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Can (dynamic) social norms encourage plant-based food purchases? a quasi-experimental study in real-world Dutch supermarkets

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Abstract

Background Communicating (dynamic) social norms is considered a promising tool to stimulate healthy and sustainable food choices. The aim of the present study was to evaluate to what extent a (dynamic) social norm intervention in real-world supermarkets could increase sales (grams per week) of meat alternatives (i.e. meat substitutes and legumes).

Methods A quasi-experimental study, including three intervention and three control supermarkets, was conducted during a 12-week period. The intervention supermarkets communicated dynamic norms textually on stickers and banners at different in-store locations (e.g. at the entrance, meat aisles). Moreover, the prominence of meat substitutes was (optically) increased and legumes were conveniently placed near the meat and meat substitutes section. Weekly sales data over a period of 75 weeks were obtained, 62 pre-intervention and 13 during intervention. Comparative interrupted time series analyses were conducted to analyse changes in meat alternative sales (in grams) during the intervention period in the intervention supermarkets compared to pre-intervention sales trends and to control supermarkets. Secondary outcomes included meat sales in grams per week and the ratio of protein content of meat alternatives to protein content of meat sales.

Results Average meat alternative sales in weekly grams before the intervention were $M = 371,931.2$ ($SD = 113,055.3$) in the control supermarkets and $M = 299,012.5$ ($SD = 91,722.8$) in the intervention supermarkets. The intervention did not change meat alternative sales in intervention supermarkets compared to pre-implementation sales trends and to control supermarkets ($B = -685.92$, 95% CI $[-9904.8; 8525.7]$). Sales of meats were also unaffected ($B = -130.91$, 95% CI $[-27,127.50; 26,858.33]$), as well as the ratio of protein content of meat alternatives to protein content of meat in grams sold per week ($B = -670.54$, 95% CI $[-8990.6; 7644.4]$).

Conclusions Communicating (dynamic) social norms via textual and environmental cues (i.e. increasing the prominence of meat alternatives in supermarkets) did not increase meat alternative sales nor reduce meat sales. With supermarkets playing an important role in modulating sustainable food choices, more substantial effort or changes are needed to increase plant-based food purchases and lower meat purchases.

Keywords Meat, Meat substitutes, Social norms, Dynamic norms, Real-world supermarkets, Intervention

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Background

Current levels of meat consumption in Western countries exceed both dietary guidelines for human health as well as recommendations aimed at climate change mitigation [1–3]. Especially processed meat consumption is associated with increased chronic disease risk, such as cardiovascular diseases, type 2 diabetes, and some forms of cancer [2–8]. Further, the production of specifically red and processed meat is considered to be an important contributor to the ongoing climate crisis as it contributes to biodiversity loss, reduced water quality, and global greenhouse gas emissions [3, 9]. Therefore, a shift from diets rich in predominantly animal-based to predominantly plant-based protein is crucial for a sustainable future, enhancing both human and planetary health [1, 9].

Changing population diets is complex and requires changes at several levels. As supermarkets are a place where most consumers in Western societies buy their groceries and thus reach a wide range of individuals, this is a setting identified as promising place to shift consumer choices at population level. An effective way to shift food purchases in supermarkets is through changing aspects of the food environment by means of ‘nudging’ [10–12]. Nudging was introduced by Thaler and Sunstein [12] and is defined as ‘any aspect of the choice architecture that alters people’s behaviour in a predictable way, without forbidding any options or significantly changing their economic incentives’. Nudges can be designed to target less conscious, more automatic decision-making processes, aiming to subtly disrupt habitual behaviours such as shopping behaviour at the supermarket [13]. By addressing these automatic processes, nudges can make it easier for customers to deviate from habitual behaviour and adopt alternative behaviours with rather minimal cognitive effort.

Within supermarkets, individuals are steered by a variety of factors in the physical and social environment. With respect to the latter, people’s food choices are widely recognised to be influenced by what they see others doing and by what they think others would approve of [14–16]. Following Focus Theory of Normative Conduct, these social norms of context-dependent, implicit, unwritten rules that explicitly distinguish between *describing* the behaviour of others within a specific referent group (i.e. descriptive norms) and/or *prescribe* what is considered appropriate by that specific referent group (i.e. injunctive norms) [17, 18]. Because of the forceful influence of social norms on food choices, social norm nudges (i.e. making social norms salient through textual communication) are deemed a promising tool to promote healthy and sustainable behaviours such as stimulating plant-based choices and/or discouraging meat choices

(e.g. [19–22]). The communication of social norms seems especially effective in changing behaviour when the norm regards the majority of a group (e.g. ‘8 in 10 people eat vegetarian most days of the week’), whereas so-called *minority norms* (e.g. ‘1 in 10 people eat vegetarian most days of the week’) can have reverse effects as it implicitly highlights that behaviour not being the normal thing to do for most of the referent group [23, 24]. Currently, reducing or abstaining from meat consumption is only done by a minority of Dutch consumers as the majority still consumes meat on five or more days of the week. In addition, only 5% of Dutch consumers are vegetarian or pescatarian [25]. Thus, communicating an absolute norm about meat reduction or abstention would result in a minority norm, risking adverse effects of such norm communication.

Recently, the communication of dynamic norms is considered promising to stimulate specifically behaviours that are currently not performed by the majority of a certain group. Instead of framing a norm statically, dynamic norms are social norms framed as a trend or an expected direction of a certain behaviour (e.g. ‘5 in 10 people are now changing and reducing their meat consumption’). By framing norms dynamically rather than statically, communicating a minority norm can be circumvented when it is a minority group that portrays the behaviour [26]. The communication of dynamic norms favouring meat reduction has shown to increase intention to reduce meat [20, 26, 27], increase meat-free orders at a café [26, 28], and reduce self-reported weekly servings of meat [29]. However, the communication of dynamic norms favouring meat reduction has in some instances also resulted in no effects [30, 31] or counter-effects, reducing vegetarian orders [28].

Although the effectiveness of dynamic norm communication aimed at plant-based food choices has been tested in food services (such as cafés or in-store restaurants) [26, 31], such interventions have yet to be tested in retailers such as in supermarkets. With over 75% of food in the Netherlands being purchased in the supermarket, supermarkets play a key role in stimulating the protein transition (i.e. increasing meat alternative sales and decreasing meat sales; [32]). Recently, Wolfswinkel and colleagues [33] showed that social norm perceptions favouring meat consumption tend to be stronger in supermarket settings compared to worksite cafeterias. Moreover, whereas food choices in restaurants and cafés are generally limited to one dish out of a fixed set of limited options, supermarkets offer a wide range of products for multiple dishes and purposes. As it is unclear to what extent the (dynamic) social norm communications impacts increasing meat alternative product sales in supermarkets, the present study aims to evaluate the effectiveness

of a dynamic norm intervention in real-world supermarkets aimed at increasing meat alternatives (i.e. meat substitutes and legumes). The intervention implemented in this study utilises both placement nudges (e.g. increased product salience, accessibility, or availability) as well as property nudges (e.g. highlighted product information or adjusted product design; [34]). Specifically, the property nudge included textual communications of dynamic norms throughout the supermarket. The placement nudges included increased availability of meat substitutes and legumes to increase norm salience through physical aspects of the supermarket [21, 35–37]. More specifically, the availability of meat substitutes and legumes (together labelled as meat alternatives) was (optically) increased, to make them more in the meat and meat substitute aisle. Primarily, it was hypothesised that these (dynamic) social norm communications favouring meat alternative purchases would increase meat alternative sales, relative to the pre-intervention meat alternative sales trend and control supermarkets. The secondary hypotheses posed that the intervention would increase (1) the ratio of meat alternatives to meat products (both in grams per week), (2) weekly sales of meat substitutes, (3) weekly sales of legumes, and (4) the ratio of protein content per 100 g of meat alternatives to total protein content of meat and meat alternatives per 100 g, and (5) would decrease meat product sales in grams per week.

Methods

Study design

A quasi-experimental study was conducted during a 13-week intervention period, including three intervention and three control supermarkets in the Netherlands. Sales data of the intervention supermarkets were compared to the control supermarkets sales and to a 62-week pre-intervention sales period. The presented study was pre-registered at Open Science Framework (OSF; osf.io/ak4q5). The TREND Statement checklist was used for the present study [38]. Ethical approval was granted by the Social Sciences Ethics Committee of Wageningen University (reference code: 2022–93-Wolfswinkel).

Study context

The project was initiated by the General Affair manager of the supermarket chain in collaboration with a private organisation that supports food services and retailers with improving the sustainability of their food supply. This private organisation worked together with the supermarket chain and their aim for this project was to pilot two interventions: (1) aimed at reducing food waste and (2) enhancing the protein transition through increasing plant-based sales and decreasing meat sales. The collaboration with the research team regarded the

second aim of the project. The intervention was developed and proposed by the authors and finalised in collaboration with the supermarket chain and the private organisation involved in the project.

Supermarket selection

The supermarkets where the intervention was implemented were located in the east-part of the Netherlands. The control supermarkets were matched by the retailer, based on three characteristics: compatible meat sales trends, compatible meat substitute sales trends, distance to nearest competitor in the area. The control supermarkets were located in the west-part of the country. Randomisation was not feasible as the retailer was in charge of the supermarket selection, including which locations were allowed to be intervention locations.

Intervention implementation and elements

The intervention was implemented in the three intervention supermarkets in week 36 of 2022 and ran through week 48 of 2022. The fidelity of the intervention was monitored through weekly to bi-weekly contact with the supermarket managers of the intervention supermarkets (i.e. images shared through text messages, contact by phone, and email). Additionally, members of the research team and employees from the private organisation involved visited all three intervention supermarkets four times in total.

Dynamic norm communications

As property nudges, banners were placed throughout the supermarket communicating a dynamic norm (i.e. ‘Our customers are increasingly buying vegetarian – [supermarket name] offers a wide range of options’) on floor stickers near the entrance and the meat (alternative) shelves (Fig. 1a). These texts were also placed as stickers in the shopping trollies and baskets (Fig. 1b–c), and as a banner placed above the meat and meat substitute shelves (Fig. 1d). Wobblers (i.e. bouncy shelf barker) were placed in the meat shelf communicating a dynamic norm ‘Increasingly purchased’ accompanied by a picture of a meat product on the left-hand side, a meat substitute on the right hand side, and an arrow between the two pictures pointing towards the meat substitute to indicate that the meat substitute increasingly replaced the meat product (Fig. 1e). The products depicted on the wobbler were placed on each side of the wobblers (e.g. hamburger—wobbler depicting a hamburger and a veggie burger—wobbler depicting a veggie burger) (Fig. 1e).

Availability of meat alternatives

To increase the availability of meat substitutes with placement nudges, meat and meat substitutes were



Fig. 1 a–g Intervention elements implemented in the intervention supermarkets.

placed next to each other in the same aisle and shelf. The availability of meat substitutes was increased by presenting meat substitutes so that the meat substitute assortment seemed (optically) larger than the meat assortment (Fig. 1f). Moreover, additional island racks with legumes (Fig. 1g) were placed right next to the meat and meat substitute aisle in addition to the regular canned food section of the supermarket, with the aim to reduce the effort to buy legumes.

Collected data and study outcomes

Sales data of all six supermarkets of 62 weeks prior to the intervention and thirteen during the intervention were

shared with the researchers by the retailer. Data consisted of number of items sold for each product, combined with product characteristics. Missing data (e.g. weight in grams or grams of protein content per 100 g of a specific product) were derived via online websites. For example, 38.5% of the products had missing data on corresponding weight. This was derived via the supermarket chains' website. If not found on their website, competitor websites were consulted combined with indications of standard sizes as reported by the Netherlands Nutrition Centre [39]. Similarly, missing protein content of 34.7% of the meat and meat alternative products was mainly derived from the Dutch Food Composition Database

Table 1 Study outcomes extracted from sales data categories as described in the supermarket sales data (Dutch)

Defined outcome	Sales data product categories
Meat products	Barbecue packs ('B.G.F. pakketten'), organic ('Bio'), processed meat ('Gedraaide vleesproducten'), chicken ('Kip'), lamb ('Lam'), beef ('Rund'), free range chicken ('Scharrelkip'), pork ('Varken'). <i>Excluding soups and sauces ('Soepen en Sauzen') and deli meats ('Vleeswaren')</i>
Meat alternatives	
Meat substitute	Vegetarian meat substitutes ('Vegetarische vleesvervangers'), including but not limited to vegetarian burger, tofu, tempeh, and vegan chicken nuggets. <i>Excluding vegetarian lunch meats ('Vegetarische producten') such as vegetarian chicken slices</i>
Legumes	Legumes ('Peulvruchten')

[40] and at the retailer's website. If not available, other retailers' websites were consulted to determine a protein content as accurate as possible. To this set, total grams, turnover, and protein were also calculated for *meat alternatives* (*legumes* and *meat substitute* combined). Moreover, the ratio of meat alternatives sold per week in grams of meat sold in grams per week and the ratio of protein content for meat alternatives to total protein content of both meat and meat alternatives (*legumes* and *meat substitutes*) were calculated. Total grams, turnover, and grams of protein content per 100 g of the intervention products (*meats*, *meat substitutes*, and *legumes*) were calculated for each week and supermarket.

From a total of 75 datasheets, detailing weekly sales data of all six supermarkets, all outcomes were extracted through pivot tables. The primary outcome variable was *meat alternative sales in grams per week*. Meat alternatives included all vegetarian and vegan meat substitutes (e.g. tofu, veggie burgers) and all legumes (e.g. chickpeas, lentils). Meat alternatives excluded lunch meat substitutes (e.g. mock ham, mock bacon) and products made from legumes (e.g. chickpea pasta or lentil rice). The secondary outcome variables were *ratio meat alternatives to meats sold in grams per week*, *meats in grams per week*, *meat substitutes in grams per week*, *legumes in grams per week*, and the *ratio of protein content meat alternatives to total protein of meat and meat alternatives*. Meat products included all uncooked meats and poultry (e.g. patties, chicken breast, sausages) but excluded all preserved and salt-cured meats (e.g. beef jerky, chorizo, hot dogs) and excluded lunch or deli meats (e.g. bacon, chicken slices). All outcome variables are summarised in Table 1.

Statistical analyses

The statistical analyses plan was pre-registered at OSF (osf.io/ak4q5). There is a slight deviation from the pre-registered analysis plan that does not affect the main and secondary outcomes in the present study (i.e. separate interrupted time series analyses were not run before the controlled interrupted time series analysis). Scatterplots, histograms, and line graphs of the main outcome (*Meat alternative sales in grams*) were checked for all six supermarkets separately. Further, descriptive statistics (M, SD, IQR, min, max) were inspected for all outcome variables (primary and secondary) for each supermarket. Also, specifically the descriptive variables (M, SD, IQR, min, max) were checked during the Dutch Week Without Meat ('Week Zonder Vlees') (March 7 till March 13 2022 for all supermarkets; i.e. pre-intervention period) to check the extent to which the 'proneness to buying meat alternatives' was comparable in each supermarket (inspired by Piernas and colleagues [41]).

For both primary and secondary outcomes, a controlled interrupted time series (CITS) analysis was conducted with R statistical software (version 4.2.1). CITS is considered the most fitting approach because the quasi-experimental intervention took place in a natural setting, the outcome measures were expected to change relatively quickly after implementation of the intervention, and a substantial amount of pre-intervention data points were available [42]. CITS analysis is considered advantageous compared to single-group interrupted time series analysis (e.g. data analysis of intervention supermarkets without considering control supermarkets), as CITS allows for comparing both intervention and control supermarkets in the same time period, while controlling for pre-intervention sales trends and time-sensitive factors [43]. Because all supermarkets showed approximate comparable pre-intervention sales trends (Figs. A1–A11, Additional file 1), the three intervention supermarkets were combined and compared to the three control supermarkets combined (0 = control supermarkets, 1 = intervention supermarkets). The analysis omitted the first week of the intervention as a transition period. One supermarket showed a slight deviation in pre-intervention sales trends, which was therefore excluded in a sensitivity analysis (see further below). All supermarkets showed comparable sales trends of meat alternatives and meats in grams per week during the Week Without Meat (i.e. 'Week Zonder Vlees'; Figs. A12–A14, Additional file 1).

The CITS analysis was based on a linear mixed model to measure changes in meat alternative sales during the intervention period in the intervention supermarkets compared to the control supermarkets, treating the pre-intervention period trend as a fixed effect and with a random intercept for supermarkets. The change in product

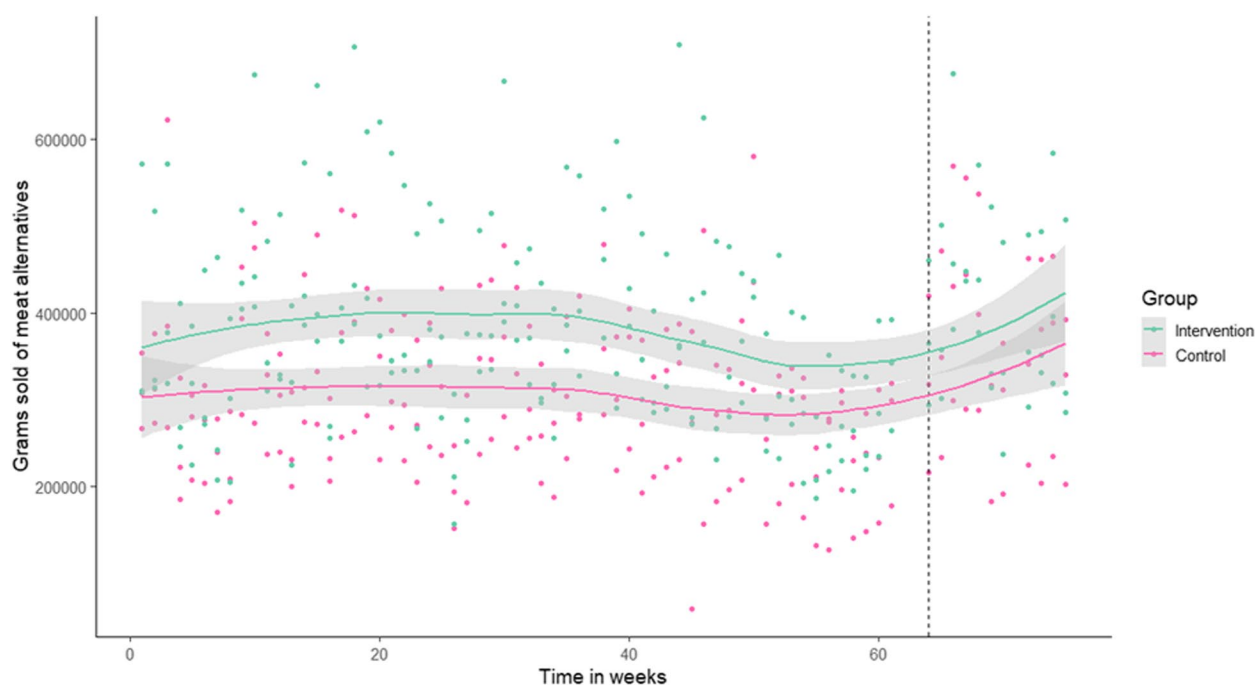


Fig. 2 Sales trends of meat alternatives sold in grams per week pre- and post-implementation of nudge interventions in intervention supermarkets and control supermarkets. Dashed line marks implementation of (dynamic) social norm intervention

sales in grams per week was modelled as an immediate step change, assuming an immediate and stable intervention effect. The same analysis was run for all secondary outcomes (*Ratio meat alternative sales to meat sales in grams per week*, *Meats in grams per week*, *Meat substitute sales in grams per week*, *Legume sales in grams per week*, and *Ratio protein content per 100 g of meat alternatives to protein content per 100 g of meat sold per week*).

Outliers below the lower fence ($Q1 \text{ value} - (3 \times IQR)$) or above the upper fence ($Q3 \text{ value} + (3 \times IQR)$) were excluded from the main analysis. For the sensitivity analysis, a CITS analysis was done with the outliers included into the dataset. As one of the intervention supermarkets had a pre-intervention trend that differed slightly from all three control supermarkets, the same CITS analysis was repeated excluding this supermarket as a second sensitivity analysis.

Results

Primary outcome: meat alternative sales in grams per week

The average sales of meat alternatives before the intervention were $M = 371,931.2$ ($SD = 113,055.3$) grams per week in the control supermarkets and $M = 299,012.5$ ($SD = 91,722.8$) grams per week in the intervention supermarkets. During the intervention, average meat alternative sales in grams per week were $M = 405,885.8$ ($SD = 102,872.1$) in the control supermarkets and $M = 351,264.7$ ($SD = 108,580.8$) in the intervention

supermarkets. The (dynamic) social norm intervention did not change meat alternative sales in grams per week compared to the pre-intervention sales trends and to control supermarkets ($B = -685.9$, 95% CI $[-9904.8; 8525.7]$; Fig. 2).

Secondary outcomes

Average sales and ratios of the secondary outcomes are summarised in Table 2. The (dynamic) social norm intervention did not change sales trends of the ratio of meat alternative to meats sold in grams per week compared to the pre-intervention sales trends and to control supermarkets ($B = -0.1$, 95% CI $[-0.5, 0.4]$), nor did the interventions change meats in grams per week ($B = -130.9$, 95% CI $[-27,127.5; 26,858.3]$), meat substitutes in grams per week ($B = -14.9$, 95% CI $[-2933.0; 2903.7]$), legume sales in grams per week ($B = -670.5$, 95% CI $[-8990.6; 7644.4]$), and ratio of meat alternative protein content to total protein content ($B = -0.01$, 95% CI $[-0.19, 0.2]$).

Sensitivity analyses

The sensitivity analysis excluding the intervention supermarkets with a slightly different pre-intervention trend than the control supermarkets showed comparable results to the main outcome meat alternative sales in grams per week ($B = -1804.6$; 95% CI $[-12,174.3; 8559.7]$). Similarly, the sensitivity analysis including the

Table 2 Average sales of secondary outcomes pre- and post-implementation of social norm interventions

	Pre-intervention period		Intervention period	
	Control supermarkets	Intervention supermarkets	Control supermarkets	Intervention supermarkets
Ratio meat alternatives to meats	17.4 (3.6)	17.4 (4.1)	18.3 (2.9)	19.2 (3.5)
Meats in grams per week, mean (SD)	2,127,419.0 (427,608.7)	1,747,579.0 (447,358.7)	2,193,451.0 (295,261.9)	1,827,294.0 (428,294.8)
Meat substitutes in grams per week, mean (SD)	78,066.9 (27,817.0)	75,981.7 (28,089.2)	70,846.6 (18,876.5)	75,274.0 (21,229.6)
Legumes in grams per week, mean (SD)	293,864.3 (108,548.4)	223,030.8 (76,304.6)	335,039.2 (4528.6)	275,990.8 (90,500.5)
Ratio of protein content meat alternatives to total protein of meat and meat alternatives	7.1 (1.2)	7.5 (1.5)	7.6 (1.1)	8.4 (1.5)

outliers that were excluded for the main analysis also showed comparable results to the main outcome ($B = -412.1$, 95% CI $[-9843.3; 10,667.4]$).

Fidelity

During weekly supermarket visits, some differences between the planned intervention implementation and actual implementation were observed. First, some adjustments were made to the banners and stickers as they slightly differed from the original design (i.e. a logo associated with plant-based products was placed on the banners and stickers; Fig. A15, Additional file 1). The stickers and banners with the correct design were placed in week 37 of 2022 (i.e. Figure 1a–e). Second, due to logistical issues, the dynamic norm communications in the trollies and baskets were only implemented in week 41 of 2022 and did not have product images on them as planned (osf.io/ak4q5). In one of the intervention supermarkets, the norm communication was placed in only a small number of carts because it was considered too labour-intensive by the supermarket manager. Lastly, due to shortages and delivery issues, there were empty spots in the meat substitute section throughout the intervention period (e.g. a plant-based burger of a certain brand was out of stock). The place where a plant-based product was supposed to be placed was at times replaced with a meat product to fill the empty spot.

Discussion

Communicating (dynamic) social norms textually and via the physical environment by increasing the prominence of meat alternatives in real-world supermarkets did not change sales of meat alternatives (i.e. meat substitutes and legumes) over a 13-week intervention period, nor did it change the sales of meat substitutes, legumes, meats, or the ratio of protein content of meat alternatives to protein content of meats and meat alternatives combined. Acknowledging the sub-optimal intervention

implementation fidelity, the results seem to suggest that additional and/or more substantial efforts or changes in the supermarket environment are needed to increase plant-based food purchases or to decrease meat purchases in supermarkets.

While this is, to the best of our knowledge, the first social norm intervention aimed at meat alternative sales, this is not the first supermarket intervention using social norms aimed to change purchase behaviour. For example, social norms communicated in grocery carts were considered effective in increasing money spend on fruits and vegetables [44], social norm banners increased low-fat cheese purchases (instead of regular cheese) among ego-depleted customers [45], and social norms communicated on shopping trolley inlays increased vegetable purchases [46]. The findings of the present study contradict these findings. One reason for this contradiction may be related to the preference for meat in the Netherlands. Nudges have shown to be more effective in the absence of strong preexisting preferences [47, 48]. Meat has a prominent place in Western countries, and meat consumers may feel (emotionally) attached to meat [49, 50]. It is possible that customers feel strong preferences towards meat products, where these preexisting preferences may be weaker for fruits and vegetables or (low-fat) cheese.

One explanation for this contradiction and the lack of effectiveness of these (dynamic) social norm communications may, in part, be explained by the salience of prevailing meat consumption norms in supermarkets. For example, although (dynamic) social norms favouring meat reduction were highlighted through textual communications and (optically) increased prominence of meat alternatives, meat products still have a dominant presence in supermarkets. To illustrate, meat options were still more available compared to their plant-based alternatives, and this larger assortment of meat products may have served as a cue implying a norm favouring meat consumption. This is in line with social norm literature

stating that social norms need to be salient (i.e. focal in attention) at the moment of said behaviour in order to be able to exert an influence on behaviour [17, 51]. Hence, the effect of the intervention may have been overruled by salient social norms favouring meat consumption. In a similar vein, preexisting norm perceptions may have blurred the effect of the social norm communications in the intervention. For example, a recent cross-sectional study among meat eaters showed that social norm perceptions favouring meat consumption tend to be stronger in supermarket settings compared to worksite cafeterias [33]. This could explain why (dynamic) norm communications were successful in previous worksite cafeterias settings but not in the current supermarket study.

Another explanation for the null results of the intervention could be related to its salience (i.e. if and how much it is visible to customers). According to the Focus Theory of Normative Conduct, social norms exert an influence on behaviour only when they are salient to individuals (i.e. when customers noticed the intervention; [17]). This is particularly relevant in supermarkets, as real-world supermarkets are complex food environments with external cues such as price promotions, lighting, and music that may influence customers' decisions [52]. Such external cues may have diverted the focus away from the (dynamic) social norm communications. Therefore, there is a considerable chance that (the majority of) customers did not notice the intervention elements as consumers are bombarded with information and external incentives demanding their attention [46].

Another explanation for the null results is plausibly related to the habitual nature of food purchases supermarkets [53]. Shopping behaviour in supermarkets is often unplanned, requires little cognitive elaboration, and largely habitual, which minimises the need for information seeking [13, 53, 54]. In the Netherlands, over 75% of the food purchases take place in supermarkets, where customers likely follow established routines and strong shopping habits. As in most Western countries, meat holds a prominent place in most traditional Dutch dishes [50, 55, 56]. It is, therefore, plausible that these habits and routines may have been more influential on the purchasing behaviour of customers than the (dynamic) social norm communications. That is, the intervention may not have been substantial enough to disrupt strong meat purchasing habits.

Lastly, the intervention's lack of effectiveness might also be partly due to shortcomings in implementation fidelity, including errors in the design of the norm communications and product shortages. Relatively low implementation fidelity is however common in complex real-world settings such as supermarkets [57, 58]. Yet, a

more systematic or quantitative fidelity check approach would have benefited the reporting of the present study.

Strengths and limitations

Strengths of this study include implementing nudges aimed at increased meat alternative sales in a real-world supermarket setting, a controlled design, and real-world sales data of both the intervention period as well as an extensive pre-intervention period. Moreover, it was deliberately decided to postpone public and (social) media communications regarding the intervention until after the intervention period, to prevent influencing customers during the intervention.

A limitation of the present study that should be acknowledged is the relatively low number of supermarkets included. Since the intervention was initiated by the supermarket chain, researchers had no influence over the number of intervention supermarkets. A larger number of supermarkets would have led to a more precise estimate of the intervention effects and would have increased external validity [59], while allowing to explore potential regional differences across the county. However, we are confident that including of a high number of pre-intervention weekly sales data time points has secured sufficient statistical power to conduct the present analyses [60]. Moreover, as a result of the aggregated nature of the sales data, individual differences disappear. As individuals may respond differently to an intervention (e.g. 45), it remains unclear to what extent some customers may have been influenced whereas others have not or even showed resistance.

Implications and future research

Nudging-type interventions, as conducted in the present study, are generally considered cost-efficient and relatively low-effort to implement [12, 61, 62]. A previous study in the Netherlands indicated that supermarket chains prefer these type of interventions as they are considered low-risk in terms of profit margins and market position [63]. However, the findings of the present study, together with those of previous studies, underscore that these 'soft' interventions in supermarkets seem insufficient to move the needle on sustainable behaviour change, such as increasing meat substitute sales and decreasing meat product sales [41, 64–67]. Instead, there is a growing call for more structural interventions such as price promotions or combined intervention techniques [66, 67]. Supermarket interventions aimed at increasing healthy purchases using economic incentives (e.g. subsidies, taxes) seem to be most promising, specifically when combined with additional promotions [68]. While carbon-tax on meat seem to be promising in terms of reducing green-house-gas emissions in simulation

studies [69], it could be a potential fruitful direction for future research to investigate the impact of more structural interventions such as carbon-tax implemented over a longer period (i.e. 1 year or longer) to increase plant-based product purchases and decreased meat product purchases. Moreover, although (dynamic) social norm communications did not affect meat alternative and meat sales in the present study, it remains unknown to what extent the intervention was able to affect social norm perceptions of customers. For example, although Raghoobar and colleagues [21] did not find an effect on hypothetical food choice when increasing the prominence of plant-based foods (opposed to animal-based), they did find an increase in descriptive norm perceptions. Future research could investigate the extent to which such (dynamic) social norm interventions in real-world supermarkets affects social norm perceptions.

Lastly, from the present study it remains unclear to what extent customers value animal welfare, individual health, and environmental health in light of meat consumption while it is reported that these are common drivers for people to switch to plant-based diets [70, 71]. Having insight in the extent to which customers value such considerations may shed light on potential explanations for the (lack of) effectiveness of social norm interventions aimed at reducing meat purchases and/or increasing meat alternative purchases. To illustrate, previous studies have shown that appealing to conscious psychological determinants of meat reduction (e.g. ethical or health considerations; [10]) lacks effectiveness in changing behaviour. It would be a valuable addition for future research to combine aggregated sales data with individual survey data to gain insights in potential individual considerations related to meat consumption.

Conclusions

The present study showed that a (dynamic) social norm intervention evaluated in real-world supermarkets was not effective in changing meat alternative (i.e. meat substitutes and legumes) sales, but also that the intervention was only implemented in a limited way. As the vast majority of food purchases take place in supermarkets, the supermarket is a crucial food environment to play a role in stimulating meat alternative food purchases. The results of the present and previous studies underscore the need for more structural interventions such as pricing strategies (e.g. carbon-tax) aimed at increasing meat alternative sales and decreasing meat sales.

Abbreviations

OSF Open Science Framework
CITS Comparative interrupted time series

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12916-025-03986-3>.

Additional file 1: intervention sales trends of meat substitutes, legumes, meat, meat alternatives, and bread.intervention trends of the ratio of protein content per 100 g of the product of meat alternatives to total protein in the separate intervention and control supermarkets. Sales trends of meat substitutes, legumes, and meat before, during, and after the Dutch Week Without Meat. Initial design of intervention elements

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Authors' contributions

All authors contributed to the design of the study, and all authors contributed to the writing and reviewing of the manuscript. S.W. and J.M.S. conducted the data analysis. All authors read and approved the final manuscript.

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Data availability

This research was carried out in collaboration between Wageningen University and the supermarket chain. The dataset is considered confidential under the agreement between Wageningen University and the supermarket chain. Therefore, external researchers cannot access the dataset of the present study without explicit written consent of the supermarket chain.

Declarations

Ethics approval and consent to participate

The Social Sciences Ethics Committee of Wageningen University & Research approved this study (reference code: 2022-93-Wolfswinkel) and this study complies with the Netherlands Code of Conduct for Research Integrity.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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