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Enabling sustainable food transitions in schools: a systemic approach

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Abstract

Purpose – Recent reviews and reports have highlighted the need for integrated, context-specific efforts to enable sustainable food transitions. This study aimed to identify pathways to promote healthier and more environmentally friendly food practices in school contexts, with a focus on increased plant-based eating.

Design/methodology/approach – The study used a systemic approach with data collected from relevant stakeholders in an EU country (Portugal) at diverse levels of influence in the school meals system (i.e.

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proximal, intermediate, distal; from end-consumers to food providers, market actors, civil society organizations, and policy and decision-makers). Data from individual interviews ($N = 33$) were subjected to thematic analysis.

Findings – Meat-centric cultural perceptions of a 'proper meal' can be a socio-emotional barrier for sustainable food transitions in schools. Main pathways identified to unlock these transitions included: (1) Levering orientations toward ethical and environmentally beneficial consumption; (2) Improving and increasing the offer of plant-based meals; and (3) Mobilizing local communities and society.

Originality/value – The current findings suggest that promoting healthier and more environmentally friendly food practices in schools requires systemic, integrated approaches which focus on food consumption, food provision, and the broader political and sociocultural environment.

Keywords Planetary health diet, School meals, Meat consumption, Plant-based diets, Sustainable consumption

Paper type Research paper

1. Introduction

Feeding a growing global population raises environmental challenges that include climate change, water scarcity, biodiversity loss, and disruption of carbon and nitrogen cycles (Coimbra *et al.*, 2020; Poore and Nemecek, 2018; Shepon *et al.*, 2018; Springmann *et al.*, 2018; Willet *et al.*, 2019). There are also global health concerns whereby food insecurity, obesity and micronutrient deficiencies coincide side-by-side paradoxically across the world (IFPRI, 2016). Nearly thirty percent of the world's population is overweight or obese, and almost half of the adult population (41%) will be suffering from excessive weight by 2030 (Dobbs *et al.*, 2014). Child obesity is a significant concern, as the number of young children between 0–5 years who are overweight or obese increased from 32 million in 1990 to 41 million globally in 2016 (WHO, 2019). This calls for urgent action, as child and adolescent obesity is known to be associated with a range of health problems which include cardiovascular disease, insulin resistance, respiratory problems, impaired musculoskeletal development and physical morbidity in adulthood (e.g. Cote *et al.*, 2013; Dobbs *et al.*, 2014; Mohanan *et al.*, 2014).

Against this backdrop, a shift toward increasingly plant-based diets (i.e. diets which have the bulk of calories from plant sources while limiting or avoiding animal sources) is one of the necessary (albeit not sufficient) pathways to enable healthier and more sustainable food systems (Aiking and de Boer, 2020; Springmann *et al.*, 2018; Willet *et al.*, 2019). Established evidence suggests that well-planned plant-based diets can help lower the risk of Non-Communicable Diseases (NCDs) such as cancer, obesity and cardiovascular diseases (Satija and Hu, 2018; Willet *et al.*, 2019). Plant-based food products also tend to have a lower environmental impact in terms of greenhouse-gas emissions, eutrophication and acidification potentials, and land, freshwater and fossil fuel use, when compared to animal-sourced foods (Chai *et al.*, 2019; Hayek *et al.*, 2021; Poore and Nemecek, 2018; Willet *et al.*, 2019). However, despite these potential benefits, large-scale transitions toward healthier and more sustainable diets will not happen automatically. A systematic review on barriers and enablers to unlock these transitions identified relevant capability (information and ability to acquire new skills and habits), opportunity (social and physical context), and motivation variables (reflective and automatic psychological drivers) for dietary behavior change (Graça *et al.*, 2019; see also the capability, opportunity, motivation, behavior (COM-B) system, Michie *et al.*, 2011). Similarly, other recent reviews and reports have highlighted the need for a combination of consumer-centered efforts and socio-structural changes to enable food sustainability transitions (e.g. de Boer and Aiking, 2019; Kemper and Ballantine, 2020; Stoll-Kleemann and Schmidt, 2017; Rust *et al.*, 2020), such as promoting changes in collective meal contexts, and designing and implementing meat curtailment policies. To address this need for integrated (consumer-, context-, and policy-focused) approaches, the present study focuses on the possibilities that school meals systems provide for enabling transitions toward healthier and more environmentally beneficial food practices.

1.1 Sustainability transitions in school meals systems

School meals systems play a significant role in the global food complex, with around 370 million children receiving a school meal a day worldwide (UNICEF, WFP, 2020). Furthermore, school-meals have a multi-sectoral influence over society, including direct educational (e.g. school enrolment, attendance, and academic performance) and public health benefits (especially with students from financially deprived families), agricultural outputs, economic development, social protection and environmental sustainability (Anderson *et al.*, 2018; Oostindjer *et al.*, 2017; Verguet *et al.*, 2020). This suggests that school meals can be seen as a platform in which food sustainability transitions account for multiple stakeholders' needs, resources and expectations at distinct spheres of influence.

Drawing on a systems approach (e.g. Bronfenbrenner and Morris, 2006; Fiksel, 2006), the current study defines stakeholders of the school meals system as the key actors whose ideas, actions and/or decisions may impact the system at different (but interdependent) levels of influence. Accordingly, we developed a three-tiered model to map relevant stakeholders at different levels of influence in the school meals system – i.e. proximal, intermediate, and distal (Figure 1). These stakeholders are embedded in the natural environment, which offers the backdrop and foundation for all their actions (Lozano, 2008). This three-tiered model also fits with the setting of the current study. As in many other countries in Europe, the Portuguese school meals system provides free or low-cost meals to all students as an attempt to tackle

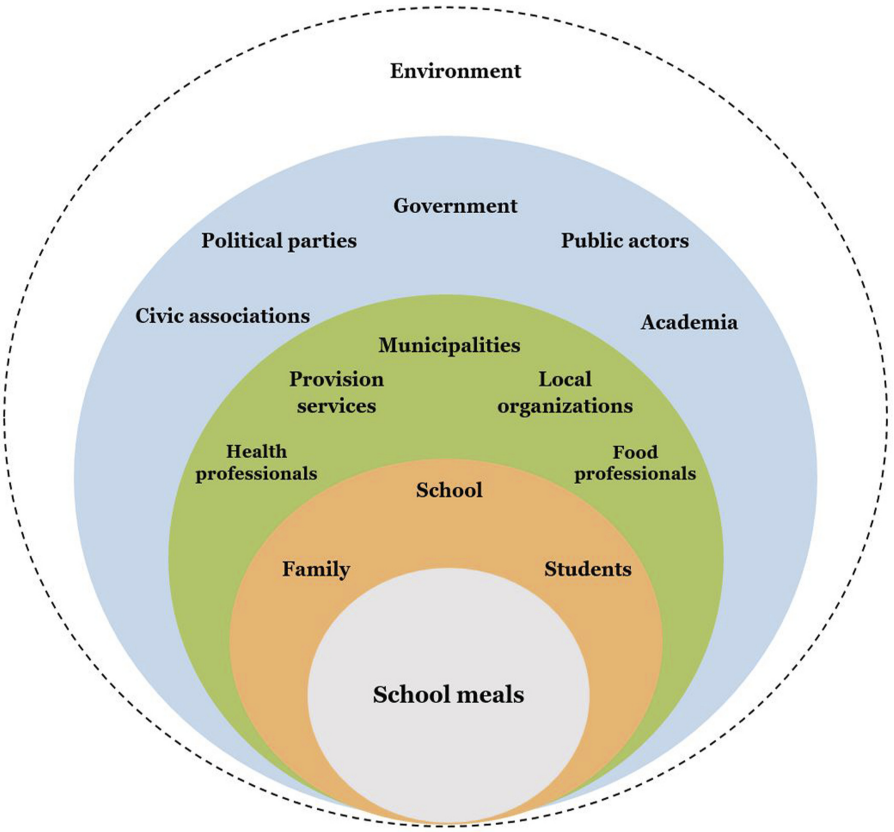

Figure 1.
Stakeholders at proximal, intermediate, and distal levels in the school meals system, embedded in the environment

socioeconomic inequalities and promote health and school achievement (Truninger *et al.*, 2015). School canteens must comply with a list of authorized products based on healthiness and origin (i.e. foods produced within Portugal or in the nearby regions should be prioritized), as well as standardized cooking and procurement procedures set by the Portuguese Ministry of Education. School canteens can be operated by the municipalities and/or subcontracted to private providers, but the system is relatively centralized as they are subject to national guidelines. Importantly, as is the case in other Western industrialized societies, Portugal is a highly meat-centric country (Brittin, 2011) and children tend to eat more than the formally recommended levels of animal protein in their diets (Durão *et al.*, 2017). The high consumption of animal products, together with an excessive intake of sugar, are linked to strikingly high levels of child obesity in the country (Durão *et al.*, 2017; Frade *et al.*, 2020). This is also reflected in the typical offer provided in the school meals system, in which the standard practice is to rotate between meat and fish meals every day of the week with little room for plant-based meals. Hence, changes toward increased plant-based eating in schools should require concerted action by stakeholders across the three levels of influence – i.e. proximal, intermediate, and distal (Figure 1).

The proximal level of influence includes the actors and variables that directly impact the target behavior (i.e. eating more plant-based school meals). Students' families and schools also emerge as actors and contexts of particular interest, considering students as end-consumers. Household habits and practices shape food preference in children and young people (Contento, 2011). Parents and caregivers usually act as nutritional gatekeepers determining what foods are available for consumption at home and as models of eating behavior (Larson and Story, 2009). Additionally, parents and caregivers may shape food habits and preferences by planning and preparing meals or by choosing and ordering school lunches. The school context also plays an important role in children's and adolescents' eating habits. Peer pressure influences what and how children eat, inside or outside the school premises, namely the food retail outlets close to the schools (Truninger and Teixeira, 2015). Children and adolescents usually spend a significant proportion of their waking hours in educational contexts; hence, the school environment plays a pivotal role in their food practices (Frisvold and Price, 2019). The growing number of school-based programs and policies regarding food provision highlight the potential (and responsibility) of educational contexts for promoting healthy and pro-environmental behaviors (Dudley *et al.*, 2015).

The intermediate level of influence comprises groups and/or organizations with relevant influence over school meals, albeit with less direct interaction with the end-consumers. Influence at this level occurs predominantly at the local scale. This may include municipal structures, community-level individuals or organizations, and food provision services/companies. In some cases, intermediate-level organizations may directly regulate food choice, for instance, by determining food provision (as in the case of schools under municipal or district-level management; Kubik *et al.*, 2010). In other cases, the influence can be indirect, by shaping the surrounding social (e.g. neighborhoods' socioeconomic characteristics, Li *et al.*, 2016) and physical environment (e.g. access/proximity to healthy or sustainable food retail stores, Lucan and Mitra, 2012). Local food environments play a key role in determining food choices (Walker *et al.*, 2010). For instance, the concepts of food "deserts", "swamps" or "oases" reflect the myriad of local social, economic, and geographic factors influencing access to safe and nutritious food (Cooksey-Stowers *et al.*, 2017). The food environment shapes students' consumption patterns, and it is often the case that food- and retail-establishments surrounding schools enable inadequate eating practices (da Costa Peres *et al.*, 2020). This suggests that a lack of nutritionally balanced, appetizing plant-based meal options in educational contexts and their surroundings may compromise sustainable food transitions in schools. Social influences at the intermediate level of influence may also contribute to shaping eating behaviors, through social support, modeling, legitimation and social norms

(de Boer and Aiking, 2020; Larson and Story, 2009). For instance, health professionals (e.g. doctors, dietitians, nutritionists) may address health concerns and motivations, and provide skills and knowledge to enable behavior change (Cant and Aroni, 2008). Chefs, caterers, and other food sector professionals may contribute to increasing the availability, attractiveness, and nutritional adequacy of plant-based meals (Zellner and Cobuzzi, 2017).

At the distal level, the model emphasizes policy and decision making (e.g. political and governmental structures), civic action (e.g. advocates for societal change), and knowledge production and transfer (e.g. universities). Despite the broader scope of influence, stakeholders at this level may substantially impact food practices and outcomes. For example, government policy and regulation may affect farming and production, purchasing, processing, distributing, and marketing, thus shaping food market trends and, consequently, the affordability and availability of healthy, sustainable foods (Larson and Story, 2009). Other policy interventions implicating consumer behavior more directly include awareness and knowledge promotion initiatives (e.g. through public campaigns or nutrition labeling), fiscal measures and taxations targeting specific food types (e.g. sugar-sweetened beverages), as well as provision regulation (for a review of policy interventions see Brambila-Macias *et al.*, 2011). Alongside governmental action, civil society movements have strongly levered the transition to more sustainable food systems (Hinrichs, 2014). Multiple civil actors (e.g. companies, non-profit organizations, civil associations) participate in governance processes through policymaking, social provisioning and discursive interventions, which help shape the transformation of agri-food systems (Andrée *et al.*, 2019).

1.2 The present work: aim and overview

Reviews and reports calling for more sustainable food systems increasingly emphasize the need for integrated, context specific trajectories for sustainable food transitions (e.g. de Boer and Aiking, 2019; Rust *et al.*, 2020; Willet *et al.*, 2019). But how can these trajectories be envisioned and materialized? The present study aims to help address this question and identify pathways to healthier and more environmentally friendly diets in school contexts. We focused on how to enable increased plant-based eating in schools by promoting less meat-centric and more flexitarian school food environments. Using a systemic approach, the study collected inputs from multiple stakeholders at different spheres of influence (i.e. from end-consumers to food providers, market actors, civil society organizations, and policy and decision-makers). First, we mapped relevant stakeholders based on the three-tiered model presented in Figure 1. Afterward, we collected data using individual interviews with the stakeholders and engaged with the data using inductive thematic analysis. Lastly, to give conceptual meaning to the findings and enable interdisciplinary dialogue, we offered an overview and theory-based discussion of the results, linking policy and intervention options.

2. Methods

2.1 Sample

This study was conducted in the Portuguese school-meals context. Participants were selected through a process of snowball, purposeful sampling, based on the three-tiered model presented in Figure 1 (i.e. encompassing proximal, intermediate, and distal influences). The scope of potential interviewees was defined according to three broad fields: school meals, sustainability, and food/nutrition. The identification of potential interviewees in each level resulted from media analysis and search in institutional websites. Additionally, participants were asked at the end of each interview to suggest other potential interviewees that matched our criteria/domains of interest. The final sample comprised 33 participants (23 female, 10 male; 8–71 years of age, $M = 42.7$, SD = 14.3) and ensured a balanced representation across levels of influence (i.e. Proximal = 12; Intermediate = 11; Distal = 10). Table 1 describes each

#	Gender	Age	Role	Level of influence
1	F	42	Nutritionist, Professor, Regulation (Order)	Intermediate
2	F	45	Chef, Professor	Intermediate
3	F	55	Nutritionist, Professor, Regulation (Audits)	Intermediate
4	F	27	Nutritionist, Regulation (National Health Guidelines)	Intermediate
5	M	29	Advocate (Civil Society)	Distal
6	M	56	Quality manager (catering services), Nutritionist	Intermediate
7	F	17	Advocate (civil society), Student	Proximal
8	F	43	Quality manager (catering services), Nutritionist	Intermediate
9	M	56	National coordinator of the public-school meals system	Intermediate
10	M	52	Advocate (Civil society), Teacher	Distal
11	F	44	Advocate (Civil society), Journalist, Chef	Distal
12	F	47	Municipal Officer (Education)	Intermediate
13	F	N/A	Marketing Specialist and Advocate (Sustainability)	Distal
14	M	55	Farmers' Union representative	Distal
15	F	51	Quality Manager (Catering Services)	Intermediate
16	M	35	Researcher (Nutrition Science)	Distal
17	M	45	Researcher (Planning and sustainability)	Distal
18	F	39	Elected member of the National Parliament, Political representative	Distal
19	F	43	Parent	Proximal
20	M	14	Student	Proximal
21	F	44	Parent	Proximal
22	F	45	Advocate (Sustainability)	Distal
23	M	71	Advocate (Sustainability)	Distal
24	F	N/A	Elected city councilor, Political representative	Intermediate
25	F	45	School Dean	Proximal
26	F	46	Teacher	Proximal
27	F	59	School canteen cook	Proximal
28	F	N/A	Advocate, School Program Coordinator	Proximal
29	M	8	Student	Proximal
30	F	20	Student	Proximal
31	F	40	Local coordinator of the public-school meals system	Intermediate
32	F	49	Parent	Proximal
33	F	59	School canteen cook	Proximal

Table 1. Stakeholders' characteristics, presented in the order in which the interviews were conducted

interviewee's role, level of influence, age and gender, in the order in which the interviews were conducted.

2.2 Data collection and analytical procedure

This research was reviewed and approved by the ethical review board of the host institution (Institute of Social Sciences of the University of Lisbon). Regarding the recruitment procedures, participants were firstly invited via email. The email included general information about the project and the purpose and conditions of the proposed interview. A follow-up contact (by email or phone call, whenever possible) ascertained willingness and availability to participate in the study. A semi-structured interview script was tailored to the participants' characteristics and level of proximity/involvement with the school meals system. The script started with broader questions about health and sustainability challenges in food practices or food systems (e.g. "What is your opinion/perspective on current and future challenges regarding sustainability [health] in food consumption?"), and proceeded to explore more specific questions about plant-based eating and healthy/sustainable food consumption in schools (e.g. "Based on your experience, what do you think are the biggest challenges/barriers [and opportunities/drivers] to promote increased plant-based eating with

students?"; "In your opinion, what needs to happen to ensure that students have access to [and interest in choosing] plant-based school meals?").

Before each interview, participants were introduced to the project's aims and briefed about the purpose of the interviews. Participants were also assured of the voluntary and confidential nature of their participation and asked for consent to record the interview. A sociodemographic questionnaire was used to assess the sample's general characteristics (i.e. age, gender, education). The interview recordings were transcribed verbatim and analyzed with MAXQDA v.10 using a data-driven (i.e. bottom-up) approach, following Braun and Clarke's (2006) guidelines for thematic analysis: (1) familiarizing with the data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; and (5) defining and naming themes. Given the range and diversity in stakeholders' profiles and experiences, we acknowledged participants' verbalizations as dependable (albeit non-self-standing) inputs on how to enable sustainable food transitions in schools. The analysis was led by three authors (LR, DG, JG), which independently read and reread the interview transcripts (step one). Two coders (LR, DG) generated the initial list of codes (step two) and searched for themes (step 3) based on semantic criteria (i.e. bottom-up analysis). These were then discussed and reviewed iteratively with the third coder (JG) vis-à-vis the interview transcripts and the aims of the study (step four), until a coherent thematic map with three levels (i.e. themes, sub-themes, codes) was achieved (step five). All authors validated the clarity and coherence of the analysis and output (i.e. thematic map).

3. Results

The analysis identified and described three main themes in the dataset (Figure 2): Levering orientations toward sustainable consumption; Optimizing and increasing plant-based meal offer; and Mobilizing local communities and society as a whole. Each theme comprised a set of sub-themes.

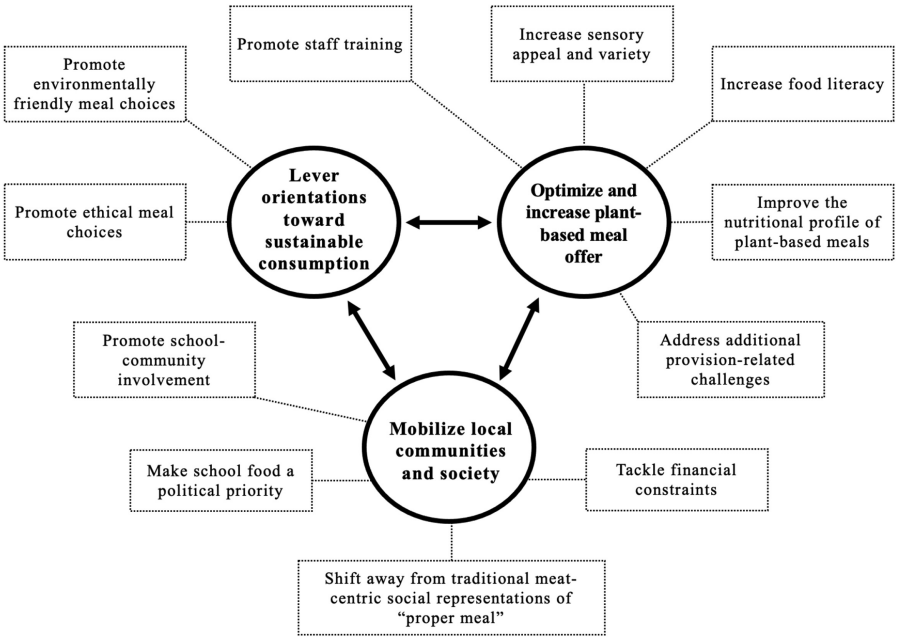

Figure 2.
Enabling sustainable food transitions in schools by promoting less meat centric and more flexitarian school food environments

3.1 Levering orientations towards sustainable consumption

One important pathway to enable plant-forward transitions in the school meals system was to lever orientations towards more sustainable consumption. More specifically, two sub-themes were identified, which focused on the promotion of environmentally-friendly and ethical meal choices.

3.1.1 Promoting environmentally-friendly meal choices. This sub-theme referred to the main concerns and beliefs expressed by the stakeholders regarding the relationship between food and environmental sustainability. The responses addressed issues related to climate change, increased deforestation and the destruction of ecosystems. Factory farms and the excessive consumption of animal products were regarded as problematic due to the links with GHG emissions and significant environmental impacts (e.g. biodiversity; land; water; air). A shift towards increased plant-based eating was seen as a desirable (albeit not sufficient) measure to halt and reverse the destruction of ecosystems (e.g. *"I think it is more than obvious that we need to consume much less meat, isn't it? Therefore, a big change must happen soon, especially in the meat industry. Because of deforestation [. . .] and the whole impact, including [. . .] greenhouse gases, etc. Although the problem of deforestation, at this moment, is the one that hurts me the most, it is the one that causes the most problems. [. . .] We are [. . .] accelerating the destruction of ecosystems just because we insist on eating meat"* – Marketing Specialist and Sustainability Advocate, I.13).

3.1.2 Promoting meal choices that take into consideration animal ethics. Participants also mentioned that promoting ethical food consumption could help encourage shifts toward food sustainability transitions. Most inputs on this matter referred to increasing awareness and concern about the death and anthropogenic suffering inflicted on the animals used in the food industry. Participants referred to disturbing videos on social media or documentaries exposing animal slaughter, suffering and abnormal behaviors (e.g. chicken "*pecking each other's heads until they bleed*"), as well as debilitating life conditions (e.g. *"very confined spaces"; "cows (. . .) with objects attached to their nipples*"- Parent I.19), which made eating meat look less appealing (*I watched a video on Facebook of animals being killed, so, I did not want to eat them anymore"* – Advocate-civil society, Student, I.7). Hence, promoting increased plant-based eating was regarded as a way to reduce animal exploitation and take a stand against anthropogenic suffering.

3.2 Optimizing and increasing plant-based meal offer

The need to optimize and increase plant-based meal offer in school settings was also highlighted in the interviews. Recurrent patterns of response focused on the structural and logistic issues that schools face daily, which compromise this optimization. The main issues included the need to increase staff training, food literacy, improve the nutritional profile and sensory appeal of plant-based meals, increase the variety and diversity of plant-based meal options, and address logistic- and other provision-related challenges.

3.2.1 Promoting staff training. The need to increase staff training, both in the kitchen as well as the number of qualified school nutritionists, was mentioned by participants as a way to optimize and increase plant-based meal offer. Recurrent patterns of response focused on a general lack of knowledge and skills to prepare balanced and appetizing plant-based meals, which resulted in negative taste experiences and expectations on behalf of students as end-consumers (e.g. "*There is a lot of ignorance on the part of the employees on how to cook these, these ingredients. For example, if some of these ingredients are not soaked, they have a bad taste and you cannot eat them";* Nutritionist, Professor, Regulation/Audits, I.3). Similarly, another barrier for the transition was the lack of school nutritionists who are qualified to ensure and supervise the nutritional adequacy of school meals, as well as addressing parents' concerns and representations about plant-based eating (e.g. *"An issue that should also be noted is the lack of school nutritionists, the failure to ensure that there is, in fact, a sufficient number to*

monitor what should be the nutritional needs of school children"; Elected Member of the National Parliament, Political representative, I.18).

3.2.2 Increasing food literacy at schools. Participants referred to the need to have more dedicated spaces and allocated periods at schools where students could have direct contact with nature and food, to promote general food sustainability transitions and increased plant-based eating in particular. Providing these experiences could be seen as part of an integrated strategy to optimize the offer of plant-based meals, via opportunities in schools to identify plant-based foods and to learn how to grow, harvest, prepare and cook these foods. These experiences were considered relevant to increase familiarity and positive affect toward plant-based foods and meals, thus creating involvement and higher willingness to change (e.g. *"Schools should also have an educational component that provides children with more direct contact with nature, like vegetable gardens, for example, at the schools";* Elected Member of the National Parliament, Political representative, I.18).

3.2.3 Improving the nutritional profile of plant-based meals. An important concern referred to the need to improve the nutritional profile of plant-based school meals. Participants mentioned many anecdotal situations where school meals were mainly composed of refined carbs (e.g. rice, cereals), salad and boiled vegetables, with an evident lack of important macronutrients. Improving and ensuring the nutritional adequacy of plant-based meals was considered critical to enabling food transitions within the school community (e.g. *"Then there is also the question (. . .) that it is often not nutritionally balanced (. . .), there are many cases of a rice dish with [only] grated carrots";* Advocate-Civil Society, I.5).

3.2.4 Increasing sensory appeal and variety. The need to create, prepare and provide more attractive and appetizing plant-based meals was identified as a critical enabler for change. Plant-based meals were described as repetitive, unappealing and visually unattractive. This reinforced prejudice against plant-based eating among the school communities and reinforced meat-based meals as the standard of a 'proper meal' in the school-meals context. Investing time, effort and material resources into the development of new and more appealing plant-based meals in the school meals system was considered a priority (e.g. "*Non-vegetarian meals [. . .] look more appealing than vegetarian meals, which seem so bland . . . I cannot explain it, it's just less appetizing";* Student, I.30).

3.2.5 Addressing additional provision-related challenges. One important concern referred to the need to tackle challenges to provide plant-based meals in schools, namely logistic difficulties (i.e. investing time and energy preparing and distributing plant-based meals which may have low demand), concerns about food waste due to having to prepare (plant-based) meals in addition to the standard (i.e. conventional) meat- or fish-based meals, and the lack of staff training and expertise in preparing *"non-familiar food"* (i.e. plant-based meals; "*And then we are going to open a product — for example, a package of soy milk [in addition to cow's milk] that will go to waste [due to low demand]. [. . .] All of this [. . .] leads to increased waste, which brings financial problems for organizations and the problem of food waste";* Quality Manager-Catering Services, Nutritionist, I.6).

3.3 Mobilizing local communities and society as a whole

A third theme referred broadly to mobilizing local communities and society around the potential benefits of plant-based eating. Stakeholders addressed potential pathways to enable these mobilization efforts, identified in the sub-themes: promoting school-community involvement, making school food a political priority, tackling financial constraints, and shifting away from traditional meat-centric representations of 'proper meal'.

3.3.1 Promoting school-community involvement. Participants mentioned that effective food sustainability transitions in the school context would require the active involvement of students and the involvement of parents and teachers as members of the school community.

Students were described as prejudiced against plant-based meals and plant-based eaters (e.g. *"Kids are (. . .) stigmatized for not eating like the majority";* National coordinator of the public-school meals system, I.9), parents were seen as persistently criticizing and complaining about plant-based meals (e.g. *"[Meals with] Neither meat nor fish –Parents are still shocked by this";* Quality Manager-Catering Services, I.15), and teachers were also described as a group *"that is not very open to making changes in general"* (Advocate-Civil society, Teacher, I.10). Therefore, active involvement of the school community was seen as necessary to shift the social environment – i.e. socially supporting (instead of socially repressing) plant-based eating and plant-based eaters.

3.3.2 Making school food a political priority. Making school food a political priority was another important pathway to mobilize local communities and society toward food sustainability transitions in schools. Participants addressed the need to increase public investment in the school-meals sector to ensure nutritional adequacy (e.g. *"Another problem is that school meals [. . .] are bought [. . .] at a price that is not compatible with what is necessary for proper nutrition. [. . .] It's a vicious cycle"* (Nutritionist, Professor, Regulation- Order, I.1). Recurrent patterns of response also included the need to establish meal request systems that are flexible but based on clear and well-defined criteria (i.e. students/families should be given a chance to request plant-based meals on a daily or weekly basis, instead of monthly or yearly), which should facilitate and encourage greater access to plant-based meals within school-communities (e.g. *"You should be able to choose it on a daily basis. [. . .] The menu would be made available, and it would be scheduled for the week: "I want this, I want that" [. . .]. Other kids – even if they are not vegetarian – [. . .] could eat it occasionally. They could try [a vegetarian meal] and even like it"* (Parent, I.32). Participants also asked for regulations to ensure that schools must serve plant-based meals when students or families request these meals, even if the demand is arguably low (e.g. *"[. . .] some schools [. . .] defend themselves against having to provide this option [. . .], by simply claiming that there is no demand or that demand is low"* (Advocate-Civil Society, I.5).

3.3.3 Tackling financial constraints. Participants referred to the need to tackle financial constraints such as the schools' limited budgets and social representations of plant-based products as expensive – especially when compared to animal products (e.g. *"[. . .] vegetarian food is not accessible to everyone and therefore, even when buying groceries to make at home [. . .] it's easier, it's cheaper to buy a chicken steak than to buy a 'seitan steak'";* Municipal Officer-Education, I.12). Such limitations and representations were seen as hindering the mobilization of local communities and society towards increased plant-based eating in schools. In addition, schools' financial limitations were identified as important obstacles in transitioning towards increased plant-based eating, as these constraints compromised not only the nutritional quality of plant-based meals, but also the recruitment and training of qualified staff (e.g. *"Schools already have a very tight budget, isn't it? Often very limited. This is one of the limitations, and maybe that is the reason why we only provided [staff] training [on plant-based meals] to two or three schools, and not 40 or 50"* (Advocate-Civil Society, I.5).

3.3.4 Shifting away from traditional meat-centric representations of 'proper meal'. Another key theme identified throughout the interviews was the need to shift away from traditional meat-centric representations of 'proper meal' both in the context of school catering, and among families and students in general, as these representations were seen as a critical barrier for school food sustainability transitions. Promoting flexible and more inclusive representations of what constitutes a balanced and appetizing meal was seen as a necessary step for a large-scale transition towards increased plant-based consumption to take place (e.g. *"In this specific context of catering, people's focus is on meat, isn't it? [. . .] [in] any main dish, the focus is on lots of meat, lots of fish"* (Nutritionist, Professor, Regulation-Order, I.1).

4. Discussion

School meals systems can be seen as levers to enable large-scale (integrated) food sustainability transitions. This study aimed to identify how to enable large-scale transitions toward healthier and more environmentally friendly diets in schools, focusing on increased plant-based eating. Drawing on a systemic approach, we collected data from multiple stakeholders at different levels of influence in the school meals system (from end-consumers to food providers, market actors, civil society organizations, and policy and decision-makers). In short, three main pathways for enabling sustainable food transitions in public schools were identified: (1) Levering orientations toward sustainable consumption; (2) Optimizing and increasing plant-based meal offer; and (3) Mobilizing local communities and society as a whole. To enable interdisciplinary dialogue and inform integrated approaches for food sustainability transitions (Graça *et al.*, 2019; Rust *et al.*, 2020), we provide an overview of the findings and discuss them in light of an integrative model of change (i.e. COM-B system of behavior). The COM-B system frames behavior as resulting from the interplay between (physical/psychological) capability, (social/physical) opportunity, and (reflective/automatic) motivation variables (see Michie *et al.*, 2011, 2014). Variables across these three domains (i.e. capability, opportunity, motivation) can be targeted with a set of intervention functions (e.g. education, training, environmental restructuring) and policy categories (e.g. guidelines, communication/marketing) to enable behavior change (see Michie *et al.*, 2011, 2014). We discuss the findings and implications based on this model because it is action-oriented, provides an analytical entryway to socio-material contexts and not only individual behavior, enables interdisciplinary dialogue, and has been applied to dietary change and plant-forward transitions on several recent reviews and research reports (e.g. Graça *et al.*, 2019; Lacroix and Gifford, 2020; Onwezen, 2022; Timlin *et al.*, 2021).

4.1 Levering orientations towards sustainable consumption

According to stakeholders' views, one of the pathways to trigger large-scale food sustainability transitions in schools is to lever orientations toward ethical and environmentally friendly consumption. This means focusing on (and communicating) the risks and benefits of different dietary options regarding climate change, biodiversity, social justice and human-animal relations (e.g. anthropogenic suffering; human and animal exploitation). These results are consistent with previous findings on the growing consumer awareness about the environmental impacts of the livestock industry (Hopwood *et al.*, 2021; Krizanova *et al.*, 2021; Sanchez-Sabate *et al.*, 2019), as well as the impact that factory farms have on the animals who are used for human consumption (Hartmann and Siegrist, 2020; Mathur *et al.*, 2021; McGuire *et al.*, 2022; Rosenfeld, 2019). Sustainable and ethical consumption orientations have been identified as enablers of increased plant-based eating (Bryant, 2019; Hopwood *et al.*, 2021; Graça *et al.*, 2019).

Viewing these findings in light of the COM-B system of behavior (Michie *et al.*, 2011, 2014), these concerns and consumption orientations can be framed mostly under the Motivation domain (e.g. reflective beliefs about food production and consumption, environmental sustainability, and ethics; motives for reducing the negative impact on others and the environment). Hence, education and persuasion can be proposed as intervention functions (Michie *et al.*, 2014) to strengthen these motivational processes and lever orientations towards ethical and sustainable food consumption in schools. This can expectedly be achieved with "learning by doing" outreach activities targeting relevant audiences (e.g. students, families, teachers) to raise awareness about health, environmental and ethical considerations about food production and consumption in general, and meat- and plant-based eating in particular. Furthermore, education by credible and qualified sources (e.g. environmental scientists, nutrition scientists, NGOs), in collaboration with local food actors and service providers, can potentially help promote increased plant-based eating. Policy categories to raise awareness

on these issues (Michie *et al.*, 2014) may include communication and marketing strategies (e.g. print, electronic, broadcast media), eventually combined with fiscal measures (e.g. addressing the costs of food production and consumption that are currently externalized to the environment) to signal broader normative and institutional endorsement of food sustainability transitions (de Boer and Aiking, 2020; Graça *et al.*, 2020; Rust *et al.*, 2020).

4.2 Optimizing and increasing plant-based meal offer

Improving the offer of plant-based school meals was identified as another pathway for sustainability-oriented transitions in the school meals system. According to the stakeholders interviewed in this study, this may include promoting staff training (i.e. kitchen staff and school nutritionists), increasing food literacy, improving the nutritional profile and sensory attractiveness of plant-based meals, and addressing the challenges experienced by caterers (e.g. logistic issues concerning the preparation and distribution of plant-based meals, food waste, untrained staff). Viewed under the lens of the COM-B system (Michie *et al.*, 2014), these findings emphasize the need to empower stakeholders with the Capability to materialize sustainability transitions in the school meals system (e.g. knowledge and skills to prepare appetizing plant-based meals; knowledge of what constitutes a healthy and sustainable diet in practice; skills to enable changes in institutional and operational routines). Potential intervention functions (Michie *et al.*, 2014) to improve the offer of plant-based school meals may include staff training and education on relevant topics, including food nutritional/environmental literacy and cooking skills. Likewise, potential policy categories to support and deliver these efforts (Michie *et al.*, 2014) may include establishing appropriate guidelines and specific (formal) regulations on how to prepare and distribute plant-based meals in the school system.

4.3 Mobilizing local communities and the society as a whole

In addition to consumption- and provision-focused recommendations and concerns, the stakeholders also emphasized the need for mobilizing local communities and the society as a whole. This included actively involving the school community to restructure the social environment (i.e. shifting from socially repressive toward socially supportive environments regarding plant-based eating and plant-based eaters). Recent research has shown that social prejudice against plant-based meals and plant-based eaters (e.g. vegans, vegetarians) can be a relevant barrier to change at the individual level (Markowsky and Roxburgh, 2019; Michel *et al.*, 2021). Another input from stakeholders was the need to promote structural changes such as implementing flexible plant-based meal requisition systems (i.e. on a daily or weekly basis, instead of monthly or yearly), to increase the accessibility of plant-based meals to both individual students and school communities as a whole. The need to tackle (perceived and/or actual) financial constraints was also addressed, as stakeholders referred to negative perceptions of plant-based meals as being too expensive, in a backdrop where the public-schools meals system is already seen as lacking in financial and material resources. Lastly, participants also emphasized the need to collectively shift away from traditional meat-centric representations of a 'proper meal' among meal providers, families, students, and local communities in general.

Efforts to address these recommendations and concerns should target primarily the Opportunity domain of the COM-B system (Michie *et al.*, 2014). In practice, this means providing physical/material (e.g. budget; availability) and social (e.g. perceived norms; social representations) opportunity for change. For instance, relevant intervention functions (Michie *et al.*, 2014) may include education and persuasion (e.g. raising awareness in the local community about health, sustainability, and ethical concerns about food production and

consumption), as well as modeling (e.g. taste makers, providing examples of how and why significant others engage in the target behavior). Potential policy categories to support and deliver these efforts (Michie *et al.*, 2014) may include communication and marketing strategies (e.g. messages; presentations; effective conversation systems; storytelling of biographical change showing how challenges in plant-based food transition were tamed; TV cooking programmes showcasing appetizing plant-based meals), legislation (e.g. ensuring flexible and inclusive plant-based meals provision and requisition systems), as well as fiscal measures (e.g. distributing/directing financial resources to meal providers to increase and improve the quality/availability of plant-based meals), which – again – should also signal broader normative and institutional legitimation of food sustainability transitions (de Boer and Aiking, 2020; Graça *et al.*, 2020; Rust *et al.*, 2020).

4.4 Limitations and future research

The current findings should be transferred and applied to different cultural and geographical contexts with caution. Portugal is a very meat-centric country (Brittin, 2011); hence, further research with stakeholders from diverse cultures and countries is warranted to inform efforts that are tailored to the strengths, needs and preferences of other settings, in addition to the Portuguese school meals system. Moreover, the focus of this study was the state-funded school meals system. It is necessary to collect data with stakeholders in private schools, which likely have more flexible and diverse procurement and provision procedures than the public-school meals system. Another limitation is that we collected views from a limited number of participants per target group (e.g. students, parents, teachers, coordinators, advocates, policy and decision-makers). Our systemic approach ensured diversity in different target groups across the three spheres of influence, at the expense of depth and range *within* each target group. This means that the views conveyed by each participant cannot be seen as representative of their group, which is why we refrained from making inferences on which features were more (or less) mentioned by different groups and participants in the current dataset. More research is necessary to reliably identify patterns and differences between and within stakeholder groups at different spheres of influence (i.e. proximal, intermediate, distal), preferably using larger samples and recruitment procedures that warrant external validity. As a next step, it would also be useful to ask stakeholders to link the pathways identified in this study with specific policies and interventions (Michie *et al.*, 2014) via visioning and sustainability transitions research (Koole, 2022; Loorbach *et al.*, 2017; Vinnari and Vinnari, 2014) or consensus-building techniques such as variants of the Delphi method (e.g. Boylan *et al.*, 2019; Vinnari and Tapio, 2009). Lastly, future research is necessary to materialize and assess the pathways proposed in this study, ideally with intervention studies using longitudinal and experimental or quasi-experimental designs, combined with qualitative research and following a pragmatic orientation that privileges mixed methods (Creswell, 2009).

4.5 Conclusion

Taken as a whole, the current findings suggest that meat-centric cultural perceptions of a 'proper meal' are an important socio-emotional barrier for sustainable food transitions in schools, and highlight three main pathways to unlock these transitions: levering orientations toward sustainable consumption, optimizing and increasing plant-based meal offer, and mobilizing local communities and society. Efforts to materialize these pathways and promote more flexitarian school food environments will likely require systemic approaches based on multi-stakeholder partnerships, whereby knowledge, practices and resources are shared, and challenges are collectively addressed. The current findings also reinforce the need for integrated efforts which focus both on food consumption (consumer needs, beliefs,

preferences), food provision (physical, material, human resources; availability), and the broader political and sociocultural environment (policies, priorities, trade-offs).

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