Reckwitz, 2002), are usually described as having a general relationship with food waste, without any direction of association (for e.g. Cappellini & Parsons, 2012; Waitt & Phillips, 2016). Behaviours were either positively associated - such as buying promotional offers (for e.g. Jörissen, Priefer, & Bräutigam, 2015) and shopping exclusively at large supermarkets (for e.g. Kowalewska & Kołhajtis-Dołowy, 2018) - or negatively associated with food waste - such as using shopping lists (for e.g. Giordano, Alboni, Cicatiello, & Falasconi, 2019) or checking food stocks before shopping (for e.g. Abeliotis, Lasaridi, & Chroni, 2014).

Table 1 collates the different categories of influencing factors extracted from studies based either on their association with different food-waste related behaviours/practices, or with household food waste. These categories in turn are organised into different columns representing individual (micro), household (meso) levels, or those levels external to the household (macro).

The factor categories described in each column are based on the more specific factors they represent and, where possible, the directions of their associations with household food waste are also summarised. For example, 'attitudes' is a key factor category at the individual level and this includes attitudes related to food waste, food safety and risk, and to healthy eating. Food waste is negatively associated with attitudes about the value of food and food waste (for e.g. Graham-Rowe, Jessop, & Sparks, 2015) and is positively associated with concerns about food safety (for e.g. Aschemann-Witzel, de Hooge, Almlí, & Oostindjer, 2018) and desires to eat 'fresh' foods rather than leftovers (for e.g. Østergaard & Hanssen, 2018). At the household level, 'demographics' is a factor category and includes household size, income level and make-up. Food waste is positively associated with household size (for e.g. Edjabou, Petersen, Scheutz, & Astrup, 2016), income (for e.g. Melbye, Onozaka, & Hansen, 2017) and if children are part of the household (for e.g. Ellison & Lusk, 2018).

We make a distinction between norms at an individual-level and at the household level based on the methodological emphasis of different studies. Those studies that use the TPB typically measure the individual respondent's perceptions of social norms (either injunctive or descriptive), as well as their personal norms (for e.g. Mondejar-Jimenez et al., 2016; Stancu et al., 2016; Visschers et al., 2016). Other studies, often ethnographically focused, use third party (typically the researcher) descriptions of what is normal in a household based on observed routines and rituals (for e.g. Cappellini, 2009; Revilla & Salet, 2018; Waitt &

Phillips, 2016). We acknowledge that these perceived vs observed norms would overlap, but make this distinction in Table 1 to acknowledge this factor is relevant to both micro and meso levels.

The neat representation of factors and trends shown in Table 1 hides a sometimes messy, contradictory and ambiguous body of evidence. Some studies do not consider the direction of particular associations and only generally describe the relationship between particular factors and food waste. For example, studies by Devaney and Davies (2017) and Andrews et al. (2018) identify the influence of relationships between family members on household food waste, but do not describe how this actually occurs, the possible direction of associations, and which facets of relationships are important. Other factors have contradictory associations across studies. For example, some suggest women waste more food (for e.g. Fanelli, 2019; Fonseca, 2013), others found they waste less (for e.g. Di Talia, Simeone, & Scarpato, 2019; Marangon, Tempesta, Troiano, & Vecchiato, 2014) and still more found no difference based on gender (for e.g. Neff, Spiker, & Truant, 2015). Factors such as habits and emotions are only examined in four studies (Aschemann-Witzel, de Hooge, Amani, Bech-Larsen, & Oostindjer, 2015; Birau & Faure, 2018; Blichfeldt et al., 2015; Russell, Young, Unsworth, & Robinson, 2017) and as such do not have a strong evidence base.

Roodhuyzen et al. (2017) point to a very heterogeneous and ambiguous research domain in their review. They found that the broad spectrum of research designs, food waste definitions, measurement methods, and data presentation makes comparing between, and synthesising across, studies challenging. Two years later, and based on an even larger set of reviewed studies, we whole-heartedly echo these concerns, and offer them as a caveat for readers interpreting Table 1.

3.3. A research field skewed towards the individual level

85 studies collated in this review identified individual-level factors associated with household food waste. 64 studies identified household level factors and 37 studies addressed factors external to the household. Most studies investigated more than one factor and a number included factors from different levels (for e.g. Chen, 2018; Secondi et al., 2015; Waitt & Phillips, 2016).

Fig. 3 shows the number of studies that address the different factor categories identified in Table 1. At the individual-level, attitudinal (n = 45 studies), individual demographics (n = 40 studies) and skills and knowledge factors (n = 31) were the most commonly studied, while at the household-level, demographic factors (n = 43 studies) were most commonly investigated. For factors external to the household, studies that identify the influence of country or regional demographics were again the most common (n = 16 studies), followed by those that looked at the influence of food retailers (n = 13 studies).

4. Discussion

We began this paper asking about the insights a multi-level perspective can provide to the field of household food waste and consumer behaviour, and what these mean for new research agendas and behaviour change interventions. Here we discuss the main themes from our systematic review to show a research domain concentrated on particular disciplines, methodologies and on individual level influencers of household food waste. We organise factors that influence household food waste and behaviour at micro, meso and macro levels, and use this logic to propose and describe a multi-level framework of consumer behaviour and household food waste. We conclude by considering future directions for food waste research and for interventions that target household food waste.

4.1. A research domain of 'bald spots'

Since the turn of the century, the burgeoning social, economic and environmental implications of food waste have seen a substantial

Table 1

Categories of factors that influence household food waste or food waste related behaviours (organised to individual, household or external to the household levels). Factors are ordered from those most commonly identified in studies to those less commonly identified.

Individual (micro) level factors associated with food waste	Household (meso) level factors associated with food waste	External to household (macro) level factors associated with food waste
<ul style="list-style-type: none"> · Demographics. Include an individual's age, gender, and educational and income levels. Food waste is positively associated with income level, and negatively associated with educational level and age. Associations with gender are contradictory across studies and less well evidenced for other demographic factors. · Attitudes. Include an individual's attitudes towards food and its value, food waste, food safety and risk, healthy eating and eating 'fresh' food. Food waste is negatively associated with attitudes about the value of food and food waste, and is positively associated with concerns about food safety and desires to eat healthily and 'fresh'. · Time constraints. An individual's personal schedule and their available time for food related activities. The relationship of these factors to food waste is usually described generally. It's recognized that the unpredictability of life, and competing demands on an individual's time, can lead to food being wasted. · Perceived norms. An individual's personal and subjective norms about food and food waste. Perceived norms about the value of food and the need to reduce food waste are generally associated with lower levels of food waste. · Skills and knowledge. Include an individual's skills, knowledge and confidence in food storage, preservation, cooking, date-labels and meal planning. Greater levels of skills, confidence and knowledge are generally associated with lower levels of food waste. 	<ul style="list-style-type: none"> · Demographics. Include the average size, income level and make-up of a household. Food waste is positively associated with household size and income, and if children are part of the household. Associations with other demographics are less well evidenced. · Needs and tastes of others. Includes the food-related preferences, desires and needs of others in a household. The relationship of household needs and tastes to food waste is usually described generally. Food waste emerges from the combined food related needs and tastes of all household members. · Equipment and infrastructure. Includes the physical food storage and cooking equipment within a household, as well as the presence of vegetable gardens. The presence of refrigerators and vegetable gardens, are associated with lower levels of food waste. Well-organised fridges and pantries are also associated with lower levels of food waste. · Combined time constraints. The combined schedules and available time of household members for food related activities. The relationship of time related factors to food waste is usually described generally. Food waste emerges from the unpredictability of life, and competing demands on time, associated with a group of people living together. · Norms. Include the food related routines and rituals of the household. The relationship of household norms to food waste is usually described 	<ul style="list-style-type: none"> · Demographics. Includes a country's (or region's) GDP, level of urbanization, food retail density and level of food security. Food waste is positively associated with GDP and levels of urbanization, and negatively associated with food security and the number of supermarkets and grocery stores (as opposed to restaurants and take-away meal venues). · Retail. Includes food retailers' marketing, advertising and sales strategies, package sizes, food pricing and promotion of particular cosmetic and freshness standards. The relationship of retail factors to food waste is often described generally. Some evidence that package sizes and food promotions are associated with greater food waste. · Physical settings (other than retail). The influence of food waste education activities at school. Generally understudied, there is evidence to suggest that what children learn at school can influence food related knowledge and awareness at home. · Legal and regulatory frameworks. Include a country's (or region's) food health standards, date-label requirements and cost of waste disposal. The relationship of these frameworks to food waste is usually described generally, with recognition that externally imposed food safety requirements indirectly influence when food is disposed. Domestic food waste collection charges are negatively associated with food waste. · Social. Food related social obligations,

(continued on next page)

Table 1 (continued)

Individual (micro) level factors associated with food waste	Household (meso) level factors associated with food waste	External to household (macro) level factors associated with food waste
<ul style="list-style-type: none"> · Personal values and identity. An individual's moral stand-point towards waste, their broader ideologies and their particular self-identity. The relationship of these factors to food waste is usually described generally, with no direction of association shown. · Awareness. An individual's awareness and knowledge of food waste as an issue, together with its environmental and social consequences. Greater levels of awareness are generally associated with less food waste. · Perceived control. An individual's sense of control over their food waste and food related practices and behaviours. Lower perceived control is usually associated with higher amounts of food waste. · Intention. An individual's intentions to reduce food waste or to change food wasting behaviours. Higher intentions to reduce food waste are usually associated with lower food waste amounts. · Habits and emotions. The influence of individual's habits and emotions on food related behaviours. While generally understudied, evidence suggests that food related behaviours of an individual have a significant habitual and emotional component. 	<p>generally. Routines to do with households eating together are negatively associated with food waste.</p> <ul style="list-style-type: none"> · Dynamics between householders. Include the interactions, communications and decision making between household members about food and food waste. <p>The relationship of household dynamics to food waste is usually described generally. Adult authority over children's eating and combined decision making about food purchasing is associated with less food waste.</p> <ul style="list-style-type: none"> · Roles. The food-related roles and identities of different members of a household (assigned by others, or taken up on their behalf). The relationship of different roles and identities to food waste is usually described generally, with food waste emerging from the actions or decisions of individuals in relation to their role in the household. There is often a gender component to these roles, with women playing a key part. 	<p>identities and standards.</p> <p>The relationship of social factors to food waste is often described generally, with recognition that social identities and obligations determine who we eat leftovers with and influence our desires to be a good host through over-catering.</p> <ul style="list-style-type: none"> · Culture/place. Include culturally and geographically defined notions of edibility, norms about food sharing, and ideals of abundance. <p>The relationship of cultural and place-based factors to food waste is usually described generally and tends to have an indirect influence.</p>

increase in policy, program and research attention (Parfitt et al., 2010; Porpino, 2016; Young, Russell, Robinson, & Barkemeyer, 2017). Specifically, there have been considerable efforts to define what 'food waste' is (for e.g. Roodhuyzen et al., 2017), to quantify the amount, and type, of food waste at global and national levels (for e.g. FAO, 2011, 2014; Thyberg, Tonjes, & Gurevitch, 2015); to identify where in the food system waste occurs (for e.g. HLPE, 2014; Parfitt et al., 2010); to track its associated ecological and social impacts (for e.g. Kummu et al., 2012) and finally; to consider its policy and program implications (for e.g. FUSIONS, 2014; HLPE, 2014).

Attention to household food waste and consumer behaviour has been much more recent (Schanes et al., 2018). As with other reviews, our study shows a relatively young research field that has grown rapidly

over the past five years (Porpino, 2016; Schanes et al., 2018; Stangherlin & de Barcellos, 2018). However, this growth has been largely concentrated to a few key areas and a comprehensive, varied and multi-disciplinary approach is still missing.

The majority of studies collated in our review are European-based (particularly from the UK and Italy), with smaller 'pockets' identified in North America and Australia/New Zealand. This trend likely reflects the considerable European policy and practice attention to food waste over the past decade, such as the long-running UK-based WRAP program and the EU's FUSION and REFRESH projects (Reynolds et al., 2019). However, while these studies provide valuable insights into consumer behaviour and food waste, their applicability and transferability to other regions may be limited (Questa et al., 2013).

The dominance of either psychological or sociological oriented studies identified in other reviews (Roodhuyzen et al., 2017; Schanes et al., 2018) was also apparent. Psychological studies typically used the TPB, while sociological studies were often driven by social practice theory. Beyond these disciplinary and theoretical concentrations, our review also highlights surveys as the primary methodological tools used to explore household food waste and behaviour.

While we do not suggest that the field should completely abandon its current ontologies and methodologies, it should be wary of their exclusive application. The individual-level focus of psychological studies can miss the complexity of contexts and their influence on behaviour, while the detailed descriptions of sociological studies make it difficult to generalise beyond the particular case being examined (Reid et al., 2010; Shove, 2010; Whitmarsh, O'Neill, & Lorenzoni, 2011). The reliance on surveys limits insights into what people actually do, as opposed to what they say they do (Ganglbauer et al., 2013; Jerolmack & Khan, 2014; Kusenbach, 2003).

The final concentration was the substantial focus on individual-level influencing factors of consumer behaviour and household food waste. This was particularly true for factors such as demographics, attitudes, skills and knowledge. Beyond demographics, other factors at meso and macro levels were only addressed by a limited number of studies. This may emerge as a natural consequence of using primarily individual focused ontologies and methodologies, or may reflect more historical trends in the focus of Western research traditions (Cartwright, 1951; Steiner, 1974). Regardless of the cause, we argue that the association of individual level factors such as attitudes and demographics with food waste is now well established and further studies on these factors should not be a priority.

The research approaches and foci discussed here have done much to advance our understanding of the relationship between food waste and behaviour. However, their unwavering use risks creating *bald spots* in the field. Coined by environmental education researchers Reid and Scott (2013), the term refers to those areas in a research domain that may become worn down by "having the same questions or approaches unremittently pursued" (p. 520). While Reid and Scott acknowledge that the robustness of a field requires a degree of repetition and replication, the flipside is that we know more and more about one specific area, while other questions remain unanswered. Any theoretical or methodological lens hides as much as it reveals and the spaghetti soup of consumer food waste and behaviour requires multiple lenses to explore its complexity (Teddie & Tashakkori, 2011). The challenge for the field is to engage with different disciplines, ontologies and methodologies to generate new research agendas, insights and interventions. This is discussed further in section 4.3.

4.2. Towards a multi-level framework of household food waste and consumer behaviour

Drawing on the micro, meso and macro-level grouping of factors in Table 1, we propose the following multi-level framework of household food waste and consumer behaviour (Fig. 4). This framework is a first step towards structuring the wide range of factors that influence

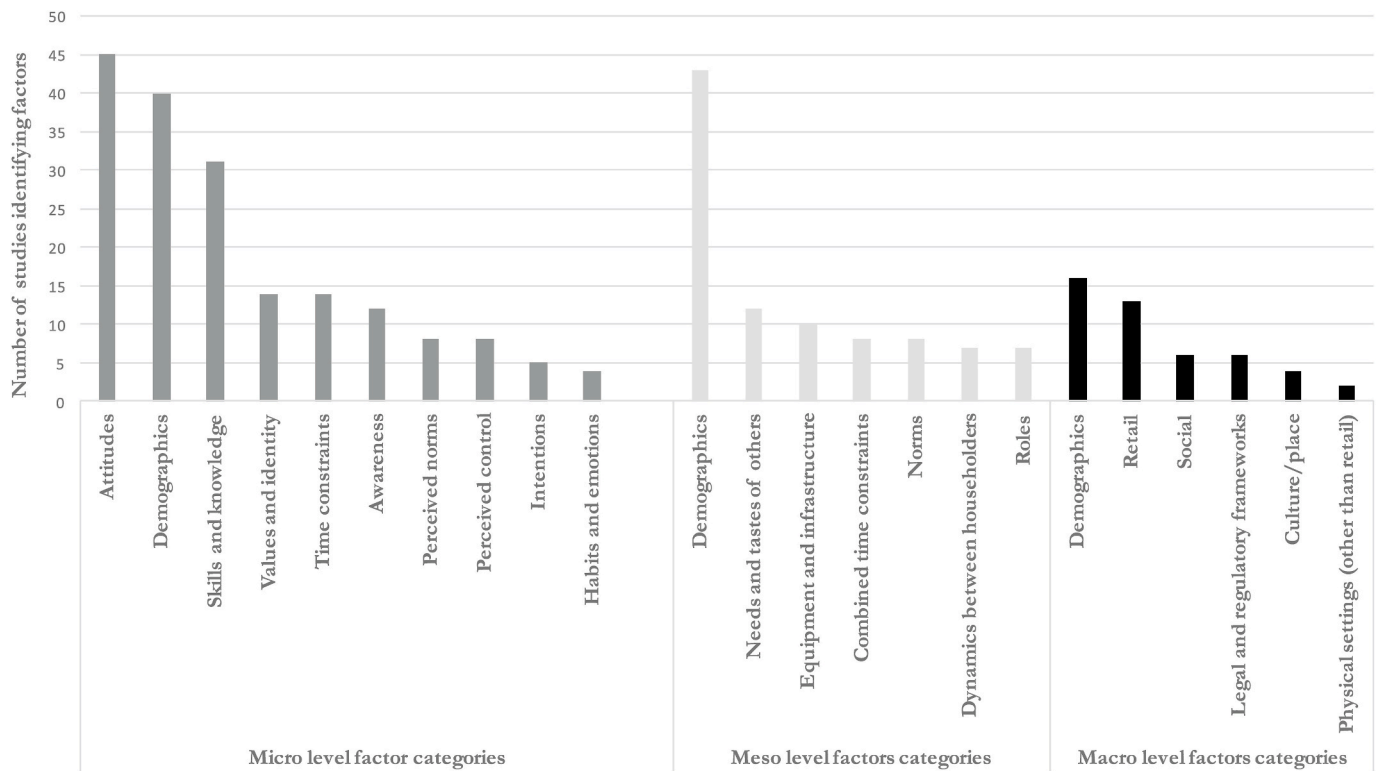


Fig. 3. Number of studies investigating factors within particular individual, household, or external to the household level factor categories.

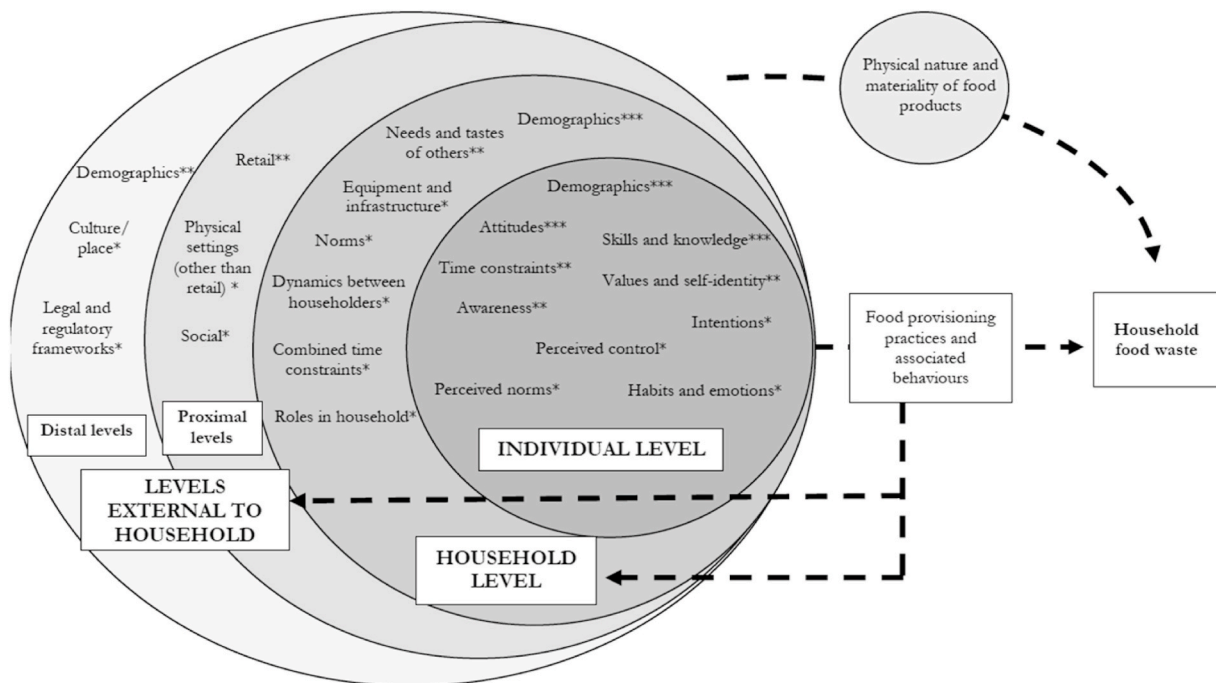


Fig. 4. A multi-level framework of household food waste and consumer behaviour. Factors with *** have been confirmed by > 20 studies, with ** have been confirmed by 10–20 studies, and with * are supported by < 10 studies.

consumer and household food waste into a multi-level perspective. It extends from previous models, such as those from Roodhuyzen et al. (2017) and Aschemann-Witzel et al. (2015), by organising factors that are internal and external to the individual into contexts (levels) relative to each other, and considers both their potential interplay and combined influence on food related behaviour and household food waste.

Fig. 4 also gives a visual representation of the number of studies that support each of the factors identified in this review, highlighting its relative bold, and blank, spots.

The individual (micro) level of the framework contains the various internal factors that have an association with household food waste and behaviour. These include an individual’s attitudes, demographics and

intentions, as well as their perceived control and norms of food waste and its related behaviours. The household (meso) level has factors to do with the physical properties and infrastructure of the house (such as refrigerator and pantry size) and with the group of people living there (such demographics, norms, dynamics and relationships). Finally, the level external to the household (macro) is divided into *proximal* factors with which households (and individuals) have frequent engagement (namely external physical settings and extended social networks) and *distal* factors (such as economic, market and regulatory factors) that sit in the background and are more removed from consumers' daily lives.

The enacted food provisioning practices of an individual, and their specific associated behaviours, are the emergent property of the interactions between the different factors depicted across the levels in Fig. 4. Household food waste is then the final outcome of individuals responding (consciously and unconsciously) to these multi-level influences.

We recognise that the behaviours of individuals can also be possible factors that strengthen (or break) food-related norms in a household or in a community (Nikolaus, Nickols-Richardson, & Ellison, 2018; Parizeau et al., 2015). This potential dynamic is represented by the arrow in Fig. 4 that links practices and behaviours back to factors at the household, and beyond household, levels.

Additionally, some factors included in the framework can directly influence a household's food waste without being mediated by individuals' behaviours. Food amounts purchased during a shopping may come as much from available supermarket package sizes as from a consumer's purchasing behaviours (Aschemann-Witzel et al., 2016; Williams, Wikström, Otterbring, Löfgren, & Gustafsson, 2012). Additionally, the materiality of food can influence household food waste irrespective of human behaviour (Evans, 2011; Farr-Wharton et al., 2014; Mattila et al., 2018; Watson & Meah, 2012). These 'behaviour-agnostic' influences are represented by the second arrow and text box in Fig. 4.

In contrast to the substantive focus of the research domain on the association of food waste with individual level factors, the nested hierarchy in our framework illustrates that these factors can be moderated, or even cancelled out, by factors that exist at other levels. For example, while an individual may have particular attitudes, skills and knowledge which would predict minimal amounts of food waste, these might be subsumed by the tastes and needs of others in the household, or might be not be valued, and subsequently ignored, due to the particular dynamics between household members (Cappellini, 2009; Evans, 2011). Other studies, and frameworks, have acknowledged the interactions possible between factors at different levels (Aschemann-Witzel et al., 2015; Roodhyuzen et al., 2017), even if none have empirically investigated them. Our embedded framework builds on this by bringing an explicit multi-level logic to these interactions.

Models that use individual level factors to predict behaviour (such as the TPB) only partially account for actual behaviour or food waste outcomes (Jorgensen, Boulet, & Hoek, 2020), and the gap between an individual's intentions and their final actions has been demonstrated in a number of studies (Graham-Rowe et al., 2015; Russell et al., 2017; Stefan et al., 2013; Toma, Costa Font, & Thompson, 2017). Graham-Rowe et al. (2015) argue that "it is likely that people may not have complete control over the amount of [food] thrown away, due to the behaviour of other members of the household" (p. 200). Our framework takes a step away from an individualistic focus on food waste and explicitly recognises the influence of the contexts in which the individual is embedded.

Reid et al. (2010) point to the often-undertheorized centrality of households in influencing behaviour, and highlight their role as *mediators* (translating social values and other factors through to individuals), as *generators* (by feeding back into factors at macro levels) and as *propagators* (grounding and making macro-level factors practical in a real-world social unit). "By examining the role of the household as an institution of the meso level, one is recognizing that households incubate

interactions between macro and micro levels and, importantly, that understanding those inter-actions can also aid the understanding of ... behaviour" (Reid et al., 2010, p. 316). The central role of the household in food waste behaviour is illustrated in our framework.

Our framework also builds on current conceptualizations of factors relevant to the household meso level. While work by Aschemann-Witzel et al. (2015) and Principato (2018) include factors at this level, these are limited to household size and compositions or to generally described 'social norms'. We extend this by acknowledging the diversity of factors associated with the household as a *physical unit* (available equipment and infrastructure) and *social unit* (Blunt, 2005; Reid et al., 2010). The characteristics of the social unit are important to note here, such as different food related needs and tastes, different schedules and time availability, established norms, or the dynamics between householders. Food waste becomes the emergent phenomenon of these characteristics and interactions, namely from the various negotiations, joint decision-making, compromises and interdependencies that are typical of groups sharing the same space (Devaney & Davies, 2017; Evans, 2012a; Ganglbauer et al., 2013; Grønhoj, 2006).

Studies using social practice theory do explicitly consider the influence of broader sociocultural, technological and material contexts on food waste, including the dynamics, routines and patterns of 'daily-life' in a household (Ganglbauer et al., 2013; Schanes et al., 2018; Watson & May 2012). To date, social practice studies of food waste have mainly given case-specific, and often undifferentiated, descriptions of influencing factors, and have not yet been generalised into models to assist the development of food waste policies and programs (as they have for sustainable consumption (Sahakian & Wilhite, 2014; Spaargaren, 2003) or climate change policy (Shove, 2014)). Acknowledging the potentially deep ontological differences between social practice theory and a multi-level perspective (Schatzki, 2016), we suggest that our framework, at least visually, illustrates the "intersection of various activities, actors, materials, spatial temporal elements and their implications on the generation of food waste" (Schanes et al., 2018, p. 981) that a social practice analysis of household food waste would reveal.

4.3. Implications for research and practice

Taken together, the prevailing themes from the review and our proposed multi-level framework have a number of implications for researchers and practitioners interested in household food waste. For food waste researchers, we propose a multi-level research agenda that explores under-represented factors within particular levels and considers the interactions of factors across different levels. This is summarised in Table 2 with exemplar research questions, some of which also include possible interventions types for practitioners to prioritise and test.

As Table 2 demonstrates, we propose a move from individual level factor research to expanded and diverse studies that identify, and explore, the influence of factors from other levels. While the influence of macro level factors such a culture and legislative frameworks can be hard to trace into a household due to their relative 'distance', there are a number of more proximal factors that warrant further research. How might, for example, interventions in macro level physical settings such as workplaces and schools affect the food waste of a household? In a previous study, Boulet and co-authors propose a series of school-based food waste initiatives that require involvement from parents, as well as teachers and students (Boulet, Wright, Williams, & Rickinson, 2019). They argue that these initiatives' impacts would not just be limited to schools and could change behaviour and food waste patterns in students' homes.

At the meso level, the use of individual-level theories and methodologies does not capture interactions between household members and can miss their influence on a household's food waste (Jorgensen et al., 2020; Scott et al., 2015). Moving away from theoretical and methodological bald spots, food waste researchers might look to other disciplines (such as social marketing, consumer studies or cultural geography) to

Table 2

A multi-level research agenda on household food waste and behaviour and exemplar research questions.

Underexplored influencers within levels	Exemplar questions
<p><i>At the distal and proximal macro levels</i></p> <p>What is the influence of:</p> <ul style="list-style-type: none"> · Culture/place · Legal and regulatory frameworks · Food retailers · Other external physical settings 	<ul style="list-style-type: none"> · Do food waste interventions in workplaces influence food waste and behaviours in households? · Can the food package design reduce household food waste? · Does online shopping reduce food waste compared to visiting the supermarket? · How can social networks be utilized to reduce waste? · Learning from South Korea: how might food waste disposal costs affect household food waste patterns in other countries or cultures? · Does household fridge or pantry size lead to more or less food waste? · Do typologies of family communication and decision-making about food have an association with household food waste? · How might household cohesion affect food waste? · Gate-keepers vs fussy eaters: how do different roles in a household affect food waste patterns? · How much of household food provisioning is habit based? · Can new food waste habits be created by implementation intentions and environmental restructuring? · Can heuristics in consumer decision making and choice (optimism bias, planning fallacy, availability heuristics) be used to reduce household food waste?
<p><i>At the household level</i></p> <p>What is the influence of:</p> <ul style="list-style-type: none"> · Household food related equipment and infrastructure · Group structures, dynamics and interactions? 	<p>Exemplar questions</p> <ul style="list-style-type: none"> · How do different household types (e.g. young families, empty nesters etc.) respond to food waste interventions? · Products or process? How might supermarkets support different household types to reduce food? · Which type of macro level interventions work best for different household types? · How do food waste norms take hold? Examining the influence of household level changes on community and social norms. · How do individuals navigate food waste values and attitudes in relation to household norms around food waste? · Do household food 'gatekeepers' influence the food waste behaviours of others in the household? What does this mean for intervention design? · How do individual behaviour changes influence household social norms?
<p><i>At the individual level</i></p> <p>What is the influence of:</p> <ul style="list-style-type: none"> · Unconscious psychological influences like habits and biases? 	<ul style="list-style-type: none"> · To legislate or educate? How do different consumer typologies respond to different macro-level food waste interventions? · How do individuals navigate food waste values and attitudes in relation to the norms within their social networks? · How do external social norms influence an individual's food waste behaviours? · Which household level factors block or enhance the impact of external food waste campaigns on individuals? · Which factors matter? Identifying salient factors across the levels with regards to their influence on household food waste behaviours.
<p>Interactions between levels</p> <p><i>Macro and meso factor interactions</i></p>	<p>Exemplar questions</p> <ul style="list-style-type: none"> · How do different household types (e.g. young families, empty nesters etc.) respond to food waste interventions? · Products or process? How might supermarkets support different household types to reduce food? · Which type of macro level interventions work best for different household types? · How do food waste norms take hold? Examining the influence of household level changes on community and social norms. · How do individuals navigate food waste values and attitudes in relation to household norms around food waste? · Do household food 'gatekeepers' influence the food waste behaviours of others in the household? What does this mean for intervention design? · How do individual behaviour changes influence household social norms?
<p><i>Meso and micro factor interactions</i></p>	<ul style="list-style-type: none"> · To legislate or educate? How do different consumer typologies respond to different macro-level food waste interventions? · How do individuals navigate food waste values and attitudes in relation to the norms within their social networks? · How do external social norms influence an individual's food waste behaviours? · Which household level factors block or enhance the impact of external food waste campaigns on individuals? · Which factors matter? Identifying salient factors across the levels with regards to their influence on household food waste behaviours.
<p><i>Macro and micro factor interactions</i></p>	<ul style="list-style-type: none"> · To legislate or educate? How do different consumer typologies respond to different macro-level food waste interventions? · How do individuals navigate food waste values and attitudes in relation to the norms within their social networks? · How do external social norms influence an individual's food waste behaviours? · Which household level factors block or enhance the impact of external food waste campaigns on individuals? · Which factors matter? Identifying salient factors across the levels with regards to their influence on household food waste behaviours.
<p><i>Macro, meso and micro factor interactions.</i></p>	<ul style="list-style-type: none"> · To legislate or educate? How do different consumer typologies respond to different macro-level food waste interventions? · How do individuals navigate food waste values and attitudes in relation to the norms within their social networks? · How do external social norms influence an individual's food waste behaviours? · Which household level factors block or enhance the impact of external food waste campaigns on individuals? · Which factors matter? Identifying salient factors across the levels with regards to their influence on household food waste behaviours.

help conceptualise interaction-based household level factors. For example, Grønhoj (2006) used 'whole of family' consumer studies methodologies to explore family decision-making and communication about 'green' household practices. This identified group influence and socialization processes that would have remained hidden if only one member of the family had participated in the research (see also Grønhoj & Thøgersen, 2017; Thøgersen & Grønhoj, 2010).

At the micro level, the influence of psychological factors such as habits, biases and heuristics is under-explored. Aschemann-Witzel et al. (2015) and Russell et al. (2017) consider the role of habits and routines in household food provisioning practices, but as Block et al. (2016) outline in their consumer research agenda for the food waste field, there is an incredibly diverse range of, often unconscious, psychological underpinnings to consumer choice and their effect on household food waste is unknown.

Table 2 also considers *interactions across* the levels in our framework. This echoes Roodhuyzen et al.'s (2017) call for greater "empirical examination of the workings of interacting (facilitating, amplifying or mitigating) factors" (p. 48) and how these workings might enhance or minimise the influence of particular factors on behaviour and food waste. Do food retail factors such as package size or discounted close-to-date food at the macro level 'cancel' individual level attitudes and intentions and lead to more food waste, or can these be mediated by consumer's food storage and cooking skills?

Our framework includes the influence of an individual's food provisioning behaviours back to meso and macro levels. This suggests an additional type of interaction that could be explored, namely the recursive influence of changed behaviours on factors such as household dynamics and macro level social norms. The current Covid-19 pandemic and its increasingly evident impact on household food provisioning (see for e.g. NSW DPIE, (2020)), affords researchers the opportunity to trace out these particular pathways.

While Secondi et al. (2015) studied of the association of macro level factors (such as GDP) and of individual level demographics with food waste behaviours, they did not consider the interactions of these factors and their *combined* influence on food waste. We point to disciplines such as organisational science (for e.g. Hitt et al., 2007; Zhang, Zhao, & Li, 2015) and education (for e.g. Armstrong, 2015) that have used statistical methods such as hierarchical liner modelling to analyse multi-level interactions and combined effects. These provide rich examples to the household food waste research field to investigate the interactions of different factors from a multi-level perspective, one that incorporates appropriate theoretical, measurement and analytical approaches (Rosseau, 1985).

Examining interactions between factors across levels might also assist the field in moving towards more parsimonious models of household food waste. Most frameworks to date, including our own, attempt to collate and summarise all known factors that influence household food waste. While this provides a holistic and systematic perspective, it does not always help practitioners when developing household food waste and they are back to cherry-picking as previously described. Which factors actually matter? Which ones can be ignored? Is a parsimonious model of household food waste behaviours possible? Our framework provides a conceptual 'mud-map' for food waste researchers to explore the interactions of different factors across different levels and to 'hone in' on those that matter, especially for practice and policy.

For practitioners, the multiple levels of interacting factors in our framework show that behaviour change to reduce household food waste cannot be achieved by focusing only on one factor or one level. For example, Sallis et al. (2008) describe how anti-smoking programs support behaviour change in target populations by ensuring both environmental and policy alignment (macro level) as well as motivating and educating individuals (micro level). Changing food waste attitudes at the individual level will, for example, only have limited impact on behaviour if other household members do not support these changes or if supermarkets continue to encourage over-purchasing. Our framework

gives structure for policy makers and program designers to develop joined up, multi-level interventions to effectively reduce household food waste.

While research on interventions targeting household food waste is still limited (Reynolds et al., 2019), to the best of our knowledge most are still primarily targeted at the micro level and focus on changing attitudes, knowledge or food management skills of individuals (Boulet, 2018; Falcon, Gray, & Virtue, 2008; Parry, LeRoux, Quedsted, & Parfitt, 2014; Quedsted & Ingle, 2013). Interventions that do target other levels (such as retailers or school settings) are not necessarily integrated with these individual level efforts (with the possible exception of a limited number of initiatives such as WRAP). Some exemplar questions in Table 2 give guidance to practitioners on where to focus their intervention and design efforts at other levels beyond the individual to achieve a bigger impact on household food waste reduction.

In addition, we recommend that practitioners focus on promoting food waste reduction programs in settings such as schools and workplaces to facilitate potential changes back in households. We also suggest that greater priority is given to matching current intervention types with household-level typologies based on their characteristics and dynamics. Increasing cooking skills might be appropriate for younger households with mainly single adults, while busy families with children might need more assistance with flexible meal and shopping planning.

5. Conclusion

Reducing household food waste represents a significant contribution to tackling the global food waste crisis. Comprehensive frameworks that represent the relationships between household food waste and consumer behaviour are needed to guide the development of on-the-ground programs that support consumer behaviour change, and to stimulate new research agendas. This review systematically brings together primary research studies to provide an overview of the current behaviour and food waste research domain and uses a multi-level perspective to organise the different factors identified.

Based on the outcomes of our review, we propose a new multi-level framework of consumer behaviour and household food waste. This gathers different influencing factors at their relevant individual, household, and external to the household, levels and suggests that behaviour and food waste emerge from their interactions. As well as providing a template for the possible design of multi-level interventions to reduce household food waste, our framework urges the research domain to lift its gaze from current bald spots and to pay more attention to meso and macro level factors as well as interactions between factors.

Ethical statement

This study did not require ethics approval as it is a systematic review that made use of existing primary studies that have been published in peer-reviewed academic journals. It did not involve human or animal participants, material, or data.

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Authorship

M. Boulet was involved in all aspects of the systematic review, developing the framework and writing the final paper. A. Hoek was involved in co-screening and data extraction, as well as review and editing of the study. R. Raven was involved in the review and editing of the study.

Declaration of competing interests

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2020.104856>.

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