SUSTAINABLE DIETS: MODELLING INDIVIDUAL SOCIAL AND SITUATIONAL INFLUENCES ON DIETARY CHOICES

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Key findings

Our models illustrate the influence of social networks and other people on food choices. A series of interventions, including providing information, limiting canteen choice and pricing structures, were modelled to explore any changes in food choices.

The effects of interventions only last as long as they are being implemented. Across all the models, once an intervention was lifted the effects waned, or were significantly reduced. Eventually, other factors might begin to change food culture, but behaviours tend to regress if constraints are removed.

A combination of interventions is likely to have the greatest effect. Behavioural preferences, such as copying what is considered normal, the convenience of food, or personal tastes, differentially respond to interventions. This means that a suit of interventions is likely to have a larger impact than any single policy.

Policies, such as taxing and subsidies, tend to have larger, but shorter-term impacts than policies aimed at behaviours, such as convenience or educational messaging.

Behaviours can spill over from one social setting to another as individuals interact and start to spread the influence of different scenarios, such as families improving their whole diet quality following regulations to improve workplace meals.

The Scottish diet is unsustainable both in terms of health and environmental impacts and therefore policy interventions are needed to encourage dietary change. However, our understanding of how policies unfold within a population is hampered by looking at population average dietary intakes that can mask how subgroups behave. More targeted approaches are necessary as no one-size-fits all. We know from our previous work that social networks and situational setting are associated with food choices [1].
In this research we modelled the influence of interactions between individuals in social networks on food choices in different setting (workplaces, home and school) and the effect of different types of interventions.

Research questions

How do social networks and interactions affect food choice?

What is the role of environment and beliefs in shaping social interactions?

What is the effect of different messaging, e.g. environment, health, price, to stimulate diet behaviour change?

Can a work-place intervention change the population diet?

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Approach to the research

Our aim was to gain a greater understanding of how influences from social networks and interactions, environments, and beliefs affect food choice within the complexity of the food system.

Why are we using modelling and not intervention studies? Unlike an intervention study, a computer simulation can run for a long time and without the risk of any negative impacts on what people eat or how they live. This means that within a computer model we can have control over all aspects of how people interact and even try radical experiments at scales that would be difficult or expensive in reality. For example, it would be difficult to intervene to change the diets across a whole city, and track what every household eats. A model can also be run many times under different assumptions, and this helps to capture how variable or uncertain the responses of a population might be. However, it is recognised these are models (not real life) and that they give insights into behaviours and diet patterns. In these studies, we used the modelling technique 'agent-based modelling' [see box Agent-Based models below].

What (theories) underpin these models? Because empirical data to describe behaviours and social interactions are quite rare, we base our models on well-established theories that describe how people act. For example, how people modify their behaviours to conform to what they perceive to be normal, and the way that ideas can spread through social contagion.

Workplace: settings for models. Examining eating habits in the UK revealed the importance of context – when, where, and with whom meals are eaten. Our initial work showed that this was the case for meat [2]. The probability of eating meat was higher at weekends, at meals consumed outside the home, and in company, all of which point to the influence of social interactions and environmental settings. Workplaces provide a regulatable setting to target interventions to change food choices, with a relatively large adult population. Workplaces are also a point of interactions for many people, where they meet, mingle, and share ideas and observe behaviours. While the current pandemic has disrupted some of the workplace interactions, these will re-establish as people continue to return to work. The pandemic closed most workplace, but as they open there is a unique opportunity to intervene to change food environments and choices in workplace.

Agent-Based models

Agent-based models are dynamic computer simulations used to study complex systems of interacting actors and explore 'real-world' scenarios to observe emergent phenomena.

They comprise agents that interact and might be individual people, workplaces, homes or environments.

Agents, in this case people, individually assess its situation, makes decision based on a set of rules and are:

- proactive in trying to reach a goal (e.g. satisfying a behavioural preference or meeting a food budget),
- reactive to their surroundings (e.g. they can pick different types of food or move to a different food vendor)
- interactive with other agents and their environments (e.g. they might copy what others are doing).

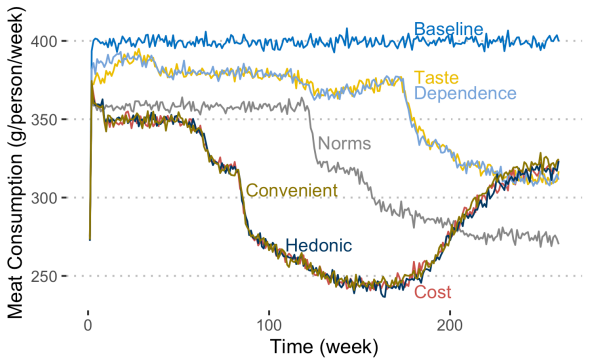
In our models, agents are people and represents everyone in a population. Each person follows the same set of rules, but they have autonomy through different preferences describing how they respond to their context. For example, all individuals have to select a meal to eat, but they have a personal preference as to what it might be. Similarly, family groups have a budget, but the size of the budget is different. This means that these models can be used to explore the diversity of responses to a scenario. Crucially, agents interact. In our case, this means that individuals can look at what people around them in a network are eating or observe the attitudes of others and then change their diet behaviour over time.

Strengths These models can capture the diversity of responses to a scenario and allow feedback to see if there are unexpected emergent phenomena (i.e. population behaviour patterns that were not expected).

Limitations Agent-based models of social interactions are based on a set of rules that are theoretically robust but often hard to evidence. Therefore, they are better suited to exploring the consequences of rules and scenarios than generating predictions.

Models and observations

Each of our models represent a different sized population and scale to address a specific question. The results from one could then be used to inform the next. For example, the DISMAL model (DIminiShed Meat At Lunchtime) was based on a small number of people, e.g. a single workplace, but this was increased in the SIMULFOOD and SPILLOVER models to look at a city-sized population that included multiple workplaces and even schools. Similarly, we started by investigating reductions in meat (DISMAL and MEATNET), but built out to examine the whole diet (SIMULFOOD and SPILLOVER).



Mean meat consumption can be decreased by addressing different behavioural drivers and beliefs, but reduction in consumption was temporary.

Personal preferences (DISMAL model)

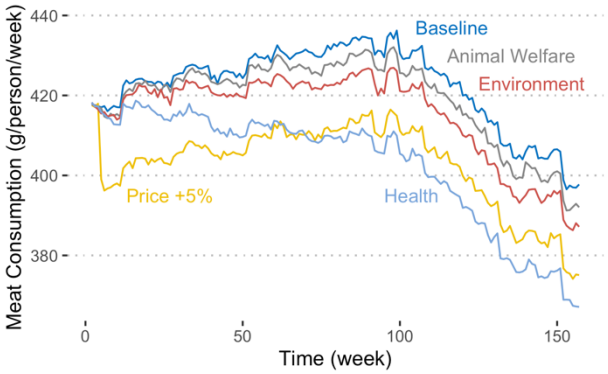
Can a meat-free lunch alter meal choices at other times?

People have many (sometimes conflicting) drivers for their dietary decisions. Interviews with study participants identified key indicators of personal beliefs around eating meat: taste, convenience, dependence, hedonics, norms and cost. We then built a simulation model in which individuals had a "meat free Monday" lunch at work each week. The reduction in meat consumption over a week exceeded changing a single meal, suggesting that agents (individuals) updated their beliefs over time to reduce overall consumption of meat in their overall diet. Each belief had a different impact, in the size or timing of the reduction. For example, changes to the cost or convenience of food produced a faster drop in meat consumption than the perceived taste of meat-free meals. However, the drop in meat consumption began to be reversed. In contrast, the perception about what was the "norm", *i.e.* the more agents see that other agents have selected meat free meals the more it becomes normal, produced a slower, but more sustained change in behaviour.

Influencing attitudes and pricing (MEATNET model)

How can attitudes to eating meat be most effectively influenced by others within a social network?

In the MEATNET model we extended the way in which perceptions are susceptible to different norm-based messaging in the workplace (i.e. health, environment or animal welfare) [3]. Agents were exposed to different types of norm-based information about meat in their workplace, the attitudes towards eating meat of their colleagues' (other agents) and a memory of what they had previously eaten. Within the context of colleagues eating together, health concerns had the largest and most sustained impact on reducing meat consumption, but these changes only lasted during the campaigns. To sustain the reduction, repeated campaigns were required. Increasing price had a greater effect than concern about health, environment or animal welfare, but price increases disproportionately impacted low-income households.

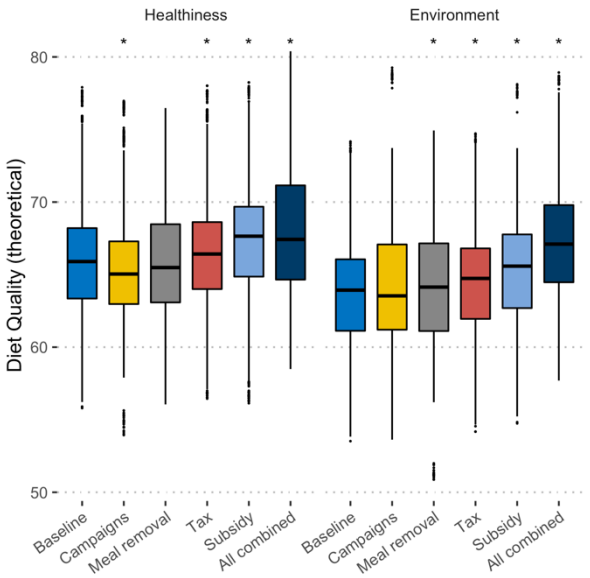


Mean meat consumption is reduced with every campaign compared to the baseline, but to differing extents. Price has the biggest impact, but it did not last as long as changing norms.

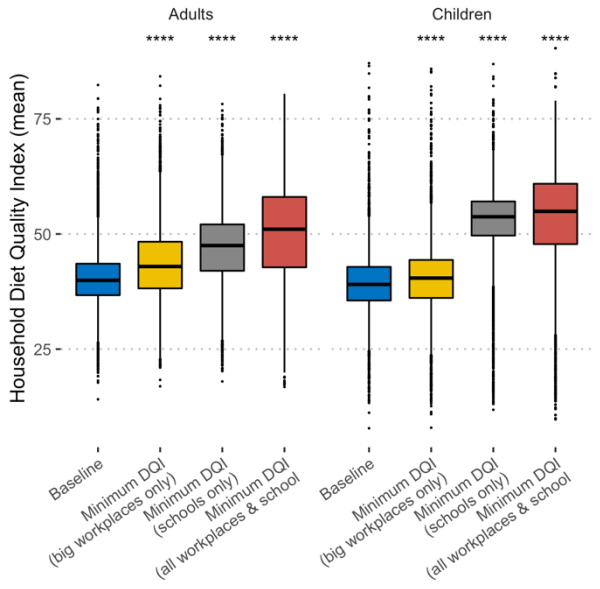
Household budget constraints, tax and subsidies (SIMULFOOD model)

Can price and messaging interventions improve people's choice for healthy and/or environmentally sustainable meals when there are is a budget constraint?

Purchase power is known to be a strong driver of diet choices, and household budgets can constrain these choices. We incorporated the constraints of a household budget on the individual adult agents, who then made choices about their whole diet, extending from meat alone, for healthiness and environmental sustainability. Agents were more responsive to subsidies or taxes in choosing healthier or more environmentally sustainable meals than to information campaigns or removal of meals. But like the DISMAL model, the effect of price interventions was small if the intervention stopped, whereas the information campaigns had a small but persisting impact. It is important to note that all changes in overall diet quality were small (a few percentage points), but shifts in diet environmental sustainability were greater when suasive (campaign), market-based (taxes and subsidies), and regulatory (meal removal from workplace canteens) interventions were combined. However, a tax on unhealthy or unsustainable meals disproportionately impacted the largest and most deprived households, and the modelled subsidy (including when combined with a tax) resulted in considerable costs for public finances due to the shift of food choices towards subsidised products. This would need to be balanced against gains made in population health.



When constrained by a household budget, interventions aimed at subsidising healthier or taxing less healthy options had the largest impact, but combined strategies were the most impactful (* significantly different from the baseline).



Imposing minimum diet standards (DQI) in a workplace or school can spill over into other settings as agents adopt new standards for their norms (* significantly different from the baseline).

Food availability and intervention impact amplification (SPILLOVER model)

Do diet choices of people in one social network affect choices in other social settings?

In the *SPILLOVER* model we focused on the diet choices of agents at work (adults) or school (children) and at home to test whether there could be amplification of an intervention in a work or school setting. In this model, unlike the previous, we explicitly looked at 'spill over' between settings in the whole diet. Results emerging from the *SPILLOVER* model suggest that individuals interact and start to carry legislated minimum standards for workplace meals back to their household. They then start to improve the diet quality of the whole household, who were not necessarily subjected to the same regulated minimum standards. As might be expected, the more workers that can be exposure to minimum standards, the greater the positive impact on the population.

[1] https://doi.org/10.1186/s12966-016-0370-1 [2] https://doi.org/10.1016/j.appet.2019.03.007
[3] https://doi.org/10.18564/jasss.4134