Food Quality and Preference 114 (2024) 105067

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

A *meta*-review of consumer behaviour studies on meat reduction and alternative protein acceptance

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ARTICLE INFO

Keywords:
Consumer
Meat reduction
Protein transition
Drivers
Interventions
Insects
Cultured meat
Seaweed
Meat analogues

ABSTRACT

Transitioning away from meat-heavy diets towards more plant-based diets is beneficial to environmental and public health as well as animal welfare. However, current food consumption practices do generally not follow this "protein transition". Therefore, we are in need of taking action to accelerate the protein transition. We conduct a systematic review of systematic reviews (hereafter 'meta-review') to provide an overview of potential drivers and moreover we observe these findings from a policy perspective, resulting in two main outcomes. First, the *meta*-review mapped potential drivers in terms of capability, opportunity, and motivation. The latter appeared to be given more attention. Motivational and opportunity drivers emerged as the most prominent. Especially motives, emotions, awareness, taste, and physical environment (redesign of menus, defaults, portion sizes and visibility of plant-based options) proved relevant with high evidence. Social and cultural environment, familiarity, food neophobia, and development of skills appeared promising but remained under-researched. Second, the present *meta*-review reviewed the findings from a policy perspective. The number of studies that translated findings to policymaking or included policy evaluations turned out to be limited. Besides, all studies only refer to non-coercive interventions. The *meta*-review finalizes with the most prominent routes for future research and policies. It highlights the need for an integrated framework, comparative research and a focus on real-life and long-term behaviour change, to support coherent research and scholarly conclusions on the one hand and evidence-based, action-oriented policymaking targeted at the acceleration of the protein transition on the other.

1. Introduction

On average current Western food consumption patterns are characterized by an intake of animal-based foods, particularly meat and dairy products, exceeding dietary recommendations (Dagevos & Verbeke, 2022; Stubbs et al., 2018). Despite somewhat flattening trends in overall meat consumption levels in high-consuming countries, usually accompanied by minor decreases in red meat consumption and rising consumer preferences for poultry meat, global meat consumption is projected to keep on rising significantly in the foreseeable future: growth in global meat consumption is estimated to increase by 15% by 2031 compared with the base period 2019–2021 (Font-i-Furnols, 2023; OECD/FAO, 2022; Parlasca & Qaim, 2022). Particularly in middle-income countries the meatification of the diet is contributing substantially to the rising meat demand at a global scale due to population growth, rising incomes and urbanisation (Milfort et al., 2019). This transition is anathema to the protein transition with its emphasis on the urgency of a dietary shift – first and foremost in high-consuming regions in the (Western) world – from animal proteins to plant-based proteins (i.e., plant-based meat substitutes, whole grains, legumes, nuts, and seeds). A de-meatification of the diet (Weis & Ellis, 2022) is generally acknowledged as an important pathway towards a more sustainable food system in terms of climate emissions reduction, lowering environmental impact (water, land, energy use), alleviating animal suffering and improving human health (Aiking & de Boer, 2020; Onwezen, 2022; Willett et al., 2019). This transition also fits the 2030 Agenda for Sustainable Development from the (United Nations, UN, 2015), particularly Sustainable Development Goals 12 and 13 on Responsible Consumption and Production and Climate change respectively.

Despite the amount and consistency of the scientific evidence found in recent decades that transitioning away from meat-heavy diets towards dietary patterns higher in plant-based foods is essential, and despite the calls of academics and the dietary recommendations of authoritative organisations in favour of the protein transition, many of

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https://doi.org/10.1016/j.foodqual.2023.105067
Received 7 March 2023; Received in revised form 6 November 2023; Accepted 29 November 2023
Available online 4 December 2023

today's Western food consumers express low to no meat reduction intentions or behaviours (Dagevos, 2021; Hartmann & Siegrist, 2017). After decades of research, it seems to be high time to promulgate that we are in need of decades of action to accelerate the protein transition. The practice of the recent past and the present day teaches that diets do not change automatically into lower animal-based protein intake and higher plant-based protein consumption (e.g., Onwezen et al., 2022). Many food consumers are personally, socially, and culturally attached to their meaty eating patterns and these cherished food habits are continuously perpetuated in the supermarket, on the menu or during social gatherings. Consequently, bending the meat curve through reducing meat consumption and/or substituting meat products for alternative protein foods is anything but self-evident. In brief, to boost the protein transition, it needs support.

This paper aims to contribute to the ambition of making the 2020s a decade of action by conducting a *meta*-review of consumer studies covering the two Rs of *reduction* and *replacement* (Dagevos, 2021, p. 531). Meat reducing strategies (i.e., reduction) and alternative protein acceptance strategies (i.e., replacement) can be qualified as two overarching strategies featuring in the protein transition literature. A *meta*-review can be described as a systematic review of systematic reviews. Given its comprehensive scope, a *meta*-review is most useful to inform scholars and policymakers about the state of affairs and how to proceed given the evidence as well as the knowledge gaps found. This is what we aim for with the *meta*-review we have conducted.

1.1. Consumer behaviour and protein policies

More specifically, the focus of the current *meta*-review on consumer-centred research may be seen against the backdrop of a recent interest in the demand-side of the protein transition. After being ignored for a long time due to a 'productivist' dominancy, change in eating patterns through shifting food consumer choices and preferences to more sustainable and healthy directions has gained momentum. This trend indicates a reduction of (over-)consumption of animal-based foods and an increase of consumption of plant-based food products. Currently, food consumer behaviour is an indispensable part of the sustainability equation and, by the same token, a pivotal part of finding support for the protein transition.

Even though the topic of sustainable food consumption has gained increasing attention in academic and policy circles, this has not yet converted into concrete ambitions and specific policies on the protein transition across Europe. Admittedly, the European Commission has mentioned clearly in its Farm to Fork Strategy (2020) that shifting to a more plant-based diet with less meat is key to make food consumption patterns more sustainable from both health and environmental points of view. But this does not undo that the policy focus is usually on the production of plant-based proteins, whereas consumption and demand-side policies receive merely secondary attention (e.g., EU, 2022). The Netherlands, however, has made a first attempt to change this situation: in 2022 the Dutch Ministry of Agriculture stated the policy objective to change the ratio between plant-based/animal-based protein consumption from 43/57 at present to 50/50 in 2030. This policy goal is remarkable at least for two reasons. First, public policymaking breaks here, albeit cautiously, with the political taboo on addressing attention to meat moderation. With the notable exception of Flanders (Belgium) we are not aware of other current examples at a country level in which a direct policy objective has been set in rebalancing protein consumption away from meat. Most national policies do not refer to the protein transition – let alone, refer to meat reduction –, and the countries that do focus on the protein transition primarily focus on shifts in the supply side such as food production and provision (e.g., Austria, Denmark, UK). Second, as a result of behaviour change being pivotal to this Dutch policy objective, consumers are considered important agents of change. This consumer behaviour perspective is innovative in food policymaking.

Given this context, the current work aims to support the protein transition from the demand side by providing food policymaking with robust findings. A better understanding of what drives consumer behaviour in the domains of meat reduction and meat replacement through alternative protein products could support policymaking and the implementation of policies that facilitate the protein transition.

The collection of findings and gaps in research identified in this *meta*-review of food consumer studies on meat reduction and acceptance of alternative proteins connects to both contexts just mentioned: *consumer insights* and *policy insights*. First, regarding consumer insights, the current study will result in an evidence-based overview of drivers of food consumer behaviour change to demonstrate which ones have been extensively addressed and which ones remain under-researched yet. We will map the field by differentiating in motivation, opportunity, and capability. This approach expands on an impactful approach in behavioural research generally, i.e., the COM-B model by Michie et al. (2011) as well as on the call by Graça and colleagues (2019) to use this model in the domain of the protein transition specifically. Second, regarding policy insights, special attention will be paid to what extent policymaking is already considered in consumer studies as well as to promising routes for protein policies, and related to these issues, what should be on the knowledge agenda of future research devoted to support food policymaking. The categories will be based on the policy intervention ladder developed by the Nuffield Council on Bioethics (2007) – consistent with a related study we conducted (Dagevos & Onwezen, forthcoming).

This policy perspective is also distinctive from other recent reviews. Instructive relevant reviews on the acceptance of specific novel proteins (Hartmann & Siegrist, 2017; Onwezen et al., 2021), reducing meat consumption (Graça et al., 2019; Sanchez-Sabate & Sabaté, 2019), adopting plant-based consumption (Corrin & Papadopoulos, 2017; Rosenfeld, 2018), or cultured meat acceptance (Bryant & Barnett, 2018), hardly if ever address policies nor aim to serve policymaking with scholarly insights. A recent *meta*-review devoted to interventions intended to (decrease or increase) animal-product consumption by Grundy et al. (2021) lacks a policy orientation too. However cognate, this *meta*-review also differs from ours due to Grundy and colleagues' primarily interest in interventions targeted at (decreasing or increasing) the consumption of meat and dairy foods, whereas we are particularly interested in drivers of consumer behaviour in favour of the protein transition, i.e., meat reduction and alternative protein replacement.

2. Methods

2.1. Literature search and eligibility criteria

The current *meta*-review identifies systematic literature studies based on a protocol for identifying, screening, and evaluating the eligibility of articles, following the PRISMA reporting approach (Rethlefsen et al., 2021), and the best-practice guidelines to conduct a *meta*-review (Johnson & Hennessy, 2019). Following Johnson and Hennessy a *meta*-review entails the following steps: formulating research problem, collecting the reviews, coding and thoroughly evaluating the quality of the included results, calculating effects, analysing database and interpretation of results. Below the steps are described in detail.

2.2. Research problem and search strategy to collect reviews

The current *meta*-review aims to provide an overview of consumer studies covering the two Rs of reduction and replacement. We developed a search string based on previous review articles (particularly Kwasny et al., 2022; Onwezen et al., 2021) to assure we included systematic reviews that focus on consumer behaviour that supports the protein transition.

The search term was tested and refined through multiple rounds until the resulting number of papers was manageable while simultaneously

demonstrating face validity (i.e., whether important key papers were included). Terms that relate to 'Review' were included to ensure that the main focus of the study was to provide a systematic overview. 'Consumer' was included to ensure a primary focus on consumers' food consumption. The various words for 'meat reduction' and 'alternative proteins' were included because we aimed to include articles that focus on meat reducing and meat replacing strategies.

In June 2023, a literature search was conducted in the electronic database of Scopus, Web of Science and Pubmed using the following search query:

(TITLE (review) AND TITLE-ABS-KEY (consumer) AND TITLE-ABS-KEY ("meat reduc*") OR TITLE-ABS-KEY ("meat avoid*") OR TITLE-ABS-KEY ("reducing meat") OR TITLE-ABS-KEY ("less meat") OR TITLE-ABS-KEY ("low meat") OR TITLE-ABS-KEY ("meat consumption") OR TITLE-ABS-KEY ("reduced meat") OR TITLE-ABS-KEY ("decrease meat") OR TITLE-ABS-KEY ("plant-based") OR TITLE-ABS-KEY ("vegetarian") OR TITLE-ABS-KEY ("meat substitute*") OR TITLE-ABS-KEY ("alternative protein*") OR TITLE-ABS-KEY ("meat analogue") OR TITLE-ABS-KEY ("sustainable protein*") OR TITLE-ABS-KEY ("insect*") OR TITLE-ABS-KEY ("cultured meat") OR TITLE-ABS-KEY ("invitro meat") OR TITLE-ABS-KEY ("pulse*") OR TITLE-ABS-KEY ("synthetic meat") OR TITLE-ABS-KEY ("seaweed") OR TITLE-ABS-KEY ("alga*") OR TITLE-ABS-KEY ("lupin*") OR TITLE-ABS-KEY ("legume") OR TITLE-ABS-KEY ("bean*") AND TITLE-ABS-KEY ("systematic review") OR TITLE-ABS-KEY ("literature review")) AND (LIMIT-TO (PUBYEAR,2022) OR LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2020) OR LIMIT-TO (PUBYEAR,2019) OR LIMIT-TO (PUBYEAR,2023)).

The selection protocol was developed prior to the search. All review studies were screened on title, abstract and keywords by two independent raters following inclusion criteria that were based on the relevant components of PICO (Population, Intervention and Outcome) (Table 1). Interrater agreement resulted in a conformity of >95 %. Disagreement on two review studies was resolved by a discussion as a more detailed look revealed these reviews did not confirm the inclusion criteria. Most reviews were excluded because either they did not focus primarily on consumers, meat reduction or alternative proteins. A list of excluded articles including the reason of exclusion can be found in the Appendix (Table A1). Based on this screening, 22 review studies were considered relevant.

Subsequent searches with a wider scope (excluding the search term review in the title, and adapting consumer to consum*) were conducted from which only the titles were screened. Resulting in 6 relevant potential studies, which were also screened on title and abstract by both authors. Resulting in the selection of an additional 2 review articles.

In the next step, full-text articles were retrieved. All review studies were read and we further refined the set of included reviews by excluding one additional paper that did not fit the main purpose of our *meta*-review. The selection was limited to the years 2019–2023 and resulted in a total of 23 articles. See Fig. 1 for a flow diagram visualising all steps of our search.

2.3. Coding and quality assessment

All relevant information from the review studies was extracted. Information was gathered on countries, number of papers, level of drivers and/or framework, focus area, most prominent driver(s), conclusions, policy, and future research. Finally, chatGPT (i.e., Chat Generative Pre-trained Transformer) was used to add an additional nonhuman summary of the general discussion and conclusion (assignment: summarize in scientific text: [include discussion and conclusion]). The information is summarized in Table 2 (for more details of the full table see Appendix A2).

Additionally, we extracted information on the underlying studies used in each systematic review, by extracting information on the search, used articles, research question, amount and type of databases searched, exclusion criteria, search term(s), total studies, selection of studies and type of studies in terms of design and type of literature (see Table in Appendix A3).

Quality assessment of all included review articles was conducted using the AMSTAR2 checklist (i.e., Assessing the Methodological Quality of Systematic Reviews; Shea et al., 2017). Systematic reviews vary widely in quality, so it is important to critically evaluate them (Shea et al., 2017). The assessments can be found in the Appendix (Table A4). Note that AMSTAR scores are not developed to use as total scores. The overview provides an indication of quality assessment, and especially can be used to assure at which points conclusions can be drawn and at which points one should be more careful. Having a detailed look at the AMSTAR scores in combination with the scientific outlet (A-journals or not) and the number of citations reveal that not all systematic reviews have a high quality. The field can be advanced by using stricter guidelines (see 4.3).

2.4. Assessing effects and used frameworks

As very few review studies reported effect sizes of primary studies it was not feasible to report effect sizes. Moreover, our study is unique as it has a broad focus, including all types of studies towards various consumer groups, drivers or products. Therefore, a narrative synthesis is needed (Siddaway et al., 2019). To support our *meta*-review in getting insights in which conclusions can be drawn we used the number of studies in combination with the quality assessment (AMSTAR) to categories conclusions on low, medium and high evidence. See details in Table 3.

We used an established framework to categorise the different drivers of behaviour. The division in motivation, opportunity and capability follows the highly influential COM-B model (Michie et al., 2011), which is applied in various domains, also in the specific domain of the protein transition (following Graça et al., 2019; Nguyen et al., 2022; Onwezen et al., 2021). Used definitions and drivers are based on a previous review study (Nguyen et al., 2022). The key reviews are used to count for each driver how often it is mentioned. The categories with more than 3 counts are in turn selected (see Appendix Table A5 for the selection of most relevant drivers). Note that many more drivers or subgroups could have

Table 1
Inclusion and exclusion criteria.

	Inclusion criteria	Exclusion criteria
Types of reviews	• A systematic review study • Scientifically published articles in English	• Non-systematic reviews or *meta*-analyses; primary research papers; theory papers; narrative reviews • Grey literature and non-English articles
Types of participants	• Concerns any type of target population, or groups of participants, or segments	
Focus area	• Concerns meat reduction strategies • Concerns acceptance of alternative protein sources	• Focus on meat consumption without link to meat reducing strategies
	• A main focus on consumers	• Is unrelated to consumer behaviour
Types of outcome measures	• A focus on drivers of behaviour or behaviour change	• Given our focus on immediate drivers of behaviour, we excluded reviews which focused solely on sensory aspects, knowledge of or affective responses without assessing consumption

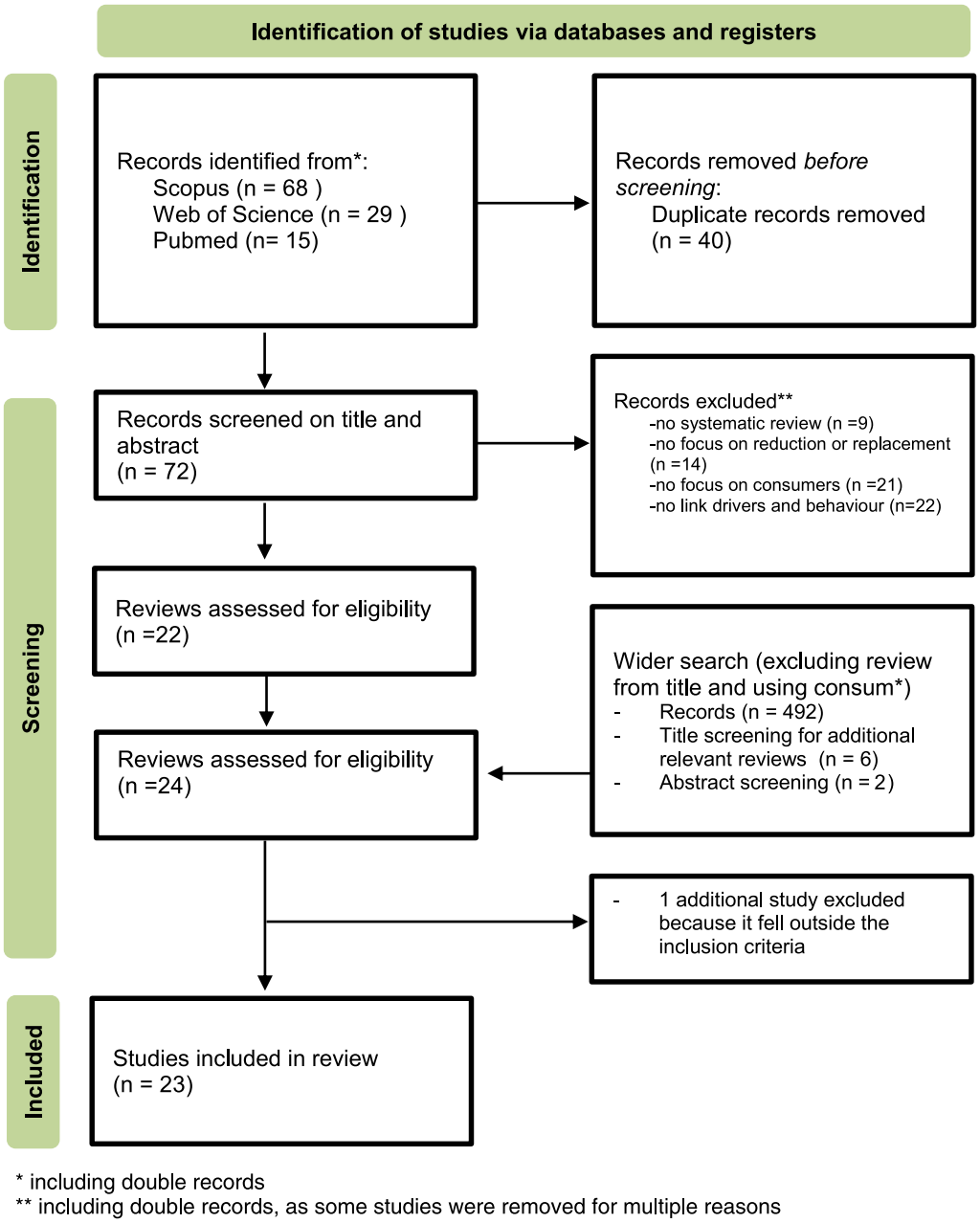

Fig. 1. Overview of systematic literature search visualised in a PRISMA flow diagram.

been differentiated, but we aimed for a detailed though parsimonious overview highlighting the most relevant and most promising drivers (see Table 2 for a concise overview, and the Appendix Table A2 for a detailed overview).

In a similar way we used an existing taxonomy to categorise the findings from the policy perspective. We used the intervention ladder (Nuffield Council on Bioethics, 2007) to develop a taxonomy to define and categorise various interventions and policies (see Table 4).

3. Results drivers

3.1. Descriptive overview

The first 23 references in the reference list refer to the key papers included in the *meta*-review (also see the notes of Table 2 and 3 for an overview of the key papers). We start with a descriptive overview of the included reviews, indicating that the majority of studies were conducted in Western countries (7 review studies). Note that reviews with a focus on global studies also indicate that most reviewed articles were conducted in Western countries (Stiles et al., 2022; Kwasny et al., 2022; Valli et al., 2022; Chang et al., 2023), also showing a focus of current research on Western countries. Only one review study focussed on a comparison across western and insect-eating countries (Florença et al., 2022).

The total number of articles searched was 275,244, the total of included review articles was 1,278, with a range of 10–123 studies across the review papers. The reviews with a smaller number of studies had a more specific focus, such as a focus on default, animal welfare, or dissociation. Nine reviews concentrated on meat reduction (Fonseca & Sanchez-Sabate, 2022; Meier et al., 2022; Kwasny et al., 2022; Benningstad & Kunst, 2020; Harguess et al., 2020; Sanchez-Sabate et al., 2019; Sanchez-Sabate & Sabaté, 2019; Valli et al., 2022; Chang et al., 2023), ten on meat replacement (Bryant & Barnett, 2020; Fehér et al., 2020; Florença et al., 2022; Kouarfaté & Durif, 2023; Kröger et al., 2022;

Lonkila & Kaljonen, 2021; Mina et al., 2023; Onwezen et al., 2021; Pakseresht et al., 2022; Siddiqui et al., 2022; Weinrich, 2019), and three on both (Nguyen et al., 2022; Stiles et al., 2022; Taufik et al., 2019). Quantitative research was the primary focus of most reviews, although some included qualitative or diverse types of methods (see Table A3).

3.2. Demographics and segments

The definition of demographics or segments varies across studies, including small and broad definitions. For this section we included all references to demographics or segmentation resulting in the fact some variables are included in both sections (3.2 and 3.4). A variety of demographic variables is discussed in the various reviews, including age, gender, lifestyle, dietary intake, values, personality traits, and cultural traditions. Studies reveal differences across demographic groups, for example age and gender are consistently mentioned as relevant factors in explaining variations in acceptance of meat reduction or acceptance of plant-based alternatives (Bryant & Barnett, 2020; Florença et al., 2022; Fonseca & Sanchez-Sabate, 2022; Kouarfaté & Durif, 2023; Kröger et al., 2022; Lonkila & Kaljonen, 2021; Mina et al., 2023; Pakseresht et al., 2022; Siddiqui et al., 2022; Valli et al., 2022). The impact of demographics is generally lower than drivers, though some findings can be found regarding other demographics like highly educated consumers are more receptive to alternative proteins (Kröger et al., 2022; Mina et al., 2023; Onwezen et al., 2021; Pakseresht et al., 2022), and less receptive to meat reducing strategies (Fonseca & Sanchez-Sabate, 2022). Though there are also some mixed or no effects regarding demographics (Nguyen et al., 2022). For example, men appear to be more open to eating insects (Florença et al., 2022; Kröger et al., 2022) and more inclined to opt for cultured meat (Bryant & Barnett, 2020; Kouarfaté & Durif, 2023) whereas women tend to be more open to plant-based alternatives or already have reduced their meat consumption (Kouarfaté & Durif, 2023). One study indicate that socio-demographics can be especially relevant in combination with contextual factors, like life changing events such as young mothers are more open to plant-based options (Lonkila & Kaljonen, 2021). Thus, a general line of recommendations is that demographics might be of relevance though mainly in combination with more prominent drivers.

Although also a wide range of segmentation variables is mentioned like motives, values, personality traits, cultural traditions (Lonkila & Kaljonen, 2021), prior consumption (Florença et al., 2022; Kröger et al., 2022), environmental concerns (Valli et al., 2022), segmentation based on dietary intake seems the most often used criteria. Resulting in a division in meat lovers, meat reducers or flexitarians, vegetarians and vegans (Lonkila & Kaljonen, 2021; Bryant & Barnett, 2020; Benningstad & Kunst, 2020; Sanchez-Sabate et al., 2019; Sanchez-Sabate & Sabaté, 2019; Pakseresht et al., 2022). A related view is segmentation based on consumers' decision stage or goal orientation: consumers who consider reducing their meat are sensitive to information about reasons to do so (e.g., motivational reasons), whereas consumers who already have more defined intentions to reduce meat consumption are more receptive to information how to do so (e.g., recipes, skills, availability) (Kwasny et al., 2022). In a similar way consumers can be segmented in adoption phase, showing that for example taste and appearance are the most crucial factors for the successful adoption of meat substitutes by consumers, whereas easy availability is essential for long-term success (Weinrich, 2019).

Our overview suggests that segments based on dietary intake, adoption phase, or decision stage result in consumer groups with different motivations. These motivations are especially researched for environment, health and animal welfare. For example, most prevalent reasons to become vegetarian or reduce meat consumption are health and animal welfare (Sanchez-Sabate et al., 2019), whereas animal welfare seems less relevant to meat lovers (Sanchez-Sabate et al., 2019). Dissociation, the mechanism in which consumers develop a gap between meat and animals, is higher among people with meat-intensive diets (Benningstad & Kunst, 2020). This difference is even visible for vegetarians: Vegetarians who are primarily motivated by concerns about animal welfare follow their diets more strictly than vegetarians with other motivations (Benningstad & Kunst, 2020). This indicates that animal welfare and the link with animals might play a significant role in meat reducing strategies.

Finally, there is evidence that different profiles of consumers are likely to prefer different forms of alternative proteins. Evidence suggests that cultured meat is likely to be particularly appealing to avid meat eaters (Bryant & Barnett, 2020; Pakseresht et al., 2022), and that it is likely to be particularly unappealing to those high in disgust sensitivity and/or neophobia (Bryant & Barnett, 2020). Moreover, vegans are shown to be more open to other sources of alternative proteins, like seaweed and pulses (Onwezen et al., 2021).

3.3. Frameworks to understand the role of drivers

It is valuable to have a closer look at whether and which frameworks are generally used. Not all review studies apply a specific framework (Benningstad & Kunst, 2020; Bryant & Barnett, 2020; Fehér et al., 2020; Florença et al., 2022; Fonseca & Sanchez-Sabate, 2022; Kröger et al., 2022; Lonkila & Kaljonen, 2021; Meier et al., 2022; Mina et al., 2023; Pakseresht et al., 2022; Siddiqui et al., 2022; Stiles et al., 2022; Valli et al., 2022) to describe the drivers of acceptance. Some studies had a specific focus on one driver, which makes a broad theoretical model not suitable (e.g., Fonseca & Sanchez-Sabate, 2022; Meier et al., 2022; Kouarfaté & Durif, 2023). Seven reviews make use of a framework apply a range of different frameworks indicating the fragmentation within the field on definitions of drivers, levels of categorization and theories. The applied frameworks are: the DONE-framework (Taufik et al., 2019), framework on acceptance of novel foods (Onwezen et al., 2021), a self-developed framework (based on Stoll-Kleemann & Schmidt, 2017) (Kwasny et al., 2022; Harguess et al., 2020), stages in the innovation-decision process (Weinrich, 2019), intervention classification scheme (Chang et al., 2023), and an integration of the COM-B model (Michie et al., 2011) and the socio-ecological model (Sallis et al., 2006; Nguyen et al., 2022). The limited use and diversity of used frameworks is also confirmed by the individual studies used in the systematic reviews: some reviews notify that over half of the studies reviewed did not specify any overarching theoretical framework (Nguyen et al., 2022; Stiles et al., 2022; Onwezen et al., 2021).

Also regarding the review studies that do not use a specific framework, it can be observed that they use a wide range of different levels to describe their findings, and a theoretical lens is often lacking. Some studies use different levels of drivers (Bryant & Barnett, 2020; Fehér et al., 2020; Florença et al., 2022; Fonseca & Sanchez-Sabate, 2022; Kouarfaté & Durif, 2023; Kröger et al., 2022; Pakseresht et al., 2022; Siddiqui et al., 2022; Valli et al., 2022), others have a specific focus in which levels of context are included (menu redesign recipe redesign (Stiles et al., 2022) university setting (Chang et al., 2023), or a broader focus in which consumer preferences form one of the categories (Lonkila & Kaljonen, 2021).

Generally, three different perspectives can be specified from the included systematic reviews: 1) types of drivers (e.g., attitudes, personal drivers, emotions, COM-B model (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Harguess et al., 2020; Taufik et al., 2019; Weinrich, 2019), 2) different individual and contextual levels (individual, interpersonal, physical environment (Nguyen et al., 2022; Kwasny et al., 2022; Onwezen et al., 2021; Harguess et al., 2020; Taufik et al., 2019; Chang et al., 2023), and 3) differences in the coerciveness of interventions (internal incentives, external incentives (Onwezen et al., 2021; Sanchez-Sabate & Sabaté, 2019).

3.4. Framework and definitions of drivers

Below follows an overview of the state of the art of the research on

Table 2
Simplified overview drivers of meat reducing and meat replacing strategies.*

Classification and definitions (Michie et al., 2011)		Selection of drivers (Nguyen et al., 2022)	Relevance of drivers	Most prominent	More research needed on:	Concluding
Motivation *Motivation refers to the psychological processes that activate behaviour, it can be reflective or automatic*	**Reflective motivation** *Involving evaluations and plans*	**Motives** *Consumer motives for choosing or eating food*	Motives are often researched [1, 2, 3, 8, 9, 10, 11, 12, 13, 15, 16, 18, 19, 20]*. Positive effects of motives [2, 3, 8, 9, 10, 15, 22] are found, especially for egocentric motives. Sustainability is effective [18, 19], though generally shows low effects [21], or no effects [16, 19] are found. Moreover these motives seem especially relevant for the decision phase [20]. Sustainability can be regarded as a secondary motive [13].	Egocentric motives [9, 13, 18, 19, 20], e.g. like health and nutrition are most prominent in food choice. Egocentric motives can be allies of environmental motives [13] *(see framing)*	-How to trigger values and motivations, and how to integrate the negative impact of meat with health and environmental appeals [1]. -How to increase the relevance of environmental impact.	Often researched, in general found to positively associate with alternative protein acceptance.
		Attitudes *Cognitive, affective or connotative attitudes, that refer to an enduring pattern of evaluative response*	Positive effects of attitudes [1, 2, 3, 6, 8, 9, 12, 17, 18, 20, 23] and ambivalence (mixed or contrasting attitudes) [17] are found to associate with acceptance of alternative proteins. For example, attitudes related to animal suffering or showing pictures of unprocessed meat [6]. Some opposing results are also found [23].	The dominant determinants of attitudes are informational, ethical and intrinsic determinants, respectively [17].	-Insights in various dimensions of attitudes are needed. -Insights in association between various forms of attitudes is needed. -Find other mechanisms to overcome cognitive dissonance [6]. - Highlighting the dominant determinant of each attitude component would impact the overall attitude level [17].	Often researched in general positive effects are found by low amount of studies.
		Framing *how the information is framed to influence acceptance*	Type of information or how the information is framed can influence the acceptance [1, 3, 7, 8, 12, 20], moreover barriers can be addressed by framing via marketing strategies [3]. Relevance of framing suggests that messages focusing on the personal benefits, such as improvements to product healthiness and safety [9, 18, 19, 20], nutritional value [16, 18, 19] and taste [16, 18, 20, 21], food-related risk perception [19] are likely to be the most persuasive. Combining information about (health and environment) is more effective than single-framed messages [6].	-Naturalness [19]. -Persuasion drivers involve arguments on health, environment as well as animal welfare aspects [20], whereas others indicate the relevance of egocentric motives as allies to environmental motives [8, 13]. -Importance of ontological ambiguities, resulting in a less superior product alternative in comparison to traditional meat [7]	-How to target different segments [20] -Many of the barriers to alternative protein consumption can potentially be addressed by marketing/framing strategies [3]. -Find means to position alternative proteins as a product on its own instead of being as comparable as possible to meat [7]	Framing information in the right manner is more effective than providing information alone [8]
	Automatic motivation *involving emotions and impulses that arise from associative learning and/or innate dispositions*	**Emotions** *Affective mental states that refer to positive negative or more specific emotional experiences*	Positive effects of emotions and emotional messages [1, 6, 8, 9, 12, 14, 16, 18, 23] are found, for example by means of disgust, affect, and guilt. For example via evoking emotions with animal images [12]. Especially disgust is often mentioned as	Emotional influences proved to add considerable predictive power for the acceptance of insect-based foods [23].	-Promising though more research needed [1, 8, 15]. -Negative emotions seem effective (disgust and dissociation), though more knowledge is needed on positive emotions [6, 8]	Many research showing impactful findings in negative emotions (e.g., disgust) in specific contexts (like insects), more research on positive emotions is needed.

(*continued on next page*)

Table 2 (*continued*)

Classification and definitions (Michie et al., 2011)		Selection of drivers (Nguyen et al., 2022)	Relevance of drivers	Most prominent	More research needed on:	Concluding
			main barrier to the development of entomophagy [16, 18, 23]. Emotions are also mentioned as a barrier, for example the enjoyment of eating meat [9].		-What drives disgust and aversion [3]? The current food environment is positioned in a very rational manner, it is necessary to explore what would happen when more emotions are used [15].	
		Habits *Automatic behaviuor occurring due to environmental cues from past behavior*	Mentioned as a significant barrier to stop eating meat [3, 6, 10, 20, 21].	Very promising, though not much research reported yet. Long-term effects of intervention measures on actual meat consumption show their potential to initiate fundamental changes in dietary habits [6].	-Habits are promising as strong meat eating habits are a major barrier for the protein transition, more research is needed how to break old habits and form new habits [6, 20]. -Supporting habit change [1]. -What are current habits [3]? - There is a need to invest in more long-term intervention (counselling by personal health coaches with educational materials on healthy lifestyles) that specifically focus on changing habits [6].	Promising route though more research is required. Most focus is currently on measuring meat eating habits and habits as a barrier. There is a need for a focus on building new habits.
Capability *Capability refers to the ability to perform a specific behaviour, it can be psychological or physicological.*	**Psychological** *psychological capability being the capacity to engage in the necessary thought processes*	**Awareness** *Being aware of consequences of a specific behaviour*	A significant body of reviews state the relevance of awareness, such that consumers are to a high extend unaware of animal welfare issues and environmental impacts associated with meat consumption [1, 3, 6, 11, 12, 13, 15, 19, 21]. Currently there are low levels of awareness [1, 3] . consumers have reservations and misconceptions [3], and only small groups of consumers are aware of ecological concerns [15]. There are also mixed findings on the effects of awareness [23]. A prominent barrier to awareness is that consumers perceive food as detached from the environment. Therefore they have no insight in the environmental impact of food [13].	Most relevant [19] Most effective: living animals cuteness babiness. Whereas animal activism leads to ignorance [1]. Dissociation [1] is a highly relevant driver to explain consumer acceptance, e.g., via individuation [1].	-How to decrease dissociation [1]. -Going beyond resistance [12]. -Moderators of dissociation [11].	Often mentioned as a relevant driver and barrier. In general stated to be relevant, though the route how to increase concerns and awareness seems promising it seems not clear yet how interventions can be used to increase these drivers without reactance.
		Skills *the ability to perform a specific behaviour*	Many studies report positive effects of skills, including cooking skills, and feeling able to perform the behaviour [3, 6, 7, 10, 13, 14]. For example cooking courses to assist in the preparation of vegetarian food [6]. Skills are sometimes also referred to as a barrier: preparation of meals is too time- consuming, and a plant-based diet may become tasteless and dull [10, 13].	-Do not underestimate the importance of providing food-related skills in getting consumers to reduce meat intake [13]. -Formulating implementation intentions or action planning. Self-regulation was found to be effective in just over half of these studies [14].	Clearly, the evidence on this domain is still insufficient, more research is needed [6, 14, 15]. Competence training needs more research [1].	The development of skills seems promising and necessary to support the protein transition, though more focus is needed on skill development (policy and research).

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Table 2 (*continued*)

Classification and definitions (Michie et al., 2011)		Selection of drivers (Nguyen et al., 2022)	Relevance of drivers	Most prominent	More research needed on:	Concluding
		Familiarity *Being familiar with a specific food or behaviour*	Familiarity with or exposure to alternative proteins is relevant for consumer acceptance [2, 3, 8, 9, 16, 23]. Especially for more novel products [8]. Effective routes to increase familiarity are using existing and recognizable dishes and products and decreasing the visibility of the novel product [8] or use a "try before they buy" strategy [9]. Familiarity is more relevant in Western than in Eastern cultures [18].	Familiarity plays a central role [8].	-Also works in the opposite direction: People are unwilling to change their eating habits and prefer to continue doing what they know and are familiar with [21]. - Not much direct comparisons are made between different countries [18].	Promising route to increase acceptance of novel alternative proteins.
		Food neophobia *Being reluctant to eat and/or avoidance of novel foods*	Food neophobia is often researched and shows to explain the unwillingness to accept alternative proteins [2, 3, 8, 9, 18, 19, 23]. More relevant in Western than Eastern cultures [18].	One of the most prominent factors affecting the willingness of consumers towards insects is food neophobia [18].	-Differences across countries. -Finding ways to counter food neophobia.	Highly relevant factor in explaining the reluctance to accept alternative proteins. There is a need to find ways to counter food neophobia.
		Taste *Taste experiences and taste expectations*	Taste is often referred to 1, 2, 3, 6, 7, 8, 9, 10, 12, 13, 18, 19, 20, 21, 23]. Note that this includes taste experiences and taste expectations, which are not necessarily the same thing. It is relevant that consumers are able to verify a taste [9], the first taste experience [23] or a "try before they buy" strategy to verify taste firs [9] are highly relevant. Especially in insect eating countries sensory attributes are relevant [18, 23].	Taste and also the perception of taste is one of the most crucial factors for the successful adoption of meat substitutes [20]. Taste is also a relevant barrier as many consumers like the taste of meat [13].	Not experimentally tested [12].	Taste is often researched and a highly relevant factor. It seems a precondition products need to meet in first instance. It can serve as both as a facilitator and a barrier.
Opportunity *Opportunity refers to contextual factors that encourage or inhibit behaviour*	**Social environment** *social opportunity afforded by the cultural milieu that dictates the way that we think about things*					
		Social environment *often-unconscious influence of significant others in forming opinions and behaviours*	Social norms are often included [1, 3, 5, 6, 8, 9, 10, 12, 14, 23] and show to influence meat reducing strategies in various ways. For example, a vegetarian way of life may generate social constraints and negative discrimination [10]. Or providing restaurant customers with information highlighting social norms of how people are starting to reduce meat consumption [12].	Least effective compared to individual drivers and physical environment [14].	Less evidence for social norms [6,14]. Promising, though more research is required [3, 6, 8].	Social environment is a strong mechanism in related domains. Already some studies reveal relevance for the protein transition. Though also mixed findings, asking for more research.
		Cultural *deeply-rooted cultural influences that form opinions and behaviours*	A strong resistance to alter meat consumption is described from a socio-cultural perspective, food cultures and traditions make meat a powerful cultural symbol [1, 3, 13, 18].	Less evidence compared to toher drivers [6].	More research is needed [1, 12, 13], also as moderating variable [11]. No more than five studies tested socio-cultural factors [6]. More research is needed as "meal" is often synonymous with "meat" [3].	Often referred to, though the number of studies that address culture is surprisingly low. Promising factor though difficult to research and use in policies.

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Table 2 (*continued*)

Classification and definitions (Michie et al., 2011)		Selection of drivers (Nguyen et al., 2022)	Relevance of drivers	Most prominent	More research needed on:	Concluding
					Which cultural aspects are most relevant, and how can alternative proteins become cultural dishes [3]. Not experimentally tested [12].	
	Physical environment *physical opportunity afforded by the physical environment*	**Environmental redesign** *Adaptations and interventions in the physical environment, such as nudges that alter decision making*	Making changes to the environment shows to be effective [3, 8, 12, 14, 22], more precisely the following examples are referred to: Default shows to be effective [4, 5]. Increased availability, such as more plant-based options in restaurants [3, 5, 6, 12, 18, 19]. Menu redesign, recipe redesign, service redesign, menu labelling, and prompting at the point of sale[5]. Portion sizes [14, 15]..The physical environment is found to be most effective in combination with interventions that focus on conscious processing [22] or the social environment [12].	Defaults are shown to be the most effective [4,5]. It appears that strategies changing the environment (e.g., menu and recipe redesign) are most effective [5]. Determinants (such as modifying portion sizes) are relatively effective to promote more plant-based and less animal-based food consumption [15].	More research on nudging [3], and default moderators [4] and environmental appeals [1] is required. Lack of studies, only limited amount of studies included situational influences [3].A need to axplore underlying mechanisms and moderators to understand long-term impact of defaults [4].	Menu redesign specifically defaults and portion sizes are most effective. Keep attention for resistance.
		Affordability and price *The price and perceived affordability of products*	Affordability and price show to be relevant [3, 9, 10, 14]. Often referred to as a relevant condition, such that price is considered a relevant determinant of consumer acceptance [19]. More relevant in Eastern compared to Western cultures [18].	Interventions that included price incentives such as financial subsidies as a determinant are all found to be effective [14].	More studies are needed to evaluate financial outcomes [5].	Often mentioned, though the empirical evidence including hard measures of price and real choices are scarce. The limited studies show positive effects.

Note. Physiological capabilities are excluded from the table. This refers to physical restrictions that are necessities to form a behaviour, for example impairments of allergies. This forms no part of our overview as we focus on social psychological drivers and interventions. Moreover, the focus was on selecting promising drivers, we included some mixed and no effects, though the main focus of data extraction was finding which drivers are of relevance. There is also a form of physiological capability refers to physical restrictions that are necessary to perform a behaviour, like allergies. Education is left out of this overview as it fits more to the next section. This forms no part of our overview.

* the numbers correspond with the following key reviews part of the meta-review: [1] Fonseca et al., 2022; [2] Siddiqui et al., 2022; [3] Nguyen et al., 2022; [4] Meier et al., 2022; [5] Stiles et al., 2022; [6] Kwasny et al., 2022; [7] Lonkila & Kaljonen, 2021; [8] Onwezen et al., 2021; [9] Bryant & Barnett, 2020; [10] Fehér et al., 2020; [11] Benningstad & Kunst, 2020; [12] Harguess et al., 2020; [13] Sanchez-Sabate et al., 2019; [14] Taufik et al., 2019; [15] Sanchez-Sabate & Sabaté, 2019; [16] Mina et al., 2023; [17] Kouarfaté & Durif, 2023; [18] Florença et al., 2022; [19] Pakseresht et al., 2022; [20] Weinrich, 2019; [21] Valli et al., 2022; [22] Chang et al., 2023; [23] Kröger et al., 2022.

drivers following the tripartite division of motivation, capability and opportunity (see Table 2) (Michie et al., 2011).

3.5. Motivation

3.5.1. Motives

Multiple review studies focus on motives (Onwezen et al., 2021; Benningstad & Kunst, 2020; Sanchez-Sabate et al., 2019; Sanchez-Sabate & Sabaté, 2019; Florença et al., 2022; Pakseresht et al., 2022; Weinrich, 2019; Valli et al., 2022; Chang et al., 2023). In general, they explore which motivational messages are most prominent or effective in steering consumer behaviour. The reviews observe that respondents usually do not stop eating meat for environmental reasons (Mina et al., 2023; Pakseresht et al., 2022; Weinrich, 2019; Valli et al., 2022). Environmental motives seem a more peripheral motive (Sanchez-Sabate et al., 2019; Valli et al., 2022), even for vegans/vegetarians (Sanchez-Sabate & Sabaté, 2019). Besides, in the limited number of studies in which participants were presented with scientific evidence linking meat consumption and climate change, to trigger environmental motivations, consumers did not consider the environment an important aspect when buying/eating meat, nor were they willing to reduce their meat intake (Valli et al., 2022). Egocentric and valued motivations, like health (Bryant & Barnett, 2020; Florença et al., 2022; Pakseresht et al., 2022; Weinrich, 2019) and nutrition (Mina et al., 2023; Florença et al., 2022; Pakseresht et al., 2022) can be supportive to environmental motives in increasing consumers' willingness to reduce meat intake (Harguess et al., 2020). There is also evidence that animal suffering may be a more compelling motivation for consumers' readiness to change their diet than for healthy or environmental reasons (Fonseca & Sanchez-Sabate, 2022).

3.5.2. Attitudes

In comparison to other factors, the impact of attitudes has been investigated frequently (Bryant & Barnett, 2020; Florença et al., 2022; Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kouarfaté & Durif, 2023; Kröger et al., 2022; Kwasny et al., 2022; Nguyen et al., 2022; Onwezen et al., 2021; Siddiqui et al., 2022; Weinrich, 2019). The attitudes show to be highly relevant in terms of associations with meat replacement and meat reducing strategies. In a few cases, these attitudinal evaluations are not just positive or negative. Consumers can develop positive or negative attitudes at the same time, for example loving the taste of meat though also loving animals (the so-called 'meat paradox'). This concept is referred to as ambivalence (Kouarfaté & Durif, 2023). Findings reveal the existence of a group of most relevant determinants for each attitude component. Thus, the dominant determinants of cognitive, affective and conative components are informational, ethical and intrinsic determinants respectively (Kouarfaté & Durif, 2023). Research suggests that repeated consumption of meat substitutes is necessary to establish a favourable attitude (Weinrich, 2019).

3.5.3. Framing

Framing refers to how the type of information is presented or said otherwise how it is framed. Various studies in the context of alternative proteins have highlighted the importance of framing to significantly influence consumer perceptions and behaviours (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Lonkila & Kaljonen, 2021; Onwezen et al., 2021; Harguess et al., 2020; Weinrich, 2019).

Some studies examine strategies for alternative proteins to access the market (Nguyen et al., 2022; Lonkila & Kaljonen, 2021). One effective strategy involves positioning alternative proteins as unique products rather than direct meat replacements (Lonkila & Kaljonen, 2021). By emphasizing their distinct qualities, marketers can create a niche market, catering to consumers seeking novel culinary experiences. Distancing themselves from animal-based food as the reference point may be necessary for a durable change in consumer acceptance of alternative proteins (Kwasny et al., 2022).

The concept naturalness for example also plays a crucial role in framing. Consumers often associate natural products with health and well-being, making it a powerful persuasive tool (Pakseresht et al., 2022). Framing messages around personal benefits also proves highly persuasive. Studies have shown that emphasizing improvements in product healthiness and safety, nutritional value, taste, and managing food-related risk perceptions enhances consumer acceptance (Bryant & Barnett, 2020; Mina et al., 2023; Florença et al., 2022; Pakseresht et al., 2022; Weinrich, 2019; Valli et al., 2022). Consumers are more likely to adopt alternative proteins when they perceive tangible advantages in these areas. Moreover, framing is also more effective when it encompasses multifaceted arguments, including health, environmental concerns, and animal welfare (Weinrich, 2019).

3.5.4. Emotions

Emotions refer to affective mental states or more specific emotional experiences. Emotions are mentioned in a broad range of reviews as a potentially relevant driver, showing interesting impactful findings (Bryant & Barnett, 2020; Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kröger et al., 2022; Kwasny et al., 2022; Mina et al., 2023; Onwezen et al., 2021; Taufik et al., 2019), though also mixed effects are described (Taufik et al., 2019) and generally this area is stated to be under-researched (Onwezen et al., 2021). Although emotions are often referred to, mostly only specific negative emotions are included. Consequently a robust approach in which multiple emotions are compared and evaluated seem to be lacking (Onwezen et al., 2021). It is, for instance, suggested that acceptance can be increased with activating positive emotions (Onwezen et al., 2021; Bryant & Barnett, 2020), as well as emotional environmental messages to promote meat curtailment strategies (Sanchez-Sabate & Sabaté, 2019). Other examples of emotional messages are about slaughtering or animal suffering or unprocessed meat to increase disgust among consumers; messages regarding personality of animals or about human-animal friendships increase feelings of guilt; pictures of cute and baby animals foster empathy and caretaking intentions (Kwasny et al., 2022). It is relevant to stay aware of resistance and backfiring (Sanchez-Sabate & Sabaté, 2019). Finally, some differences across specific product groups can be seen, in the specific case of cultured meat and insects feelings of disgust are found to be one of the major barriers to explain consumer acceptance (Florença et al., 2022; Kröger et al., 2022; Mina et al., 2023).

3.5.5. Habits

Various reviews indicate that consumers generally have strong meat-eating habits, and that these habits form a significant barrier to reduce meat consumption (Nguyen et al., 2022; Kwasny et al., 2022; Fehér et al., 2020; Weinrich, 2019; Valli et al., 2022). Habits are often equated with past behavioural frequency, though in essence habits refer to responding automatically to cues that result in similar behaviour as in the past. Habits are strong and difficult to change on the one hand, but have the potential to support long-term behaviour change once (new) habits have been established (Verplanken & Orbell, 2022). The reviews indicate habits are very promising, though not much research reported yet that specially signals how consumers' meat-eating habits could be changed. More research is needed how to break old habits and form new ones.

3.6. Capabilities

3.6.1. Awareness

Awareness refers to whether someone takes sustainability into his/her/its doings or is aware of the environmental consequences when choosing an object, for instance, when buying meat or meat alternatives (Kröger et al., 2022). A significant part of the reviews (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Kwasny et al., 2022; Benningstad & Kunst, 2020; Harguess et al., 2020; Sanchez-Sabate et al.,

2019; Sanchez-Sabate & Sabaté, 2019; Pakseresht et al., 2022; Valli et al., 2022) indicate that consumers are frequently highly unaware of animal welfare issues and environmental impacts associated with meat consumption. The review studies show that consumer awareness is hindered (or facilitated) by beliefs about food (nutrition, health, and taste), meat, and personal behaviour (Harguess et al., 2020). Moreover, consumers may employ dissociation strategies (Fonseca and Sanchez-Sabate, 2022), thereby choosing to be unaware or unconcerned. For example, ignoring animal welfare and environmental consequences of meat consumption, and instead shifting focus to the taste, convenience, or affordability of meat (Fonseca & Sanchez-Sabate, 2022). In addition, some reviews even mention a strong resistance to learn more on consequences of sustainability (Stiles et al., 2022; Sanchez-Sabate et al., 2019; Sanchez-Sabate & Sabaté, 2019). Other strategies are also reported, for example some groups of respondents reported that other issues like deforestation, food waste, and food packaging are more important and harmful for the environment compared with meat consumption. Moreover, participants were sceptical of the credibility of sources and arguments reported by the media about the impact of meat consumption (Valli et al., 2022). Ultimately, increased awareness of animal welfare and environmental issues related to meat consumption may promote more sustainable food choices, however, strategies are only relevant when consumers are willing and able to digest the information instead of resisting or ignoring this information.

3.6.2. Skills

Skills are the abilities to perform a specific behaviour, specific examples include competence training or providing cooking courses to assist in the preparation of plant-based food (Nguyen et al., 2022; Kwasny et al., 2022). The most effective strategies that relate to skill development are implementation intention and self-regulation, shown to be effective in the domain of health (Taufik et al., 2019). For example, supporting individuals in the development of specific intentions for a specific moment and context ('when I am in the school canteen, I am going to choose a vegetarian option').

Consumers' state that one of the reasons for unwillingness to alter their meat consumption is their self-acknowledged lack of nutritional and culinary knowledge that hinders them eating little or no meat (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Kwasny et al., 2022; Harguess et al., 2020). Given the fact that consumers self-report nutritional and culinary education as important barriers, reflects an opportunity. Although there might be a bias, it may also reflect that it is not only (strong) resistance that matters but also ordinary knowledge and practical skills to adopt an appealing low or meat-free diet. This points to a relevant route to explore the importance of providing food-related skills (i.e., cooking, purchasing, tasting) in getting consumers to reduce meat intake (Harguess et al., 2020). Other studies demonstrate that interventions emphasizing skills show mixed evidence (Taufik et al., 2019), and that it is in any case an under-explored area, showing a need for more research on this domain (Kwasny et al., 2022; Taufik et al., 2019; Sanchez-Sabate & Sabaté, 2019).

3.6.3. Familiarity

An extensive amount of research has been conducted to investigate the impact of familiarity on the acceptance of alternative proteins. Positive effects of familiarity are shown (Bryant & Barnett, 2020; Florença et al., 2022; Kröger et al., 2022; Mina et al., 2023; Nguyen et al., 2022; Onwezen et al., 2021; Siddiqui et al., 2022). Interventions have been implemented to increase familiarity and consequently, the acceptance of alternative proteins, such as introducing alternative proteins in familiar dishes and products and decreasing the visibility of alternative proteins (especially with respect to insects).

Familiarity is shown to be more relevant for innovative (e.g., cultured meat) compared to less innovative products (e.g., Florença et al., 2022; Kröger et al., 2022; Onwezen et al., 2021). Over time, individuals will become more accustomed to alternative sources of protein, resulting in a decreased aversion to unfamiliar products and a greater acceptance of these items, contingent upon their pricing and flavour (Bryant & Barnett, 2020). Comprehensive marketing strategies (Siddiqui et al., 2022) like a 'try before you buy'-strategy (Bryant & Barnett, 2020) might boost food consumer acceptance of alternative proteins as they might increase familiarity.

Note that at this moment the relevance of familiarity seems to enforce meat eating behaviours. A review suggests that people are unwilling to change their eating behaviours and prefer to continue doing what they know and are familiar with (Valli et al., 2022).

3.6.4. Food neophobia

Food neophobia refers to individuals trait levels as being reluctant to eat and/or avoidance of novel foods (Pliner & Hobden, 1992). Food neophobia is found to significantly influence consumer behaviour and willingness to accept novel protein sources, and is even mentioned as one of the crucial concepts of consumer acceptance (Bryant & Barnett, 2020; Florença et al., 2022; Kröger et al., 2022; Nguyen et al., 2022; Onwezen et al., 2021; Pakseresht et al., 2022; Siddiqui et al., 2022). Moreover, the reviews reveal that food neophobia is especially relevant for novel foods, viz insects (Florença et al., 2022; Kröger et al., 2022; Nguyen et al., 2022; Onwezen et al., 2021; Siddiqui et al., 2022) and cultured meat (e.g., Onwezen et al., 2021; Florença et al., 2022; Pakseresht et al., 2022). Consumers, hesitant to venture into unfamiliar culinary territories, often resist adopting insect-based foods despite their potential advantages.

Understanding the link between food neophobia and the acceptance of alternative proteins is vital for the food industry (Kröger et al., 2022; Onwezen et al., 2021; Pakseresht et al., 2022; Siddiqui et al., 2022). By actively addressing food neophobia through innovative marketing strategies and culinary education, the acceptance of alternative proteins, including insects, can be enhanced, paving the way for a more sustainable and diverse food future.

3.6.5. Taste

Because it is food we are interested in, unsurprisingly taste (Bryant & Barnett, 2020; Fehér et al., 2020; Florença et al., 2022; Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kröger et al., 2022; Kwasny et al., 2022; Lonkila & Kaljonen, 2021; Nguyen et al., 2022; Onwezen et al., 2021; Pakseresht et al., 2022; Sanchez-Sabate et al., 2019; Siddiqui et al., 2022; Valli et al., 2022; Weinrich, 2019) is often referred to as one of the most prominent drivers. Apart from the importance consumers attach to taste, the taste experience is also highly relevant, and a needed success factor for repeated consumption (Weinrich, 2019). A detailed description of sensory attributes is beyond the scope of this *meta*-review, but the relevance of taste experiences is worth mentioning as it remains a prominent barrier for acceptance of meat alternatives and novel proteins.

Research highlights the significance of taste verification (Bryant & Barnett, 2020; Kröger et al., 2022; Onwezen et al., 2021). Innovations such as the "try before they buy" strategy (Bryant & Barnett, 2020) allow consumers to assess taste, leading to informed decisions. Understanding this initial taste experience is critical for food manufacturers and marketers aiming to create products that resonate positively with consumers, ensuring long-term loyalty and repeat purchases (Kröger et al., 2022).

In the realm of the protein transition, wherein alternative and sustainable protein sources are introduced, taste can act as a barrier and a facilitator. Consumers might be hesitant to embrace novel protein-rich foods due to unfamiliar tastes, and because they love the taste of regular meat. Conversely, taste can serve as a facilitator in the protein transition. By developing products that cater to diverse taste preferences, food scientists and producers can enhance the acceptance of alternative proteins.

3.7. Opportunity

3.7.1. Social environment

The social environment relates to the often-unconscious influence of significant others in forming opinions and behaviours. Many reviews include some form of social environment (Bryant & Barnett, 2020; Fehér et al., 2020; Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kröger et al., 2022; Kwasny et al., 2022; Nguyen et al., 2022; Onwezen et al., 2021; Stiles et al., 2022; Taufik et al., 2019), and most reviews pay specific attention to social norms (Kröger et al., 2022; Kwasny et al., 2022; Onwezen et al., 2021). Studies have demonstrated that interventions focused on shifting social norms can be successful in inducing behavioural changes, though mixed effects are also observed (Kröger et al., 2022; Taufik et al., 2019). For example, providing restaurant customers with information highlighting social norms of how people are starting to reduce their meat consumption (e.g., dynamic norms) can support meat reducing behaviours (Harguess et al., 2020). Though the source of social influence determines its impact, experts and the experiences of peers were reported as effective, whereas 'someone else' was not (Kröger et al., 2022).

Results from review studies examining the vegetarian way of life are not all positive on the impact of the social environment. A review for example reveals that a vegetarian way of life may be associated with social constraints (Fehér et al., 2020). Although the number of studies and evidence is limited, reviews indicate the social environment to be a promising area of research (Kwasny et al., 2022; Onwezen et al., 2021; Harguess et al., 2020).

3.7.2. Culture

Meat is a deeply-rooted cultural and social symbol (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Sanchez-Sabate et al., 2019; Florença et al., 2022), so much that meat is often regarded as synonymous to a meal and that these meaty cultures and traditions form a barrier to change. It is relevant to explore the external influences that can lead individuals to alter their perception of meat and view alternative proteins as a valuable replacement (Nguyen et al., 2022), as currently cultural influences often trump motives or mindsets in favour of meat behaviours (Sanchez-Sabate et al., 2019). One systematic review specifically focused on cultural differences showing that the main factors influencing insect acceptability differ between Western and insect-eating cultures (Florença et al., 2022). Altogether a range of reviews report the relevance of cultural factors (Nguyen et al., 2022; Kwasny et al., 2022; Benningstad & Kunst, 2020; Harguess et al., 2020; Florença et al., 2022; Chang et al., 2023), however more research is required to understand and explore the potential of cultural influences, as our understanding is limited (Kwasny et al., 2022; Benningstad & Kunst, 2020; Sanchez-Sabate et al., 2019), and the cultural aspects are not thoroughly explored yet (Harguess et al., 2020).

3.7.3. Physical environment

The physical environment refers to the efficacy of physical interventions, specifically environmental redesign, in promoting the protein transition. A wide range of reviews includes the physical environment (Nguyen et al., 2022; Meier et al., 2022; Stiles et al., 2022; Kwasny et al., 2022; Onwezen et al., 2021; Harguess et al., 2020; Taufik et al., 2019; Sanchez-Sabate & Sabaté, 2019; Florença et al., 2022; Pakseresht et al., 2022; Chang et al., 2023), and various reviews refer to the physical environment as the most prominent driver (Harguess et al., 2020; Taufik et al., 2019; Chang et al., 2023). The material food environment could be altered to allow for more plant-based options in restaurants. Numerous studies (Nguyen et al., 2022; Onwezen et al., 2021; Harguess et al., 2020; Taufik et al., 2019; Chang et al., 2023) have demonstrated the effectiveness of environmental redesign strategies. Especially the default is mentioned as most effective (Meier et al., 2022; Stiles et al., 2022; Harguess et al., 2020). The same holds for studies employing modified portion sizes (Meier et al., 2022; Stiles et al., 2022; Harguess et al., 2020; Taufik et al., 2019; Sanchez-Sabate & Sabaté, 2019). One review adds to this understanding that multimodal interventions, combining physical environment interventions with conscious processing interventions, are even more effective (Chang et al., 2023).

3.7.4. Price and affordability

Research (Nguyen et al., 2022; Bryant & Barnett, 2020; Fehér et al., 2020; Taufik et al., 2019) has underscored the relevance of price for consumer acceptance in the protein transition. Notably, in Eastern cultures, where dietary choices are often influenced by economic factors, the role of price becomes even more prominent (Florença et al., 2022).

Interventions incorporating price incentives, such as financial subsidies, have demonstrated effectiveness in encouraging the adoption of alternative protein sources (Taufik et al., 2019). These interventions play an important role in making sustainable protein options more accessible to a broader consumer base. However, the limited number of studies evaluating financial outcomes and real choices highlights the need for more comprehensive research (Stiles et al., 2022).

Despite the acknowledgment of price's relevance, challenges persist in understanding its precise impact on consumer behaviour. Empirical evidence, especially concerning hard measures of price and real choices, remains scarce. While positive effects have been observed in limited studies, a more thorough exploration is necessary to establish a concrete link between affordability and protein choice.

3.8. Comparisons across drivers

Not all types of drivers are equally researched yet. For example, one review noted that almost 60 % of all studies assessed interventions addressing personal factors (from which most focused on motivational factors), followed by 22 % of studies testing external factors and not more than five studies tested the effectiveness of interventions addressing socio-cultural factors (Kwasny et al., 2022). Our *meta*-review also reviews that most studies focus on motivational drivers. Moreover, few review studies provide a comparison across the relevance of drivers (Onwezen et al., 2021; Harguess et al., 2020). A range of review studies provides an overview of various drivers, without making direct comparisons though (Kröger et al., 2022; Kwasny et al., 2022; Mina et al., 2023; Onwezen et al., 2021; Pakseresht et al., 2022; Taufik et al., 2019; Weinrich, 2019). Thus, research on different drivers has not developed equally, and direct comparisons between the drivers are mostly lacking. Therefore, the findings below should be read as preliminary. We did use the amount of studies and the quality assessment of the reviews to complement these findings, and get further insight on the relevance of the drivers in comparison to each other (see Table 3). Note that this by no means provides a fair comparison as the different studies used different methods to highlight these categories, have different scopes for example sometimes even having a main focus on a category. It does provide an indication of relevance of the different drivers.

Environmental redesign, motives and taste show a large amount of studies and strong evidence of impact, and awareness and emotions show a medium amount of studies and strong evidence. These drivers therefore show the strongest evidence for being relevant drivers to support behaviour towards the protein transition. The drivers of skills, familiarity, food neophobia, social environment, and culture show medium evidence. Note that some drivers are broader defined than others, and that some drivers show moderate evidence with only a small amount of studies (e.g., familiarity, food neophobia and culture) indicating that these drivers might have high potential when more studies will be conducted on these topics. Finally, attitude, framing and price show small evidence, whereas attitudes and framing are frequently researched they are not frequently mentioned as most prominent driver.

We also took the review studies that do make comparisons to underscore our findings. To begin with, these studies indicate that environmental determinants seem to be most effective as these interventions

Table 3
Overview of amount of studies and quality assessment.

Classification (Michie et al., 2011)		Drivers	Key reviews mentioned driver	Number of studies[1]	Computed total points (amount X quality)	Key reviews mentioned as most relevant	Number of studies	Total score of mentioned as most relevant driver	**Concluding** (based on total amount of studies and total score of most relevant indicator)
Motivation	**Reflective motivation**								
		Motives	1*, 2, 3, 8, 9, 10, 11, 12, 13, 15,16, 18, 19, 20	14	55	1, 2, 8, 9, 10, 13, 19	7	29	**Large number of studies| high evidence**
		Attitudes	1, 2, 3, 6, 8, 9, 12, 17, 18, 20, 23	11	47	8, 17	2	8.5	**Large number of studies| low evidence**
		Framing	1, 3, 6, 7, 8, 9, 12, 18, 19, 20, 21	11	47	3, 7, 16	3	8.5	**Large amount of studies| low evidence**
	Automatic motivation								
		Emotions	1, 6, 8, 9, 12, 14, 16, 18, 23	9	47	1, 6, 8, 10, 12, 14, 23	7	35	**Medium amount of studies | high evidence**
		Habits	3, 6, 10, 20, 21	5	21		0		**Small amount of studies | low evidence**
Capability	**Psychological**								
		Awareness	1, 3, 6, 11, 12, 13, 15, 19, 21, 23	10	45.5	1, 3, 10, 19, 21	5	21.5	**Medium amount of studies | high evidence**
		Skills	3, 6, 7, 10, 13, 14	6	22.5	6, 7, 10, 13, 14	5	19	**Small amount of studies | medium evidence**
		Familiarity	2, 3, 8, 9, 16, 18, 23	7	33.5	2, 8, 16	3	16	**Small amount of studies | medium evidence**
		Food neophobia	2, 3, 8, 9, 18, 19, 23	7	32	2, 8, 18	3	17	**Small amount of studies | medium evidence**
		Taste	1, 2, 3, 6, 7, 8, 9, 10, 12, 13, 18, 19, 20, 21, 23	15	60.5	1, 7, 8, 9, 13, 20	6	22.5	**Large amount of studies | high evidence**
Opportunity	**Social environment**								
		Social environment	1, 3, 5, 6, 8, 9, 10, 12, 14, 23	10	48	1, 8, 10	3	14	**Medium amount of studies | medium evidence**
		Cultural	1, 3, 13, 18	4	20	1, 3, 13	3	14	**Small amount of studies | medium evidence**
	Physical environment								
		Environmental redesign	3, 4, 5, 6, 8, 12, 14, 15, 18, 19, 22	11	61	3, 4, 5, 6, 12, 14, 15	7	37	**Large amount of studies | high evidence**
		Affordability & price	3, 9, 10, 14	4	14	9, 10	2	4	**Small amount of studies | low evidence**

Note. Scores are computed by computing the number of studies by the quality of the studies to provide an indication of the strength of the conclusion. Note that the studies that mention a study not necessarily state a positive effect, and that the studies mentioning a driver as most prominent vary a lot in scope, for example some studies comparing effect sizes whereas other only focus on 1 determinant. This assessment is therefore only an indication of the relevance.

[2]Total score of most relevant indicator: <10 = low evidence; 10–25 = medium evidence; >20 = high evidence.

[1] *Number of studies: 0–7 = small; 8–10 = medium; >10 = large.*

[*] the numbers correspond with the following key reviews part of the meta- review: [1] Fonseca et al., 2022; [2] Siddiqui et al., 2022; [3] Nguyen et al., 2022; [4] Meier et al., 2022; [5] Stiles et al., 2022; [6] Kwasny et al., 2022; [7] Lonkila & Kaljonen, 2021; [8] Onwezen et al., 2021; [9] Bryant & Barnett, 2020; [10] Fehér et al., 2020; [11] Benningstad & Kunst, 2020; [12] Harguess et al., 2020; [13] Sanchez-Sabate et al., 2019; [14] Taufik et al., 2019; [15] Sanchez-Sabate & Sabaté, 2019; [16] Mina et al., 2023; [17] Kouarfaté & Durif, 2023; [18] Florença et al., 2022; [19] Pakseresht et al., 2022; [20] Weinrich, 2019; [21] Valli et al., 2022; [22] Chang et al., 2023; [23] Kröger et al., 2022.

show significant effects on behaviour relatively often (i.e., a success rate of about 65 % (Taufik et al., 2019); interventions regarding choice architecture more effective than interventions related to conscious processing (Chang et al., 2023). Targeting individual determinants are almost equally effective (i.e., a success rate of about 60 % (Taufik et al., 2019) (Chang et al., 2023), whereas targeting interpersonal determinants seems to be least effective (i.e., a success rate of about 45 % (Taufik et al., 2019) (Kwasny et al., 2022; Taufik et al., 2019). Note that one review adds to this understanding by indicating that multimodal interventions, combining physical environment interventions with conscious processing interventions, are even more effective (Chang et al., 2023).

There is strong evidence that especially certain interventions addressing personal and environmental factors are effective in reducing meat consumption (Stiles et al., 2022; Kwasny et al., 2022; Taufik et al., 2019). Regarding environmental factors, changing the default (Meier et al., 2022), and modifying portion sizes, and increasing visibility (Sanchez-Sabate & Sabaté, 2019; Stiles et al., 2022). Regarding personal factors (motivation and capabilities), clear comparisons across drivers are even less often performed.

4. Results policy perspective

We already discussed the reviews from the perspective of the different drivers (sections 3.3–3.8). In this section we aim to link the findings to policy-based interventions. In order to truly capture a policy perspective, this section includes a different angle to the same reviews. Note that these two perspectives are handled independent from each other in this *meta*-review. Based on the intervention ladder (Nuffield Council on Bioethics, 2007), a policy taxonomy was developed to categorise policy interventions based on the extent on which these differ in freedom of choice (see Table 4 for categories and definitions).

4.1. General overview policy perspective

In general, we can observe that links to policymaking are overlooked in terms of research and recommendations. In more detail, even a specific search within the articles (search full reviews for the use of the word 'policy') revealed that many articles only had one (Fonseca & Sanchez-Sabate, 2022; Siddiqui et al., 2022; Sanchez-Sabate & Sabaté, 2019; Valli et al., 2022; Chang et al., 2023) or no reference at all (Benningstad & Kunst, 2020; Bryant & Barnett, 2020; Florença et al., 2022; Harguess et al., 2020; Kröger et al., 2022; Onwezen et al., 2021) to 'policy'. The references made were mostly generic, also including other stakeholders, and summarizing a main conclusion without specific recommendations for policymakers (Fonseca & Sanchez-Sabate, 2022; Siddiqui et al., 2022; Sanchez-Sabate & Sabaté, 2019; Mina et al., 2023; Kouarfaté & Durif, 2023; Valli et al., 2022). For example: "This is particularly useful for outlining possible paths for further research and for contributing to increasing knowledge about the more efficient market strategy and policy development to increase the consumption of edible insects in Europe" (Mina et al., 2023). And, for example, integrating all relevant stakeholders in their recommendations: "Our results have direct implications for several stakeholders such as guideline developers, researchers, and policymakers" (Valli et al., 2022).

Finally, and most relevant, there is a dearth of evidence on the specific effects of policy interventions. Policy evaluations, randomized controlled trials (RCTs), and real-life interventions that, for instance, explore tax policies, are mainly lacking (e.g., Nguyen et al., 2022; Taufik et al., 2019), and there are only few individual studies that include policy perspectives, resulting in mixed findings and limited policy interventions towards reducing meat consumption (Stiles et al., 2022). Lonkila and Kaljonen (2021) also explicitly searched for policy recommendations and evaluations in their review, and they correspondingly concluded that multiple studies refer to the importance of politics but are hardly devoted to policy evaluations. Weinrich (2019) states that a focus on alternative proteins is currently only observed in the Netherlands and that policymakers in other European countries should facilitate research on enablers and barriers of the consumption of meat substitutes. It is also suggested that policymakers could use scientific results to develop strategies that reduce meat consumption or increase consumption of meat substitutes, e.g., by nudging and information campaigns or by supporting start-ups in the meat substitute industry (Weinrich, 2019).

The results (Table 4) clearly indicate that current studies mostly focus on interventions that have low levels of intervening. Providing information is not intrusive at all, and shows to be the most researched intervention (e.g., Florença et al., 2022; Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kröger et al., 2022; Kwasny et al., 2022; Mina et al., 2023; Onwezen et al., 2021; Stiles et al., 2022; Taufik et al., 2019; Weinrich, 2019). Followed by more in-between are interventions that focus on nudging (Nguyen et al., 2022; Stiles et al., 2022; Kwasny et al., 2022; Onwezen et al., 2021; Harguess et al., 2020; Taufik et al., 2019; Florença et al., 2022; Pakseresht et al., 2022; Chang et al., 2023). These interventions alter the choice environment but do not constrain the freedom of choice. Hardly to no interventions of a more intrusive nature, such as financial (dis)incentives, are object of research (Kwasny et al., 2022; Taufik et al., 2019; Pakseresht et al., 2022; Valli et al., 2022). The same holds for forced restrictions: studies are very rare and show mixed results (Stiles et al., 2022).

4.1.1. Informing

The low levels of awareness (see 3.6.1) might imply that there is a large educational role in increasing consumer acceptance. However, the findings indicate that information as such is not a powerful instrument to change behaviour. Although information is shown to be the most studied intervention in several reviews (Fonseca & Sanchez-Sabate, 2022; Onwezen et al., 2021; Harguess et al., 2020; Mina et al., 2023), information is found to be not extremely effective: both mixed and negative findings are found (Onwezen et al., 2021) as well as unclear effects are reported (Harguess et al., 2020). Some positive effects might also be explained by social desirability and different designs (Sanchez-Sabate & Sabaté, 2019). All this indicates that the problem is not (only) a knowledge gap but also a matter of internal dispositions and mental frameworks that could make it hard for consumers to learn and accept scientific evidence regarding detrimental environmental impacts of meat production and consumption as we know it (Harguess et al., 2020). Moreover, information might be only effective in some stages of adoption, the knowledge phase in which consumers learn about the behaviour (Weinrich, 2019).

Various reflections on making information provision more impactful are presented in the literature, for example indicating that a meatless diet is the most effective personal behaviour (Harguess et al., 2020), increasing the availability of reliable information (Fehér et al., 2020), combining environmental messages with egocentric values like health or taste (Kwasny et al., 2022), and the source of information (Kröger et al., 2022; Nguyen et al., 2022; Sanchez-Sabate et al., 2019).

4.1.2. Enabling (framing)

Information alone is believed to be less effective than framing information (e.g., fact-based persuasive communication strategies (Harguess et al., 2020), such as highlighting societal benefits, nontechnical (versus technical) descriptions of production, including specific instead of generic information (Onwezen et al., 2021). A wide array of reviews indicates that framing is relevant when focussing on a link with personal benefits, such as improvements to product healthiness and safety (Bryant & Barnett, 2020; Florença et al., 2022; Pakseresht et al., 2022; Weinrich, 2019), nutritional value (Mina et al., 2023; Florença et al., 2022; Pakseresht et al., 2022) and taste (Mina et al., 2023; Florença et al., 2022; Weinrich, 2019; Valli et al., 2022), food-related risk perception (Pakseresht et al., 2022). The link with sustainable values is related to specific groups, or referred to as a more peripheral motive

Table 4
Simplified overview interventions of meat reducing and meat replacing strategies.

Category	Definition	Relevant, mixed, no effects	Most prominent	More research needed on:	Concluding
Informing	*Providing information*	Mentioned as a relevant (Mina et al., 2023; Florença et al., 2022; Weinrich, 2019), though in many cases boundary conditions are also mentioned. In general, increasing knowledge alone or when combined with other methods was shown to successfully reduce meat consumption behaviour or intentions/willingness to eat meat, or accept alternative proteins (Kwasny et al., 2022; Harguess et al., 2020). For example, also the source of information is mentioned as relevant condition in trustworthiness (Kröger, Dupont, Büsing, & Fiebelkorn, 2022). Some studies report information as having mixed effects (Taufik et al., 2019). Others report no results (Stiles et al., 2022; Onwezen et al., 2021).	Framing and combinations are reported as more effective (Harguess et al., 2020).	Relatively little reliable information is available (Fehér et al., 2020). Promising strategy might be to inform that food, in general, has an environmental dimension (Sanchez-Sabate et al., 2019).	In general, all studies indicate that a single focus on information is too limited. Though that it might be helpful in providing, transparency, and increasing awareness. Especially framing and emotions are often mentioned as additional means to increase effectiveness.
Enabling (framing)	*Framing of message in terms of for example health, environment, safety and taste. Taste as framing of tastiness*	Relevance of framing suggests that messages focusing on the personal benefits, such as improvements to product healthiness and safety (Bryant and Barnett, 2020; Florença et al., 2022; Pakseresht et al., 2022; Weinrich, 2019), nutritional value (Mina et al., 2023; Florença et al., 2022; Pakseresht et al., 2022) and taste (Mina et al., 2023; Florença et al., 2022; Weinrich, 2019; Valli et al., 2022), food-related risk perception (Pakseresht et al., 2022) are likely to be the most persuasive. Sustainability is shown to be effective (Florença et al., 2022; Pakseresht et al., 2022), though generally shows low effects (Valli et al., 2022) or no effect (Mina et al., 2023; Pakseresht et al., 2022) for the specific contexts of cultured meat and for the decision phase (Weinrich, 2019). Positive effects of motives (Siddiqui et al., 2022; Nguyen et al., 2022; Onwezen et al., 2021; Bryant and Barnett, 2020; Fehér et al., 2020; Sanchez-Sabate and Sabaté, 2019; Chang et al., 2023) are found. Most effective if conscious processing interventions are combined with physical environment interventions (Chang et al., 2023).	Most prominent: enjoyment of eating meat and the difficulty in abandoning it (Fehér et al., 2020), dissociation (Fonseca and Sanchez-Sabate, 2022; Fehér et al., 2020), importance of ontological ambiguities, resulting in a less superior product alternative in comparison to traditional meat (Lonkila and Kaljonen, 2021).	-Decrease dissociation (Fonseca and Sanchez-Sabate, 2022). -Trigger values and motivations (Fonseca and Sanchez-Sabate, 2022). -Increase awareness and relevance on environmental impact. -Many of the barriers to alternative protein consumption can be addressed by marketing/framing strategies (Nguyen et al., 2022).	Often researched, in general found to positively associate with alternative protein acceptance.
Nudging	*Making changes to the physical environment while leaving the freedom of choice*	Making changes to the environment shows to be effective (Nguyen et al., 2022; Onwezen et al., 2021; Harguess et al., 2020; Taufik et al., 2019; Chang et al., 2023), more precisely the following examples are referred to:Default shows to be effective (Meier et al., 2022; Stiles et al., 2022). Availability (Nguyen et al., 2022; Florença et al., 2022;	Defaults are most effective (Meier et al., 2022; Stiles et al., 2022). It appears that strategies changing the environment (e.g., menu and recipe redesign) are most effective (Stiles et al., 2022). Determinants (such as modifying portion sizes) is relatively effective to promote more plant-based and less animal-based food	-More research on nudging (Nguyen et al., 2022), and default moderators (Meier et al., 2022) and environmental appeals is (Fonseca and Sanchez-Sabate, 2022) required.	Menu redesign specifically defaults are most effective. Keep attention for resistance as consumers may drop away.

(*continued on next page*)

Table 4 (*continued*)

Category	Definition	Relevant, mixed, no effects	Most prominent	More research needed on:	Concluding
		Paksereshet et al., 2022) visibility and placement (Nguyen et al., 2022). Menu redesign, recipe redesign, service redesign, menu labelling, and prompting at the point of sale (Stiles et al., 2022).Visibility of vegetarian food appears to be effective (Kwasny et al., 2022). Most effective in combination with interventions that focus on conscious processing (Chang et al., 2023).	consumption (Sanchez-Sabate and Sabaté, 2019).		
(dis)incentivising	*Interventions that create expectation of reward or cost*	Interventions that included price incentives such as financial subsidies as a determinant are all found to be effective (Taufik et al., 2019). Product features, such as price are mentioned as relevant (Paksereshet et al., 2022; Valli et al., 2022). The high prices of alternatives are for example mentioned as a barrier (Valli et al., 2022).		More research required (Kwasny et al., 2022).	Price often referred to as a barrier (Bryant and Barnett, 2020), though the number of studies on incentives is limited (Kwasny et al., 2022; Harguess et al., 2020).
Restricting and eliminating	*Reduce opportunities or limit the choice*	Number of studies is extremely limited. The only studies found using policy changes used forced restriction, which showed mixed results (Stiles et al., 2022).			

Note. There is some overlap in table 2 and 4, both are based on the same reviews, and motives and framing and physical environment and nudging show high overlap between drivers and interventions because the research methods overlap.

(e.g., Sanchez-Sabate et al., 2019; Mina et al., 2023). The link to sustainable values might be relevant in combination with the more egocentric values (Harguess et al., 2020).

Note that message framing experiments did not consistently prove effective as strategies to reduce meat consumption behaviour or intention (Harguess et al., 2020), and the results indicate some product specific approaches (Onwezen et al., 2021). For example, specifically for cultured meat it was relevant to be framed as a solution to existing food safety problems (Bryant & Barnett, 2020) or highlight naturalness (Paksereshet et al., 2022).

4.1.3. *Nudging*

The physical food environment could be altered to allow for more plant-based options in restaurants, supermarkets, canteens and other food purchase contexts. It is mentioned as a highly effective strategy (Meier et al., 2022; Chang et al., 2023). Regarding the physical environment, especially the default is mentioned as most effective (Meier et al., 2022; Stiles et al., 2022), as if studies employing modified portion sizes (Meier et al., 2022; Stiles et al., 2022; Harguess et al., 2020; Taufik et al., 2019; Sanchez-Sabate & Sabaté, 2019). Furthermore, studies revealed the relevance of making the vegetarian choice the easy choice and making plant-based food options more visible (Kwasny et al., 2022).

Downsides of the relevance of the food environment are also mentioned. Currently the food environment supports the protein transition in the opposite direction, especially enforcing meat consumption. For example, the food industry currently facilitates dissociation, a distance from meat to animals (Benningstad & Kunst, 2020), and positioning meat analogues, as alternative to meat might even further strengthen meat as the usual option and the dominant norm (Lonkila & Kaljonen, 2021). Moreover, changing choice settings may also make the choice location less attractive. It is important that consumers still engage with the options provided, and, particularly in commercial settings, customers may choose to go elsewhere if they do not like the options provided (Stiles et al., 2022).

4.1.4. *(Dis)Incentivising*

Price is often mentioned as a relevant barrier in changing meat-eating habits (Fehér et al., 2020; Kröger et al., 2022; Paksereshet et al., 2022; Valli et al., 2022). However currently, few if any, financial incentives exist on the market (Kwasny et al., 2022) which provide physical financial opportunities to motivate alternative protein consumption, examples might be taxes, subsidies and promotion restrictions of meat. Studies have found that an underlying problem associated with the consumption of meat is that the environmental impacts of production are not calculated in the market price (Nguyen et al., 2022). Interventions that included price incentives such as financial subsidies as a determinant are all found to be effective. This is in line with other literature demonstrating the effectiveness of price incentives (Taufik et al., 2019). However, this is a field of research that needs to be explored much further, as very few studies seem to be present that truly measure the effects of financial incentives in the market.

4.1.5. *Restricting and eliminating*

Very few studies explored forced restrictions. The only studies found using policy changes used forced restriction showed mixed results (Stiles et al., 2022). The absence of studies in the policy-domain may indicate that governmental interventions are often not experimentally tested and/or published in scientific journals (Taufik et al., 2019). Restricting measures employed in food environments such as mandatory vegetarian days or other restricting economic policy instruments such as “meat taxes” (i.e., a higher value-added tax for emission-intensive foods, such as meat). While currently employing a meat tax is discussed in several countries, it has not yet been implemented anywhere. While it is expected that higher meat prices would indeed

influence consumer's food choices there is no experimental research investigating these causal links (Kwasny et al., 2022).

To fully understand the potential of policy to shape consumer behaviour in this area, further research is needed to evaluate the effectiveness of specific policies and develop evidence-based recommendations for policy makers. A multi-faceted approach and combination of intervention measures will be critical (Kwasny et al., 2022; Onwezen et al., 2021; Harguess et al., 2020) Only few studies include multiple interventions and drivers (15 % (Kwasny et al., 2022), though these generally show to be more effective (Harguess et al., 2020; Chang et al., 2023).

5. General discussion

Research on the transition from meat-based to plant-based diets has been increasing in recent years. Influential systematic reviews by Hallström et al. (2015) or Aleksandrowicz et al. (2016) have shown the urgency of dietary transition to reduce animal-based foods, and highly-cited systematic reviews by Hartmann and Siegrist (2017), Bryant and Barnett (2018), Graça and colleagues (2019) or Onwezen and colleagues (2021) have shown that the fields of meat reduction, consumer acceptance of plant-based meat alternatives or insects and cultured meat as alternative proteins became vibrant during the past decade. However, it was also observed that the literature remains fragmented and lacks an overarching theoretical framework (Graça et al., 2019; Onwezen, 2022). To contribute to the extant literature as well as to contribute to the ambition of making the 2020s a decade of action focusing on the demand-side of the protein transition, this *meta*-review of consumer studies presents an overview of 23 systematic reviews published between 2019 and 2023. Salient characteristics of the present *meta*-review were a focus on (i) the two Rs of reduction and replacement, (ii) drivers of consumer behaviour in favour of the protein transition, and (iii) a policy perspective. We close the current work by drawing up a knowledge agenda to support both research and public policies devoted to actions which encourage the protein transition. Although there is a potential for publication bias to inflate the results of this *meta*-review, and although the inclusion of an extensive range of recently-published systematic reviews does not guarantee completeness, as underlying studies of the included reviews were not analysed, we believe the present work provides meaningful insights for both scholars and policymakers.

5.1. Drivers of motivation, capability, and opportunity

5.1.1. Motivation

Motivational variables are often studied (Benningstad & Kunst, 2020; Bryant & Barnett, 2020; Chang et al., 2023; Fehér et al., 2020; Florença et al., 2022; Harguess et al., 2020; Kouarfaté & Durif, 2023; Kröger et al., 2022; Kwasny et al., 2022; Lonkila & Kaljonen, 2021; Mina et al., 2023; Nguyen et al., 2022; Onwezen et al., 2021; Pakseresht et al., 2022; Sanchez-Sabate et al., 2019; Sanchez-Sabate & Sabaté, 2019; Siddiqui et al., 2022; Taufik et al., 2019; Valli et al., 2022; Weinrich, 2019), specifically including motives, attitudes, framing, emotions, and habits. Almost all systematic reviews include a motivational component (21 out of 23). Suggesting a line of research that is well established, it is also a field in need of more theoretical underpinning and unity. Both observations are in accordance with Graça et al. (2019). Motives and emotions show strong evidence of being a prominent driver, whereas habits are shown to have moderate evidence and attitudes and framing low evidence. Note that these are the generic findings, though also some context-specific findings are present. Hitherto habits are especially related to current meat-eating patterns, and emotions of disgust are a driver especially emerging in the field of meat replacement by alternative proteins.

The overall evidence framed in the motivational domain also indicates to reinforce the role of health, sustainability and/or animal ethics motivations in reducing meat consumption, and how this differs across different meat-eating and flexitarian groups. A recent study also highlights the relevance of motives across stages of change. Indicating that perceived pros of meat reduction (i.e., benefits of a plant-based diet, downsides of factory farming) and lowering the perceived cons (i.e., health barriers, legitimation barriers, feasibility barriers) might be promising interventions to encourage meat eaters to start thinking about a behaviour change in terms of meat reduction (Strässner & Hartmann, 2023).

Some studies have suggested that environmental motives are a peripheral motive. Egocentric motivations such as convenience and health can be employed to frame information and enable choices towards more positive feelings and outcomes towards the formation of long-term habits.

5.1.2. Capability

A large amount of studies includes some aspect of capabilities. At first glance, this gives the impression that much research has been done in this category. However, the current *meta*-review demonstrates a concentration of studies on taste (Kröger et al., 2022; Kwasny et al., 2022; Lonkila & Kaljonen, 2021; Nguyen et al., 2022; Sanchez-Sabate et al., 2019; Valli et al., 2022; Weinrich, 2019) and awareness (Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kröger et al., 2022; Nguyen et al., 2022; Pakseresht et al., 2022; Sanchez-Sabate & Sabaté, 2019), and less studies on skills (Nguyen et al., 2022; Kwasny et al., 2022; Lonkila & Kaljonen, 2021; Fehér et al., 2020; Sanchez-Sabate et al., 2019; Taufik et al., 2019), food neophobia (Florença et al., 2022; Kröger et al., 2022; Nguyen et al., 2022; Onwezen et al., 2021; Pakseresht et al., 2022; Siddiqui et al., 2022), and raising familiarity (Bryant & Barnett, 2020; Florença et al., 2022; Kröger et al., 2022; Mina et al., 2023; Nguyen et al., 2022; Onwezen et al., 2021; Siddiqui et al., 2022). Especially taste and awareness are shown to have strong evidence as being a prominent driver. Several studies advocate broad interventions that may be useful to encourage the protein transition. These include building awareness (e.g., informing and activating consequences of reducing meat consumption) and activating relevant values to trigger awareness. Moreover, developing interventions to support consumers to taste alternative proteins. Familiarity, food neophobia, and skills (e.g., training cooking tailored to personal preferences) are also drivers that emerge in the field of meat replacement by alternative proteins. Interventions might be used to familiarize consumers with other types of products. For example, making consumers familiar with new products and dishes. These relevant aspects of capabilities are also mentioned by a recent qualitative study (Sijtsema et al., 2021). The relevance of skills as a promising driver, though needing more in-depth insights, is highlighted by various scholars (Sijtsema et al., 2021; White et al., 2022).

5.1.3. Opportunity

In total 16 out of 23 review studies include some aspect of opportunity, in which a large amount of the reviews focusses on meat reduction or both on meat replacement and meat reduction. Some clear indications of effectiveness are already found (Chang et al., 2023; Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kröger et al., 2022; Kwasny et al., 2022; Nguyen et al., 2022; Onwezen et al., 2021; Taufik et al., 2019). Especially adaptions to the physical environment show to have a strong evidence as being a relevant driver. The physical domain points to evidence for the effectiveness of defaults, followed by menu and recipe redesign such as portion sizes and visibility of plant-based options (Nguyen et al., 2022; Onwezen et al., 2021; Harguess et al., 2020; Taufik et al., 2019; Chang et al., 2023).

Moreover, the physical and social environment seem a bit more recent and founded on theory (Meier et al., 2022). The social environment and culture show to be promising. For example, social norms proof to be relevant in a variety of food-related domains (Higgs, 2015), underscoring the potential of a relevant driver. However far more research is required (Onwezen et al., 2021), especially as the dominant

social norm still supports eating meat (Onwezen et al., 2022). This triggers various relevant research questions, such as the impact of significant others (e.g., family; friends) or perceived dynamic norms (i.e., emphasizing collective meat reduction as increasing over time) on meat reduction and replacement.

Culture forms one of the aspects of opportunity variables that is underresearched. It should be noted that culture receives considerable attention in other bodies of literature, which were not part of this *meta*-review. For instance, in the domain of vegetarianism/veganism ample attention is drawn by sociologists or geographers to social, political and cultural structures in today's (meat-centric) society. Briefly put, to eat meat or not to eat meat is not merely a matter of individual responsibility but a socio-cultural phenomenon. Although a recent systematic review of quantitative studies on vegetarianism and veganism (Salehi et al., 2023) points to health and animal-related consumer concerns as core motives in favour of abstaining from eating meat – which bolster findings of the current *meta*-review – it is instructive to realise that in the field of meat avoidance also qualitative, interview-based studies (e.g., Oliver, 2023; Waters, 2022) or studies with a more conceptual orientation (e.g., Gheihman, 2021; Sexton et al., 2022) provide complementary insights. Moreover, the additional value of qualitative studies also proves itself in the fields of flexitarianism (meat reduction) (e.g., Kemper & White, 2021; Khara et al., 2021; Sijtsema et al., 2021) and consumer acceptance of plant-based meat substitutes (meat replacement) (e.g., Collier et al., 2021; White et al., 2022).

5.1.4. Meat reduction and replacement

Overall, the *meta*-review signals that meat reduction and meat replacement strategies are associated with similar (e.g., motives and awareness) though also different drivers, such that meat reduction mostly relates to reducing established meat eating habits and changes in the physical environment to stimulate change, while replacement strategies mostly associate with the development of new behaviours, therefore showing the relevance of familiarity, emotions of disgust and food neophobia. There is surely need for further research that addresses capability and opportunity variables as well as studies that integrate various components including theory-driven approaches.

5.2. Promising routes for policymaking

As noted in the Introduction, it is important to inform public policymakers about current evidence in research which they can rely on when designing policy measures aimed at supporting diets lower in meat and higher in plant-based foods. One of the most prominent findings when reviewing the key reviews from a policy perspective, is that this perspective is largely underresearched. There are few studies taking a policy perspectives, elaborated policy recommendations are scarce and empircial individual studies including large scale policies are limited and mostly focussed on policies with low levels of intervening. Providing information is not intrusive at all, and shows to be the most researched intervention, followed by framing and thereafter nudging. There are hardly to no interventions of a more intrusive nature, such as financial (dis)incentives or restricitons. Based on the current *meta*-review the following policy-oriented recommendations can be made.

5.2.1. Information alone is not enough, but links with health and morality seem promising

Providing information (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Onwezen et al., 2021; Fehér et al., 2020; Harguess et al., 2020; Sanchez-Sabate & Sabaté, 2019; Mina et al., 2023) is surely relevant to support informed decision making but as such frequently not enough to change consumer behaviour. Framing and other additional interventions should be used to increase effectiveness of information campaigns. Many studies indicated that consumers may have different motivations to engage in meat reducing strategies (Sanchez-Sabate & Sabaté, 2019), and that it is relevant to link the message to other motives like health, or convenience (Harguess et al., 2020), that fit the specific target group (Kwasny et al., 2022; Lonkila & Kaljonen, 2021; Bryant & Barnett, 2020; Benningstad & Kunst, 2020; Sanchez-Sabate et al., 2019; Sanchez-Sabate & Sabaté, 2019; Pakseresht et al., 2022; Weinrich, 2019). This is for example also mentioned in the goal framing literature, mentioning the relevance of targetting relevant information to groups of indivudals with a fitting goal frame (Steg & Vlek, 2009). Thus developing a narrative on meat alternatives that fits multiple consumer groups, without referring to meat as the norm, and linking to egocentric values. Additionally, there seem a lot of opportunities to connect information provision to other impactful mechanisms like emotions (Harguess et al., 2020; Kröger et al., 2022; Kwasny et al., 2022; Mina et al., 2023; Onwezen et al., 2021; Taufik et al., 2019), moral values (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Harguess et al., 2020; Sanchez-Sabate & Sabaté, 2019; Pakseresht et al., 2022) or social information (Fonseca & Sanchez-Sabate, 2022; Harguess et al., 2020; Kröger et al., 2022; Kwasny et al., 2022; Onwezen et al., 2021; Taufik et al., 2019).

5.2.2. Trigger moral awareness and emotions

Even more effective than providing facts about meat consumption and its negative consequences, is activating emotions such as empathy, guilt or even disgust (e.g, slaughtering of animals, or current animal welfare conditions) and making it impossible to detach meat from animals (personality or friendships) (dissociation (Fonseca & Sanchez-Sabate, 2022; Benningstad & Kunst, 2020). The possibilities to use positive emotions look promising and are highlighted as an important route to support the protein transition (Onwezen et al., 2021).

Triggering awareness seems also a promising route (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022; Harguess et al., 2020; Sanchez-Sabate & Sabaté, 2019; Pakseresht et al., 2022). Confronting consumers with their contradicting desires to consume meat but avoid to harm animals (the so-called meat paradox – Loughnan et al., 2012) might prompt them to resolve this discomfort by reducing consumption (Tian et al., 2016). On the one hand, emotions and morality seem especially relevant because they have the potential to trigger long-term behaviour change. On the other hand, caution is advised with presenting animal welfare appeals to ensure that confronting it is not harmful and does not induce defence mechanisms that maintain – or even increase – animal-product consumption (Grundy et al., 2021; Rothgerber, 2020), such as reactance.

5.2.3. Provide competence training

Although less is known on capabilities, the literature seems to focus on specific aspects of capabilities. The literature is clear that skill development is an essential part of behaviour change (Michie et al., 2011) and that these are often mentioned as barriers, e.g., familiairity, food neophobia, or lack of cooking skills (Fonseca & Sanchez-Sabate, 2022; Nguyen et al., 2022). Moreover taste (Kröger et al., 2022; Kwasny et al., 2022; Lonkila & Kaljonen, 2021; Nguyen et al., 2022; Sanchez-Sabate et al., 2019; Valli et al., 2022; Weinrich, 2019) is referred to as prominent mechanism to support the protein transition. It is worthwile to think of interventions that have a long-term focus and, for example, support counselling by personal health coaches with educational materials on healthy lifestyles, making individuals more familiar with a wide range of tastes, products and recipes, and to support lifestyle changes, for instance with an app that supports finding the difficult moment, and supports finding solutions (Carfora et al., 2017).

5.2.4. Bringing vegetarian foods to the fore

Most prominent findings are found in making vegetarian options the default or standard option (Meier et al., 2022), followed by making vegetarian food more visible, for example, by placing it differently in a restaurant or supermarket (e.g., Reinders et al., 2017) or 'dish of the day', and by reducing portion sizes (Taufik et al., 2019; Chang et al., 2023). These interventions represent a promising area, as they result in

unconscious behaviour change keeping freedom of choice for consumers (Hummel & Maedche, 2019). However, nudges usually work in a specific context with temporary behaviour change effects. Thus, to support the protein transition in long-term behaviour change it is more promising to integrate nudging interventions with interventions that also trigger lasting behaviour change (e.g., motivational incentives and morality as described above).

5.2.5. Integrated approaches

A multi-faceted approach and combination of intervention measures will be critical as there is no silver bullet solution for reducing meat consumption levels (Meier et al., 2022; Kwasny et al., 2022; Harguess et al., 2020; Chang et al., 2023). Moreover, targeting policy measures to specific consumer groups according to socio-demographic characteristics and especially prior beliefs or dietary lifestyles will make them more

Table 5
Recommendations for future research based on the key reviews.

Include multiple comparisons to further understand how proteins relate to each other, and to meat.
- As consumer responses can differ considerably depending on the type of alternative proteins (i.e., insect vs. plant-based proteins), future research should also explore various alternative protein products to understand such differences (Nguyen et al., 2022; Pakseresht et al., 2022).
- Comparing with meat: much work is needed to understand how alternative protein products can better compete with traditional meat. Our review shows that many consumers struggle to replace animal products and have difficulty identifying viable alternatives (Nguyen et al., 2022; Pakseresht et al., 2022).
- Need for comparisons across products and countries (Chang, Wooden, Rosman, Altema-Johnson, & Ramsing, 2023; Florença et al., 2022; Kröger, Dupont, Büsing, & Fiebelkorn, 2022; Weinrich, 2019), within studies or across by standardized measures (Onwezen et al., 2021) or complete reports (Stiles et al., 2022).
- Cultural comparisons in cultures that have different eating habits (Florença et al., 2022).
- Comparisons across drivers (Onwezen et al., 2021; Taufik et al., 2019; Mina et al., 2023; Kouarfaté and Durif, 2023).
- Representative samples beyond students (Mina et al., 2023) and beyond Western high-income countries (Valli et al., 2022; Chang et al., 2023).

Develop an overarching framework
- Develop an overarching framework (Onwezen et al., 2021) or further develop a used framework (Harguess et al., 2020; Weinrich, 2019).

Standardized approaches are needed to include the possibilities for comparisons
- Include effect sizes, as most of the studies did not report effect sizes. Future research should all include effect sizes to allow better comparisons across studies and better insights in the effectiveness of the different interventions (Taufik et al., 2019).
- Further research should be conducted to develop standardized measures and to understand the relative importance of different drivers for consumer acceptance (Siddiqui et al., 2022).

Better understand and measure behaviour
- Real life experimental research designs (Harguess, Crespo, & Hong, 2020; Kröger, Dupont, Büsing, & Fiebelkorn, 2022; Pakseresht, Kaliji, & Canavari, 2022; Stiles, Collins, & Beck, 2022; Taufik, Verain, Bouwman, & Reinders, 2019) and long-term measurements of behaviour (Chang, Wooden, Rosman, Altema-Johnson, & Ramsing, 2023; Kröger, Dupont, Büsing, & Fiebelkorn, 2022; Kwasny, Dobernig, & Riefler, 2022; Meier, Andor, Doebbe, Haddaway, & Reisch, 2022) are needed to advance the field.
- Objective measures rather than self-reported (Kwasny et al., 2022), for example observational studies (Chang et al., 2023).
- Future research should measure financial, environmental, and dietary outcomes of interventions (Stiles et al., 2022).
- Spillover effects to other sustainable domains (other pro-environmental behaviours) (Chang et al., 2023) should be explored.

Promising areas that are under researched
- Negative emotions seem effective, though more knowledge needed on positive emotions (Fonseca and Sanchez-Sabate, 2022; Kwasny et al., 2022; Onwezen et al., 2021). Insights how to overcome other mechanisms to avoid cognitive dissonance, such as denial of animal suffering, dichotomizing animals into those we love and those we eat or pro-meat justifications (Fonseca and Sanchez-Sabate, 2022; Lonkila and Kaljonen, 2021; Benningstad and Kunst, 2020).
- Skill development is barely addressed in existing research. There is a high potential, though more research required (Kwasny et al., 2022).
- Social and cultural research indicated that relating to the dietary preferences of other consumers could be effective, especially when communicated by advocates belonging to the consumers' reference group. However limited research is available (Nguyen et al., 2022; Kwasny et al., 2022; Onwezen et al., 2021; Sanchez-Sabate et al., 2019; Taufik et al., 2019; Sanchez-Sabate and Sabaté, 2019).
- The results on the affective and social aspects of drivers is promising , and also other bodies of literature emphasize the importance of including aspects beyond information alone—aspects such as nudging—in interventions in order to potentially change behaviour (Onwezen et al., 2021).
- In addition to vegans and vegetarians, there are a significant number of consumers who limit meat consumption. Known as meat-reducers or flexitarians, few studies have explored their motivations for reducing meat intake (Sanchez-Sabate and Sabaté, 2019).
- Insights in acceptance of meat analogues, to understand high failure rates of novel alternatives (Weinrich, 2019).

Causality
- Most of the findings captured in this *meta*-review were from observation or cross-sectional studies. There is a need to dive in causality issues (Harguess et al., 2020).
- Using experimental designs to further explore causality of associations (Kwasny et al., 2022).

Multidisciplinairy
- Consumer research is an important part of the solution, but other aspects also deserve to be investigated. Especially in combination with each other. For example, developing consumer products with a large impact on health and sustainability, and which are also accepted by consumers (Mina et al., 2023), including new technologies (Pakseresht et al., 2022).

Policy related research
- A need for policy related research, for example RCT's, testing tax-related interventions (Nguyen et al., 2022; Taufik et al., 2019).
- Consumer-centred approaches: there is an over estimation of technological solutions, and demand-side routes like consumer acceptance of pulses are underestimated (Lonkila and Kaljonen, 2021).
- Although some studies suggest small steps (Bryant and Barnett, 2020); It is relevant to also acknowledge the possibility of big steps (e.g., suggesting that currently too much emphasis is on mimicking alternative protein foods to the mouthfeel, taste and the like of animal-based foods (Lonkila and Kaljonen, 2021).
- Focus on interventions with sustained impact across time, contexts and domains, and not only rely on nudges resulting generally in a short-term impact – at best. (Onwezen et al., 2021).
- Understand and deal with resistance. Often resistance is notified as an end station. However, it is valuable to explore for how many individuals, and under which conditions, reactance occurs (Sanchez-Sabate and Sabaté, 2019).

powerful (Onwezen, 2018). While we have not assessed the cost-effectiveness of the different intervention types in this review, it is likely that group-specific policies are more feasible and acceptable than more generic and coercive measures, such as bans or meat taxes (Reisch et al., 2021). However, we do realize that the evidence on these policies, and the specific recommendations, are limited and that ample additional research is needed to inform protein policies better – both conceptually sound and empirically founded.

5.3. Future research

We disentangled the most promising and most often stated actions for future research from the body of systematic reviews. Overall, there is a need for comparisons and building upon each other, for example an integrated framework and standardized approaches should be adopted. To date, the field has a focus on short-term interventions, whereas there is a need to find solutions to sustain behaviours across contexts, situations, and time. Promising areas that are under researched include for example emotions, social and cultural aspects. Finally, the tendency among scholars to formulate policy recommendations in general terms only are a missed opportunity to translate science into policy practice. Scientists are encouraged to start trying to formulate more specific and feasible recommendations to policymakers to inspire and encourage them to take evidence-based actions that support and accelerate the protein transition. See Table 5 for a detailed overview of future research based on the key reviews.

6. In conclusion

Given its comprehensive scope, a *meta*-review is meaningful to present an overall impression of the state of the art. The existing findings not only bring clarity but also complexity. Dietary changes represent tough and thorny challenges. Hence, motivation, capability, and opportunity factors such as those identified in this *meta*-review should be addressed to successfully shape and sustain the protein transition. This *meta*-review indicates that motivation and opportunity show the strongest evidence for drivers to support the protein transition. For motivation, motives and emotions showed the most promising drivers. For opportunity it highlights environmental redesign. Like recipe re-design (default, followed by visibility and portion sizes) as the most promising drivers. For capability, awareness and taste were the most relevant. Social norms and culture, for example, appear promising though underresearched. The policy perspective is largely overlooked, focus primarily on non-intrusive policy interventions, and policy-oriented recommendations are often perfunctory. The findings of this review can be used to start developing policy interventions targeted at prominent driving forces of the protein transition. Regardless of whether more individual or more integrated interventions are involved, in both cases the necessary policy action supports food consumers to move into the direction of the protein transition as well as to contribute to make the 2020s a decade of action.

CRediT authorship contribution statement

Marleen C. Onwezen: Conceptualization, Data curation, Writing – original draft, Funding acquisition. **Hans Dagevos:** Conceptualization, Writing – review & editing, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Acknowledgements

This research was supported by the research projects 'Protein Monitor' and 'Accelerating the protein transition', funded by the Dutch Ministry of Agriculture, Nature and Food Quality (BO-43-103-011 and BO-43-103-010).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2023.105067.

Key references included in meta-review

Benningstad, N. C., & Kunst, J. R. (2020). Dissociating meat from its animal origins: A systematic literature review. *Appetite, 147*, Article 104554.
Bryant, C., & Barnett, J. (2020). Consumer acceptance of cultured meat: An updated review (2018–2020). *Applied Sciences, 10*(15), 5201.
Chang, K. B., Wooden, A., Rosman, L., Altema-Johnson, D., & Ramsing, R. (2023). Strategies for reducing meat consumption within college and university settings: A systematic review and meta-analysis. *Frontiers in Sustainable Food Systems, 7*, 162.
Fehér, A., Gazdecki, M., Véha, M., Szakály, M., & Szakály, Z. (2020). A comprehensive review of the benefits of and the barriers to the switch to a plant-based diet. *Sustainability, 12*(10).
Florença, S. G., Guiné, R. P., Gonçalves, F. J., Barroca, M. J., Ferreira, M., Costa, C. A., … Cunha, L. M. (2022). The motivations for consumption of edible insects: A systematic review. *Foods, 11*(22), 3643.
Fonseca, R. P., & Sanchez-Sabate, R. (2022). Consumers' attitudes towards animal suffering: A systematic review on awareness, willingness and dietary change. *International Journal of Environmental Research and Public Health, 19*(23), 16372.
Harguess, J. M., Crespo, N. C., & Hong, M. Y. (2020). Strategies to reduce meat consumption: A systematic literature review of experimental studies. *Appetite, 144*, Article 104478.
Kouarfaté, B. B., & Durif, F. N. (2023). A systematic review of determinants of cultured meat adoption: Impacts and guiding insights. *British Food Journal, 125*(8), 2737–2763.
Kröger, T., Dupont, J., Büsing, L., & Fiebelkorn, F. (2022). Acceptance of insect-based food products in western societies: A systematic review. *Frontiers in Nutrition, 8*, 1186.
Kwasny, T., Dobernig, K., & Riefler, P. (2022). Towards reduced meat consumption: A systematic literature review of intervention effectiveness, 2001–2019. *Appetite, 168*, Article 105739.
Lonkila, A., & Kaljonen, M. (2021). Promises of meat and milk alternatives: An integrative literature review on emergent research themes. *Agriculture and Human Values, 38*(3), 625–639.
Meier, J., Andor, M. A., Doebbe, F. C., Haddaway, N. R., & Reisch, L. A. (2022). Do green defaults reduce meat consumption? *Food Policy, 110*, Article 102298.
Mina, G., Peira, G., & Bonadonna, A. (2023). The Potential Future of Insects in the European Food System: A Systematic Review Based on the Consumer Point of View. *Foods, 12*(3), 646.
Nguyen, J., Ferraro, C., Sands, S., & Luxton, S. (2022). Alternative protein consumption: A systematic review and future research directions. *International Journal of Consumer Studies, 46*(5), 1691–1717.
Onwezen, M. C., Bouwman, E. P., Reinders, M. J., & Dagevos, H. (2021). A systematic review on consumer acceptance of alternative proteins: Pulses, algae, insects, plant-based meat alternatives, and cultured meat. *Appetite, 159*, Article 105058.
Pakseresht, A., Kaliji, S. A., & Canavari, M. (2022). Review of factors affecting consumer acceptance of cultured meat. *Appetite, 170*, Article 105829.
Sanchez-Sabate, R., Badilla-Briones, Y., & Sabaté, J. (2019). Understanding attitudes towards reducing meat consumption for environmental reasons. *A qualitative synthesis review. Sustainability, 11*(22), 6295.
Sanchez-Sabate, R., & Sabaté, J. (2019). Consumer attitudes towards environmental concerns of meat consumption: A systematic review. *International Journal of Environmental Research and Public Health, 16*(7), 1220.
Siddiqui, S. A., Alvi, T., Sameen, A., Khan, S., Blinov, A. V., Nagdalian, A. A., … Onwezen, M. (2022). Consumer acceptance of alternative proteins: A systematic review of current alternative protein sources and interventions adapted to increase their acceptability. *Sustainability, 14*(22), 15370.
Stiles, G., Collins, J., & Beck, K. L. (2022). Effectiveness of strategies to decrease animal-sourced protein and/or increase plant-sourced protein in foodservice settings: A systematic literature review. *Journal of the Academy of Nutrition and Dietetics, 122*(5), 1013–1048.

Taufik, D., Verain, M. C., Bouwman, E. P., & Reinders, M. J. (2019). Determinants of real-life behavioural interventions to stimulate more plant-based and less animal-based diets: A systematic review. *Trends in Food Science & Technology, 93*, 281–303.
Valli, C., Maraj, M., Prokop-Dorner, A., Kaloteraki, C., Steiner, C., Rabassa, M., … Alonso-Coello, P. (2022). People's Values and Preferences about Meat Consumption in View of the Potential Environmental Impacts of Meat: A Mixed-methods Systematic Review. *International Journal of Environmental Research and Public Health, 20*(1), 286.
Weinrich, R. (2019). Opportunities for the adoption of health-based sustainable dietary patterns: A review on consumer research of meat substitutes. *Sustainability, 11*(15), 4028.

References

Aleksandrowicz, L., Green, R., Joy, E. J. M., Smith, P., & Haines, A. (2016). The impacts of dietary change on greenhouse gas emissions, land use, water use, and health: A systematic review. *PLoS ONE, 11*, e0165797.
Aiking, H., & de Boer, J. (2020). The next protein transition. *Trends in Food Science & Technology, 105*, 515–522.
Bryant, C., & Barnett, J. (2018). Consumer acceptance of cultured meat: A systematic review. *Meat Science, 143*, 8–17.
Carfora, V., Caso, D., Sparks, P., & Conner, M. (2017). Moderating effects of pro-environmental self-identity on pro-environmental intentions and behaviour: A multi-behaviour study. *Journal of Environmental Psychology, 53*, 92–99.
Collier, E. S., Oberrauter, L.-M., Normann, A., Norman, C., Svensson, M., Niimi, J., & Bergman, P. (2021). Identifying barriers to decreasing meat consumption and increasing acceptance of meat substitutes among Swedish consumers. *Appetite, 167*, Article 105643.
Corrin, T., & Papadopoulos, A. (2017). Understanding the attitudes and perceptions of vegetarian and plant-based diets to shape future health promotion programs. *Appetite, 109*, 40–47.
Dagevos, H. (2021). Finding flexitarians: Current studies on meat eaters and meat reducers. *Trends in Food Science & Technology, 114*, 530–539.
Dagevos, H., & Onwezen, M. C. (forthcoming 2024). Towards consumer-oriented food policies: A toolbox for encouraging the protein transition. Under review.
Dagevos, H., & Verbeke, W. (2022). Meat consumption and flexitarianism in the Low Countries. *Meat Science, 192*, Article 108894.
EU, (2022), available at: https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/towards-sustainable-plant-protein-and-plant-oil-strategy-eu.
Font-i-Furnols, M. (2023). Meat consumption, sustainability and alternatives: An overview of motives and barriers. *Foods, 12*, 2144.
Gheihman, N. (2021). Veganism as a lifestyle movement. *Sociology Compass, 15*, e12877.
Graça, J., Godinho, C. A., & Truninger, M. (2019). Reducing meat consumption and following plant-based diets: Current evidence and future directions to inform integrated transitions. *Trends in Food Science & Technology, 91*, 380–390.
Grundy, E. A., Slattery, P., Saeri, A. K., Watkins, K., Houlden, T., Farr, N., … Zorker, M. (2021). Interventions that influence animal-product consumption: A meta-review. *Future Foods, 5*, Article 100111.
Hallström, E., Carlsson-Kanyama, A., & Börjesson, P. (2015). Environmental impact of dietary change: A systematic review. *Journal of Cleaner Production, 91*, 1–11.
Hartmann, C., & Siegrist, M. (2017). Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends in Food Science & Technology, 61*, 11–25.
Higgs, S. (2015). Social norms and their influence on eating behaviours. *Appetite, 86*, 38–44.
Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics, 80*, 47–58.
Johnson, B. T., & Hennessy, E. A. (2019). Systematic reviews and meta-analyses in the health sciences: Best practice methods for research syntheses. *Social Science & Medicine, 233*, 237–251.
Kemper, J. A., & White, S. K. (2021). Young adult's experience with flexitarianism: The 4Cs. *Appetite, 160*, Article 105073.
Khara, T., Riedy, C., & Ruby, M. B. (2021). The evolution of urban Australian meat-eating practices. *Frontiers in Sustainable Food Systems, 5*, Article 624288.
Loughnan, S., Bratanova, B., & Puvia, E. (2012). The meat paradox: How are we able to love animals and love eating animals. *Mind, 1*, 15–18.
Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation science, 6*(1), 1–12.
Milfort, A. B., Le Mouël, C., Bodirsky, B. L., & Rolinskic, S. (2019). Drivers of meat consumption. *Appetite, 141*, Article 104313.
Nuffield Council on Bioethics. (2007). *Public health: Ethical issues*. London: Nuffield Council on Bioethics.
OECD/FAO, OECD-FAO Agricultural Outlook 2022–2031 2022 OECD Publishing Parijs 10.1787/f1b0b29c-en.
Oliver, C. (2023). Vegan world-making in meat-centric society: The embodied geographies of veganism. *Social & Cultural Geography, 24*, 831–850.
Onwezen, M. (2018). Including context in consumer segmentation: A literature overview shows the what, why, and how. In: Ares, G., & Varela, P. (Eds.), Methods in Consumer Research, Vol. 1. Cambridge (MA): Woodhead Publishing, 383–400.
Onwezen, M. C. (2022). The application of systematic steps for interventions towards meat-reduced diets. *Trends in Food Science & Technology, 119*, 443–451.
Onwezen, M. C., Verain, M. C. D., & Dagevos, H. (2022). Social norms support the protein transition: The relevance of social norms to explain increased acceptance of alternative protein burgers over 5 years. *Foods, 11*(21), 3413.
Parlasca, M. C., & Qaim, M. (2022). Meat consumption and sustainability. *Annual Review of Resource Economics, 14*, 6.1-6.25.
Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite, 19*(2), 105–120.
Reinders, M. J., Huitink, M., Dijkstra, S. C., Maaskant, A. J., & Heijnen, J. (2017). Menu-engineering in restaurants-adapting portion sizes on plates to enhance vegetable consumption: A real-life experiment. *International Journal of Behavioral Nutrition and Physical Activity, 14*(1), 1–11.
Reisch, L. A., Sunstein, C. R., Andor, M. A., Doebbe, F. C., Meier, J., & Haddaway, N. R. (2021). Mitigating climate change via food consumption and food waste: A systematic map of behavioral interventions. *Journal of Cleaner Production, 279*, Article 123717.
Rethlefsen, M. L., Kirtley, S., Waffenschmidt, S., Ayala, A. P., Moher, D., Page, M. J., & Koffel, J. B. (2021). PRISMA-S: An extension to the PRISMA statement for reporting literature searches in systematic reviews. *Systematic reviews, 10*(1), 1–19.
Rosenfeld, D. L. (2018). The psychology of vegetarianism: Recent advances and future directions. *Appetite, 131*, 125–138.
Rothgerber, H. (2020). Meat-related cognitive dissonance: A conceptual framework for understanding how meat eaters reduce negative arousal from eating animals. *Appetite, 146*, Article 104511.
Salehi, G., Díaz, E., & Redondo, R. (2023). Forty-five years of research on vegetarianism and veganism: A systematic and comprehensive literature review of quantitative studies. *Heliyon, 9*, e16091.
Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., & Kerr, J. (2006). An ecological approach to creating active living communities. *Annu. Rev. Public Health, 27*, 297–322.
Sexton, A. E., Garnett, T., & Lorimer, J. (2022). Vegan food geographies and the rise of Big Veganism. *Progress in Human Geography, 46*, 605–628.
Siddaway, A. P., Wood, A. M., & Hedges, L. V. (2019). How to do a systematic review: A best practice guide for conducting and reporting narrative reviews, meta-analyses, and meta-syntheses. *Annual review of psychology, 70*, 747–770.
Sijtsema, S. J., Dagevos, H., Nassar, G., van Haaster-de Winter, M., & Snoek, H. M. (2021). Capabilities and opportunities of flexitarians to become food innovators for a healthy planet: Two explorative studies. *Sustainability, 13*, 11135.
Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of environmental psychology, 29*(3), 309–317.
Stoll-Kleemann, S., & Schmidt, U. J. (2017). Reducing meat consumption in developed and transition countries to counter climate change and biodiversity loss: A review of influence factors. *Regional Environmental Change, 17*, 1261–1277.
Strässner, A. M., & Hartmann, C. (2023). Gradual behaviour change towards meat reduction: Development and validation of a novel decisional balance scale. *Appetite, 186*, Article 106537.
Stubbs, R. J., Scott, S. E., & Duarte, C. (2018). Responding to food, environment and health challenges by changing meat consumption behaviours in consumers. *Nutrition Bulletin, 43*, 125–134.
Tian, Q., Hilton, D., & Becker, M. (2016). Confronting the meat paradox in different cultural contexts: Reactions among Chinese and French participants. *Appetite, 96*, 187–194.
United Nations, UN. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. United Nations: New York, NY, USA.
Waters, C. (2022). To V or not to V: Contingencies of going vegan. *Humanity & Society, 46*, 151–169.
Weis, T., & Ellis, R. A. (2022). The de-meatification imperative: To what end? *Canadian Food Studies, 9*(1), 10.15353/cfs-rcea.v9i1.511.
White, S. K., Ballantine, P. W., & Ozanne, L. K. (2022). Consumer adoption of plant-based meat substitutes: A network of social practices. *Appetite, 175*, Article 106037.
Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., … Murray, C. J. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet, 393*(10170), 447–492.