Social, temporal and situational influences on meat consumption in the UK population

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Abstract

The amount of meat consumed is having a negative impact on both health and the environment. This study investigated the probability of eating meat and the amount eaten at a meal within different social, temporal and situational contexts. Dietary intake data from 4-day diet diaries of adults (19 years and above) taken from the UK National Diet and Nutrition Survey (2008/9-2013/14) were used for the analysis. Individual eating occasions were identified and the effects of where the food was eaten, with whom, day of the week, age and gender on the probability of eating meat and amount of meat eaten were modelled using general linear mixed models. Each factor showed distinctive effects on the probability of eating meat and the amount consumed. The amount of meat eaten was greater when eating with family members compared to when alone or with other companions. Both the probability and amount of meat eaten in a single eating occasion were higher on Sundays compared to the rest of the week. Eating out (e.g. restaurants/cafes) increased the probability of consuming meat and the amount compared to other situations (e.g. home, work). When considering the factors influencing meat consumption, attention must be paid to the effects of social, temporal, and situational factor as they all work to shape consumption behaviour. This information should be used in the design of interventions and development of policies for the most effective way to reduce meat consumption.

Keywords

Eating behaviour; Meat consumption; Temporal effect; Social facilitation; Situational influence.

Introduction

There is rising concern about the negative impacts of a high consumption of meat products associated with health and the environment, such as the increased risk of non-communicable disease and contribution to climate change. Further, with a high demand for meat driving intensive production systems there are also concerns for animal welfare (Stehfest *et al.*, 2009). The need to reduce meat consumption to limit global warming was highlighted in the recent Intergovernmental Panel on Climate Change as a one of the mitigation pathways (IPCC 2018). The demand for meat is high and many people enjoy eating meat, which poses a challenge of knowing how to encourage people to eat less.

For health, meat is an important source of many nutrients and there are benefits in including some in the diet where nutrient intakes can be marginal (e.g. iron, zinc and vitamin B12). Intakes however need to be in moderation since overconsumption of some meats can increase the risk of diet-related diseases. Processed meat has been associated with an increased risk of coronary heart diseases (Micha, Wallace, & Mozaffarian, 2010; Snowdon, Phillips, & Fraser, 1984) and risk of type 2 diabetes (Pan *et al.*, 2011). In addition, there is strong evidence that the overconsumption of red meat can increase the risk of colon cancer and is a potential risk of other cancers (i.e. oesophagus, lung, stomach, and prostate) (World Cancer Research Fund & American Institute for Cancer Research, 2007). For this reason, people are recommended to eat no more than 500g/week of red meat and very little or no processed meat.

In terms of environmental impacts, livestock production is generally associated with having the greatest environmental impacts, including climate change, land use, water use and loss of biodiversity (Aleksandrowicz, Green, Joy, Smith, & Haines, 2016; Clune, Crossin, & Verghese, 2017; Hallström, Carlsson-Kanyama, & Börjesson, 2015; Willett et al, 2019). Globally, the livestock sector accounts for about 18% of greenhouse gas emissions and about 80% of agricultural land use (Stehfest *et al.*, 2009), therefore, a shift toward a more plant-based diet would reduce greenhouse gas emission (GHGE) from agriculture and land use. Dietary patterns have to change as technological solutions alone will be insufficient to meet GHGE reduction targets within the timeframe available to limit global warming (Bajželj *et al.*, 2014). The degree of reduction in GHGE, however, varies depending on the composition of the whole diet and the foods switched for meat, with some studies having estimated dietary change could reduce emissions by up to about 50% from diets (Aleksandrowicz *et al.*, 2016; Perignon, Vieux, Soler, Masset, & Darmon, 2017).

In relation to meat, there appears to be a paradox between the awareness of negative impacts on health, environment, and animal welfare and the reluctance to reduce meat consumption (Macdiarmid, Douglas, & Campbell, 2016). A recent survey carried out in 2017 reported that more UK consumers are aware of the environmental issues related to a diet high in meat compared to 2014 (31% vs 28%) (YouGov, & Eating Better, 2017). Nonetheless, only 19% in 2017 report they had reduced the amount of meat eaten in the past year. A number of barriers hamper consumers in reducing meat consumption. For instance, consumers tend to believe that not eating meat negatively compromise iron and protein intakes (Lea & Worsley, 2001). Eating meat is also viewed by many as being pleasurable, and an important part of traditional meal patterns or a meal being incomplete without meat as the central component. Many consider that humans have evolved to consume meat and that not doing so is unnatural (Macdiarmid, Douglas, & Campbell, 2016, Piazza *et al.*, 2015). Some difficulties in reducing meat consumption are associated with beliefs about meat, for example Joy (2001) described the concept of carnism, where people have ideologies that create norms around eating certain animals and thereby they see it as part of normal eating habits.

Factors influencing meat consumption

The composition of meals and energy intake vary across the time of the day and days of the week. For instance, de Castro (1987, 2004) showed that among students, meal size tends to follow a circadian rhythm, with increasing energy intake over the day with peaks at lunch and dinner. Similarly, nutrient intakes follow a pattern across the day, with carbohydrate intake higher during breakfasts, protein higher during lunch, and fat intakes higher in the evening (de Castro, 1987). They also found there were variations in the amounts eaten each day across a week, with the amount eaten at weekends being greater than on weekdays (de Castro, 1991). This may be related to time available to eat and social context, and therefore the amount consumed. In a French sample, Ducrot *et al.* (2015) found that time available for eating may also be related to the amount of time for cooking and state of fatigue. This suggests that there is an important temporal dimension around eating, which may be determined by other non-food related activities. de Castro (1988) proposed that people regulate food intake by adjusting meal sizes, rather than adjusting the time interval between eating occasions. This is also related to the nature of developing habits around eating behaviours.

Since Lewin (1936) the behaviour of individuals has been studied in relation to the environment where eating occurs, showing that eating behaviours vary in relation to the situational context (e.g. eating at home or out). In the recent National Dietary and Nutrition Survey (NDNS) conducted in the UK, 96% of the respondents reported that they had eaten out at least once during the previous month, and 43% of these reported doing so at least once or twice a week (Bates, Roberts, Lepps, and Porter, 2017). Food related decisions are largely influenced by the contextual food cues, which lead to different outcomes depending on how people process information. Dual processing theory suggests that people rely on two distinct systems to process information. The first one relies on cognitive functions and it requires the individual to consciously engage in a decision-making process, e.g. they consider the available information, the costs and benefits are weighed up, and the best option considered by the individual is selected. The outcome and choice will vary between people. The second system reflects the application of heuristics, which produce a decision without requiring a conscious deliberation by the individual. In comparison to the cognitive way of processing information, heuristics tend to lead to less optimal decisions, provide faster answers and require fewer cognitive resources. This appears especially true in out-of-home contexts, where decisions tend to be "*spontaneous, rapid, and influenced by heuristic cues*" (Cohen & Babey, 2012, p.5) with an impact on both the kind and the amount of food consumed.

In this regard, Lachat *et al.* (2012) reported that eating out can be associated with higher energy intake, poor dietary quality, and increased risk of gaining weight. Nguyen and Powell (2014) and Kearney, Hulshof & Gibney, (2001) also showed that adults with the habit of eating in fast-food and restaurants have a higher daily total energy intake and poorer dietary indicators (e.g. higher percentage of energy intake from fat and protein and lower from carbohydrates). Various factors can contribute to these effects, for instance, higher energy density of the food and larger portion sizes. However, given that heuristic processes tend to be more susceptible than the cognitive system to contextual cues, consumers' decisions in out-of-home contexts are likely to be influenced by other factors such as price, food presentation and menu design. Sobal *et al.* (2012) found that some consumers do perceive eating out of home as an unhealthy habit.

Moreover, social contexts can influence food choices that people make. de Castro and colleagues (de Castro, 1990; de Castro & Brewer, 1992; de Castro & Kreitzman, 1985) examined the social context (e.g. eating alone or in the presence of others) in which food was eaten by people. The analyses of food diaries showed that the amount of energy eaten in meals was over 75% more when people ate with other people present (de Castro & Brewer, 1992). This effect, termed social facilitation, where people increase their intake in the presence of others, was replicated in a number of other studies (de Castro, 1990, 1991, 1994; de Castro, Brewer, Elmore, & Orozco, 1990). With more people present the time at the table increased, which in turn increased the amount of food consumed (Cavazza, Graziani, & Guidetti, 2011). This effect was also observed by Patel and Schlundt who concluded that the presence of others "*drastically increases a person's vulnerability to increased food intake*" (2001, p.116).

The power of social influence to facilitate eating behaviour can have different effects on people. In some studies, it has been reported it can override an individual's feeling of satiety, such that after a meal a person expresses regret due to overeating (Herman, Roth, & Polivy, 2003). This effect is more evident when a person is with a familiar group of people than when surrounded by strangers. However, depending on the circumstances, social influence can work in an opposite way, suppressing eating behaviour.

Herman (2015) recently reviewed the literature on social facilitation of eating with the intention of providing an overall explanation. The author distinguished the social facilitation effect into three phenomena. First, people eat more in groups than when alone. Herman explained this phenomenon by invoking “the expansive social meal”. That is to say, individuals categorise meals eaten in groups as social meals and treat them differently from meals eaten alone (de Boer et al, 2007). Social meals are associated with socialization, which is often associated with more food available and with successive intake increment. Indeed Cavazza, Graziani, and Guidetti (2011) showed that social facilitation of eating occurs in social situations prior to eating, at the phase of ordering food. Moreover, Herman (2015) suggested that social facilitation may be a way to enhance friendship among dining companions. Second, the effects of social facilitation are greater with family members and friends than strangers. Herman explained this phenomenon in terms of self-impression management; where the presence of strangers can elicit an inhibitory response due to people’s concerns with making a good impression, which do not occur with family members or friends. Finally, Herman suggested that the positive relationship between the amount of food eaten per individual and group size, referred to as “social correlation”, can be explained by a deindividuation effect. This is where the more people present, the less will be the perceived focus by others about how much the individual is consuming.

It should also be noted that group norms can provide a shortcut for learning about food choices because members of the same social group are considered a reliable source of information about the appropriateness of behaviours (Higgs, 2015). The perception of belonging to the same social group appears to be important in the modelling of eating behaviour. The notion of social identity refers to the cognitive processes related to social groups membership together with an emotional value associated with that group (Tajfel & Turner, 1986). In relation to food behaviour, this effect was demonstrated in a study by Cruwys *et al*. (2012) using a confederate who displayed an identity but this only influenced the eating behavoirs of those in the study who associated themsleves with this identity. This effect on eating behaviour is through the process of social comparison. Hence, the mere presence of people eating together does not guarantee either the occurrence of social facilitation or the suppression of food intake, it depends on the identity of other people. For these reasons, it is important to consider the amount eaten alone and in different social groups (e.g. with friends, family members, or colleagues).

Most of the work exploring social and situational influences on eating behaviours has focused on energy intakes. There is very little literature on the effect on meat consumption. As described above, ways to encourage people to eat less meat, not only for health but environmental reason, need to be found and this requires a better understanding of the social, situational, and temporal contexts in which meat is eaten. The aim of this study is to assess whether the variation in energy intakes in different contexts are seen with eating meat.

Methods

Data

Meat consumption was modelled using data from adults (≥19 years) from self-reported dietary intakes (four-day diet diary) used in the UK NDNS (Bates *et al.*, 2014; Bates *et al.*, 2016). These data cover a 6-year period from 2008 to 2014, with 4156 individuals recorded. The NDNS is a survey of the food consumption, nutrient intakes and nutritional status of people aged 1.5 years and older living in private households. A representative sample is drawn from people living in the UK using postcodes. Adults are asked to record everything that they eat and drink over four consecutive day in a food diary. Food and drink consumed are not weighed, rather amounts are estimated using household measures or weights from packaging. They are also asked to provide recipes for composite dishes prepared at home. Each item of food or drink consumed is recorded, as well as the time it was eaten, where the meal was eaten and in what company. The number of other people present was not reported.

Eating episodes

There is not an agreed methodology for differentiating eating episodes (e.g. meals and snacks): the literature reports numerous different ways, including “traditional” meal patterns and varying the minimum time between separate episodes (Leech, Worsley, Timperio, & McNaughton, 2015). In this research, an eating episode was defined as any intake recorded where the interval between eating was greater than 30 minutes (Whybrow & Kirk, 1997), and which provided at least 50kcal (Gibney & Wolever 1997), to exclude occasions that were mainly drinks, such as coffee or tea.

For each eating episode, the amount of meat eaten was estimated, which included beef, lamb, pork, processed red meat, other red meat, burgers, sausages, offal, poultry, processed poultry, and game birds. As little meat was recorded as being consumed between 12am and 6am (0.4% of all meat consumed), this time period was excluded from the analysis.

The amount of meat per eating episode had a bimodal distribution, with 79.5% of episodes containing no meat, and peaks of meat consumption midday and in the evening. The probability that an episode includes some meat in an eating episode was modelled, and then the amount of meat in grams contained when an eating episode contained meat. Exploratory data analysis indicated that the patterns were different at different times of day, and so the intake at each hour from 6am to 11pm was separately modelled. Fitting of models covering all times and requiring interactions between factors of interest and hour showed indications of instability (such as slow convergence or failure to converge, unusual parameter estimates with large standard errors, etc.). This was due to the large numbers of additional effects and interactions, each with many levels, being required. For this reason, separate models were fitted for each hour.

Statistical methods

Generalized linear mixed models (Pinheiro & Bates, 2000) were used to model the probability of meat being included in an eating episode, since there were multiple observations for each individual, with explanatory factors varying both between and within individuals. Fixed effects were age (<30, 30 to 40, 40 to 50, 50 to 60, 60 to 70 and >70 yrs), gender, day of the week, where the eating episode occurred, and who was present. The locations were combined into four groups: home, restaurant / café, work / college and other. The effect of social facilitation was based on who was present, and it was combined into five groups: alone, family, friends, colleagues and other. Individual ID was included as a random effect. Significance was assessed by Wald tests. As this was a large dataset, main effects tended to be significant at most times, and so all were included in every model. In most cases, two-way interactions were not significant, and any multiple testing adjustments would remove most scattered cases of significance at 5%. A few cases where interactions are clearly significant with lower p-values, or maintained over more than one time period, are reported in the results. Effects were estimated as odds ratios relative to, or difference from, reference levels for the factors, which were Monday for day of the week, female for gender, under 30 for age group, home for location and alone for who was present.

To model the amount of meat recorded when this was non-zero, linear mixed models were used for the continuously distributed response. This was replicated for the total amount of meat (including no meat) in order to display the combined effects of the two stages.

All models were fitted using the lme4 1.1-8 package (Douglas, Maechler, Bolker, & Walker, 2015) in R version 3.2 (R Development Core Team, 2008).

Results

Table 1 shows the mean total amount of meat eaten (g) during three-time intervals by gender, age and the main factors examined. Men eat more meat than women, with the difference increasing throughout the day. Age group has smaller effects, and the most notable feature of the pattern is a lower amount of meat at most times in the oldest age group, though greater at lunchtime.

Table 1

Mean (SE) total amount of meat (in grams) per eating occasion at three times of the day by gender and other factors.

	Women (n=2792)			**Men (n= 1946)**		
	6-11am	12-3pm	4-11pm	6-11am	12-3pm	4-11pm
	g/day	*g/day*	*g/day*	*g/day*	*g/day*	*g/day*
Day of week						
Monday	2.8 (1.1)	17.6 (1.1)	30.2 (0.9)	7.9 (1.3)	27.2 (1.3)	41.3 (1.0)
Tuesday	3.1 (1.1)	17.2 (1.1)	27.9 (0.9)	7.6 (1.3)	26.4 (1.4)	39.3 (1.1)
Wednesday	2.2 (1.1)	17.9 (1.1)	27.9 (0.9)	6.4 (1.3)	25.2 (1.4)	38.4 (1.1)
Thursday	3.1 (1.1)	15.8 (1.1)	28.9 (0.9)	8.1 (1.2)	25.6 (1.3)	35.7 (1.0)
Friday	3.3 (1.0)	17.0 (1.0)	27.0 (0.8)	8.3 (1.2)	24.3 (1.3)	31.7 (0.9)
Saturday	6.0 (1.0)	19.7 (1.0)	27.6 (0.8)	13.4 (1.2)	25.3 (1.2)	32.5 (0.9)
Sunday	8.7 (1.1)	30.2 (1.0)	29.6 (0.8)	14.1 (1.3)	41.0 (1.2)	38.4 (1.0)
Age group (yrs)						
19-29	5.9 (1.2)	20.9 (1.1)	28.9 (0.9)	14.2 (1.5)	29.7 (1.4)	45.2 (1.1)
30-39	4.8 (1.0)	18.2 (1.0)	32.3 (0.8)	10.6 (1.2)	30.7 (1.3)	38.5 (1.0)
40-49	4.7 (1.0)	19.1 (1.0)	28.8 (0.8)	11.5 (1.1)	27.2 (1.2)	37.2 (0.9)
50-59	4.3 (1.0)	17.0 (1.1)	27.7 (0.9)	9.7 (1.2)	25.2 (1.3)	35.7 (1.0)
60-69	3.0 (1.1)	18.8 (1.1)	28.5 (0.9)	7.3 (1.2)	27.6 (1.3)	33.5 (1.0)
over 70	2.2 (1.0)	23.3 (1.1)	23.0 (0.9)	4.1 (1.3)	28.4 (1.3)	28.4 (1.1)
Location						
Home	3.5 (0.5)	19.5 (0.5)	29.5 (0.4)	6.9 (0.6)	27.8 (0.7)	39.2 (0.4)
Restaurant	21.8 (2.7)	34.2 (1.5)	30.5 (1.4)	43.4 (3.1)	43.9 (1.7)	23.4 (1.2)
Work/College	4.6 (1.2)	15.1 (1.0)	10.8 (2.1)	13.3 (1.2)	24.2 (1.1)	15.7 (2.2)
Other	6.8 (1.9)	15.2 (1.4)	12.8 (1.6)	20.4 (2.1)	24.1 (1.7)	22.4 (1.7)
Who						
Alone	2.0 (0.6)	14.5 (0.7)	18.3 (0.6)	6.6 (0.7)	23.1 (0.8)	28.7 (0.7)
Colleagues	4.8 (1.7)	17.3 (1.4)	18.6 (3.0)	18.7 (1.8)	29.4 (1.6)	28.6 (3.1)
Family	6.7 (0.7)	26.1 (0.7)	37.9 (0.5)	11.4 (0.9)	35.3 (0.9)	46.6 (0.6)
Friends	12.7 (2.1)	24.5 (1.4)	26.1 (1.0)	24.7 (2.8)	31.7 (1.8)	27.2 (1.1)
Other	4.1 (1.3)	14.7 (1.2)	16.6 (1.1)	9.1 (1.5)	22.6 (1.5)	24.2 (1.2)

Effect of time of day

Figure 1 shows the overall probability of including meat in an eating episode for every hour from 6am to 11pm. There are clearly two peaks per day, with no indication of one at breakfast time. The probability of including meat is only a little higher in the evening than in the middle of the day, but the amount of meat included increases from 15:00, and is more than 50% higher on average than when eaten earlier in the day. At a population level the probability and amount combined give the overall amount during the day, the evening peak is considerably higher than the one in the middle of the day. Not everyone, however, showed these two peaks.

--- INSERT FIGURE 1 ----

Effect of the situational and social context and day of the week per time of day

Figure 2 shows the effect of the situational and social context on the probability of including meat. These factors are the location and people present at the eating occasion and the day of the week. The effects are shown in three ways: the probability of meat being included (top row), the amount of meat when it is included (middle row), and the amount of meat including zero meat (bottom row), which is a combination of the first two.

All reported effects for each factor have been adjusted for any imbalance in the other factors. So, the effect of eating in a restaurant is the estimate of this effect alone, and is not due to, for example, any tendency to eat in restaurants more often at weekends, or by different age groups.

--- INSERT FIGURE 2 ----

<u>Social facilitation effect</u>

Eating with others increases the probability of including meat (Figure 2, top row). Note that some of the large fluctuations in some parts are not statistically significant (see supplemental tables). When eating with colleagues there is a higher chance of eating meat in the evening compared to when eating alone; on the contrary, the likelihood to consume meat when friends are present spikes in the morning and decreased during the day with a relatively small peak in the evening compared to eating alone.

Looking at the amount of meat eaten when meat is included (middle row), eating in company tends to increase the intake. Moreover, eating with others is generally associated with greater meat consumption when compared with eating alone (bottom row). In particular, eating with the family showed the greatest amount of meat consumed compared to eating alone or with other companions.

<u>Effect of the day of the week</u>

There were not many differences found among the weekdays Monday to Friday, but different patterns were seen on Saturdays and Sundays. At weekends, meat was more likely to be eaten in the morning. On Sundays there was a greater probability of meat being eaten at lunchtime, with a smaller increase also apparent on Saturdays (Figure 2, top row). The strongest effect of day of the week was on Sundays, where the amount was typically about 20g more when compared to Monday, though this disappeared in the evening (middle row). Finally, there is a clear effect of greater meat consumption on a Sunday, and also to a much smaller extent, on a Saturday (bottom row).

Effect of the situational context

The effect of location is strongest at breakfast (Figure 2, top row), with eating in a restaurant/café greatly increasing the probability of including meat. A smaller effect can be seen at work/college. Looking at the amount of meat eaten when included in a meal (middle row), this is likely to be greater in a restaurant/café, though eating in other places out of the home tends to reduce the amount of meat included, apart from at breakfast. Finally, the bottom row of Figure 2 shows a pattern of greater meat consumption in restaurants/cafes until 16:00, and reduced consumption from 17:00 to 19:00. However, if occasions consisting mainly of consuming alcohol are omitted, this dip in evening meat consumption largely disappears.

Interactions

There were very few two-way interactions between the factors. A full table of interaction term odds ratios, and for coefficients for amount of meat when meat was included is given in the supplementary tables.

The most notable interaction was related to the odds ratios for the interaction of being in a restaurant and being with friends, which indicates that two influences, both of which increase the probability of meat consumption, do not necessarily combine to produce an even greater effect. Either by itself is enough to increase the probability of meat consumption.

There were also interaction terms with covariates age and gender. Eating in a restaurant between 12:00 and 13:00 had less effect in increasing the probability of eating meat among older age groups than among 19-30 year olds. The effect of being male appears less in older age groups. The effect of eating in a restaurant appears less in males than females.

It should be noted that the NDNS data had only basic demographic information about the participants, which meant it was not possible to account for the effect and interaction of individual characteristics other than age group and gender. Including a factor for living-alone, there was no indication that this had any clear effect, or interaction with location or situational effects, on the patterns found. Statistical power may be limited however, and such influences may still occur.

Energy

To compare the patterns observed with eating meat, the total energy intake was modelled in the same way (Figure S1 in supplemental materials). The same patterns were observed for energy consumption as found with meat consumption, with greater intake at weekends, particularly Sunday, and greater intake when eating out in restaurants or with others.

Discussion

This study has shown that social and situational factors influence the probability of consuming meat and the amount of meat consumed in a meal in the UK population. Time of the day, and day of the week also showed distinctive effects on meat consumption independent from eating location or with whom they ate.

Social and situational context around eating meat

The results showed that a greater amount and probability of eating meat, and a greater amount is consumed, when eating with other people compared to when alone. The effect was stronger when in the presence of family members or friends compared to colleagues, independent from the situational context or the time of the day. This finding is in accordance with previous research on social facilitation effects related to energy intakes (de Castro, 1990, 1991, 1994; de Castro & Brewer, 1992) and the observation is consistent with the explanation of a social facilitation effect proposed by de Boer, Hoogland, and Boersema (2007) and Herman (2015). Accordingly, the presence of other people during a meal should be considered in the development of strategies aimed at reducing meat consumption. For instance, given that the social facilitation of eating begins prior to eating food (Cavazza, Graziani, & Guidetti, 2011), there is the possibility that a meat-eater may be influenced by their companions towards vegetarian alternatives when ordering food in the presence of others selecting a meat-free option. An increased availability of vegetarian meals to share rather than individual dishes could lead a meat-eater towards a meat-free option by the influence exerted by those who wish a to-share food option. There could also be a price incentive. Some fast-food restaurants including McDonalds and KFC sell ready-to-share meals targeted at friends or families by keeping the cost of the combined meal lower than the sum of the single products. Similar offers with vegetarian food could be constructed for sale in supermarkets or in out-of-home businesses to drive groups of consumers toward meals with less meat (Harris, & Blair, 2006; Carroll, Samek, & Zepeda, 2018).

Meat consumption across the day and week

Results showed that the overall amount of meat eaten during the day follows a circadian rhythm, with two spikes at midday and in the evening. Previous research showed similar energy and nutrient intake patterns (de Castro, 1987, 2004). Moreover, the analysis showed that while during the weekdays the probability of consuming meat remains relatively stable, it spikes at the weekend. This is in accordance with a previous research showing that, in UK, emphasis on meat tends to increase at weekends compared to weekdays (Marshall, 2005). Following the study by Ducrot and colleagues (2015), different reasons might drive food choices between weekdays and weekends: for instance, the time available for eating. Further research is required to investigate the reasons that drive food choices across the days of the week.

The analysis reported in this paper showed probability of meat consumption on Monday appears slightly higher than the other weekdays, but lower than Sundays. This result is important as it provides some useful insights for promoting a reduction of meat consumption. In fact, some health and environmental campaigns such as Meatless Monday (www.meatlessmonday.com) or Meat Free Monday (www.meatfreemondays.com) proposed the beginning of the week as the most suitable day to reduce meat consumption. Their choice appears to be informed by the fact that healthy commitments vary over the week, and are greatest at the start of the week (Ayers, Althouse, Johnson, Dredze, & Cohen, 2014). Our findings suggest that Sundays more so than Mondays could be a time to reduce the amount of meat consumed individually. However, this would need to consider social aspects of eating, which may be more salient at the weekend. At the population level therefore, Sunday rather Monday may be less effective overall with fewer people engaging with it at the weekend.

The effect of eating out of the home

The situational context also appears to affect meat consumption. The results showed that eating in restaurants is associated with an increase in the likelihood of eating meat compared to eating at home (especially at breakfast). This appears in line with consumption trends, for instance, the last report by Food Standards Scotland (2018) reported beef burger and meat-based dishes among the top five categories of food purchased out-of-home. Moreover, the analysis showed that the amount of meat is higher when eating in restaurants than at home, consistent with evidence that restaurants tend to serve large portions (McCrory, Fuss, Saltzman, & Roberts, 2000).

Even if the amount at the individual level appears relatively small, it is important to consider such changes at the population level. Accordingly, some interventions with food services could be useful to lower meat consumption. Working on the architecture of choices could lead to a reduction in preferences of meat consumers when eating out-of-home. This includes increasing the availability and visibility of particular foods, providing disclosures in the menu (such as the number of calories in each dish or in the case of meat the environmental impact), offering meat substitutes/meat-free products, reducing portions, increasing the ease of choice (e.g. highlighting breakfast meals without meat within the menu), or altering the order of placement of products (Bianchi, Garnett, Dorsel, Aveyard, & Jebb, 2017).

Another out-of-home setting could be workplaces, where an intervention to reduce meat consumption could be to limit the availability of meat products. This could be a strategy to establish eating norms towards less meat among co-workers, so that eating habits persist in all those situations where colleagues are present, and potentially into other social settings. Social norm messages have been proven to be a useful leverage to alter eating norms via social influence (Higgs, 2015; Robinson, Fleming, & Higgs, 2014; Stea, & Pickering, 2018; Stok, De Ridder, De Vet, & De Wit, 2014). For instance, Thomas *et al.* (2017) showed the power of norm-based messages on altering food choices in a workplace restaurant. A poster stressing that most people eat vegetables with their meal was associated with an increase in the preference for meals with vegetables compared to a baseline period. Interestingly, the influence of the message on purchasing behaviour persisted after the removal of the poster. Nevertheless, the persistence of such influence outside working context requires further research.

Strategies aimed at changing consumption at the individual level should be complemented by interventions to guide collectives of consumers towards more sustainable practices. At the individual level, nudge theory provides a set of tools useful to steer consumer behaviour towards healthier and more sustainable habits by restructuring the environment at the retail level (Bianchi et al, 2017). In addition, social marketing campaigns at the national level appear to be a necessary action to produce a change in consumer behaviours. Robinson *et al.* (2014) showed that a message that included references to social norms had more effect in increasing fruit and vegetable intake than educational health messages. Accordingly, rather than relying on an educational paradigm, a variety of nudges (Sunstein, 2016) could be employed in social marketing campaigns to increase the effectiveness of such interventions. In particular, nudges based on normative influence (i.e. suggesting that others perform the desired behaviour) have been shown to be effective on changing eating behaviour. Stea and Pickering (2017) showed that the use of a message built around social norms was positively associated with a reduction in the intention to consume red meat. Alternative nudges used in the development of a persuasive message could for example employ graphic warnings, use a simpler language, or elicit commitments and raise a sense of responsibility (e.g. “Do you plan to reduce your consumption of meat?”).

However, interventions at the social level should also be planned to assure individual changes will be sustained in everyday practices (Sahakian & Wilhite, 2014). There is still some lack of awareness of some of the environmental issues caused by meat consumption by UK consumers (Macdiarmid, Douglas, & Campbell, 2016) and actions conducted at the collective level could be beneficial in increasing the awareness and sustain changes at the individual level. Meat consumption is associated with strong personal influences and preferences and therefore these too would need to be considered.

Limitations and future research

It is likely that some aspects of the influences on meat consumption were not captured by the data. The number of people present during the meal was unknown, which can affect the intake (de Castro, & Brewer, 1992). Gender of those present was also not reported, nor what they ate. When participants ate in restaurants, the specific type of establishment remained unknown. It is plausible that choices about meat differ depending on whether they are made in a fast food outlet or restaurant that may provide more options. The dietary data were self-reported and this could introduce issues associated with mis-reporting of food intakes, and underestimate consumption of foods (de Castro, 1988).

Finally, given the absence of a unique definition of meal, the analysis in this study was based on previous works (Gibney & Wolever 1997; Whybrow & Kirk, 1997), which defined an eating episode to a minimum time period and number of calories eaten. However, different definitions could be applied for differentiating eating episodes. While the current research looked at the meat content in terms of eating occasions, further research needs to understand what influences the choice of the context, time, and companions of such eating occasions.

Conclusion

In summary, this study showed that both situational and social factors play an important role in shaping consumers' likelihood to consume meat and the amount of meat intake. Despite the difference in meat consumption being modest at the individual level, when they are scaled up to the population level then substantial changes are likely to emerge, which would be beneficial for reducing GHGE. However, the analyses conducted here captured and modelled only a small part of the totality of factors influencing eating behaviour, and how this relates to the consumption of meat. The present model is conditional on the eating occasions given, although clearly decisions are made by each person on when to eat, and what to eat. The design of future interventions and policies to reduce meat consumption need to incorporate the effects of where a meal is eaten, with whom, and when.

Funding

This work was supported by The Scottish Government's Rural and Environment Science and Analytical Services Division (RESAS).

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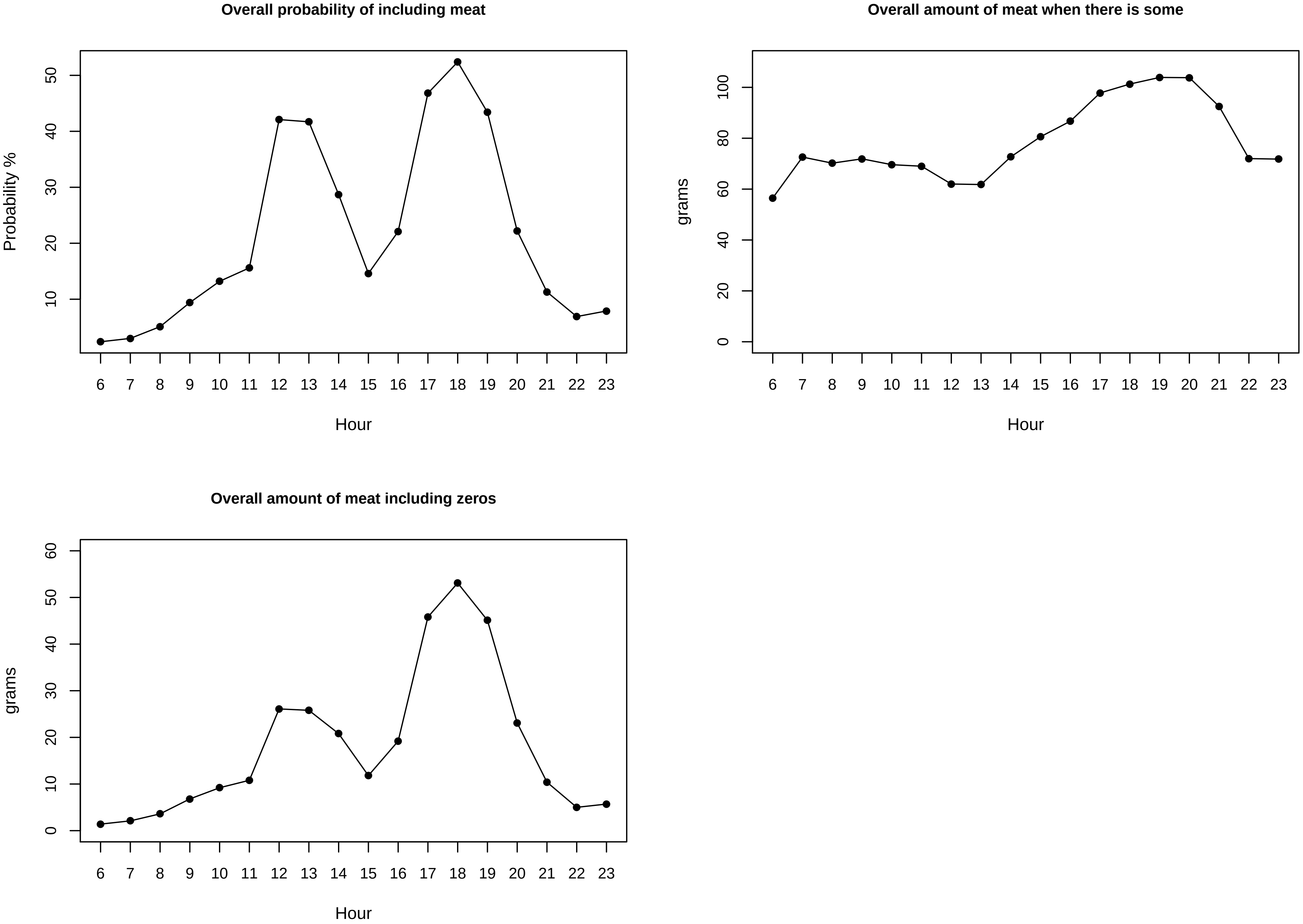
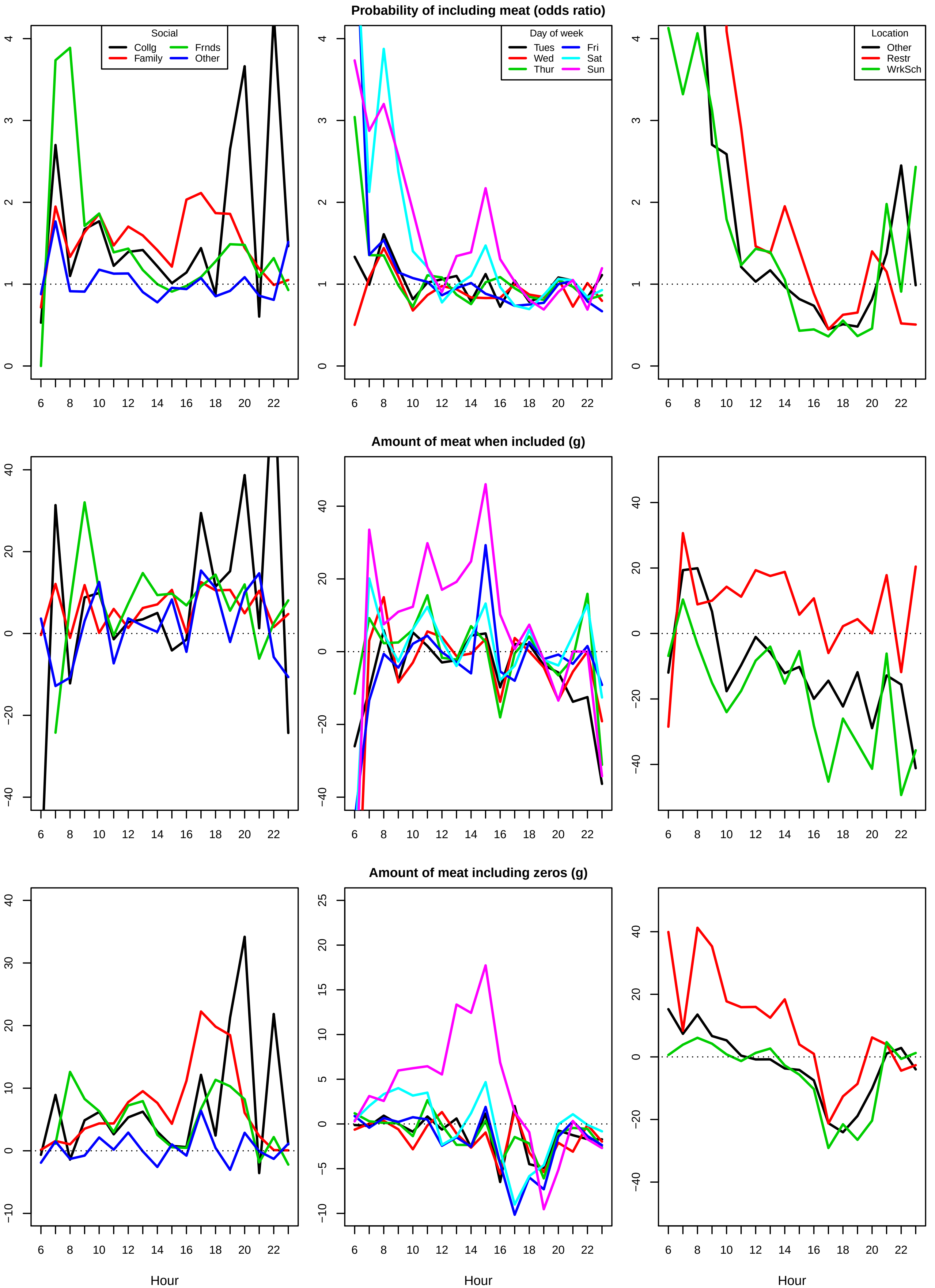
Figure captions

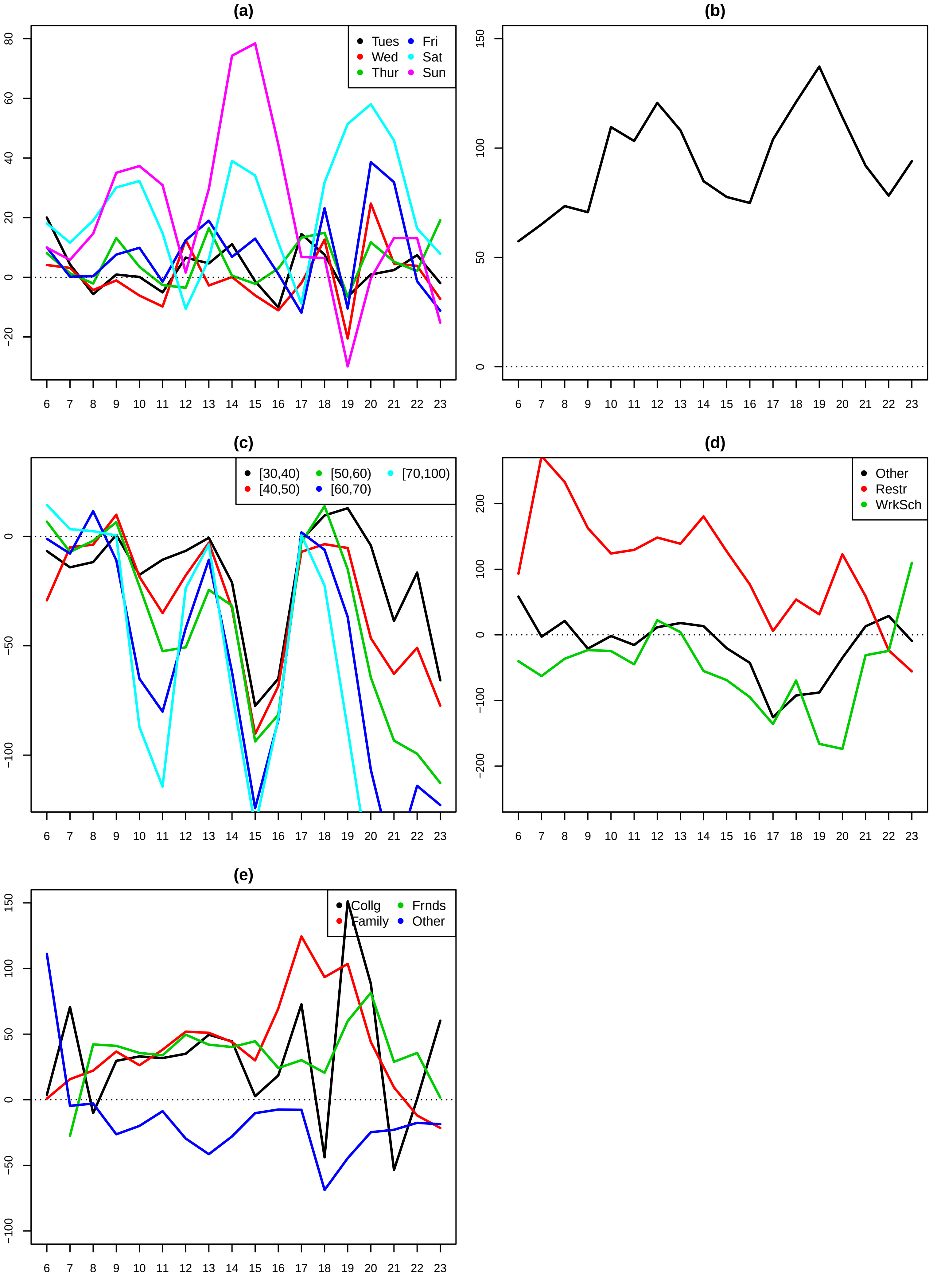
Figure 1. Change during the day of the probability of including meat, the amount of meat consumed when it is included, and the total amount of meat (including zeros)

Figure 2. Influences of company (relative to being alone), day of the week (relative to Monday) and location (relative to home) on the inclusion of meat in the diet. The top row shows the odds ratio for inclusion of meat in an eating episode, the middle row shows the amount when meat is included and the bottom row shows the overall amount, including zero meat.


Overall probability of including meat
Probability %
Hour
Overall amount of meat when there is some
grams
Hour
Overall amount of meat including zeros
grams
Hour



Probability of including meat (odds ratio)
Social
Collg
Family
Frnds
Other
Day of week
Tues
Wed
Thur
Fri
Sat
Sun
Location
Other
Restr
WrkSch
Amount of meat when included (g)
Amount of meat including zeros (g)
Hour
Hour
Hour


(a)
Tues
Wed
Thur
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Sat
Sun
(b)
(c)
[30,40)
[40,50)
[50,60)
[60,70)
[70,100)
(d)
Other
Restr
WrkSch
(e)
Collg
Family
Frnds
Other