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Bianchi F, Aveyard P, Astbury NM, Cook B, Cartwright E, Jebb SA. Replacing meat with alternative plant-based products (RE-MAP): a randomized controlled trial of a multicomponent behavioral intervention to reduce meat consumption. American Journal of Clinical Nutrition. 2021;nqab414.

What We Know, Think We Know, or Are Starting to Know

Eating behaviour is a complex phenomenon, influenced by regional, cultural, religious, moral, ethical, socio-economic, environmental, and health motivations. For example, in India the primary motivation for following vegetarian diets is religious and cultural tradition, whereas in contrast, Western populations adopting vegetarian diets are primarily motivated by moral, ethical, and health considerations ⁽¹⁾.

It has also become common for moral and ethical considerations to blur the lines of consideration of health effects, particularly in relation to foods of animal origin ⁽²⁾. While vegetarians and vegans may exhibit higher levels of altruism and empathy, omnivores may be motivated by traditional values, less openness to experience and variety-seeking ⁽³⁾. This may result in more relative resistance to change patterns of meat consumption ⁽⁴⁾.

The varying behavioural correlates of dietary pattern adherence creates a conundrum for one especially pressing factor in the consideration of modern human diets: anthropogenic climate change. In particular, the livestock industry is responsible for the greatest contribution to greenhouse gas [GHG] emissions and of related landmass use ⁽⁵⁾.

“Meat” substitutes have become an increasingly visible feature of supermarkets, with a market value of \$6.67 billion [USD] in 2020. However, overall meat consumption remains higher in Western populations than consideration of plant-based alternatives, and there is resistance to reducing meat consumption evident in the literature ^(4,6).

Is there a way to help consumers towards behaviour change to modify meat consumption by shifting to plant-based ‘meat’ substitutes? The present study tested this question.

The Study

The RE-MAP trial was a randomised controlled trial conducted in Oxford, United Kingdom. Male and female participants were eligible to participate if they consumed red meat >5 times per week, and were living in adult-only households. Participants were randomised to either an intervention or control:

- **Intervention:** The intervention was based on 4 components:
 - i. The free provision of meat substitutes for participants
 - ii. Information leaflets regarding health and environmental benefits of reducing meat
 - iii. Provision of recipes
 - iv. Success stories from people who reduced meat intake
- **Control:** The control group continued with habitual meat intake and received no dietary advice.

The intervention lasted for 4-weeks, and meat substitutes were provided to the intervention group participants for the duration of the 4-week intervention. A further 4-week follow-up period assessed the outcomes after the free provision of plant-based substitutes had ended.

Participants in the intervention group were allowed to self-select their preferred meat substitutes from commercially available products. All participants were trained at enrolment to use MyFitnessPal, which they used to track 7-days of dietary intake at baseline, the end of the intervention [Week 4] and the end of the follow-up observation [Week 8].

The primary outcome was change in meat consumption between baseline and Week 4. Secondary outcomes included change in meat intake by Week 8, and changes in psychosocial variables [e.g., subjective social norms to eat less meat] and “eating identities”. Changes in diet and cardiovascular risk factors were also assessed.

Results: At baseline, average red meat intake was 130g/d and 134g/d in the intervention and control groups, respectively.

- **Red Meat Intake:** By Week 4, the intervention group had reduced meat by 63g/d [95% CI, 44 to 82g/d]; by Week 8 the reduction in meat was 39g/d [95% CI, 16 to 62g/d].

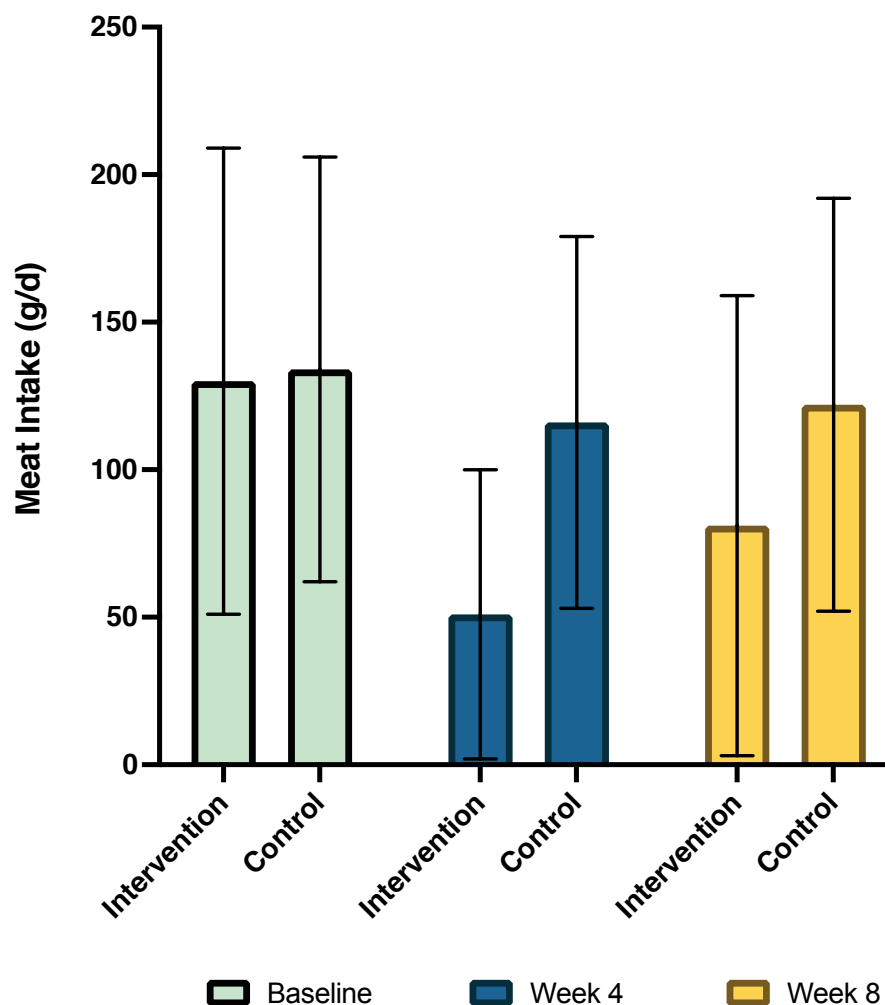


Figure illustrating the change in meat intake [in grams per day] from baseline to Week 4 and Week 8 of the study, in both the intervention and control groups. The bar itself represents the mean change in meat intake. Although the 95% confidence intervals [CI] are reported above in text, the vertical error bars that you can see here are the standard deviation [SD]. The SD is used in the calculation of the CI, and indicates the extent to which the data varied from the mean; the very wide SD error bars you can see here, often equal to or greater than the mean value itself, indicate that there was substantial individual variation in how much meat intake changed during the study.

- **Psychosocial Variables:** The Figure below graphs the changes in select outcomes from these data, in addition to the raw data in text:
 - Intention to use meat substitutes increased from 4.0 at baseline to 5.5 at Week 4 and remained at 5.5 at Week 8.
 - Desire for meat substitutes to be as similar as possible to meat increased from 3.5 at baseline to 4.0 at Week 4 and 3.8 at Week 8.
 - Attachment to meat decreased from 4.4 at baseline to 4.0 at Week 4 and 3.9 at Week 8.
 - Attitudes toward eating a low-meat diet increased from 5.1 at baseline to 6.0 at Week 4 and 6.2 at Week 8.
 - Intention to eat a low-meat diet increased from 4.0 at baseline to 5.4 at Week 4 and 5.7 at Week 8.
 - Perceived control over using meat substitutes increased from 4.9 at baseline to 5.5 at Week 4 and 5.3 at Week 8.

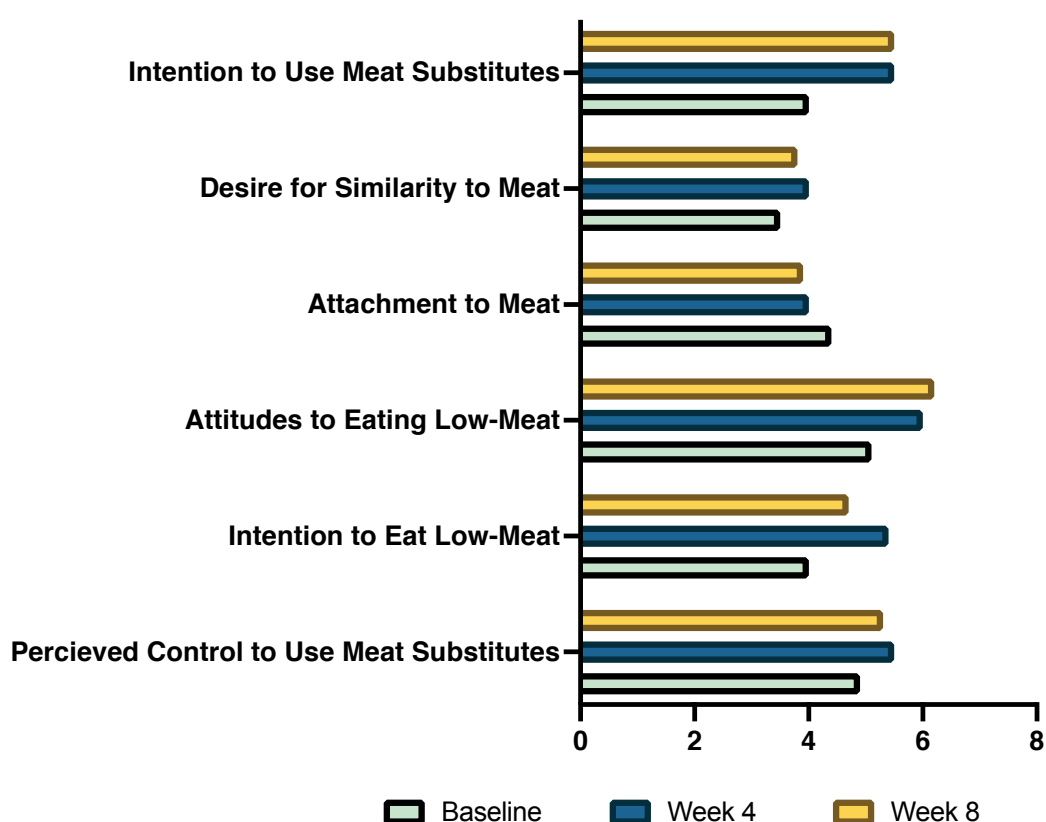


Figure illustrating the changes in psychosocial measures associated with meat intake and meat substitutes from baseline to Week 4 and Week 8. These variables were assessed using 7-point scales [1 = strongly disagree to 7 = strongly agree], except 'Attachment to Meat', which was a 5-point scale [1 = strongly disagree to 5 = strongly agree]. Thus, the scores overall reflect positive changes in outlooks for these subjective measures, except for the score for "desire for meat substitutes to be as similar as possible to meat", which increased over the course of the study, i.e., participants did want meat substitutes to be more like actual meats.

- **Diet and Cardiovascular Risk Factors:** Except for the change in meat intake, there was no difference in energy intake, total fat or fat subtypes, fibre, protein, total carbohydrates and sugar, or sodium and potassium, during the study. Blood cholesterol levels and blood pressure showed no changes during the study.

The Critical Breakdown

Pros: The study recruited high-meat consumers, providing a good baseline status for effects of the intervention. Randomisation was appropriate [generated by independent statistician] and stratified by sex to ensure balance between groups. Allocation to the intervention and control group remained concealed from researchers during baseline data collection, and the researcher assessing diet was blinded to allocation. Other than the information provided the intervention group [i.e., leaflets, etc.], the intervention and control groups received similar contacts with researchers. There was a very high retention rate for a behavioural nutrition intervention, with only 1 drop-out from the intervention and control group [2 in total]. The study required 100 participants for statistical power, and 113 completed the study. The statistical analysis was conducted using the intention-to-treat* principle.

Cons: As a multifactorial behavioural intervention, there is no way of determining which of the 4 components of the intervention may have had the most influence on the outcome [well, there is, but it would require attempting to assess how the participants rated the impact of each component and analysing that]. The study included adult-only households; thus, we have no idea whether such a behavioural intervention could be effective in family households with dependent children. The participants were well-educated, primarily White ethnicity and healthy, and as a result there would be some questions over the generalisability of the intervention to the wider population. Further, the duration of the study was quite short, and the effects of more longer-term habituation to swapping for plant-based meat alternatives remain to be determined. 65% of participants were female, and there is evidence that women may be more responsive to meat-reduction health messaging compared to men ⁽⁶⁾.

*Geek Box: Intention to Treat Analysis

In a randomised controlled trial, you want to match both arms of the trial to ensure that one side doesn't influence (i.e., bias) the results more than the other. This can be a problem if there is, for example, a high drop-out rate in one arm of the trial; the other arm will then have more statistical power, and it may over-inflate the effect of that arm vs. the comparative arm (or the control, if it is a control arm).

Intention to treat [ITT] is where the researchers will conduct analysis as if all subjects randomised in the trial completed it, irrespective of whether they dropped out, or didn't comply with the protocol. Drop-out and noncompliance are two issues which face many trials, in particular nutrition and weight loss interventions. True intention to treat analysis requires complete data to be available for all subjects who didn't complete the trial according to protocol.

However, that is not always available, and so often researchers will make assumptions based on, for example, a last data point or a baseline measurement (for example, in this study for dropouts in the maintenance phase the researchers assumed that subjects returned to their baseline weight for ITT analysis – not unreasonable given the weight regain in subjects who completed the trial). Intention to treat is a positive because it maintains the sample size, and it assumes a real-world practicality – because in the real world, not everyone is compliant with a protocol (as any practitioner knows!).

Key Characteristic

While terms like “multicomponent behavioural intervention” in the title of the study sound fancy, the key characteristic of this study’s design is that the plant-based meat substitutes were freely provided to the participants. And while we would expect that an intervention like this would cover the costs of the “treatment”, so to speak, it may also be the key factor in explaining the quite substantial reduction of daily meat intake from 130g/d at baseline to 51g/d after 4-weeks.

Put it this way: what would the effect on daily meat intake have been if the participants were *only* provided with educational materials, recipes, etc., i.e., the purely behaviour change motivating components? Would meat intake have declined so much? There is evidence that messaging regarding environmental and health impacts of meat diets may facilitate reductions in meat consumption, with combination messaging [i.e., environment *and* health] potentially more effective than single-issue messaging ⁽⁷⁾.

However, there is evidence to the contrary also indicating that “rhetorical frames”, where narratives and information regarding the environment, animal welfare, and/or health are deployed, are ineffective at influencing consumer behaviour change ⁽⁸⁾. In fact, the authors of the present study themselves highlight their previous systematic review, which found that information on health and environmental benefits of meat reduction may have led to increased *intentions* to lower meat intake but did not result in changes to actual meat intake ⁽⁹⁾.

In the Discussion to the present study, the authors highlight that there is little evidence that information leaflets, recipes, or success stories – the three behavioural components of the intervention – would likely have influenced meat intake. The implication of the present study may simply be that if you give people free food, they will eat it.

Interesting Finding

We have discussed several motivations for reducing meat intake, particularly the trifecta of the environment, animal welfare, and health. And for the latter, the findings of the present study are interesting insofar as they challenge the “halo effect”, i.e., the assumption that alternatives labelled “plant-based” are by default healthier ⁽¹⁰⁾.

In the present study there was no change in any aspect of energy or nutrient intake: total energy, total fat, saturated fat, unsaturated fat, carbohydrates and sugars, sodium, or potassium. This lack of change in nutrient intake occurred despite the change in meat intake. There was also no change in objective cardiovascular risk factors, either blood lipids, triglycerides, or blood pressure.

This is not necessarily a new observation; the ingredient composition of many plant-based meat alternatives may be high in saturated fat, sodium, and sugars, and there is little reason currently to suggest that, from a purely nutrition and health perspective, many meat substitutes are actually a healthier alternative ^(11,12). The present study suggests little nutritional benefit to the meat substitutes chosen by participants in the intervention group. It would have been really useful to have data on the actual choices of meat substitute products by participants.

Relevance

This is the kind of study that, on first glance, appears quite sophisticated and impactful, then as you dig into it, a different picture emerges. But let's take the positive, which is the primary outcome; meat consumption declined to 51g/d after 4-weeks of being provided with free plant-meat substitutes, then remained 39g/d lower than at baseline after 8-weeks. If we consider that baseline meat intake was 130g/d, this decrease maintained at 8-weeks would still put participants <100g/d, in a range at which there is little to no evidence of health risks in the UK and European populations ^(13,14).

However, this potential 'health-gain' may not be so simple. As discussed under **Interesting Finding**, above, there was no impact of the use of meat substitutes on nutritional quality or objective risk factors. The study modelled the effects on GHG omissions and land use and found significant effects of the diet on both outcomes, and there would no doubt be a benefit to animal welfare; thus it may be that arguable that reasons to swap meat for plant-based substitutes are more environmental/ethical than nutritional, at this point.

And as highlighted under **Key Characteristic**, above, intention may not mean action. The "Theory of Planned Behaviour" [TPB], upon which the intervention in the present study was predicated, holds that behaviours are determined by the intentions to engage with a given behaviour coupled with perceived control over that behaviour. However, while the assessments of intention and perceived control showed modest increases in this study, there is somewhat of a disconnect between TPB measures and actual meat intake, which increased by 38% between Week 4 and Week 8.

Bearing in mind that the participants in this study were a demographic almost ideal for these behaviour changes – middle class, living alone [indicative of self-efficacy], majority female – the study highlights the potential challenges in sustaining long-term dietary behaviour change in the absence of a strongly valued social identity associated with an individual's diet ⁽¹⁵⁾. There remain numerous potential moderating factors – social class, age, and cultural factors – which need to be considered in this literature.

Application to Practice

Even for those consuming omnivorous diets, the data on environmental impacts of high meat diets is clear. Independent of health considerations, this is a sufficient reason to aim to reduce overall intake. However, we must be mindful of who is able to achieve this, and to meet any individual where they are at, always acknowledging that any dietary behaviour is a complex interaction of personal values, beliefs, ethics, habits, etc.

Where behaviour change to reduce meat consumption is desired by an individual, there are several behavioural correlates that show varying degrees of support in the research: intention to consume, self-efficacy and self-identity with the dietary changes, potential 'health gain', while endorsing action-based framing of effects on the environment and animal welfare ^(4,6,8,9).

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