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Association between school garden participation and pupils' school motivation

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ABSTRACT

This study examined whether schooldays in school gardens are associated with higher levels of basic psychological needs satisfaction and intrinsic motivation compared to regular school days, and whether participation in a school garden program improves overall school motivation. Experiences of autonomy, competence, relatedness, and intrinsic motivation were measured among 827 pupils (9–12 years) on schooldays with and without school garden activities. General school motivation was measured pre- and post-program among 718 participants and 638 nonparticipating control pupils. Pupils reported small increases in autonomy, competence, relatedness, and intrinsic motivation during days with 4–5 h in school gardens compared to regular schooldays. No significant differences were found for relatedness and autonomy on days with only 2.5 h of gardening. Participation in the program did not significantly influence overall school motivation. School gardens foster pupils' daily motivation and needs satisfaction, especially with at least 4–5 h of engagement.

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KEYWORDS
Outdoor learning; school-based outdoor education; school-based health promotion; school gardens

1. Introduction

Positive affect and enjoyment in school activities are closely related to intrinsic motivation and other types of autonomous (non-controlled, self-determined) motivation for school, which in turn are important for learning and academic achievement (Grassinger et al., 2024; Martela & Sheldon, 2019). However, pupils' enjoyment of and motivation for school decreases with age, especially between ages 11–15 (Gutman et al., 2010; Jerrim, 2025; Rasmussen et al., 2015), pointing to a need for more motivating educational practices.

An increasing body of research points to the benefits of using outdoor learning, often called Education Outside the Classroom (EOtC), for promoting autonomous motivation, engagement, well-being, and learning (Backman et al., 2012; Bølling et al., 2019; Dettweiler et al., 2015, 2017, 2022, 2023). One aspect of EOtC is the use of school gardens, which provide hands-on, interactive learning experiences by engaging children in the various tasks involved in growing, harvesting and

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cooking food in outdoor gardens (Beames et al., 2023). More concretely, in school gardens, children are taught about and involved in the tasks and challenges of weeding, sowing, nurturing, harvesting, and cooking vegetables for themselves and each other. A qualitative study of the Danish school garden program, "Garden to Bellies" found that the program supported pupils' well-being and ability to learn through hands-on experiences and social recognition (Malberg Dyg & Wistoft, 2018). A longitudinal study in Britain showed that garden-based learning environments can support intrinsic motivation and active engagement in science education, particularly among underserved youth, by fostering pupils' feelings of relatedness, competence, and ownership of their learning (autonomy) (Skinner et al., 2021). Many studies have indeed shown that intrinsic motivation and well-being are fostered when learning environments support children's basic psychological needs for feeling competence, autonomy, and relatedness (Ahmadi et al., 2023; Bureau et al., 2022). Within Self-Determination Theory (SDT), motivation is understood as operating at multiple levels: situational (motivation experienced in a specific activity, e.g., when pupils are working in the school garden), contextual (motivation within a particular domain, e.g., motivation for school), and global (a more general motivational orientation in life). Experiences in specific learning activities may therefore influence pupils' situational motivation and, over time, contribute to their broader contextual motivation (Vallerand, 1997). However, despite the extensive literature on the importance of these SDT constructs in explaining well-being, motivation, and learning in educational contexts, no other quantitative studies have used the SDT framework to investigate the motivational potential of school gardens. As the Danish "Gardens to Bellies" school garden program is becoming widely used by schools, it is important to investigate whether and how participating in this already existing program contributes to pupils' motivation for school.

Therefore, this study aims to examine both short-term (acute) and long-term (general) motivational changes associated with participating in the Gardens to Bellies eight-week school garden program in a large cohort of pupils in Danish schools.

1.1. Conceptual background

A central part of the SDT is the description of three basic psychological needs: to experience/feel *competence*, *autonomy*, and *relatedness* (Ryan & Deci, 2017). These experiences in life are considered universal basic psychological needs because studies have confirmed them to be associated with various measures of well-being and autonomous motivation across and independently of culture, age, background, or personal values (Chen et al., 2015; Slemp et al., 2024; Yu et al., 2020). At a more situational level, experiences of autonomy, competence, and relatedness during specific tasks such as school or learning activities have been shown to promote and sustain autonomous and particularly intrinsic motivation for those activities (Bureau et al., 2022; Deci et al., 1999; Ratelle & Duchesne, 2014). The basic need for *autonomy* entails feelings of doing things of own volition and feeling personal ownership and relevant purpose. The feeling of *competence* comes from experiencing being able to solve tasks and challenges that are personally interesting and relevant (i.e., autonomous). Feelings of *relatedness* entail feelings of connectedness, positive relations, and interactions with others (Ryan & Deci, 2017). Features in the environment, such as pedagogy and teacher behavior, that promote these feelings are called needs supportive (Ahmadi et al., 2023; Bureau et al., 2022).

SDT has identified four distinct types of motivational regulations with different levels of autonomy or control that influence children's learning, academic success and well-being (Ryan & Deci, 2000). These include *intrinsic motivation*, where pupils engage in an activity because it is inherently enjoyable, for example, exploration that sparks curiosity and encourages exploration. *Identified regulation* occurs when pupils understand and accept the personal value of an activity and put effort into solving tasks because they perceive them as meaningful or useful. *Introjected regulation* is driven by internal pressures, like guilt or the desire for approval, for instance, when a pupil participates in school activities mainly to avoid feelings of failure or to gain approval. Finally, *external*

regulation refers to motivation based on external demands or rewards, such as when pupils do school work solely to obtain a reward external to the activity itself or to avoid punishment (Deci & Ryan, 1985; Reis et al., 2000). The more autonomous types of motivation (intrinsic motivation and identified regulation) have consistently been shown to be positively associated with long-term involvement in learning activities, higher school achievement, better understanding of taught concepts, improved school satisfaction, higher persistence when facing difficulties and a lower school dropout rate (Bartholomew et al., 2018; Baten et al., 2020; Deci & Ryan, 2004; Gottfried, 1985; Ratelle & Duchesne, 2014; Ryan, 2009). In contrast, more externally controlled forms of motivation (external regulation and introjected regulation) have been shown to be related to lower school achievement (Taylor et al., 2014) and experiences of distraction, negative feelings, and lower grades (Bartholomew et al., 2018; Guay et al., 2010).

1.2. Study rationale and hypotheses: school gardens' potential for basic psychological needs support

Participation in school gardens involves solving concrete tasks such as growing and cooking vegetables, which may help pupils recognize and identify the value, rationale, and purpose of the activities, which, according to SDT theory, should support feelings of autonomy (Steingut et al., 2017). Compared to classroom-based learning activities, these situated learning activities may seem less abstract, and more tangible/concrete and hence foster clearer or more relatable perceptions of achievements, which could support feelings of competence. Finally, school garden tasks and challenges, such as weeding, sewing, nurturing, harvesting, and cooking vegetables, are shared tasks and aims of the class and subgroups of the class and may therefore support feelings of relatedness. Furthermore, in the Garden to Bellies school garden program, school garden instructors and teachers were educated and encouraged to show unconditional regard and refrain from scolding and showing contempt regardless of pupils' behavior. As described in Ahmadi et al. (2023), this is especially important for supporting pupils' need for relatedness but may also be important for supporting feelings of competence and autonomy (Ahmadi et al., 2023).

The strengthened opportunities for experiencing autonomy, competence and relatedness described above could make school garden activities more needs supportive and hence more intrinsically motivating than regular, classroom-based school activities. Moreover, participating in school garden activities as a regular part of the school year may even influence pupils' motivation for school in general. Based on these rationales, this study posits and tests the following two hypotheses:

1. Pupils participating in a school garden program have higher levels of perceived autonomy, competence, relatedness (i.e., psychological needs satisfaction), and intrinsic motivation on days with the school garden compared to regular school.
2. Pupils exposed to eight days of school gardens might develop higher levels of autonomous motivation (intrinsic motivation and identified regulation) and lower levels of controlled motivation (introjected and external regulation) for school in general, compared to a group not participating in school gardens.

Hypothesis 1 concerns situational motivation (referred to as acute) at a school day level, whereas hypothesis 2 concerns contextual motivation (referred to as general) related to school as a broader domain.

2. Materials and methods

2.1. Study design

A combination of within-subjects and quasi-experimental between-subjects designs was utilized in the study. Within-subject comparisons were used to assess differences in psychological needs

satisfaction and intrinsic motivation on school garden days and on regular school days for the same pupils (Hypothesis 1); this was based on a subsample of the intervention group with two separate weeks of measurement in European Spring and Autumn. The between-subjects quasi-experimental comparisons contrasted the development of general motivation for school for pupils in the intervention group to those in a matched comparison group (Hypothesis 2). Please, see Figure 1 for study design.

2.2. Intervention: the gardens to bellies program

We investigate school gardens through the Danish initiative Gardens to Bellies (GtB). The program consists of eight sessions of visits to and activities in school gardens outside the school, which are provided and staffed by the organization Garden to Bellies. School classes follow the pre-defined program, where garden activities are supervised by external providers (garden facilitators). While teachers are present with the pupils in the school garden, the activities are facilitated by designated garden instructors. The sessions involve organizing pupils into small groups, with each group responsible for cultivating a designated plot, including all tasks from preparation to harvest, and cooking the vegetables in the outdoor kitchen.

The aim of the program is to promote pupils' knowledge, understanding and practical skills regarding environment and food, as well as their school motivation and well-being by engaging them in the journey from soil to table to soil. The GtB program adopts a facilitative pedagogical approach aimed at fostering active pupil engagement. It prioritizes the development of both critical and practical competencies, encourages an appreciation for organic and seasonal produce, and promotes meaningful interactions with peers and the natural environment through multisensory experiences. Activities are grounded in hands-on, experiential learning, with an emphasis on sensory and social processes to support authentic participation. The school garden days start and end with everyone meeting up and getting instructions for the session. Usually, the pupils within the group of four can choose from two different activities, one taking place within the specific plot of land they are responsible for and the other taking place outside their responsible plot of land. The school garden program consists of eight days in the school gardens (please see Figure 1 for illustration), and the length of the days depends on which municipality your school is located in. One municipality only offers half day sessions of 2.5 h (referred to as "low dose" in this paper) whereas the rest offer full days of 4–5 h (referred to as "high dose" in this paper). The sessions will always include activities related to the plot of land, nature, and a culinary experience. Additional pedagogical components of the GtB program, designed to promote well-being and motivation, include that

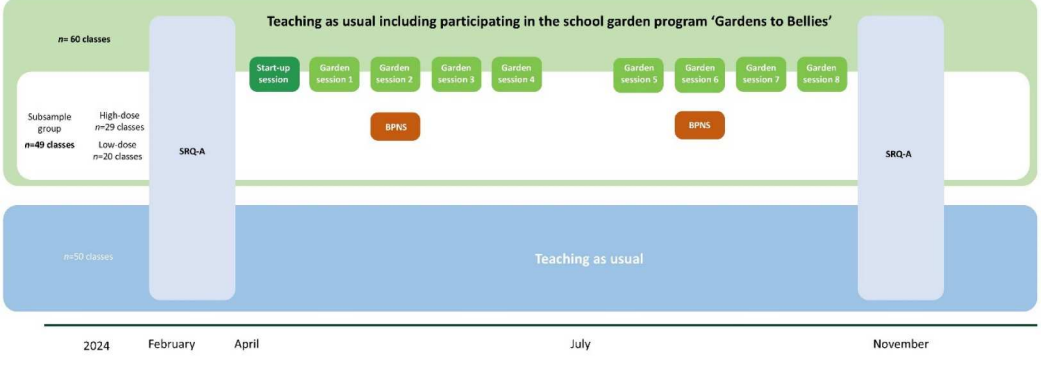

Figure 1. Study design and timeline of data collection for pre- and post of general motivation (measured with SRQ-A) and measures of Basic physiological needs satisfaction and intrinsic motivation questionnaire (BPNS), which was only measured in an intervention subsample group.

neither garden facilitators nor classroom teachers are allowed to scold or reprimand pupils, and that the use of mobile phones by both pupils and teachers is prohibited during garden sessions. For more details about the GtB program, please see the study protocol for the full study (Stage et al., 2025).

2.3. Participants

Participants were pupils in 3rd, 4th and 5th grade. Schools, classes and pupils in the intervention group were recruited in close collaboration with the organization behind the GtB program. The comparison group was recruited by the research team among nearby schools with an attempt to achieve similarity to the intervention group. School classes with no previous participation in GtB and not scheduled to take part in 2024 were invited via e-mail to join the control group. To enhance comparability, recruitment of control classes was based on similarity to intervention schools in terms of geographical proximity and municipal-level average disposable income. A list of suitable municipalities was generated by identifying those that closely matched the intervention municipalities on average disposable income (Statistik, 2019) and were geographically nearby. Public primary (non-private) schools within these municipalities were invited to participate, with an aim of achieving an even distribution of classes. All schools that expressed interest were included. Further descriptions and explanations of this can be found in the FoodACT study protocol (Stage et al., 2025). The intervention group consisted of 1413 pupils from 60 school classes from 29 schools from six municipalities. The intervention group received the school garden program, GtB, consisting of eight sessions. In the within analysis of basic psychological needs satisfaction and intrinsic motivation on schooldays with and without school garden, complete data were collected for 49 classes. For 29 classes, school garden sessions lasted 4–5 h (a whole school day) whereas for 20 of the classes, sessions lasted half a school day (2.5 h). The provision of half-day versus full-day in the school gardens was intended and was a part of what the schools were signing up for. The comparison group consisted of 1193 pupils from 50 classes from 30 schools that did not receive any school garden program (see Table 1).

To be included in the comparison of acute psychological needs satisfaction and intrinsic motivation on school garden days versus regular school days (Hypothesis 1), pupils were required to have data from at least one school garden day and one regular school day. This inclusion criterion was the minimum required, as the within-subject design compares school garden days with regular school days. A total of 25 pupils were excluded for not meeting this criterion. Additionally, 62 pupils were excluded from the final analysis due to incomplete data. As a result, the statistical analyses comparing needs satisfaction and intrinsic motivation on school garden days with other school days were based on data from 827 pupils in the intervention group (see Figure 2).

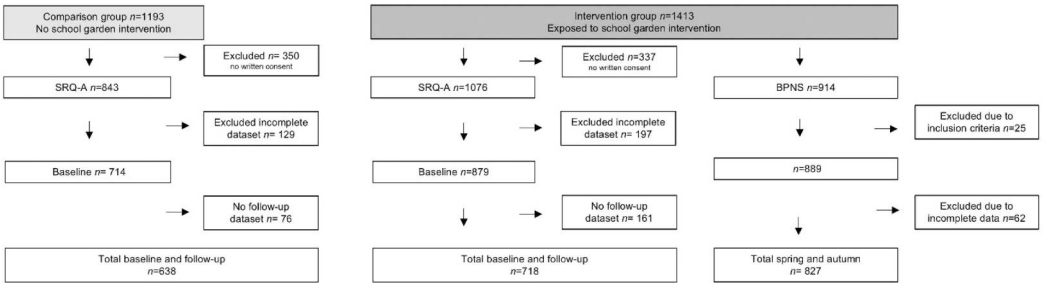

Figure 2. Participant flow and data inclusion across groups and time points. The intervention and comparison group received the Academic Self-Regulation Questionnaire (SRQ-A) pre and post the intervention. A subsample of the intervention group received the Basic Psychological Needs Satisfaction (BPNS) questionnaire two times, both in Spring and in Autumn.

Table 1. Demographics of participants in the study's analysis.

Analysis of within subject differences in motivation (measured with BPNS) on days with school garden and regular school			
	Total	High dose	Low dose
Participants (*n*)	827	466	361
Number of schools /classes	18 / 49	12 /29	6 / 20
Age (mean)	10.20		
Gender			
Boys (*n*, %)	408 (49.3%)	236 (50.6%)	172 (47.6%)
Girls (*n*, %)	419 (50.7%)	230 (49.4%)	189 (52.4%)
	SES (*n*)		
1	443	227	216
2	197	120	77
3	71	42	29
4	46	53	23
5	23	17	6
6	17	7	10
School days (*n*)	4474	2497	1977
School garden days (*n*)	1019	571	448

Between subject analysis of General School Motivation (measured with SRQ-A)		
	Intervention Group	Control Group
Participants (*n*)	718	638
Number of schools/classes	29 / 60	26 / 50
Age (mean)	10.20	10.30
Gender		
Boys	349 (48.6%)	294 (46.2%)
Girls	369 girls (51.4%)	345 (53.6%)
Other		1 (0.2%)
SES (*n*)		
1	387	273
2	178	167
3	58	79
4	65	88
5	16	18
6	14	13

Notes: Basic Psychological Needs Satisfaction (BPNS), Academic Self-Regulation Questionnaire (SRQ-A). "High dose" refers to pupils having a full day (4-5 h) in the school garden, whereas "low dose" refers to pupils only half days (2.5 h) of school gardening. Socio-economic-status (SES) was measured using the Danish Social Class Classification: 1 = high-level professionals/managers; 2 = medium-level professionals/managers; 3 = non-manual or small-scale self-employed; 4 = skilled manual/technical workers; 5 = semi- or unskilled workers; 6 = economically inactive (e.g., unemployed, disability pensioners).

In the analysis of general school motivation (Hypothesis 2), which included both the intervention and comparison groups, a total of 197 pupils from the intervention group and 129 from the comparison group were excluded due to incomplete baseline data. Additionally, 161 pupils from the intervention group and 76 from the comparison group were excluded due to missing follow-up data. Consequently, the final analysis of the intervention's association with the development of general school motivation included 718 pupils from the intervention group and 638 pupils from the comparison group. As can be seen in Table 1, participants had an equal gender distribution, an average age of 10 years, and exhibited relatively high levels of socio-economic status. For further details, see the FoodACT study protocol (Stage et al., 2025).

2.4. Measures

2.4.1. Basic psychological needs satisfaction and intrinsic motivation

To assess pupils' experiences during school garden days and regular school days, a 12-item questionnaire was administered at the end of each school day. The questionnaire measured four constructs based on SDT Theory: competence, relatedness, autonomy, and intrinsic motivation, each assessed with three items. Example items include: "I am satisfied with how I managed/solved the tasks, exercises, and activities" (competence), "I felt accepted" (relatedness), "I did the activities

because I wanted to" (autonomy), and "I enjoyed the activities" (intrinsic motivation). Responses were rated on a four-point Likert scale ranging from 1 (Not at all true) to 4 (Very true). Two items were reverse-coded to reduce acquiescence bias: "I did this activity because I had to" (autonomy) and "This was an activity that I could not do well" (competence). The instrument was developed and piloted within the framework of two former Danish school-based intervention projects (Bølling et al., 2023; Wienecke et al., 2021). Scale validity and reliability were previously established using exploratory structural equation modeling (Wienecke et al., 2021).

Measures of intrinsic motivation, competence, autonomy, and relatedness were based on validated subscales from the Intrinsic Motivation Inventory (Tsigilis & Theodosiou, 2003) and Basic Psychological Need Satisfaction Scales (Bhavsar et al., 2020; Van der Kaap-Deeder et al., 2020). Further details are provided in the study protocol (Stage et al., 2025).

2.4.2. General School Motivation (SM)

An electronic version of the Academic Self-Regulation Questionnaire (SRQ-A, n.d.) (Ryan & Connell, 1989) was used to measure pupils' general motivation for school (Hypothesis 2) before and after the school garden program (in February and in November 2024). The questionnaire was administered during a school day, organised by class teachers. For study design and timeline, see Figure 1. SRQ-A is based on SDT Theory (Ryan & Connell, 1989) and is developed for measuring the degree of autonomy regulating pupils' involvement in various academic tasks. The 32-item questionnaire employs a four-point Likert-type scale to evaluate pupils' reasons, i.e., behavioral regulation, for completing homework, participating in classwork, answering questions, and aiming to succeed academically (Ryan & Connell, 1989). However, as homework is sometimes not used in Danish primary schools, the items for this domain were omitted. Hence, the measure only included 24 items measuring four scales: i.e., external regulation (7 items), introjected regulation (7 items), identified regulation (5 items), and intrinsic motivation (5 items) for school. Responses were recorded using a four-point Likert scale: 1 = Not at all true, 2 = Not very true, 3 = Sort of true, and 4 = Very true. Besides calculating mean scores for each motivational regulation, a Relative Autonomy Index score (RAI) (also referred to as SDT Index, SDI) was calculated using the formula: $2 \times \text{intrinsic motivation} + \text{identified} - \text{introjected regulation} - 2 \times \text{external regulation}$ (Sheldon et al., 2017). The validity and reliability of the Danish version of SRQ-A were assessed in the previously mentioned study (Wienecke et al., 2021).

2.4.3. Background information

Information on the pupils' gender, age, and socio-economic status (SES) was collected as part of the written electronic consent provided by the parents/guardians. Pupils' SES was categorized using the Danish Occupational Social Class coding scheme of six socioeconomic categories/classes (Christensen et al., 2014), based on the parent with the highest social class. For more detailed information, please see the FoodACT study protocol (Stage et al., 2025). Figure 1 provides an overview of the data collection procedure and measures.

2.5. Data analysis

Cronbach's alpha analysis was used to assess the internal reliability of each scale measure. Cronbach's alpha provides an estimate of how closely related the items within each scale are to ensure that the items intended to measure the same construct are consistent with one another. For the daily basic psychological needs questionnaire, each construct (competence, relatedness, autonomy, intrinsic motivation) was measured with only three items, and alpha is known to underestimate reliability for short scales. Therefore, values around 0.60–0.70 were considered acceptable, in line with previous recommendations for exploratory research and child samples (Ertanir et al., 2021; Ponterotto & Ruckdeschel, 2007). The SRQ-A subscales, consisting of 5–7 items each, were interpreted using standard thresholds, with previous validation in Danish school populations supporting

their reliability (Wienecke et al., 2021). Cronbach's alpha values above 0.70 were considered acceptable (Ponterotto & Ruckdeschel, 2007).

To examine differences in the intervention group's experiences of competence, relatedness, autonomy, and intrinsic motivation during school days with school gardens compared to regular school days, we applied linear mixed models using daily observations as the unit of analysis, with days as cases clustered in classes and IDs, adjusted for gender and SES. Separate analyses were conducted for participants in schools that received a full day of school gardening, referred to as the "high-dose", and participants who only received a half day of school gardening, referred to as the "low-dose". For all models, we report both the unstandardized and the standardized beta coefficients to allow interpretation of the raw effects as well as comparison of effect sizes across variables.

In order to assess the impacts of the school garden program on pupils' development of motivational regulation for school in general, we applied linear mixed models with group time interaction as fixed effects and pupils clustered in classes, adjusting for gender and SES. Both unstandardized and standardized beta coefficients were calculated and reported.

All statistical analysis was performed in R version 2024.04.2. Significance tests were two-tailed, and p values <0.05 were considered statistically significant.

2.6. Ethics

The study was conducted in close collaboration with schools, and head teachers provided institutional approval prior to data collection. Participation involved no invasive measures or sensitive topics, and the burden of participation was considered minimal.

Written informed consent was obtained from parents/guardians, and participants could withdraw at any time. All data were anonymized using personal ID numbers. The study is preregistered at ClinicalTrials.gov (#NCT05839080) and complies with the Danish Data Protection Act. According to Danish law, only biomedical studies or those involving risk require formal ethics approval. This study was reviewed by the Regional Committee on Health Research Ethics and deemed exempt (protocol no: H-23010743).

3. Results

As can be seen in Tables 2 and 3, all psychometric variables (measures of psychological needs satisfaction and motivations) had acceptable to good internal reliability, as Cronbach's alpha values were higher than the generally recommended 0.60 level of alpha, indicating acceptable internal consistency. Descriptive statistics for basic psychological needs satisfaction and intrinsic motivation indicated higher mean values on school garden days than on regular school days. For SRQ-A, means were higher at pre-measurement than at post-measurement.

3.1. Differences in psychological needs satisfaction and intrinsic motivation

As can be seen in Table 4, pupils had significantly higher levels of experienced competence, autonomy, and intrinsic motivation for the activities on days with the school garden compared to regular school days. The differences in relatedness were not statistically significant ($p = 0.10$). When distinguishing between high and low exposure to the school garden program, we found that pupils who received a high dose (4–5 h, equivalent to a full day) reported significantly higher levels of perceived autonomy (B = 0.13, $p < 0.00$), competence (B = 0.07, $p = 0.00$), intrinsic motivation (B = 0.26, $p < 0.00$), and also relatedness (B = 0.06, $p = 0.01$) on school garden days compared to regular school days. In contrast, for pupils in the low-dose group, significant differences were observed only for competence (B = 0.05, $p = 0.01$) and intrinsic motivation (B = 0.09, $p < 0.00$). Furthermore, the

Table 2. Cronbach's alpha values for psychological needs satisfaction and intrinsic motivation, and for the intervention groups' experiences of autonomy, competence, relatedness, and intrinsic motivation during school days and school garden days.

	All					High-dose subgroup				Low-dose subgroup			
		School garden day		School day		School garden day		School day		School garden day		School day	
	Cronbach's alpha	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Autonomy	0.70	2.75	0.76	2.67	0.77	2.83	0.78	2.70	0.78	2.64	0.71	2.64	0.76
Competence	0.65	3.36	0.51	3.30	0.53	3.39	0.53	3.32	0.54	3.33	0.47	3.27	0.51
Relatedness	0.78	3.26	0.62	3.24	0.63	3.33	0.63	3.29	0.64	3.18	0.61	3.19	0.61
Intrinsic Motivation	0.86	3.08	0.79	2.89	0.73	3.16	0.81	2.91	0.74	2.97	0.74	2.87	0.72

Notes: Cronbach's alpha indicates the internal consistency (reliability) of each scale, with values above 0.60 considered acceptable. Intervention group experience of autonomy, competence, relatedness and intrinsic motivation are reported as mean and SD (standard deviation variables).

Table 3. Cronbach's alpha and descriptive statistics for SRQ-A scales at pre- and post-measurements for the intervention and control groups.

	Cronbach's alpha		Intervention group				Control group			
	T0	T1	Pre		Post		Pre		Post	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
External regulation	0.68	0.69	2.48	0.60	2.40	0.60	2.48	0.60	2.44	0.55
Introjected regulation	0.79	0.79	2.42	0.70	2.36	0.63	2.43	0.62	2.35	0.64
Identified regulation	0.75	0.76	3.04	0.63	2.91	0.64	2.97	0.63	2.88	0.65
Intrinsic motivation	0.80	0.81	2.56	0.71	2.44	0.71	2.49	0.71	2.35	0.73
RAI			0.80	2.18	0.62	2.34	0.56	2.11	0.36	2.21

Notes: Cronbach's alpha indicates the internal consistency (reliability) of each scale from the baseline measure (T0) and the follow-up measure (T1)., with values above 0.60 considered acceptable. For the intervention and control group pre- and post-measurements are calculated as mean and SD (standard deviation values).

difference in intrinsic motivation was notably greater in the high-dose group (0.26) compared to the low-dose group (0.10).

3.2. Effects of school garden participation on general motivation for school

Table 5 depicts the differences between the comparison group and the intervention group in the development of general school motivation from pre- to post measures. As can be seen, there were no significant differences in the pupils' development of general motivation for school across any of the four types of motivation (external regulation, introjected regulation, identified regulation, and intrinsic motivation), nor in the RAI score.

4. Discussion

EOtC has been shown to positively affect various aspects of pupils' well-being and autonomous motivation (Backman et al., 2012; Bølling et al., 2019; Dettweiler et al., 2015, 2017, 2023). Our study contributes to this body of educational research by showing that school gardens, as a specific type of EOtC, are associated with higher basic psychological needs satisfaction and intrinsic motivation, and therefore are a needs supportive educational context and a viable way of practicing EOtC.

Our results showed that pupils had small but significantly more positive experiences of autonomy, competence, and intrinsic motivation during days in school gardens than during other school days. For children spending 4–5 h in the school garden, this was also the case for experiences of relatedness. This indicates that school gardens and school garden activities are better at supporting pupils' basic psychological needs, which have been shown to be important for both their well-being (Chen et al., 2015) and autonomous motivation (Bureau et al., 2022). It also indicates that 4–5 h of school garden per day is more optimal than 2.5 h to ensure psychological needs satisfaction, especially for experiencing relatedness. As this study evaluates an existing school garden program, the comparison of different amounts of exposure (2.5 vs. 4–5 h) reflects what is feasible and commonly practiced in a Danish school context. From a SDT perspective (Ryan & Deci, 2000, 2017), sustained engagement over time may be necessary for the satisfaction of basic psychological needs, as opportunities for autonomy, competence, and relatedness often develop through continued participation, social interaction, and meaningful activity. In this light, longer sessions may allow for a qualitative shift in the learning experience rather than merely reflecting increased exposure. Accordingly, the observed dose–response pattern may not only reflect a quantitative increase in time but also qualitative differences in pacing, immersion, and group dynamics. Longer sessions may enable pupils to engage more deeply in activities, develop social relations, and experience greater continuity, all of which may support need satisfaction. At the same time, it remains unclear whether shorter sessions are diluted by subsequent classroom activities.

Table 4. Differences in pupils' psychological needs satisfaction and intrinsic motivation on school days with and without school gardens.

	All						High-dose						Low-dose					
	β	CI 95%	B	CI 95%	*p*	ICC	β	CI 95%	B	CI 95%	*p*	ICC	β	CI 95%	B	*CI 95%*	*p*	ICC
Autonomy	0.04	0.02;0.06	0.07	0.04;0.12	0.00	0.45	0.06	0.04;0.09	0.13	0.07;0.18	0.00	0.45	0.01	−02;0.03	0.02	−0.04;0.07	0.62	0.44
Competence	0.04	0.02;0.07	0.06	0.03;0.09	0.00	0.37	0.04	0.02;0.07	0.07	0.02;0.10	0.00	0.38	0.04	0.01;0.08	0.05	0.01;0.10	0.01	0.35
Relatedness	0.01	−0.00;0,03	0.03	−0.01;0.05	0.10	0.54	0.03	0.01;0.06	0.06	0.01;0.10	0.01	0.53	0.01	−0.04;0,01	−0.01	−0.06;0.03	0.49	0.54
Intrinsic Motivation	0.10	0.08;0,12	0.18	0.14;0.23	0.00	0.35	0.13	0.10;0.16	0.26	0.20;0.31	0.00	0.35	0.05	0.02;0.84	0.10	0.03;0.16	0.00	0.34

Notes: Models were adjusted for gender and SES, with observations clustered within individuals and individuals clustered within classes. β denotes the standardized regression coefficient and B the unstandardized regression coefficient, both reported with 95% confidence intervals (CI). β represents the change in the outcome in standard deviation units per one standard deviation change in the predictor, whereas B represents the absolute change in the outcome per one-unit change in the predictor in the original measurement units. ICC denotes the intraclass correlation coefficient at the individual and class levels. *p* denotes statistical significance.

Table 5. Differences between intervention and the comparison group in the development of general school motivations.

	B	CI 95%	B	CI 95%	*p*	ICC
External regulation	−0.05	−0.18;0,08	−0.03	−0.10;0.05	0.46	0.06
Introjected regulation	0.03	−0.08;0.13	0.02	−0.05;0.09	0.57	0.27
Identified regulation	0.01	−1.11;0.09	0.00	−0.07;0.06	0.89	0.02
Intrinsic motivation	0.05	−0.05;0.16	0.04	−0.04;0.11	0.32	0.03
RAI	0.04	−0.08;0.17	0.11	−0.18;0.40	0.45	0.07

Notes: Estimates reflect differences in the development of general school motivation between the intervention and comparison groups, adjusted for group, sex, and socioeconomic status (SES), with observations clustered within classes. β denotes the standardized regression coefficient with 95% confidence intervals (CI) and *p*-values, representing the change in the outcome in standard deviation units per one standard deviation change in the predictor, allowing comparison of effect sizes across variables. B denotes the unstandardized regression coefficient with 95% CI and *p*-values, representing the absolute change in the outcome per one-unit change in the predictor in the original measurement units. Intraclass correlation coefficients (ICC) are reported separately to reflect the proportion of variance attributable to class-level clustering.

However, we did not observe any significant association of school garden participation with the pupils' motivation for engaging in school learning activities in general. These findings are in line with previous findings of positive short-term effects of other EOtC interventions (Dettweiler et al., 2015, 2017), but conflict with previously found long-term positive effects of EOtC (Bølling et al., 2018). The observed effect-sizes in our study were small, as most standardized beta coefficients (β) were below 0.1, indicating generally small effects according to conventional benchmarks (Cohen, 2013). The largest observed effect size was for intrinsic motivation, which was 0.26 points higher on a 1–4-point scale during school garden days for the high-dose group, corresponding to a 9% difference. While these effect sizes are small, they may still be practically meaningful in a school context. Even modest increases in motivation can influence pupils' engagement and learning trajectories and may interact with other benefits of the program, such as promoting hands-on learning and physical activity. From a population perspective, small effects distributed across many pupils may yield substantial overall impact by shifting the distribution of outcomes across the population. Thus, low-cost scalable interventions reaching large groups of pupils may be considered worthwhile despite small standardized effects (Philipp, 2010; Rose et al., 1992).

The fact that pupils had increased levels of perceived autonomy, competence, relatedness, and intrinsic motivation on school days spent in school gardens may be explained by pedagogical and didactical features such as the learning activities being more concrete, meaningful, purposeful, and interactive compared to regular academic classroom activities, which are often more abstract and individualized in nature (Beames et al., 2023). Being involved in concrete, tangible, practical tasks such as growing and cooking vegetables may enable pupils to recognize and identify with the value and purpose of the activities, which supports feelings of autonomy (Steingut et al., 2017). Solving less abstract and more tangible and concrete tasks and challenges may also foster clearer or relatable perceptions of achievements and hence foster feelings of competence. Finally, in school gardens, these tasks and challenges are shared tasks and aims of the class or subgroups of the class, which might foster feelings of relatedness, as argued elsewhere in relation to EOtC (Dettweiler et al., 2022). It may also be that the physical space available in the school gardens provides pupils a greater experience of freedom of movement (i.e., more autonomy in their physical activity behavior) and more choice in how and where to do the tasks and activities compared to the classroom setting which often facilitates learning activities in a more restricted sitting-behind-the-desk position (Cerino, 2023; Mandelid et al., 2024). Other important needs supportive features of the school-garden program GtB is that teachers were instructed to refrain from telling of or scolding the pupils and that pupils were not allowed to use mobile phones. Even though integral to the GtB program, these more general pedagogical features may influence pupils' motivational experiences independently of the garden-based activities themselves.

According to SDT research, satisfaction of basic psychological needs is a strong proximal predictor of intrinsic motivation in specific situations (Bureau et al., 2022; Deci et al., 1999; Slemp et al., 2024). In this study, school garden activities were associated with increased situational

autonomy, competence, and intrinsic motivation, but these changes did not translate into changes in general school motivation. This likely reflects that school motivation is a broader contextual motivation and therefore more stable than the situational measures of immediate, situation-specific experiences of needs satisfaction and intrinsic motivation in the school gardens, in line with SDT's distinction between immediate/situational (e.g., school garden), context/domain-specific (e.g., motivation for school) and general motivation (Chanal et al., 2026). That the pupils who participated in eight days of school garden activities did not develop higher levels of autonomous motivation for school in general compared to the control group suggests that a total of eight days may not be sufficient to influence children's overall school motivation. Another more methodological explanation could be that the pupils did not perceive and include the school garden activities as part of their regular school experience, and hence their general motivation for school activities prompted and captured by the SRQ-A instrument that was used. In contrast to these findings, a comparable EOtC intervention, though not focused on school gardens, targeted the same age group, used the SRQ-A, and found positive effects on general intrinsic motivation for school (Bølling et al., 2018). However, in this study, the exposure was approximately five hours of EOtC per week across an entire school year (Bølling et al., 2018), which supports the explanation that eight days of school garden are too low an exposure to affect pupils' general motivation for school. Another possible explanation could be that the SRQ-A instrument may be less sensitive to changes resulting from domain-specific interventions such as school garden programs.

Similarly, Wienecke et al. found that participation in "basketball mathematics" was associated with increased feelings of competence, autonomy, and intrinsic motivation compared to traditional classroom-based mathematics. However, unlike our study, their intervention also led to a measurable increase in pupils' autonomous motivation for mathematics in general, assessed through SRQ-A items specifically adapted to the subject of mathematics (Wienecke et al., 2021). One reason this study was able to show a relation between a more needs supportive maths learning activity and more autonomous motivation for math in general may be due to basketball mathematics and mathematics in the classroom are perceived as closer related or as part of the same school subject or domain (Chanal et al., 2026) and hence reflected in the same contextual motivation as that of the activities in school gardens and other activities at the school in general. In school gardens, the learning activities are located at a different place, and the learning focuses on the practical tasks of growing and cooking vegetables, which might have little transfer to or resemblance to the pupils' motivation for their other school activities in general, which were measured using the SRQ-A (Bureau et al., 2022; Deci et al., 1999; Slemp et al., 2024). Therefore, future studies should investigate whether longer or more integrated school garden programs could produce stronger effects, particularly if the activities are more clearly linked to the broader academic curriculum.

4.1. Strengths and limitations

In this study, the intervention group consisted of schools and municipalities already enrolled in the GtB program. This makes the study more of a natural experiment evaluating a program and initiative that takes place in real life, independent of researchers' intervention resources, but also introduces risks of selection biases (Craig et al., 2012; Crane et al., 2020). In other words, the pragmatic design can be criticized (or praised) for prioritizing ecological validity over internal validity.

Pupils participating had high SES, which cannot ensure that the results are representative of other schools and municipalities with lower SES. Additionally, the analyses were only adjusted for gender and SES, and potential influences of teacher characteristics, teacher behavior and classroom social climate were not considered.

Since participation in the GtB program is voluntary (except from one municipality), participating schools may differ systematically from control schools (e.g., in teacher engagement or interest in outdoor learning, school culture and priorities from the leader), which introduces the possibility of unobserved confounding when interpreting the observed motivational changes.

A strength is that we used validated questionnaires to measure the pupils' school motivation, which has been used in several other studies (Bhavsar et al., 2020; Bølling et al., 2018, 2023; Tsigilis & Theodosiou, 2003; Van der Kaap-Deeder et al., 2020; Wienecke et al., 2021). The questionnaire for measuring needs satisfaction and intrinsic motivation was sent out every evening with a text message to the pupils' parents, which could have caused proxy answers if the parents had answered the question for their child. Parent-assisted reporting may also introduce the risk of a social desirability bias, as responses could be influenced by parental presence or by a tendency to report more favorable experiences of the school day. These factors may have influenced the accuracy of pupils' self-reports and should therefore be considered when interpreting the daily motivation measures. The text message was sent at 6 pm, a few hours after the pupils came home from school, introducing possible recall bias where other things happening after school hours may have affected their answers. Additionally, we compared a minimum of one school garden day with up to four regular school days. This may have influenced the results, as a single day in the school garden could carry more weight in the analysis than the average of multiple regular school days. The school garden day may have been perceived as more novel than regular classroom-based days, which may lead to motivational responses being influenced by the novelty of the activity rather than the garden-based learning environment itself. At the same time, the garden as a physical setting cannot be meaningfully separated from the pedagogy enacted within it. From a situated learning perspective (Lave & Wenger, 19911991), learning is inherently embedded in context, social interaction, and practice. Thus, the garden environment and pedagogical approach should be understood as co-constituting the learning situation.

Means for the basic psychological needs and general motivation scales were generally centered around the midpoint of the 1–4 response scale, suggesting no substantial ceiling or floor effects and adequate variability to detect differences in pupils' motivation and psychological needs. Exceptions are the measures of competence and relatedness, which had means above three, which could indicate some ceiling effect that could have decreased the effect-sizes.

The subgroup receiving only 2.5 h of school garden per day was smaller than the group receiving 4–5 h. This imbalance reduces statistical power and may have contributed to the lack of statistically significant differences for this group and should be interpreted with caution. The effect sizes for the subgroup were also consistently smaller, supporting the finding that a full day of 4–5 h is more optimal for creating a needs-supportive intrinsically motivating school day.

4.2. Implications for practice, future research and policy

Although no overall effect was found on pupils' general autonomous motivation for school, the fact that pupils reported higher levels of psychological needs satisfaction and intrinsic motivation during participation in school garden activities suggests that these activities may support motivation in specific contexts. It suggests that the school garden as a learning setting and approach to EOtC holds potential for supporting core psychological needs, even if this does not immediately translate into broader motivational outcomes. This is particularly relevant given that many children struggle with poor motivation in traditional school settings. These findings point to the value of exploring alternative educational environments and pedagogical approaches that better support pupils' basic psychological needs and they support that EOtC approaches and more specifically school gardens have potential in this regard. As schools increasingly adopt policies aimed at promoting psychologically healthy learning environments, school gardens may offer a meaningful contribution toward that goal. Future research should implement the intervention in an even earlier stage, perhaps already from kindergarten and then consider a longitudinal design to examine whether situational changes in motivation transfer to general school motivation over time. This could be supported by qualitative research investigating how pupils experience the integration of outdoor learning into their institutional routines and identify factors that facilitate or hinder

motivation from garden-based activities to classroom learning activities. To support their impact on general school motivation, school garden activities may need to be more intentionally connected to everyday teaching and learning goals. When better integrated into the broader curriculum, school gardens can evolve from stand-alone experiences into meaningful, motivating elements of general school practice. Additionally, our findings indicate a need for integrating outdoor learning more systematically into everyday school curricula, for example through regular school garden sessions, outdoor lessons across subjects, or project-based learning in natural environments. Such integration could provide repeated opportunities for pupils to improve motivation and other relevant health or academics outcomes, which have been shown in previous research (Otte et al., 2019; Schneller et al., 2017).

To achieve a greater impact on pupils' motivation for school, it could be considered not only to focus the school garden intervention on learning activities, settings and content, but also on educating teachers on how to provide needs supportive behaviors in their teaching and interaction with the pupils in the gardens as described in Ahmadi et al. (2023).

To achieve broader scale impacts, policymakers could financially support the GtB program by paying for the schools' participation in the program or helping finance building school gardens within their municipality. This would help scale up the program across multiple schools and municipalities. On a political level, the Danish government has prioritized 2.5 million DKK to expand the GtB program in West Denmark, which makes a great opportunity to investigate whether the results apply to other parts of Denmark with different municipal characteristics such as the size of the town, rural/urban, and SES of the population.

5. Conclusion

This study of an eight-week school garden program showed that pupils had more experiences of autonomy, competence, relatedness, and intrinsic motivation during days with 4–5 h of school garden compared to other school days. This indicates that school gardens and school garden activities provide better support for pupils' basic psychological needs, which elsewhere have been shown to be important for both their well-being and autonomous motivation. As such, school gardens may serve as an important supplement to traditional classroom settings. However, pupils participating in the school garden program did not develop more autonomous motivation for school in general than the control group. Whether this is due to the low dose of only eight school garden days over a school year or a lack of association between pupils' experiences in the school gardens and their feelings and motivation for school in general remains unclear.

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MB serves on the board of the NGO The Danish Education Outside the Classroom Association (UdeskoleNet). MCV and CRO are employed at Gardens to Bellies. These affiliations have had no influence on the design, conduct, or reporting of the study. All other authors declare no competing interests.

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Data availability statement

Due to ethical restrictions, the data are not publicly available but can be obtained from the corresponding author upon reasonable request.

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