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Red and Processed Meat Consumption and Purchasing Behaviours and Attitudes: Impacts for Human Health, Animal Welfare and Environmental Sustainability

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Abstract

Objective: Higher intakes of red and processed meat are associated with poorer health outcomes and negative environmental impacts. Drawing upon a population survey this paper explores meat consumption behaviours, exploring perceived impacts for human health, animal welfare and the environment.

Design: Structured self-completion postal survey relating to red and processed meat, capturing data on attitudes, sustainable meat purchasing behaviour, red and processed meat intake plus socio-demographic characteristics of respondents.

Setting: Urban and Rural districts of Nottinghamshire, East Midlands, UK, drawn from the electoral register.

Subjects: 842 UK adults aged 18-91 years old; 497 female, 345 male representing a 35.6% response rate from 2,500 randomly selected residents.

Results: Women were significantly more likely ($P<0.01$) to consume ≤1 portion of meat per day, compared with men. Females and older respondents (>60y) were more likely to hold positive attitudes towards animal welfare ($P<0.01$). Less than a fifth (18.4%) of the sample agreed that the impact of climate change could be reduced by consuming less meat, dairy products and eggs. Positive attitudes towards animal welfare were associated with consuming less meat and a greater frequency of 'higher welfare' meat purchases.

Conclusions: Human health and animal welfare are more common motivations to avoid red and processed meat than environmental sustainability. Policy makers, nutritionists and health professionals need to increase the public's awareness of the environmental impact of eating red and processed meat. A first step could be to ensure that dietary guidelines integrate the nutritional, animal welfare and environmental components of sustainable diets.

Key words: meat; health; animal welfare; environment

Introduction

The 20th century witnessed many high income countries (HICs) adopting meat as the basis around which meals are prepared[1]. These cultural norms have been sustained and reinforced by the increased production efficiency of the animal food supply chain; meat has become both more widely available and financially accessible. This has also had the effect in more recent years of low income countries (LICs) increasing intakes of foods of animal origin, in particular meat, contributing to rising levels of obesity in these countries[1]. The complexity of the issues surrounding meat consumption in a modern era is extensive; consumers should arguably consider personal and family health, their diet related environment footprint, animal welfare and fiscal issues[2-5] which are influenced by a range of factors including socio demographic and gender aspects. Collectively these factors influence attitudes towards food consumption, which are both important in predicting consumer behaviour and potentially modifiable, to enhance health or environmental patterns of consumption in a population[6]. Hence, understanding the relationship between attitudes towards meat consumption and effective consumer communication strategies to jointly enhance population health and sustainability of food consumption, is an important area of research enquiry.

There is a long standing assumption that meat and dairy products (MDPs) are good for human health[7] and UK dietary guidelines currently state: *"Meat is a good source of protein in your diet, as well as vitamins and minerals"*[8]. Protein is an essential nutrient providing amino acids required for normal human growth and development; current UK recommendations for protein consumption stipulate that an average woman and man requires approx. 45g and 55g of protein per day respectively[9]. Protein from red meat sources tends to provide a broader range of amino acids, which are easier for the body to digest than protein from plant based sources, but also tend to be micronutrient-rich foods, in particular iron,

which plays a role in a number of essential functions in the body[10-11]. It is unlikely that a large proportion of the UK population are protein deficient, as average intakes are around 66g (women) and 88g (men), almost double requirements[12]. In the USA protein intakes are also substantially above recommendations at 70g (102g) for women (men)[13], while across a range of European countries, Halkjær et al.[14] found overall average protein consumption ranging from 60-94g (72g-144g) for women (men), highlighting the extent of over-consumption of protein across HICs. However, recent evidence points to a clear link between higher meat consumption and risk of certain cancers, as well as cardiovascular disease[15-16]. The World Cancer Research Fund advocates reducing red meat consumption to no more than 70g/day[16], and the UK Department of Health has incorporated this recommendation into dietary advice for the public "If you currently eat more than 90 g (cooked weight) of red and processed meat a day, the Department of Health advises that *you cut down to 70 g"*[8]. A recent study demonstrates that a sustained reduction in red and processed meat consumption in the UK population would reduce the incidence of coronary heart disease, diabetes mellitus and colorectal cancer, by 3%–12%[17]. Hence, while playing an important dietary role, there is also robust evidence that excess meat consumption is linked to major health problems. At the individual or micro level, there is a strong health argument for reducing meat consumption. Yet meat consumption plays an important role in meal formation[18] and self-identity (including non-meat eating)[19], further complicating the (micro-level) choices consumers face. The consumption of meat is further complicated when considering macro or environmental perspectives. Levels of meat consumption currently observed in the UK are unsustainable because of their contribution to greenhouse gas (GHGs) emissions; meat has a poor input – output resource use when compared to plant based foods[20-21]. Livestock production represents a poor use of arable land in terms of producing human consumable protein per hectare. Current estimates suggest that 66-75% of European arable land is used to

produce animal feed, with 75% of protein-rich feed derived from South American agricultural production[22], leading to calls for reduced livestock production to lower global GHG emissions[21, 23-24]. However, differences in both the type of meat (e.g. beef, pork), and the production method (e.g. intensive, grass-based) also influences the environmental impacts of meat consumption, further complicating consumer choice. Whilst beef and lamb emit higher GHGs per kilogram (kg) of meat product than pork and chicken[25], grass-fed animals require fewer inputs (e.g. concentrated animal feed, bedding, housing and energy), contribute to carbon sequestration and, with grass-fed beef, provide a more favourable nutritional profile[26]. The complexity of meat-based food choice, conceptualised by both macro and micro perspectives, has been previously examined[21]. At the macro level, recent literature cites the need to produce and consume within planetary boundaries[27] - the utilisation of resources, and production of negative environmental outputs which are within globally environmental sustainable limits. Moreover, others have noted that biodiversity loss, nitrogen cycle disruption and climate change represent planetary boundaries that have been already transgressed, with land use change, freshwater use and non-renewable fertiliser demand approaching their respective planetary boundaries[28].

Higher quality animal welfare production systems have been associated with perceived higher product quality[29-30] for which some consumers are willing to pay a higher product price[31], albeit that even in HICs free range and organic meat constitutes a small proportion of the total market[32]. However, the environmental resource use impacts of meat production are further complicated by the trade-off between animal-welfare and feed resource use efficiency[22]. Free-range, or less densely populated animal production rearing systems, can also lead to a higher feed requirement to (meat) output ratio, whereby animals expend greater energy in keeping warm and foraging for food, hence reducing feed conversion efficiency[22],

98 and are therefore environmentally more damaging than intensively reared systems. While
99 these competing demands are arguably counterintuitive to individuals considering meat
100 consumption, they serve at best to highlight the complexity of issues with respect to
101 'sustainable' meat choice, and at worst a lack of understanding of the impact of individual
102 food choice on the environment. Indeed, the disconnection between food production and
103 consumption in HICs[33] has arguably led consumers to implicitly take a lower degree of
104 ownership over the source of their food. Others have identified that consumers associate
105 animal welfare with animal health and living environment (e.g. free range), and do not
106 consider welfare in more detailed contexts[29], for example, as highlighted by environmental
107 impacts of higher quality animal welfare systems.

108 Consumers with meat-eating environmental concerns may choose to reduce meat
109 consumption as part of a coherent individual action that aligns with their environmental
110 beliefs. However, while such approaches offer potential for reducing meat consumption
111 amongst consumers who care for nature, proposing meat-free meals may be
112 counterproductive as consumers with lower environment concerns may react to these
113 messages in counter opposing ways[34]. Simplistic analyses of 'meat-eating' versus 'non
114 meat-eating' also fail to acknowledge the important aspects of portion size, frequency of
115 meat-based meals, and the need for transition pathways as meat reduction strategies in the
116 diet[35]. In the case of the Netherlands, smaller meat portions are also correlated with eating
117 meat on fewer occasions, and younger consumers place a lower importance on meat as the
118 prominent meal component[35].

119 Aspects of gender difference with respect to meat consumption have also received
120 considerable attention[36], with particular studies analysing gender-related attitudes towards
121 animal welfare foods[37-38], organic and environmentally friendly foods[39], and frequency of

122 meat-based meal occasions[40]; studies have confirmed a priori hypotheses that female meat
123 consumption and female-led family meal construction both lead to lower meat consumption
124 patterns than observed for males. Similarly, other research has examined the role of socio-
125 economic drivers towards meat consumption[5,29]. Other findings have explored these drivers,
126 for example noting that consumer desire for greater product information, and greater
127 emphasis on product quality, are associated with higher socio-economic groups[41].

128 Hence, it is clear from the literature that consumers are faced with a barrage of options and
129 conflicting messages with respect to meat consumption. The purpose of this study was to
130 investigate consumer's self-reported red and processed meat consumption (from intake and
131 purchasing data) against towards animal welfare, human health and environmental
132 sustainability.

133 **Materials and Methods**

134 The complexity of micro and macro factors involved in meat consumption raise empirical
135 and methodological issues. Previous empirical analysis has tended to draw upon the use of
136 population survey or focus group approaches. Within population surveys, the use of
137 attitudinal, preference, action or intention statements provides an appropriate data capture
138 technique, as evidenced by studies examining animal husbandry[29], plant-based protein
139 diets[21], meat portion size[42], animal welfare[42,30] and impacts of meat consumption on the
140 environment[34]. This paper draw upon this accepted approach within the context of UK
141 based meat consumption considerations exploring consumption behaviour with reference to
142 impacts for human health, animal welfare and the environment.

143 **Design and sample**

Self-administered questionnaires were posted to 2,500 Nottinghamshire residents in the East Midlands area of England, UK, accompanied by an invitation letter, an information sheet and a freepost return envelope. The demographics of the East Midlands area are in line with the UK overall on a number of indicators (life expectancy, age profile, employment rate, gross weekly earnings)[43] and provides a geographical area which captures both urban and rural areas which has been previously identified as an important driver of meat and fish consumption[44]. Participants were randomly selected from five electoral registers encompassing both urban (Nottingham City, Broxtowe, Gedling and Erewash) and rural (Rushcliffe) areas covering approximately 350,000 electors. A random number generation technique was undertaken to select the database from which to sample. Estimates from previous studies[45] identified that females represent a higher response rate than males and to account for the potential issues of gender bias in response, a minimal sample size of 996 returns was calculated. A recent population study in the region achieved a response rate of 42.3%[46], from which an initial minimum sample size of 2371 questionnaires to be distributed was calculated; for pragmatic reasons this sample size was increased to 2500. National statistics indicate that in 2008, red and processed meat consumption in the East Midlands was slightly below the mean consumption for England as a whole (83.5g/person/day compared with 88g/person/day respectively)[47]. Although this is in line with a number of other English regions it contrasts with regions of high red and processed meat consumption (North East, South East and South West)[47]. All non-responders were followed up with reminders after two weeks. All responses were anonymous and no incentives were offered. Data were collected in January 2009.

Measures used

Attitudinal scales development: A pool of attitudinal items were created from thematic categories that were derived from qualitative interviews conducted by the authors with 11 Nottinghamshire adults (unpublished data[48]). The interview schedule used in the qualitative interviews was structured around the consumer guidance for sustainable food provided by Sustain[49] as it provided the best possible working definition for consumers available in the UK at that time. Items were designed using the guiding principles outlined by Oppenheim[50], for example some items were worded positively and some negatively to avoid acquiescence response bias.

The questionnaire was piloted with a sample of 42 females and 38 males, recruited using opportunistic sampling. Frequency analysis was conducted on the pilot data and several statements were either removed or replaced due to their poor discriminative properties. The resultant scale was also assessed for readability using the Flesch- Kincaid Reading Grade Level and achieved a score of 3.8, indicating it was suitable reading material for 10-11 year olds and, therefore, acceptable for use with the general UK population[51]. A five-point Likert Scale was used with attitudinal statements with the scale ranging from 'Strongly Agree' through to 'Strongly Disagree'; participants were also able to state that the item was 'Not applicable' to account for non-meat eaters and to reduce false reporting. To simplify analysis, responses to the attitudinal variables were collapsed into 'Agree' (combined responses for 'Strongly Agree' and 'Agree'), 'Neither agree nor disagree' and 'Disagree' (combined responses for 'Strongly disagree' and 'Disagree'). Nine items related to meat purchase, animal welfare and meat consumption were used in the current study (Table 1), which when taken together, produced a Cronbach's alpha coefficient of 0.75, indicating that the construct was internally consistent and, therefore, reliable[52]. In addition, the nine items produced a good spread of responses (Table 1) establishing their face validity[50].

Red and processed meat purchasing behaviour: Participants were asked to indicate the frequency that they purchased a range of categories of sustainable food on a regular basis to capture typical behaviour rather than requesting data for a particular time frame (e.g. a week). For red meat, participants were asked to choose whether they purchased 'local', 'organic', 'free range' or 'RSPCA (Royal Society for the Prevention of Cruelty to Animals) Freedom Food labelled' red and processed meat using a four point frequency scale of 'always', 'often', 'sometimes' or 'never'. Data were re-coded to create a score for 'sustainable' meat purchases. The 'always' or 'often' categories were re-coded together, and the 'sometimes' and 'never' categories remained separate. This produced a 'sustainable meat purchasing' variable, from which two groups of respondents were identified: those reporting a high frequency of sustainable meat purchasing and those reporting low or no sustainable meat purchasing.

Red and processed meat dietary intake: A semi-quantitative food frequency questionnaire (FFQ) to assess dietary intake was developed based on the five food groups defined in the UK's food based dietary guidelines- the Eatwell plate[53]. Participants were asked to choose how frequently they ate a portion of red meat and processed meat on a usual basis, using a scale of 'never', 'less than once per week', 'once per week', 'two to three times per week', 'four to six times per week', 'once per day' and 'twice a day or more'. Standard food portion sizes were included based on national food portion sizes, which for both red meat and processed meat were 75-100g, together with an image depicting one portion size. Using this information, daily intakes were calculated.

Socio–demographic characteristics: Socioeconomic and demographic data were collected at both individual (gender, age, educational level, profession) and household levels (urban/rural, household income). Age groups were created by dividing participants into four groups: 18-

30, 31-45, 46-60 and 61-91 years. Using multiple correspondence analyses, a socioeconomic score was created that ranked participants using four demographic variables: educational level, occupation, household income and individual food spend (calculated using household food spend/number of people in household). The socioeconomic score produced a Cronbach's alpha coefficient of 0.7 indicating internal consistency[51]. Participants were then ranked and divided into three groups – higher, medium and lower socioeconomic status - each tertile representing one third of the sample.

Statistical analysis

Data were entered into SPSS (Version 16.0)[54] using EpiData software (Version 3.1)[55]. An intra-rater reliability check was conducted on a random 10% sample of questionnaires which revealed an error rate of <1%[56]. Categorical data were analyzed using chi-squared tests, followed by adjusted chi-squared tests to ensure that observed differences were not confounded by gender, age group and socioeconomic group. Significance was taken as $P<0.05$.

Ethical considerations

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the [name of ethics committee removed for blinding]. Informed consent of participants was obtained by voluntary completion and return of the questionnaire.

Results

Response rate

Of the 2,500 individuals invited to participate in this study, 842 usable responses were received. Following adjustment for people who had moved/died, a response rate of 35.6% was achieved which is lower than recent similar studies (42.3%)[46] despite similar protocols being adopted that included reminder letters and questionnaires to non-respondents. One explanation for the lower response rate may be the length of the questionnaire employed in this current study. Within the final sample participants ranged from 18-91 years, the majority of whom were in the two oldest age groups (31.8% aged 46-60y; 33.6% aged ≥ 61y; Table 2). Over half of the sample were female (n = 497, 59.9%).

Red and processed meat intake

Over a quarter of respondents (26.2%) consumed red meat daily or almost every day, whereas processed meat was consumed less regularly (3% consumed ≥ once a day), with over three-quarters (78.6%) of respondents reporting eating it ≤once a week.

Women were more likely (χ^2=7.44; P<0.01) to consume red meat less often, compared with men (Table 3). No significant relationship was observed between meat consumption and age or socio-economic group.

Attitudes to meat consumption

The oldest age group of respondents (≥ 61y) was significantly more likely than younger people to agree that they are very fussy about where their meat comes from (χ^2=39.26; P<0.001), that they always try to buy meat reared in the UK (χ^2=34.22; P<0.001), that animal welfare standards in the UK are very high (χ^2=58.15; P<0.001) and that they choose food which has been produced in a way which minimises cruelty to animals (χ^2=16.96; P<0.05)

(Table 4). Arguably the higher response rate from older residents has implications for the representativeness of the findings, which represents a potential caveat to our findings.

Attitudinal differences to meat consumption (Table 4) were also observed for gender, as women were more likely than men to agree that they are very fussy about where their meat comes from (χ^2=20.70; P<0.001), and always try to buy meat which has been reared in the UK (χ^2=5.98; P<0.05). Female respondents were also more likely to agree that they do not like the idea of indoor animal rearing, (χ^2=10.88; P<0.01) and to agree that they choose food which has been produced in a way that minimises cruelty to animals (χ^2=7.21; P<0.05). Finally, women were more likely to disagree that they did not really think much about the animal when they purchased meat (χ^2=7.25; P<0.05).

The only relationship observed between attitudes to meat and socio- economic group was for the statement 'I'm very fussy about where my meat comes from', whereby respondents from the highest socioeconomic group were more likely to agree (χ^2=12.90; P<0.05) (Table 4).

Relationship between red and processed meat consumption and purchasing behaviour and attitudes

Low meat eaters, i.e. consuming ≤1 portion of meat per day were more likely to agree that they were fussy about where their meat came from (χ^2=6.51; P<0.05), and to agree that they did not like the idea of animals being reared indoors (χ^2=14.81; P<0.001) (column a, Table 5). Low meat eaters were more likely to disagree that they did not think much about the animal when buying meat than other respondents (χ^2=8.39; P<0.01). Low meat eaters were also less likely to 'believe that animal welfare standards in the UK are very high' compared with those consuming >1 portion per day (χ^2=11.06; P<0.01).

Respondents in the group that purchased sustainable meat (local, organic, free range and RSCPA freedom food) more frequently were more likely to have positive attitudes towards sustainable meat consumption (Table 5). This group also tended to disagree with the statement 'I don't really think about the animal when I buy meat' (χ^2=67.59; P<0.001).

There were no associations between sustainable meat purchasing and gender or socio-economic group, however age group almost reached significance (χ^2=7.60; P=0.055), with respondents from the two oldest age groups (>45 years old) more likely to report frequently purchasing sustainable meat.

Discussion

The purpose of this study was to investigate consumer's self-reported red and processed meat consumption (from intake and purchasing data) against their stated attitudes towards animal welfare, human health and environmental sustainability.

Animal welfare

Animal welfare appears to be particularly important to respondents, as 88.5% of respondents believed it was important that the meat they buy has been produced with good animal welfare standards. This sentiment is consistent with other research findings for UK consumers[57-58]. Our findings demonstrate that over half of respondents try to buy meat reared in the UK and believe UK standards are very high, buy free range meat where possible, and agree that they are fussy about where their meat comes from. These findings accord with previous research that animal welfare is associated with higher product quality perceptions[29-30]. Some of the concern identified in this study may have arisen from the media coverage of animal rearing (e.g. Channel 4's The F Word and Big Food Fight, which explored poultry, pig and lamb production[59-60] aired prior to and during data collection), and correlates with evidence on the

impact of media coverage in the USA[61]. The impact of gender on attitudes towards animal welfare in this study also reinforced findings from previous studies, with female consumers being more conscious of country of origin and welfare production method[37]. Other findings have highlighted that UK consumers associate higher animal welfare with good health, and additionally view it as an indicator of food safety[62].

Environmental sustainability and meat consumption In contrast to the interest in animal welfare shown amongst the sample, awareness of climate change reduction strategies in terms of consuming animal foods (meat, dairy products and eggs) appears to be low. Under a fifth of the sample agreed that 'To help reduce the impact of climate change, it is better to eat less animal foods', reinforcing findings from Australia reporting public perception of low environmental impact of meat consumption[63]. A similar study conducted in Switzerland proposed that low levels of awareness could be linked to denial, due to perceived difficulties in reducing meat consumption[64-65]. Itfound that respondents holding health and environmental concerns reported the lowest meat intakes. However, building upon other evidence[22], it could be argued that while low meat eating consumers stated greater concern for animal welfare, their consumption choices of higher welfare foods may counterintuitively negate some of the environmental benefit derived from their relatively lower meat consumption with respect to minimising climate change impacts. Previous research identified that consumers perceive animal welfare to relate to animal health and production environment[29]. Given the sustainability conflict between welfare and environment[22], further incentivising animal welfare conscious consumers towards a lower meat based, or reduced meat portion size, diet[35] maybe the most effective environmental strategy for this subset of consumers. However, attempting to achieve reductions in meat consumption

amongst consumers unconvinced by climate change considerations may result in unexpected outcomes[34].

Drivers of meat consumption

Those consuming meat more often in this study were typically young males from higher socio-economic groups; in contrast women aged 46-60y from lower socio-economic groups consumed the lowest quantities of meat. Overall, women reported consuming less meat than men, supporting gender differences in meat consumption previously identified[64,66] and reinforcing the suggested link between 'virulent masculinity' and meat consumption [64]. Associations observed between gender and attitudes towards animal welfare and source of meat purchases were also in concordance with previous international findings from the UK[67] and other HICs[68], whereby women were significantly more likely to show concern over the source of their meat, and for animal welfare, than men.

Older adults in this sample (61-91y) displayed more concern towards the source of their meat and animal welfare, potentially influenced by memories of a food system in which meat was in short supply prior, during and post World War II; pre and post war consumption data illustrate that UK meat intakes were lower than current levels, at 58.5kg/person/year in the period 1934 -38, and 44.8kg/person/year in 1942[69], set against the recent data for average meat consumption of 84.2kg[47] Although the war ended in 1945, meat continued to be rationed until 1954, and following the removal of rationing restrictions, meat prices soared[70]. Therefore older respondents may hold a greater appreciation of meat as a food source than younger consumers, with these attitudes flowing from their experience of contrasting food availability. Respondents in the highest socio-economic group were more likely to agree that they are very fussy about where their meat comes from, and this arguably highlights the issue of cost as a barrier to lower socio-economic groups in making more

selective purchases[71]. Moreover, level of education may play a role in respondents being conscious of the production source of their meat purchase[72], arguably also concurring with previous research linking higher educational levels with increased likelihood of choosing a vegetarian diet[65].

It is unsurprising that those consuming less meat were more likely to think about both the provenance of the meat they ate, but also about animal welfare when buying meat. However, what is more revealing is that higher meat consumers were more likely to agree that animal welfare standards in the UK are very high, perhaps implying that more frequent meat consumers either assume that meat of UK origin has been reared to high animal welfare standards, or simply that they do not think critically about the issue. One suggestion is that there is a certain level of 'cultural invisibility' surrounding the slaughter of animals for food, in order to normalise the process, and this provides the separation required so that meat can be consumed without really considering the welfare of the animal involved[68]. This arguably extends to modern society's categorisation as 'animals for food' and 'companion animals' with childhood experiences embedding these distinctions at an early age[73]. Transparency at every stage of the meat chain may lead to more mindful consumption of animal based products, as previous studies have confirmed that Dutch consumers who are sensitive to animal origin and animal welfare are more likely to favour free range or organic meat[32].

Implications for policy and practice

Low awareness of the link between the consumption of animal products and their environmental impact was observed amongst respondents in this study, suggesting the need for public health interventions to raise the profile of this issue. Seeking to raise awareness of animal rearing methods could prove an effective approach, as animal welfare was particularly important to respondents in this and other UK studies, albeit that to ensure both welfare and

environmental sustainability outcomes, such approaches need to align with portion size, or frequency of meat-based meal, reduction strategies[35]. Examples of success in promoting dietary change include Korea[1], where a campaign focussed on increasing the consumption of low fat high vegetable meals; this approach could prove successful if adopted in other countries, particularly if pricing mechanisms are supported by policy measures which promote plant based agriculture to produce fruit, vegetables, beans and pulses for human consumption instead of subsidising animal source foods (as has been the case historically alongside non-vegetable arable crops). This could incentivise consumers to lower their intakes of meat whilst having the added advantage of reducing saturated fat intakes and of increasing fibre intakes[34].

Taxing red and processed meat could be considered with recognition that information sources alone do not lead to direct immediate diet change, but can play a role in longer term social acceptance of consumption behaviour. However, it is important to consider how fiscal measures on red meat may affect certain groups of the population, for example pregnant women and younger children who may be at risk of developing micronutrient deficiencies and for whom cost may already be a barrier to accessing quality sources of protein[10]. Public education campaigns seeking to achieve a reduction in meat consumption may, therefore, wish to target those groups identified as higher meat consumers, in particular the male population. There is a need for dietitians, nutritionists, and other health professionals to be adequately informed on this issue, and understand how best this message can be communicated to patients, clients and the wider public.

Policy makers need to ensure that dietary guidelines go beyond consideration for current consumers and encompass the nutritional, environmental and resource needs of future generations. In view of the environmental damage caused by livestock farming, the evidence

base should consider how best to meet not just protein, but iron and selenium requirements from other, less environmentally costly dietary sources. Although UK dietary guidelines do advise a reduction in red and processed meat consumption, meat has become deeply entrenched in the UK diet, and consideration needs to be given to social and cultural norms that need to undergo a massive shift to obtain the necessary reductions in consumption to facilitate environmental sustainability. The influence of the built and retail environment on meat purchasing decisions needs further research, to explore how retailers can choice edit at a food supply level, to simplify the situation for consumers wishing to purchase meat which is healthy and has been reared to high standards of animal welfare and environmental sustainability.

Limitations

Caveats to this study include the regional sample frame within which the research was conducted and the need to define at the outset descriptors of attitudes that respondents could understand; these considerations are often encountered when exploring consumer attitudes in population surveys. Moreover, despite embedding a protocol that included distributing a reminder letter and questionnaire to non-respondents, a lower than anticipated response rate was achieved together with a lower response rate from younger residents. Another issue may have been the lack of incentive offered. These issues represent potential response bias in our results, albeit that achieving high response rates with unbiased socio-demographic responses is generally recognised as increasingly challenging within population surveys. However, our analyses were adjusted for the socio-demographic factors, which ensured that any observed differences were not confounded by gender, age or socio-economic group. This is a cross-sectional study so we are unable to say whether attitudes influence actual behaviour in relation to consumption of red or processed meat or purchasing of sustainable meat. The gap

between attitudes and intention, and actual behaviour is well-established in work involving social cognition model [74,75]. Hence we are only able to conclude on associations and not causation of attitudes on behaviour. However, accepting these caveats, this study has both reinforced findings from previous research that has investigated attitudes towards meat consumption and placed these within the context of environmental sustainability, raising important considerations for both policy makers and consumers.

Conclusion

In this study, low red and processed meat consumption is associated with concerns regarding animal welfare while self-reported purchasing of sustainable meat are associated with positive attitudes to sustainable meat consumption. This suggests that attitudes towards animal welfare and sustainability might, therefore, be important motivators of behaviour and represent components of future campaigns to reduce meat consumption and promote health. Achieving environmental and nutritional sustainability will require co-ordinated action from a range of stakeholders; understanding public attitudes towards meat consumption is a necessary condition for successfully adopting a more sustainable food supply.

Conflicts of interest

The authors have no conflict of interest to declare.

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Red and Processed Meat Consumption, Attitudes and Behaviours: Impacts for Human Health, Animal Welfare and Environmental Sustainability

Table 1: Consumer attitudes to buying and consuming meat and animal welfare

	Strongly agree/Agree		Neither agree/ disagree		Disagree/ Strongly disagree		
Attitudes to Meat……..	n	%	n	%	n	%	Cronbach's α
I'm very fussy about where my meat comes from	443	56.2	219	27.8	126	16.0	
I always try to buy meat which has been reared in the UK	509	64.0	185	23.3	101	12.7	
I think it is important to buy meat that has been produced with good standards of animal welfare	711	88.5	79	9.8	13	1.6	0.75
Animal welfare standards in the UK are very high	439	54.6	296	36.8	69	8.6	
I don't like the ideas of lots of animals being reared indoors	654	81.1	116	14.4	36	4.5	
I choose food which has been produced in a way which minimises cruelty to animals	567	72.1	188	23.9	31	3.9	
I buy free range meat where possible	449	57.9	224	28.9	103	13.3	
I don't really think much about the animal when I buy meat	178	22.9	202	26.0	398	51.2	
To help reduce the impact of climate change, it is better to eat less animal foods (meat, dairy products and eggs)	146	18.4	364	45.8	28	35.8	

Table 2: Socio demographic characteristics of participants

		n	%
Gender:	**Male**	**333**	**40.1**
	Female	**497**	**59.9**
Age (y):	**18-30**	**101**	**12.2**
	31-45	**185**	**22.4**
	46-60	**262**	**31.8**
	61-91	**277**	**33.6**
Socioeconomic group:	**Higher**	**280**	**33.3**
	Medium	**280**	**33.3**
	Lower	**282**	**33.5**

Table 3: Relationship between red and processed meat consumption and socio-demographic profile

		Consuming ≤1/day		Consuming >1/day		χ^2 (Adjusted†)
		n	%	n	%	
Gender	Male	190	57.4	141	42.5	7.59* (7.44**)
	Female	327	66.8	162	33.1	
Age group (y)	18- 30	60	59.4	41	40.5	2.22 (3.09)
	31- 45	117	63.2	68	36.7	
	46- 60	174	66.6	87	33.3	
	61-91	166	61.7	103	38.2	
Socio economic group	Lower	185	66.5	93	33.4	2.97 (2.47)
	Middle	176	63.5	101	36.4	
	Higher	163	59.4	111	40.5	

†Adjusted for gender, age and socio-economic group.

Table 4: Relationship between attitudes and socio-demographic profile

Attitudinal item	Gender χ^2(Adjusted†)	Age group χ^2(Adjusted†)	Socioeconomic group (Adjusted†) χ^2
I'm very fussy about where my meat comes from	20.70***	39.26***	12.90*
I always try to buy meat which has been reared in the UK	5.98*	34.22***	5.54
I think it is important to buy meat that has been produced with good standards of animal welfare	ICC	ICC	ICC
Animal welfare standards in the UK are very high	4.56	58.15***	7.76
I don't like the ideas of lots of animals being reared indoors	10.88**	ICC	2.51
I choose food which has been produced in a way which minimises cruelty to animals	7.21*	16.96*	3.51
I buy free range meat where possible	4.86	11.35	0.55
I don't really think much about the animal when I buy meat	7.25*	5.63	4.36
To help reduce the impact of climate change, it is better to eat less animal foods (meat, dairy products and eggs)	3.21	7.86	2.85

***P<0.05, ** P<0.01, *** P<0.001 ICC=Insufficient cell count to conduct Chi-squared testing as <5 responses in a cell**

†Adjusted for gender, age and socio-economic group

Table 5: Relationship between: attitudes to meat with meat consumption and (b) sustainable meat purchases

	Meat consumption (high vs low)	Sustainable meat purchase† frequency (high vs little/no)
Attitudinal item	χ^2	χ^2
I'm very fussy about where my meat comes from	6.51*	45.96***
I always try to buy meat which has been reared in the UK	6.34	67.59***
I think it is important to buy meat that has been produced with good standards of animal welfare	ICC	19.02***
Animal welfare standards in the UK are very high	11.06**	1.10
I don't like the ideas of lots of animals being reared indoors	14.81***	2.90
I choose food which has been produced in a way which minimises cruelty to animals	4.53	38.34***
I buy free range meat where possible	0.83	45.89***
I don't really think much about the animal when I buy meat	8.39**	67.59***
To help reduce the impact of climate change, it is better to eat less animal foods (meat, dairy products and eggs)	1.29	2.30

***P<0.05, ** P<0.01, *** P<0.001 ICC=Insufficient cell count to conduct Chi-squared testing as <5 responses in a cell**

†local, organic, free-range, and RSPCA Freedom food