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Experts' perceptions on motivators and barriers of healthy and sustainable dietary behaviors among adolescents: The SWITCH project

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ABSTRACT

The interplay of influences shaping dietary behaviors of adolescents needs to be well-understood to develop effective strategies stimulating healthy and sustainable behaviors. This study aimed to identify the most relevant, urgent, changeable and effective motivators and barriers of healthy and sustainable dietary behaviors among adolescents (10–19 years), as perceived by an inter- and transdisciplinary expert panel. Experts working in practice ($N = 19$) and academia ($N = 13$) – in the field of sustainability, health, nutrition and/or education – participated in this exploratory mixed-methods study. Five online semi-structured focus groups were conducted (6–7 participants). Data was thematically analyzed by two coders independently, using the socioecological framework. Subsequently, the same experts individually selected the five most relevant determinants and rated those on their urgency, changeability and effectiveness through an online questionnaire ($N = 21$). Participants revealed a wide system of 31 *main determinants* including 173 *sub-determinants* that motivate or hinder healthy and sustainable eating among adolescents. This system of determinants was mapped on the different layers of the socioecological model: individual factors (25 motivators; 30 barriers), social environments (15 motivators; 13 barriers), physical environments (18 motivators; 15 barriers), macro-level environments (19 motivators; 38 barriers). 'Role of peers' (social environment) was selected most as a determinant to be targeted in interventions ($N = 13$; urgency ($M = 6.38$) changeability ($M = 3.85$), effectiveness ($M = 5.62$)), followed by 'food environment around school' ($N = 9$; urgency ($M = 5.78$) changeability ($M = 3.44$), effectiveness ($M = 5.44$)), 'social influences' ($N = 7$; urgency ($M = 5.43$) changeability ($M = 4.00$), effectiveness ($M = 5.71$)), 'autonomy in development' ($N = 7$; urgency ($M = 6.00$) changeability ($M = 4.29$), effectiveness ($M = 5.86$)) and 'food availability' ($N = 7$; urgency ($M = 6.29$) changeability ($M = 3.29$), effectiveness ($M = 6.29$)). The prioritized determinants indicate that adolescents should be provided more supportive social and physical environments that promote healthy and sustainable dietary behaviors, taking into account their growing autonomy.

1. Introduction

The world is currently facing various interrelated challenges affecting planetary and public health, including the climate crisis and obesity pandemic (Cuschieri et al., 2021). To combat these challenges, engaging in environmentally sustainable and healthy dietary behaviors is of high importance, and is required to meet the Sustainable Development Goals set by the United Nations for a sustainable future (Food and Agriculture Organization, 2016; Willett et al., 2019). Sustainable and healthy dietary behaviors should be adopted from a young age, since dietary patterns developed in youth both impact current dietary behaviors and lay foundations for individuals' future dietary behaviors (Appannah et al., 2021; Reilly & Kelly, 2011; Simmonds et al., 2016; Singh et al., 2008). Current consumption patterns contribute to proven diet-related environmental damage, such as increased greenhouse-gas emissions, biodiversity loss, and water scarcity (Swinburn et al., 2019;

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Willett et al., 2019). Although there has been an increase in the consumption of plant-based proteins in the Netherlands, on average more than half of the protein intake of Dutch adolescents is still from animal sources (RIVM, 2023). Besides the diet-related burden on the environment, dietary practices also have significant health implications throughout life. To illustrate, the high number of adolescents (aged 10–19 years) in Western society suffering from overweight or obesity raises concern, since overweight and obesity are risk factors for diet-related chronic diseases later in life, such as cardiovascular diseases or type 2 diabetes (World Health Organization, 2021). In the Netherlands, 16.3% of the adolescents is overweight (BMI $\geq$25), of which 3.4% is obese (BMI $\geq$30) (RIVM, 2022). Currently, many Dutch adolescents do not meet the dietary guidelines recommended by the Dutch Nutrition Centre. For example, in 2021 only 43.5% of the 12–16 year olds met the recommended amount of vegetables (250 g/day) on minimally 5 days a week and only 26.4% of 12–16 year olds met the recommended fruit intake (200 g/day) on minimally 5 days a week (CBS, 2022). What we eat thus matters for people and planet, underscoring the acknowledged need for a transition towards healthier and more sustainable consumption patterns (Willett et al., 2019). Such a transition encompasses a large set of different dietary behaviors, including among others, an increase in the consumption of plant-based foods and a reduction in the consumption of animal source foods, or shifts towards diets increasingly including seasonal, local, and low processed foods containing low amounts of sugar, salt and fat (Bailey & Harper, 2015; Chai et al., 2019; Gezond Gezond Leven, 2016; Springmann et al., 2018; Willett et al., 2019).

Adolescence is a suitable period to promote an effective transition to healthier and more sustainable dietary patterns from a young age for several reasons. First, many self-regulatory capacities are acquired and developed in adolescence, to alter or override immediate (short-term) responses to behave in accordance with personal (long-term) goals (Baumeister & Vohs, 2007; Gestsdottir & Lerner, 2008). Second, adolescents become responsible for (part of) their dietary choices, develop a desire for autonomy and create their own identity (De Vet et al., 2014; Stok et al., 2010). Adolescence can therefore be characterized as a critical transition period, with marked changes in a person's social, psychological, physical and cognitive development, as well as with changes in the relations with their social surroundings (Gestsdottir & Lerner, 2008). Given this critical life stage for the development of dietary behaviors, understanding the key determinants of healthy and sustainable dietary behaviors among adolescents is required; i.e., insights in the factors that might prevent (barriers) or enable (motivators) such dietary behaviors. This knowledge can strengthen the development or optimization of effective intervention strategies when targeting both domains together.

To our knowledge, understanding of these determinants, both motivators and barriers, is currently lacking. Previous research typically examined the determinants of dietary behaviors by highly concentrating on *healthy* eating determinants (e.g., RIVM (2021) or González-Gil et al. (2019) or Munt et al. (2017)), and, to a lesser extent, on the determinants of *sustainable* eating (e.g., Eker et al. (2019)). Studies rarely explicitly targeted the *combination* of healthy and sustainable dietary behaviors (Vos et al., 2022), let alone with a focus on adolescents. Findings by Vos et al. (2022) show that determinants of *healthy* and *sustainable* eating among parents are partly similar (e.g., attitudes, time, price and skills), but also note some differences between the two (e.g., preparation and planning of food reported as a barrier only for *healthy* food choices). Nevertheless, Vos et al. (2022) stress the importance of focusing on healthy and sustainable diets together, arguing that their target group mainly linked sustainability to a reduction in meat consumption, which also relates to health. Along the same lines, research by Van Loo et al. (2017) shows that healthy and sustainable dietary behaviors are not necessarily viewed as conflicting by consumers, illustrating that consumers associate healthy, sustainable as well as plant-based diets with 'nutritious' and 'natural'. Since transitions to healthy *and* sustainable diets are increasingly emphasized to favor individual and planetary health and are perceived to be combinable (e.g., Van Loo et al., 2017; Willett et al., 2019), it is essential to understand the determinants of the combination of healthy and sustainable dietary behaviors. This knowledge may be used to inform future intervention strategies for stimulating healthy and sustainable diets and to understand whether their focus should be different from those only addressing healthy diets or sustainable diets, or whether similar approaches can be applied as their determinants are comparable. Particularly, it is important to research such an integral behavior from an interdisciplinary angle. This article aims to fill this knowledge gap, by explicitly aiming to identify the determinants of healthy *and* sustainable dietary behaviors among adolescents, studied from an interdisciplinary perspective, involving knowledge and expertise from various domains including sustainability, health, nutrition and education. We explicitly consider factors within or surrounding secondary school settings – hence the inclusion of education as a domain in our interdisciplinary approach – since the school environment is regarded as an ideal entry point for the promotion of healthy and sustainable dietary behaviors among adolescents (Chaudhary et al., 2020; FAO, 2020; Rose et al., 2021). An important reason for this is that extant research demonstrates that the school environment considerably influences the dietary decisions of adolescents of all social classes, who spend a significant amount of their time at school during weekdays and regularly consume at least one snack or meal during school time (Chaudhary et al., 2020; Glanz et al., 2005; Katz et al., 2008; Micha et al., 2018; Story et al., 2008).

A wide variety of factors (potentially) influences the dietary behaviors of adolescents. This complex system of factors is clearly captured by the socioecological model (Story et al., 2008). This framework approaches adolescents' dietary behaviors as a function of multiple levels of influences, including: individual factors (e.g., desire for autonomy), factors in the social environment (e.g., role of peers), factors in the physical environment (e.g., food availability in school settings), and factors in the macro-level environment operating within the wider school system (e.g., food policies) and the larger society. The socioecological model of Story et al. (2008) is central in the present research because of its system approach, acknowledging that factors within and between the different layers affect each other. This model has successfully been applied in previous eating behavior research (e.g., Sogari et al. (2018) or Townsend and Foster (2013)). Furthermore, previous research on school-based food and nutrition interventions supports the implementation of multi-component interventions that take the complexity of the system into account (Chaudhary et al., 2020; FAO, 2020; Rose et al., 2021), which further supports a system approach in the current study.

1.1. Aim and research questions

The present research is part of the SWITCH project (Stimulating the Way In which Teenagers Consider Healthy and sustainable dietary behavior), that ultimately aims to empower adolescents in engaging in healthier and more sustainable dietary behaviors in the context of secondary schools. Prior to designing school-based interventions, insights in the system of the most important and changeable socioecological factors that influence healthy and sustainable dietary behaviors among adolescents is required. To map this system of factors that might prevent or enable such dietary behaviors, in Study 1 a set of focus groups was conducted among an inter- and transdisciplinary expert panel, including professionals (e.g., practitioners and policymakers) and academics with expertise in the field of (public) health, nutrition, sustainability, developmental psychology and education sciences. This expert panel is purposely involved in the current study given the inter- and transdisciplinary nature of the research question. This group of experts *together* can provide a *holistic* understanding of such an *integral* dietary behavior, focusing on both health and sustainability aspects in and around the secondary school context. Further, above all, experts can

provide estimates of the urgency, changeability and effectiveness of the identified barriers and motivators in practice (Belmon et al., 2020). Identification of the key determinants was central in Study 2, in which the same group of experts selected the most important determinants based on Study 1, and quantitatively rated those relevant determinants on their urgency, changeability and effectiveness. Hence, the following research questions were central in this exploratory mixed-methods study:

1) What are the determinants (both barriers and motivators) of healthy and sustainable dietary behaviors among adolescents (aged 10–19 years) in and around the secondary school context, as perceived by an inter- and transdisciplinary expert panel and mapped on the different layers of the socioecological model of Story et al. (2008) (Study 1)?
2) What are the most important determinants (both barriers and motivators) as perceived by the same inter- and transdisciplinary group of experts, and how urgent, changeable and effective are those determinants (Study 2)?

2. Methods

2.1. Study design

An exploratory mixed-methods study including focus groups (Study 1) and a questionnaire (Study 2) was conducted, inspired by concept-mapping (Kane & Trochim, 2007), to identify the perspectives of experts on the key barriers and motivators of adolescents' healthy and sustainable dietary behaviors. Prior to participation in one of the five online focus groups (Study 1), participants completed a pre-survey. The aim of the pre-survey was to reveal expert views on the concept of healthy *and* sustainable dietary behaviors, to construct a shared understanding of this concept and to guarantee a common ground for participants for the focus group discussions. This understanding was shared during the focus groups prior to discussion. In Study 2, the same group of experts individually received an online questionnaire via Qualtrics to select the five determinants they would target when aiming to stimulate healthy and sustainable dietary behaviors among adolescents in and around secondary school contexts. The experts subsequently rated those selected determinants on (a) urgency, (b) changeability and (c) effectiveness. We define (a) urgency as the extent to which targeting these factors is a priority, (b) changeability as the ease through which these factors can be changed and (c) effectiveness as the influence that changing these factors will have on healthy and sustainable dietary behavior.

2.2. Participants and recruitment

Study 1. In total, 32 experts participated in the focus group study (Study 1), who were recruited via purposive sampling (e.g., via the research network of the team) and through snowballing.

Eligible participants were Dutch-speaking, working at practical organizations ($N = 19$) or in academia ($N = 13$). Particularly, we included practitioners and policymakers working at organizations in the disciplines of health ($N = 5$), sustainability ($N = 8$), nutrition ($N = 3$) and/or education ($N = 6$), as well as academics with expertise in the disciplines of health ($N = 8$), sustainability ($N = 3$), nutrition ($N = 1$), education ($N = 5$) and/or developmental psychology ($N = 2$). On a scale ranging from (1) not much at all to (5) very much, academics indicated that on average their work focuses 3.15 ($SD = 1.46$) on healthy and sustainable dietary behaviors, whereas practitioners indicated an average of 3.79 ($SD = 1.13$). Likewise, academics indicated that on average their work focuses 3.54 ($SD = 1.20$) on adolescents, whereas practitioners indicated an average of 3.53 ($SD = 0.96$). For demographics and further information outlined per participant, please see Supplementary Table S1. Participants were approached via email with an invitation to participate, and received information on the study goal and procedure, a link to the pre-survey, and an informed consent form.

Study 2. In total 21 of those experts (62.5% response rate), working in practice/policy ($N = 13$) or academia ($N = 8$) participated in the rating study.

All experts participating in Study 1 and/or Study 2 ($N = 32$) were rewarded with a gift card of 20 euros. The studies were approved by the Social Science Ethical Committee (SSEC) from Wageningen University & Research (Approval date: 03-03-2021).

2.3. Procedure

2.3.1. Study 1

Pre-survey. Prior to participation in the focus groups, participants ($N = 33$, including an extra participant working in practice who did not participate in the focus group study) completed an online Qualtrics survey (sent in April 2021). After providing their informed consent, they answered the following open question: 'What does healthy and sustainable dietary behavior entail, according to you?'. As we acknowledge that healthy and sustainable dietary behaviors can encompass a large set of behaviors (e.g., increased consumption of plant-based foods, seasonal foods), we posed this question to gain insight into how the experts perceive healthy and sustainable dietary behaviors. The individual responses were ultimately thematically organized and visually presented into one figure (see Raghoebar et al., 2022; Supplementary Fig. S1). Prior to the focus groups, the results of this question were presented to the expert panel, to ensure that all experts were exposed to the same set of perceptions that they together linked to healthy and sustainable dietary behaviors. This may have established some sort of common ground for discussion during the focus groups, ensuring that the focus groups would be focused on the determinants of healthy and sustainable dietary behaviors rather than a discussion about what healthy and sustainable eating entails.

Further details (in Dutch) of the study methods and results on the combination of healthy and sustainable dietary behaviors as perceived by the expert panel can be found in Raghoebar et al. (2022). Additionally, demographic information of the participants was collected in this pre-survey, including their function, type of organization, education level, sex and age. Furthermore, they were asked how much of their work focuses on (a) healthy and sustainable dietary behaviors and (b) adolescents. Both items were rated on a 5-point scale ranging from (1) not much at all to (5) very much.

Online focus groups. Five online focus groups (lasting 120 min each) were held in June 2021 with 6–7 participants per group (see Supplementary Table S1). Focus group discussions stimulate interaction between participants to complement and understand each other, thereby providing insight into shared and varying meanings, perceptions and ideas (Green & Thorogood, 2018). Based on this, the research team purposely composed the focus groups aiming to enhance inter- and transdisciplinarity within each group; i.e., each group consisted of participants from different disciplinary backgrounds working in academia and/or practice. All focus groups were held in Dutch, conducted and recorded through MS Teams and led by both first authors (AM; SR), taking the roles of moderator and facilitator. The focus groups were guided by a semi-structured guide, which was designed in consultation with the larger research team and pilot tested prior to the actual study, with necessary adjustments being made. During the different tasks of the focus groups, Miro virtual whiteboard was used – a tool for remote collaboration on which participants can individually write down their ideas and see the ideas of others. The different stages of the online focus groups are outlined in Table 1.

2.3.2. Study 2

Rating study. In October 2022, participants received the results of Study 1 by e-mail and were asked to individually fill out a questionnaire exclusively on a laptop or a desktop computer. The shared results

Table 1
Stages of the focus group discussions.

Stage 1: Presentation by the moderator
Following an introduction round, all focus groups started with a short presentation by the moderator, including information on the larger ongoing research project SWITCH and the program of the focus groups. Then, the outcome of the pre-survey was presented, providing insight into the experts' associations with healthy and sustainable dietary behaviors, see Raghoebar et al. (2022) and Supplementary Fig. S1. Then, the different layers of the socioecological model of Story et al. (2008) were explained to the participants, which was central in the focus groups.
Stage 2: Warming-up tasks
Two warming-up tasks were performed. First, participants were asked to write down their assumptions about adolescents in the secondary school age. After discussing this, participants were asked to imagine themselves in the daily lives of adolescents, to sketch the context for this target group. To this end, participants wrote down their associations with a typical school day of the adolescent on a timeline, in relation to healthy and sustainable dietary behaviors.
Stage 3: Individual identification barriers and motivators
The focus groups continued with the following open-ended question: 'What are barriers of healthy and sustainable dietary behaviors among adolescents?'. Participants were first asked to individually write down the determinants on the virtual post-its and paste them on the appropriate/corresponding layer(s) of the socioecological model (in Miro). Thereafter, participants were directly asked to repeat this exercise for the motivators with the following open-ended question: 'What are the motivators of healthy and sustainable dietary behaviors among adolescents?'.
Stage 4: Group discussion on barriers and motivators
After a short break, discussion between the focus group participants on the barriers was stimulated by the researchers (AM; SR), thereby explicitly asking them to respond to and make connections with each other's post-its on the socioecological model. After a joint discussion on the barriers, participants were asked to individually complement the socioecological model with barriers they would like to add as a result of the discussion. Thereafter, a similar procedure was followed focusing on the motivators: first, jointly discussing and then individually adding additional motivators to the model.

contained: (a) the barriers and motivators visualized on the socio-ecological model and organized into main and sub-determinants (see Fig. 2), and (b) a text document explaining each main and sub-determinant (see results section and Supplementary Results S1). The two stages of the rating study are outlined in Table 2. Afterwards, all focus group and rating study participants were thanked for their participation and reimbursed.

2.4. Data analysis

2.4.1. Study 1

Focus groups. After intelligent verbatim transcription, the content was analyzed through ATLAS.ti version 9. Coding was performed by both first authors and consisted of a deductive and an inductive coding phase. First, motivators and barriers were identified and placed within the layers of the socioecological model (i.e., the deductive codes *individual factors, social environment, physical environment, macro-level environment*). Remaining factors (not a motivator nor barrier, but related to adolescents' daily lives) were coded as *contextual factors*. For the first three transcripts, two researchers (AM, SR) first coded the full transcript independently. Afterwards, differences in coding were discussed until consensus was reached. Hence, the remaining two transcripts were coded by one researcher (AM or SR) independently, after which the other researcher (AM or SR) checked the coding for potential disagreements. Disagreements were then discussed until consensus was reached. An inductive coding phase followed in which the specific labels were defined for the motivators and barriers (sub-determinants) identified in the previous coding phase. Within each layer of the socioecological model, the specific sub-determinants were labeled and grouped into main determinants. In this phase, one researcher (AM or SR) first coded the full transcript independently and the other researcher (AM or SR)

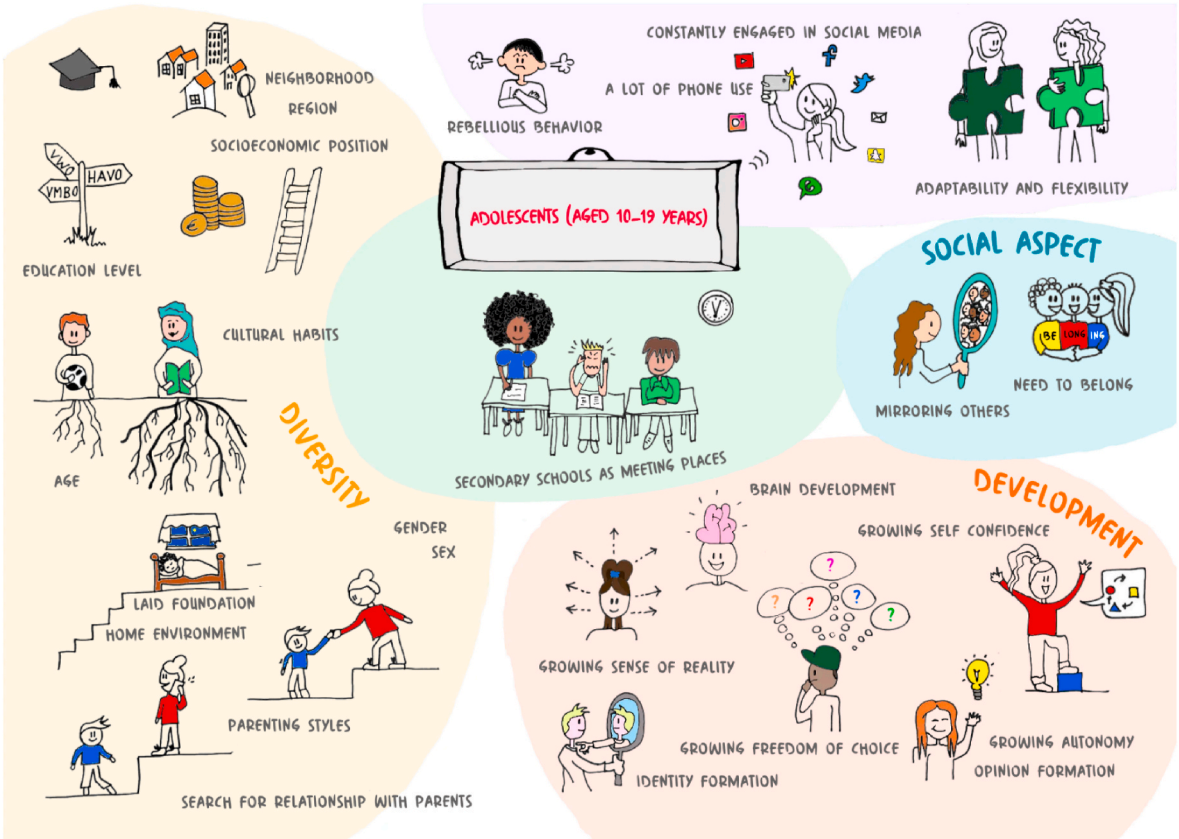

Fig. 1. Visualization of the characteristics of adolescents. Illustrated by Sanne Raghoebar (© Dr. ArtSci 2023). *Note:* Education level is shown according to the tracks of the Dutch educational system: pre-vocational education (*VMBO*, four years of schooling), senior general secondary education (*HAVO*, five years of schooling), pre-university education (*VWO*, six years of schooling).

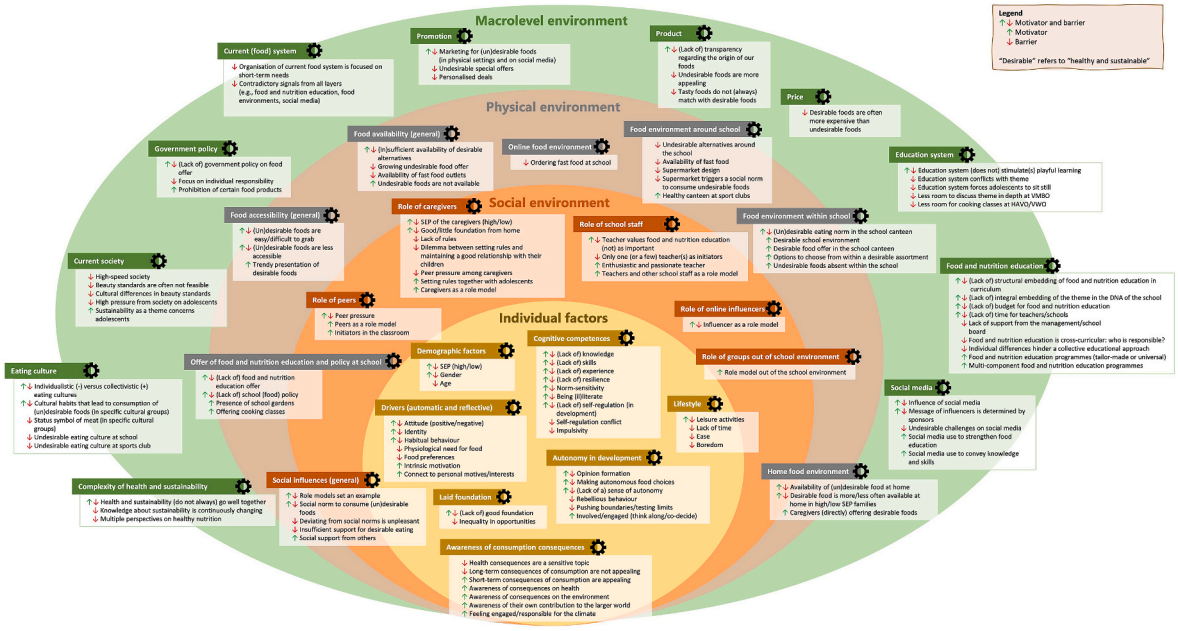

Fig. 2. Motivators and barriers of healthy and sustainable dietary behaviors among adolescents, mapped on the socioecological model.

Table 2
Stages of the rating study.

Stage 1: Selection of five main determinants
After participants provided their informed consent, they were asked to imagine the following: 'Suppose you develop an approach to stimulate healthy and sustainable dietary behaviors among adolescents, within and/or from a secondary school context.' Participants were then asked on which five main determinants they would focus their approach, in an ideal situation (without restrictions).
Stage 2: Rating each selected main determinant
Participants rated each selected main determinant respectively on:
(a) Urgency: 'how urgent do you think these determinants are?', rated on a 7-point scale from 1 (not urgent) to 7 (very urgent).
(b) Changeability: 'how changeable do you think these determinants are?', rated on a 7-point scale from 1 (very hard to change) to 7 (very easy to change).
(c) Effectiveness: 'how effective do you think a change in these determinants would be?', rated on a 7-point scale from 1 (not effective) to 7 (very effective).

checked the coding for disagreements, after which disagreements were discussed until consensus was reached. In all cases needed, remaining disagreements were resolved through further discussion with the larger research team. After all determinants were identified through the two coding steps, the data from the Miro virtual whiteboards were compared with the found determinants and if applicable additional determinants were added to the existing list.

2.4.2. Study 2

Rating study. In Qualtrics, for each main determinant, counts were used to identify how many experts selected that main determinant as important in an approach to stimulate healthy and sustainable eating. Subsequently, mean ratings of urgency, changeability and effectiveness were calculated for each main determinant, as well as the minimum and maximum scores per item to get an insight into the range of ratings given per determinant. On a scale of 1–7, a mean rating of <3 was considered to be low, a mean rating of ≥ 3 and <5 was considered to be medium and a mean rating of ≥ 5 was considered to be high.

3. Results

3.1. Characteristics of adolescents

Experts mentioned a wide variety of characteristics describing the life stage of adolescence during the focus groups (Study 1). These characteristics (e.g., age, education level, growing autonomy, identity formation) were not mentioned in direct relation to adolescents' dietary behaviors and therefore were not labeled as a determinant, but were mentioned by the experts to give context to the indicated motivators and barriers. To illustrate, experts repeatedly stated that adolescents are a heterogenous group and that the determinants may differ based on these characteristics (e.g., age), but the relation between the identified characteristics of adolescents and the determinants remained unspecified after discussion. We visualized the characteristics of adolescents in Fig. 1.

3.2. Determinants

Participants revealed a wide system of 31 *main determinants* including 173 *sub-determinants* that may motivate or hinder healthy and sustainable eating among adolescents. This system results from the focus groups (Study 1) and was mapped on the different layers of the socio-ecological model of Story et al. (2008). As this system of determinants is large and comprehensive, only the *main determinants* that have been selected by at least five experts as most important to focus on (Study 2) are presented in text per layer of the socioecological model. The results of Study 1 and 2 are therefore discussed jointly in this section. To acknowledge the full width and complexity of the entire system, a complete overview of all determinants can be found in Fig. 2. The description of main determinants (and their corresponding sub-determinants) that were selected by less than five experts can be found in the Supplementary Results S1. In the remainder of the results section, the combination of healthy and sustainable dietary behaviors is referred to as 'desirable dietary behaviors'.

3.2.1. Individual factors

On the individual level, seven main determinants (25 motivators and 30 barriers; sub-determinants) were identified based on the discussions with experts, of which 'autonomy in development' and 'drivers

(automatic and reflective)' were selected by more than five experts as important main determinants. These main determinants and their corresponding sub-determinants (in **bold**) are described below.

3.2.1.1. Autonomy in development (N = 7). The main determinant 'autonomy in development' was rated by experts ($N = 7$) on average with high urgency, medium changeability and high effectiveness (see Table 3). Several experts described that during adolescence, individuals increasingly start forming their opinions, which either works as a motivator or barrier (**opinion formation** in favor of desirable/undesirable eating). Opinion formation was described as the process of developing individual standpoints on issues related to nutrition, health or sustainability (e.g., opinions on meat consumption). Furthermore, adolescents increasingly **make autonomous food choices**. Whereas at home food is often still provided by caregivers, in out-of-home environments adolescents are often free to make their own food choices. Depending on the situation and the individual, this increased space for autonomous food choices may motivate more desirable consumption or instead may act as a barrier:

> *"But during the day I think that they* [adolescents] *feel more freedom and start searching for it. This sometimes may also mean that they throw away their sandwiches brought from home and instead get something else. That is where they feel the freedom to do what they want to do."*

Additionally, experts marked adolescence as a period of **rebellious behavior** and **pushing boundaries/testing limits**. This age period was characterized as a period of distancing themselves from their caregivers. When distancing happens through food choices, this may lead to less desirable food choices (in case of a desirable home food environment). Furthermore, when adolescents feel **a sense of autonomy** in making their own food choices, this can work as a motivator. On the other hand, feeling a lack of autonomy **(lack of a sense of autonomy)** and the feeling of being steered in a certain direction may result in purposely engaging in less desirable dietary behaviors.

Lastly, the importance for adolescents to be **involved/engaged** in healthy and sustainable dietary behaviors was perceived as a motivator, e.g., in the development of school-based interventions. Students feel more ownership when they can co-decide or think along with an intervention in their school. Students' active involvement was perceived as important in education around solutions to current and future problems (e.g., climate change):

> *"You need to actively involve them and make them think about solutions. That is also to some extent the future of education. In the past, a teacher was standing in front of the class and then you needed to learn it by heart. If you studied well, you received an A. That is not education anymore. We are preparing students for a future with questions to which we do not have answers yet."*

3.2.1.2. Drivers: automatic and reflective (N = 5). The main determinant 'drivers', including both automatic (i.e., more unconscious) and reflective (i.e., more conscious) drivers, was rated by experts ($N = 5$) high on urgency, low on changeability and high on effectiveness (see Table 3). As part of this main determinant, the sub-determinant **attitude** towards healthy and sustainable food (a positive attitude (motivator) or negative attitude (barrier) towards desirable eating) was identified. Additionally, during adolescence, **identity** formation was identified as a sub-determinant. Food choices can become a means to express identity, for example by expressing desirable eating as part of their identity (e.g., adolescents becoming vegetarian/vegan) or by expressing undesirable eating as part of their identity (e.g., buying undesirable snacks in the supermarket). Besides, **habitual behavior** (automatic cue-responses) was also perceived as both a barrier and motivator, depending on whether one formed desirable habits or undesirable habits.

A **physiological need for food** and **food preferences** were regarded as barriers. Because of the rapid growth and changes in the body, adolescents are likely to experience a higher level of appetite and feel the need to consume large quantities, especially regarding carbohydrates. Furthermore, they often prefer to consume undesirable foods, based on tastiness.

Additionally, as motivating factors, experts mentioned **intrinsic motivation** and **connecting to personal motives/interests**. Experts recognized that some students are (more) intrinsically motivated when they are particularly interested in topics related to health/sustainability/food or when they feel an urge to contribute to societal challenges. In addition, experts mentioned the importance of using adolescents' own motives and interests (e.g., looking good, sports) as starting points to create interest in desirable dietary behaviors.

3.2.2. Social environment

As part of the social environment, six main determinants were identified, including 15 motivators and 13 barriers. Within this layer, main determinants 'role of peers' and 'social influences' were most often selected by the participants.

3.2.2.1. Role of peers (N = 13). The role of peers was the most selected main determinant by participants, mentioned by more than half of the raters ($N = 13$), and was rated high on urgency, medium on changeability and high on effectiveness (see Table 3). The sub-determinant **peer pressure** was perceived as both a motivator and a barrier, as adolescents were described as being susceptible to the influence of their peers and feeling a need to conform to what others do. On the one hand, peer pressure can lead to the consumption of undesirable foods because their peers often do so, whereas for some, peer pressure can lead to consumption of more desirable foods. The dietary behavior of peers can thus influence adolescents in both positive and negative ways, depending on their consumption (undesirable/desirable). When adolescents move between various groups with different consumption

Table 3
Experts' ratings of the most selected main determinants on urgency, changeability and effectiveness ($N = 21$).

Main determinant (*N*)	Level	Urgency (Mean (Min-Max))	Changeability (Mean (Min-Max))	Effectiveness (Mean (Min-Max))
Role of peers *(13)*	Social environment	6.38 (5.00–7.00)	3.85 (2.00–6.00)	5.62 (3.00–7.00)
Food environment around school *(9)*	Physical environment	5.78 (4.00–7.00)	3.44 (1.00–7.00)	5.44 (3.00–7.00)
Food availability (general) *(7)*	Physical environment	6.29 (3.00–7.00)	3.29 (1.00–6.00)	6.29 (5.00–7.00)
Social influences (general) *(7)*	Social environment	5.43 (4.00–7.00)	4.00 (3.00–6.00)	5.71 (4.00–7.00)
Autonomy in development *(7)*	Individual factors	6.00 (5.00–7.00)	4.29 (2.00–6.00)	5.86 (4.00–7.00)
Offer of food and nutrition education and policy at school *(6)*	Physical environment	6.00 (5.00–7.00)	5.50 (3.00–7.00)	5.50 (4.00–7.00)
Food environment within school *(6)*	Physical environment	6.50 (6.00–7.00)	6.33 (5.00–7.00)	6.33 (5.00–7.00)
Drivers (automatic and reflective) *(5)*	Individual factors	5.40 (5.00–6.00)	2.80 (2.00–4.00)	5.20 (3.00–7.00)
Complexity of health and sustainability *(5)*	Macro-level environment	5.40 (4.00–6.00)	2.80 (2.00–4.00)	5.20 (4.00–7.00)
Current (food) system *(5)*	Macro-level environment	6.20 (6.00–7.00)	3.00 (2.00–4.00)	4.80 (3.00–7.00)

behaviors, this can be conflicting:

> *"It makes a difference if you are in a group which is very involved in healthy behavior or not. If you're between two groups, that can lead to confusion. Which group do you want to belong to and which behavior are you then going to portray?"*

Peers can act as a **role model** (especially older peers) or be **initiators in their classroom** (i.e., an informal leader who explicitly initiates movement), both perceived as motivators. Initiators in the classroom were described by the participants as the pupils who actively stand for themes as desirable consumption/health/sustainability and thereby actively take action (e.g., co-organizing campaigns such as a week without meat) to engage/inspire other students.

3.2.2.2. Social influences (general) (N = 7). One third of the experts (*N* = 7) selected the main determinant 'social influences (general)' and rated this determinant high on urgency, medium on changeability and high on effectiveness (see Table 3). As a sub-determinant, **role models** were described by the panel as a motivator for desirable dietary behaviors, when role models set the desirable example, are credible, and/or show resilience towards their social environment (e.g., it does not matter when one makes a different choice than others). On the other hand, experts highlighted the negative influence of role models, such as role models setting an undesirable example, e.g., engaging in extreme behaviors for a fit body.

Social norms to consume certain food were brought forward as both a barrier (social norm to consume undesirable foods) and motivator (social norm to consume desirable foods). For example, during social activities among adolescents, consuming undesirable food is often the norm. **Deviating from this social norm is considered unpleasant** for adolescents, since they may get comments (feel social disapproval) from their peers or caregivers. Experts further argued that **insufficient support for desirable eating** in general can be considered as a barrier in this age group, hindering a change towards more desirable eating behaviors. For social norms to be a motivator, it was thought to be important to set a norm in which it is normal to consume desirable foods. Adding onto that, participants perceived it to be motivating when adolescents feel **social support from others** and do not feel like an outsider due to their dietary behaviors.

3.2.3. Physical environment

With regards to the physical environment, seven main determinants were identified, including 18 motivators and 15 barriers. The main determinants 'food availability (general)', 'food environment around school', 'food environment within school', and 'offer of food and nutrition education at school' were most selected as important main determinants.

3.2.3.1. Food availability (general) (N = 7). As a main determinant, one third of the experts (*N* = 7) mentioned 'food availability (general)' and rated the determinant as high on urgency, medium on changeability and high on effectiveness (see Table 3). **Sufficient availability of desirable alternatives** to undesirable options – i.e., healthy and sustainable alternatives that are filling, tasty, cheap, attractive and easy – was perceived as a motivating factor influencing the consumption of desirable foods, in contrast to **insufficient availability of desirable alternatives** (acting as a barrier). Furthermore, the **growing undesirable food offer** available in different physical settings was indicated as a barrier. Currently, food providers stimulate undesirable foods through the abundant availability of undesirable foods. More specifically, a barrier to desirable dietary behaviors is then the **availability of fast-food outlets**. Followingly, participants stated that when **undesirable foods are not available** (i.e., discouraged or eliminated), this absence or reduced availability can stimulate desirable dietary decisions.

3.2.3.2. Food environment around school (N = 8). Eight experts selected the food environment around the school as a main determinant and rated this as high on urgency, medium on changeability and high on effectiveness (see Table 3). Experts mentioned that **undesirable alternatives around the school**, among which the **availability of fast food**, compete with the school canteen and may hinder the consumption of desirable foods. Furthermore, students were believed to often go to the supermarket nearby the school (during their breaks or after schooltime). Subsequently, the way the **supermarket is designed,** namely stimulating the undesirable choice**,** was indicated as a barrier. Participants also explained that **supermarkets trigger a social norm to consume undesirable foods**, e.g., through the presentation or placement of products. Further, as part of the food environment around the school, participants highlighted **a healthy canteen at sports clubs** as a motivator.

3.2.3.3. Food environment within school (N = 6). Next to the food environment around the school, the food environment within the school was selected as an important main determinant by six experts. They rated this determinant as highly urgent, highly changeable and highly effective (see Table 3). As a sub-determinant, experts mentioned the role of **the (un)desirable eating norm in the school canteen**. If the canteen is not a 'Healthy School Canteen', the unhealthy options are often best positioned and most available, thereby communicating an undesirable eating norm in the school canteen signaling that these foods are most normal to choose. It was therefore at the same time considered motivating when the desirable eating norm is set in the school canteen (e.g., desirable foods are highly available and easily accessible). This goes hand in hand with participants expressing the importance of the school environment to be a **desirable school environment** (in which healthy and sustainable dietary behaviors are promoted), and that it should be decided on a societal level that the schools provide such a desirable environment. Following this, **the food offer in the canteen should be desirable** to stimulate students to opt for desirable choices. Within the food offer in the canteen, it was believed to be motivating when students have **options to choose from within this desirable assortment**. Lastly, experts mentioned the **absence of undesirable foods within the school** as a motivating factor.

3.2.3.4. Offer of food and nutrition education at school (N = 6). The offer of food and nutrition education at schools was selected by six experts. Mean ratings were high on urgency, changeability as well as effectiveness (see Table 3). Experts described that the **offer of food and nutrition education** can be a stimulus or trigger for students to start making more desirable dietary decisions. However, it was also mentioned that food education is not offered in all schools and that a **lack of an offer of food and nutrition education** can be seen as a barrier. Furthermore, experts identified **school (food) policy** as a motivator, such as effective food policies or policies prohibiting students to leave school grounds during school time. Vice versa, **a lack of school (food) policy** was seen as a barrier, for example as one of the experts explained that when students are allowed to leave the school grounds during school hours, they often go to supermarkets during their breaks. Lastly, the **presence of school gardens** and **offering cooking classes** were perceived as motivators to engage students more with their own dietary practices.

3.2.4. Macro-level environment

Finally, with regards to the macro-level environment, 11 main determinants were identified, including 19 motivators and 38 barriers. The main determinants 'complexity of health and sustainability' and 'current (food) system' were most selected as important.

3.2.4.1. Complexity of health and sustainability (N = 5). Five experts selected the main determinant 'complexity of health and sustainability'. Mean ratings of this determinant were high on urgency, low on

changeability and high on effectiveness (see Table 3). Participants expressed that the themes of **health and sustainability do not always go well together.** Incorporating health and sustainability as themes in a school environment can therefore in some cases be a barrier, when they are perceived as conflicting themes (e.g., plastic cups next to a water tap to stimulate water consumption). However, participants explained that the themes can in other cases be used to strengthen one another **(health and sustainability can also go well together)**. For example, stimulating the consumption of more plant-based foods is both healthy and sustainable. Additionally, participants argued that other barriers encompass that **knowledge about sustainability is continuously changing** and that there are **multiple perceptions of healthy nutrition**.

3.2.4.2. Current (food) system (N = 5). As a main determinant, the current (food) system was rated by five experts as a highly urgent determinant, with medium levels of changeability and effectiveness (see Table 3). Experts argued that the **organization of the current food system is focused on short-term needs** (e.g., products high in sugar that physically lead to only short satiation) and poses a barrier to healthy and sustainable dietary behaviors. Furthermore, participants mentioned that there are **contradictory signals from all layers (e.g., food education, food environments, social media)** towards individuals. For example, adolescents see many stimuli in the food environments through which they navigate (e.g., the abundance of undesirable foods), which contrasts to what they get taught in food education classes (e.g., how to eat healthy and sustainable), and which again may also contradict pictures and messages they are exposed to on social media (e.g., influencers eating fast food, or influencers showing their exercise routine). The inconsistency of signals to which adolescents are exposed therefore forms a barrier to desirable dietary decisions:

> *"Then we preach to youth 'you need to move and you need to eat apples and be healthy' and at the same time we design/make an environment that has many characteristics that do not lead to a feeling of 'it's in my hands, I am responsible, I feel good'"*

4. Discussion

This exploratory mixed-methods study provides an overview of the determinants of healthy and sustainable dietary behaviors among adolescents in and around the secondary school context, including insights on the most important determinants and indications of their urgency, changeability and effectiveness. To embrace the interrelated nature of the planetary and public health challenges we are now facing, an expert panel with varying expertise in the domain of (public) health, nutrition, sustainability, developmental psychology and education sciences identified motivators and barriers of healthy and sustainable eating among adolescents. Experts identified a system of 31 main determinants including 173 sub-determinants and prioritized (a) the role of peers, (b) social influences, (c) the food environment around the school, (d) food availability and (e) the developing autonomy of adolescents as the top five main determinants to target when developing interventions supporting healthy and sustainable eating.

In line with systemic approaches, this study revealed a comprehensive system of determinants that motivate or hinder healthy and sustainable dietary behaviors among adolescents. As far as we are aware, this is the first study providing such a holistic overview of this integral dietary behavior, mapped on the different layers of the socioecological model. According to our model, the primary responsibility for healthy and sustainable eating among adolescents in secondary schools can be attributed to – among others – the government, industry (including food outlets in and around schools), secondary schools (including school policies), influential characters (including teachers, caregivers, peers) and adolescents themselves. We should, however, ensure that this shared responsibility between multiple actors does not lead to inaction or to a mere focus on the individual's responsibility, also referred to as 'lifestyle drift' (Carey et al., 2017; Savona et al., 2021; Sawyer et al., 2021; Whitehead, 2012). Rather, it is vital to use the results of this paper as a building block to identify entry points for change in this system, targeting the different layers of the socioecological model (Sawyer et al., 2021). Future research should identify the most promising and effective strategies that target the identified determinants in order to support healthy and sustainable eating in and around secondary school contexts. Thereby it is important that the appropriate and suitable agents (e.g., policymakers/advisors, health promoters, retail) who are in control of the necessary changes are involved, as the different levels of the socioecological model are accompanied by different levels of agents as well (Kok et al., 2008). Previous research on determinants of food choice, either in general or focusing on health or sustainability, also indicated that adolescents' dietary behaviors are multifactorial (e.g., Devine et al. (2023); Neufeld et al. (2022)). Like in our study, reviews by Devine et al. (2023) and Neufeld et al. (2022) reported a mix of socioecological factors influencing adolescents' food choice, including individual factors (e.g., (lack of) time and taste preferences), social (e.g., peer influence), environmental (e.g., food availability), and macrolevel (e.g., affordability and product value for money) factors. Our findings on determinants of both healthy and sustainable dietary behaviors, in general, seem to align with existing knowledge on food choice determinants in this age group. This may support a collective approach that can be used to stimulate both healthy and sustainable dietary behaviors in adolescents. Interestingly, one of the main determinants in this study, autonomy in development, was recognized as a determinant for food choice only in the study by Neufeld et al. (2022). However, even though Devine et al. (2023) do not identify autonomy as a determinant for food choice, they nevertheless acknowledge the importance of taking into account adolescents' autonomy when designing approaches to change dietary behaviors – e.g., mentioning that a ban of unhealthy food in schools may result in adolescents purchasing unhealthy food elsewhere.

The growing autonomy during adolescence as compared to childhood offers unique opportunities to give youth a central role in the transition towards healthier and more sustainable dietary patterns. Supporting our findings, Thomaes, Grapsas, van de Wetering, Spitzer, & Poorthuis, 2023 argue that adolescents are in a unique position to foster change, because of their interest in planetary health, the impacts of climate change in their lives, and their motivation to make a difference to society, although the authors also note that this does not necessarily directly lead to a change in behavior. On the same line, Neufeld et al. (2022) advocate for interventions and actions to build upon youth-led movements through which adolescents themselves already raise awareness for urgent societal issues like climate change. This also provides a unique opportunity to integrate a sustainability perspective into attempts to stimulate healthier diets. Previous research confirms this (Neufeld et al., 2022; Sanchez-Sabate & Sabaté, 2019), by showing that adolescents' motives to change their dietary behavior may come from concerns about the environment or animal welfare. Given that individuals exert an important influence on each other, and adolescents' growing need for autonomy, one may therefore advocate for more participatory approaches involving adolescents in creating strategies to support healthy and sustainable eating. At the same time, the growing autonomy characterized by adolescence also implies that adolescents are exposed to an increasing amount of factors influencing dietary behaviors, such as peers, social media and stimuli in various food environments. Therefore, the central and active role of adolescents in approaches to stimulate healthy and sustainable diets should go hand in hand with the creation of facilitating social, physical and macro-level environments (Neufeld et al., 2022). To illustrate, Kelly et al. (2021) adopted such a participatory approach, in which adolescents were involved in the mapping of the food environment to understand their perception of their external school food environment and what type of changes they would like to see within this environment.

Remarkably, the majority of selected determinants were perceived as highly urgent and effective, but were rated relatively lower on changeability. To illustrate, although factors in the social environment, such as role of peers, were perceived as urgent and effective, this determinant was rated low on its changeability. In general, the majority of selected determinants was rated relatively lower on changeability. Interestingly, however, experts perceived the offer of food and nutrition education and policies at schools, as well as the food environment within schools, as being highly changeable, urgent and effective. It has indeed been widely acknowledged that changes in assortments of school canteens and vending machines, as well as the formulation of relevant school food policies are promising in supporting more favorable food choices (Chriqui et al., 2014; Driessen et al., 2014; Evenhuis et al., 2019; Gebremariam et al., 2016; Grech & Allman-Farinelli, 2015). This might not be surprising, as the modification of those determinants is in control of the schools and/or experts themselves. Other stakeholders, such as adolescents, may have different perceptions of the modifiability of those factors. Following intervention mapping approaches or the behavior change wheel, both aimed at systematically developing behavior change interventions, it is a crucial step to select the determinants of focus (Crutzen et al., 2017; Michie et al., 2014). Our study can therefore be seen as formative research in intervention development processes (Crutzen et al., 2017). It has previously been stated that those behavior change interventions are mostly focused on psychological variables, as they are indicated as most changeable (Crutzen et al., 2017). Yet, our findings do not directly underscore this statement, as our findings only show a low to moderate modifiability of individual factors. Similarly, a scoping review by Stok et al. (2018) on determinants of eating behavior during the transition from adolescence to adulthood indicated a strong focus on individual factors in literature, but also note that their modifiability has been considered to be low. The results of our study further point at the importance of determinants in the physical environment, of which some (in-school) determinants were indicated as most changeable by the experts. Likewise, Stok et al. (2018) consider the modifiability of upstream factors (i.e., the physical environment or policy-level factors) to be potentially higher, but draw attention to the lack of research on (changing) those factors. On the other hand, it has earlier been argued that the impact of changes in the environment (e.g., changes in food availability in school canteens) on behavior (e.g., eating behavior) eventually also operates and manifests through psychological variables (Crutzen et al., 2017; Moore & Depue, 2016), such as updated social norms about normal and acceptable eating in school canteens, highlighting the potential for environmental interventions (Raghoebar et al., 2019, 2020). In any case, it is crucial to stress that for intervention planning, it is important to further specify the target population and its context (in relation to the determinants of dietary behavior), as experts stressed that adolescents are a heterogeneous group, e.g., varying in age, education level, cultural habits, socioeconomic position, and developmental trajectories. To be effective, interventions should take into account the unique developmental trajectories and diverse contexts of adolescents. Specifying the target behavior and target population are therefore important conditions for eventually achieving behavioral change (Crutzen et al., 2017; Eldredge et al., 2016), as well as the active contribution of the target group to embrace their individual needs and contexts.

In this paper, we have described the ten main determinants to be targeted to stimulate healthy and sustainable dietary behaviors, as perceived by experts. Nevertheless, it should be emphasized that these determinants operate in a larger system and should therefore not be treated in isolation of one another. For example, although some determinants (e.g., the role of caregivers) were not selected among the most important determinants by any of the experts, this does not imply that these determinants do not have a role in the dynamics of the entire system. It is likely that the main determinants that were prioritized interact with other determinants in the model, meaning that targeting the prioritized determinants may start a change in the entire system. In this research, however, we did not investigate the relations between determinants, thereby not providing insight into whether and how the components of this system interrelate. Using systems dynamics, for example through causal loop diagrams, has been argued to be a promising approach to gain insights into how the different components of a system interact within and between different sub-systems (Hawe et al., 2009; Swinburn et al., 2019; Waterlander et al., 2020). For example, a study by Waterlander et al. (2021), taking a systems-dynamics perspective to understand obesity-related behaviors in youth, revealed new subsystems (e.g., social welfare, urban systems) in addition to more familiar subsystems (e.g., home environments, school environments) in which determinants operate in relation with one another. Future research should therefore apply such systemic approaches to also investigate the interrelations between determinants of healthy and sustainable dietary behaviors in adolescents, in order to support the development of interventions that are embracing the complexity of the behaviors in practice.

This mixed-methods study uniquely contributes to the identification of determinants of dietary behaviors, by focusing on both health and sustainability aspects, targeting adolescents, and providing estimates of their urgency, effectiveness, and changeability. Moreover, this study is unique in its interdisciplinary approach. The contributions of experts of a multitude of disciplines enriched existing knowledge on determinants of dietary behaviors, for example through the included experiences from educational sciences (e.g., aspects related to adolescents' developmental trajectories and the school system) and environmental sustainability (e.g., aspects related to the food system). This study thereby emphasizes the value of further interdisciplinary collaboration to develop strategies promoting healthy and sustainable dietary behaviors among youth.

This study is also subject to several methodological limitations. First, the number of focus groups in this study was determined in advance and not dependent on the moment at which data saturation would have been reached. However, due to the set-up of the study, we deliberately chose to select the expert panel in advance and divide the members into different focus groups to ensure an inter- and transdisciplinary constellation in each focus group. Secondly, one third of the participants who participated in Study 1 did not participate in Study 2, due to non-response or unforeseen circumstances (e.g., change in job position or availability). Still, all disciplines were represented in the group of experts who participated in Study 2, ensuring that the interdisciplinarity of the panel was still covered. Consequently, however, the sample of Study 2 was relatively lower than the focus group sample and therefore conclusions from the rating study should be interpreted with some caution. Future research could confirm the results of Study 2 among a wider range of experts, as well as other stakeholders (e.g., teachers, adolescents, caregivers). Our study does not provide any insight on the perspectives of those stakeholders, which may have shifted the focus of our findings to determinants in control of experts. Therefore, other stakeholders, particularly the target group itself, should be actively engaged in future research to identify potential intervention points. Furthermore, we acknowledge that there is room for re-consideration of and discussion on the categorization of the sub- and main determinants. For example, one may argue whether the sub-determinant "physiological need for food" is appropriately categorized under the main determinant "drivers (automatic and reflective)" or whether it is more suitable to categorize this as a "biological/physiological" determinant, such as in the research of RIVM (2021). However, since in this research Study 2 builds on the findings of Study 1, we decided not to make changes in our model, and suggest that future research can take this into account. Lastly, as mentioned earlier in this paper, healthy and sustainable dietary behaviors is a complex concept that can entail a variety of behaviors (e.g., portion size reduction, lower meat consumption, or increased consumption of seasonal products). Even though we aimed to capture this complexity by asking experts beforehand how they would conceptualize healthy and sustainable dietary behaviors and by presenting their answers to the entire expert panel at the start of the study,

participants may have had different types of dietary behaviors in mind when discussing the determinants of the focus groups.

4.1. Conclusion

This mixed-methods study, uniquely performed with an inter- and transdisciplinary expert panel, identified and prioritized a complex system of determinants that motivate or hinder healthy and sustainable dietary behaviors among adolescents in and around the secondary school context. On the different layers of the socioecological model, the experts jointly identified 31 main determinants including 173 sub-determinants. The experts particularly prioritized (a) the role of peers, (b) social influences, (c) the food environment around the school, (d) food availability and (e) the developing autonomy of adolescents as the top five main determinants to target when developing interventions supporting healthy and sustainable eating in and around secondary schools. Hence, adolescents should be provided a more supportive social and physical environment that promotes healthy and sustainable dietary behaviors, while taking into account the autonomy that is in development during this life stage.

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Ethical statement

The studies were approved by the Social Science Ethical Committee (SSEC) from Wageningen University & Research (Approval date: 03-03-2021).

CRediT authorship contribution statement

Sanne Raghoebar: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft. **Anouk Mesch:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft. **Judith Gulikers:** Conceptualization, Methodology, Writing – review & editing. **Laura H.H. Winkens:** Conceptualization, Methodology, Writing – review & editing. **Renate Wesselink:** Conceptualization, Methodology, Writing – review & editing. **Annemien Haveman-Nies:** Conceptualization, Methodology, Writing – review & editing.

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

Data will be made available on request.

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Appendix A. Supplementary data

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