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Original Article

Co-creation, implementation, and evaluation of The Echnaton Health-Promoting School Program: A case study

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Abstract
Encouraging adolescents to participate in physical activity (PA) is crucial for both their immediate and long-term well-being. However, maintaining their engagement remains a challenge. The Health-Promoting School (HPS) model takes a holistic approach by integrating health promotion into education, policies, and the school environment while actively involving students and staff. The research underscores the effectiveness of co-created interventions in fostering systemic, lasting change. However, empirical studies demonstrating real-world applications and outcomes of these approaches remain limited. This study therefore explores an expanded HPS intervention at a Dutch secondary prevocational school (Echnaton) from 2010 to 2018. It aims to document the design, implementation, and sustainment of this approach while evaluating its impact on the school's health promotion infrastructure, students' PA behaviors, and physical fitness (PF) levels over a period of five years. A mixed-methods evaluation was performed. The qualitative analysis examined policy documents, reports, and semi-structured interviews with involved actors. These data were analyzed using the Action Scales Model (ASM) to track system-level changes across events, structures, goals, and beliefs. The quantitative analysis assessed PA behaviors and PF levels of 840 students over five years through validated questionnaires and fitness tests. Longitudinal changes were determined using Generalized Estimating Equations (GEE). The findings revealed lasting improvements in the school's health promotion infrastructure, realized on all ASM-system levels. Key initiatives included installing water taps, incorporating health education on nutrition and PA, and redesigning the schoolyard to promote PA. These efforts were sustained through active student and staff involvement, a dedicated HPS coordinator, fundraising initiatives, and the integration of health goals into school policies. Physically, students demonstrated significant improvements in fitness measures, including the standing broad jump, bent-arm hang, sit-ups, and grip strength. Screen time decreased significantly. However, no significant positive effects were realized in terms of sports participation or active commuting to school. This case study emphasizes the importance of integrating health promotion into a school's core policies and organizational framework to foster a lasting, supportive environment. It demonstrates the effectiveness of system-wide changes and co-creative approaches over isolated interventions. Future HPS programs should prioritize stakeholder engagement, systemic goal-setting, and sustainable partnerships to promote long-term well-being for both students and staff.
Keywords: Adolescents; Health Promoting School; Physical Activity; Case Study

Introduction

Regular physical activity (PA) is vital for adolescents' physical, mental, and social well-being, contributing to healthy development, academic achievement, and social engagement (Busch et al., 2014; Guthold et al., 2020; Hallal et al., 2012; Langford et al., 2015; Morton et al., 2016; van Sluijs et al., 2021; World Health Organization and the United Nations Educational, Scientific and Cultural Organization, 2021). However, despite widespread recognition of its benefits, a large proportion of adolescents does not meet the recommended PA guidelines (National Institute for Public Health and the Environment, 2023; Stam van et al., 2021). The Netherlands is no exception to this, since adolescent PA levels have been steadily declining over recent decades, accompanied by a deterioration in physical fitness (PF) and an increase in sedentary behavior (Anselma et al., 2020; Jakubec et al., 2020; Ortega et al., 2008; Patton et al., 2018; Phelps et al., 2024; Remmers et al., 2020; Runhaar et al., 2010).

The decline in adolescent PA and PF is not just an individual concern but a systemic challenge shaped by various factors across multiple levels of the socioecological model (Bronfenbrenner & Morris, 2007). These

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influences range from individual motivation and family and peer dynamics to school environments, community resources, and broader societal structures (Cefai et al., 2021; World Health Organization and the United Nations Educational, Scientific and Cultural Organization, 2021). Among these factors, schools are uniquely positioned to promote PA owing to their structured environments, daily interaction with adolescents, and ability to implement health initiatives (Arruda et al., 2022; Hayes et al., 2019). Beyond being educational institutions, schools play a crucial role in shaping students' daily behaviors, including PA habits, making them an ideal setting for interventions aimed at fostering long-term healthy lifestyles.

A widely adopted framework for school-based health promotion is the Health Promoting Schools (HPS) model, developed by the World Health Organization (WHO). This model takes a holistic, multi-component approach, integrating health education, school policies, and supportive environments while incorporating parental involvement and ongoing health monitoring (World Health Organization and the United Nations Educational, Scientific and Cultural Organization, 2021). The HPS model has been implemented across diverse educational settings, presenting a promising strategy for improving adolescent health. However, its effectiveness has shown mixed results. While some studies have reported positive effects on PA levels, PF levels, and overall well-being, others have found limited or highly variable outcomes (Langford et al., 2015; McHugh et al., 2020; van de Kop et al., 2019; van Sluijs et al., 2021). A key challenge in HPS implementation is its frequent reliance on isolated interventions that are not deeply integrated into school policies and daily routines (Neil-Sztramko et al., 2021). The success of health promotion efforts depends on their ability to drive lasting changes in how health is perceived and prioritized in the school system (Butler et al., 2010; Lewallen et al., 2015; Rosas, 2015; Rutter et al., 2017). Enhancing the impact and sustainability of school-based PA interventions requires a paradigm shift. Research increasingly emphasizes two key success factors. First, co-creation with students and school staff fosters active involvement in the design, implementation, and adaptation of interventions, strengthening ownership, motivation, and long-term commitment (Chiang et al., 2015; Sawyer et al., 2018; Turunen et al., 2017; van Koperen et al., 2020). Second, rather than relying on short-term, stand-alone interventions, schools should adopt a systemic, embedded approach that integrates PA into the curriculum, policies, and school culture, ensuring lasting impact (Nobles et al., 2021). This shift goes beyond treating PA promotion as a series of activities, integrating it instead as a core element of the educational experience.

Despite increasing evidence on the importance of co-creation and achieving systems changes, empirical studies on effectively developing, implementing, and sustaining such approaches in the HPS framework remain limited. Previous research has often focused on short-term intervention effects, neglecting the mechanisms that drive long-term success or failure. Furthermore, while participatory methods are widely discussed, few studies have explored how these approaches translate into lasting structural and policy-level changes in schools. This study fills this gap by examining the Echnaton HPS intervention as a case study. It offers a unique opportunity to explore how co-creative, participatory methods, and targeting school systems changes, instead of implementing stand-alone thematic interventions, can add to the existing HPS model and how they potentially lead to more impactful sustainable improvements in adolescent PA behavior and fitness.

The main goal of this study is to examine the development, implementation, sustainability, and impact of the Dutch Echnaton HPS Program. Specifically, it aims to 1. explore the long-term integration of health promotion in the school's policies, physical environment, and educational framework by adopting a co-creative and participatory approach. Additionally, it seeks to 2. assess the impact of the intervention on students' PA behavior and fitness levels over a period of five years, investigating whether structural changes lead to lasting improvements in adolescent health.

Materials and Methods

The Echnaton HPS Intervention and Case Study Design

This case study examined the development, implementation, and impact of the Echnaton HPS intervention as a systemic health promotion program in a secondary school in the Dutch city of Almere. To achieve this, the study uses a longitudinal case study design that evaluates both qualitative and quantitative aspects of the intervention. By examining institutional adaptations, policy integration, student participation, and fitness outcomes, this research offers empirical insights into how the HPS model can be improved to ensure greater long-term effectiveness. The intervention emphasized co-creative approaches, actively engaging students, staff, and the wider community to incorporate health promotion into the school's structure and culture.

School Setting

The Echnaton is located in the Stedenwijk district of Almere, the eighth-largest city in the Netherlands, which has a population of approximately 220,000. Stedenwijk, with approximately 10,000 residents, is primarily characterized by a low socioeconomic status. The school is part of the Almere school group, which includes 39 primary schools and eight secondary schools. It caters to approximately 1,500 students aged 12–16 at the prevocational (VMBO) level and has a staff of 120 individuals. In 2010, the school board chose to transform Echnaton into an HPS by adopting a data-driven, grassroots approach. This strategy included: a) A Needs Assessment, which aimed to identify common healthy behaviors, health issues, and specific challenges faced by

both students and staff; and b) An Asset Assessment, which focused on evaluating the current state and potential improvements in health education, health policies, physical and social environments, parental involvement, and health care infrastructure.

The insights gained from these assessments guided the school's shift to an HPS. In contrast to traditional HPS models that often focus on specific themes, Echnaton adopted a holistic perspective, prioritizing realizing systems changes to their school's core beliefs, goals, structures and resulting actions and intervention implementation activities. These changes were designed and implemented together with relevant actors such as students and teachers. These changes included collaboratively developed interventions such as updating school policies, redesigning physical spaces, and embedding health promotion in the school culture.

Co-Creation Process

A distinguishing aspect of the Echnaton HPS intervention was its focus on co-creation. Students, teachers, parents, and community members participated from the initial planning stages all the way through implementation. Key co-creative activities that were undertaken include:

- Collaborative workshops to assess health priorities and develop targeted interventions.
- Establishment of committees with student and staff representation to oversee projects such as installing water taps and redesigning the schoolyard.
- Regular feedback loops through surveys and focus groups to refine and adapt strategies.

By incorporating participatory methods into the intervention, Echnaton aimed to foster a supportive and inclusive environment, ensuring that the changes were both relevant and sustainable and widely embraced by the school community.

Data Collection

To comprehensively map and understand all changes at Echnaton, we used a combination of the following different qualitative methods.

Document Analysis

We performed a structured document analysis of school policies, project office evaluation reports, and grant applications. This analysis was performed iteratively and inductively, focusing on identifying key events, processes, and system-level changes. These documents offered a foundational understanding of the systemic shifts in the school.

Semi-structured Interviews

To gain a deeper understanding of the HPS system's functioning, we performed semi-structured interviews with two project office employees. We developed an interview guide featuring open-ended questions aimed at exploring the implementation of the HPS framework, participant involvement, and perceived system-level changes. All interviews took place in a one-on-one setting, lasting 1–1.5 h, and were recorded with the participants' consent. The transcripts were then transcribed verbatim and subjected to member checking for descriptive validity to ensure accuracy and alignment with the participants' intended meanings.

Thematic Analysis

The qualitative data, comprising interview transcripts, document notes, and coded observations, were analyzed using thematic analysis (Braun et al., 2016; Braun & Clarke, 2006). This method facilitated an inductive and systematic examination of the data to identify patterns and themes relevant to the HPS transition (Nobles et al., 2021). The thematic analysis followed six steps: 1) Familiarization, 2) Generating Initial Codes, 3) Searching for Themes, 4) Reviewing Themes, 5) Defining and Naming Themes, and 6) Reporting.

Data segments were coded to highlight key elements related to events, structures, goals, and beliefs in the ASM framework. All transcripts and observational data were stored in a locked cabinet, accessible only to the data manager and the primary researcher.

Analytical Framework

We thematically coded the information from the document analyses and interviews to align with the Action Scales Model's (ASM) system levels. The ASM was used to analyze the school as a health promotion system. This framework addresses complex issues by differentiating between various levels—events, structures, goals, and beliefs—to study a system and implement interventions aimed at achieving sustainable, meaningful changes to specific problems, such as health issues or behaviors like obesity and PA. The ASM outlines four levels for understanding and intervening in a system: events, structures, goals, and beliefs. The "deepest level" of a system, meaning the foundation that underlies real-world practicalities, entails the beliefs and motivations of the system's actors, which ultimately shape the system's purpose, also referred as goals. From this, the system's structure—defined as the organization that facilitates events—and the events themselves, which are the observable outcomes of the system, come together to achieve the designated goals. The deeper levels of the

system, such as goals and beliefs, possess greater potential for creating lasting and significant changes. However, these deeper levels are often more challenging to modify and require more effort compared to changing the other levels, such as events and structures (Figure 1) (Nobles et al., 2021). A common metaphor used to illustrate this concept is the iceberg, where the tip represents the visible, tangible events and structures that typically draw the most attention in preventive and remedial actions, whereas the "underwater areas," which refer to deeply held beliefs and system goals, often receive less attention despite being less visible yet more influential driving forces from which tangible elements arise. A HPS example might be that when schools have the core belief that a school should be more than a place for cognitive development of children, but also as a place to stimulate a healthy upbringing (belief) that this might result in a concrete organizational vision to reflect that (goal) as well as a healthy nutrition policy (structure) and health education initiatives (event). Adopting the ASM as an analytical framework offers a comprehensive understanding of the HPS implementation process from a complex systems perspective, allowing for the exploration of the potential impacts of specific interventions on the overall functioning of the school system as a health promotion system.

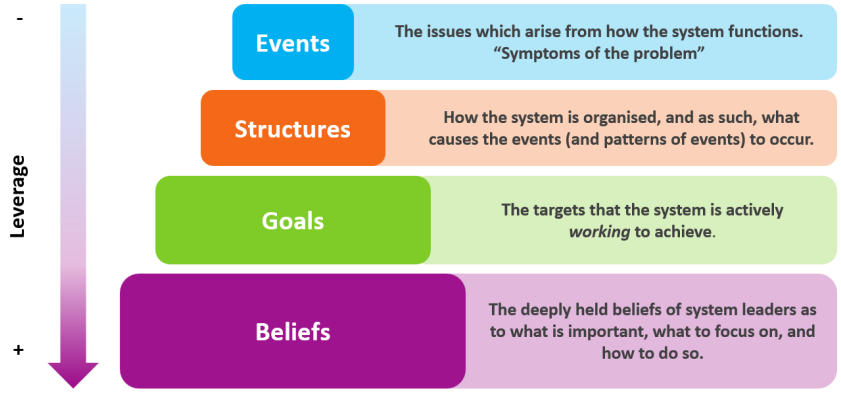

Figure 1: ASM identifying modifiable points (events, structures, goals, and beliefs) within a (school) system that can drive changes in its functioning. Figure reproduced with permission (Nobles et al., 2021).

Program Effects

The quantitative component of this study aimed to evaluate the long-term effects of the HPS intervention on students' PA levels and PF outcomes. It also aimed to generate insights that could guide future HPS implementations and enhance the overall understanding of the role of school-based interventions in promoting adolescent health.

Participants

A total of 840 students aged 12–16 were studied across two cohorts in 2013 and 2014. Baseline measurements were collected from 588 students and were monitored annually in October for the following four years. Pilot tests performed from 2010 to 2012 helped refine the procedures of the test battery, which included the Eurofit assessment and an online questionnaire.

Procedures

PA levels were evaluated using a validated questionnaire, which students completed digitally during mentor hours (Janssen et al., 2014). PF data were collected using a validated Eurofit test battery (Mechelen, 1991) during PE lessons, following standard procedures. The tests were administered by pre-trained test leaders. Upon arrival, students received instructions and then completed the performance tests in a circuit format.

Measures

The outcome measures included weekly screen time in hours, active commuting to school, and total time spent on sports activities. The PF measures comprised the standing broad jump (cm), bent arm hang (s), 10 × 5-m sprint (s), sit and reach (cm), plate tapping (seconds for 50 taps), number of sit-ups in 30 s, handgrip strength (kg; using the Takei hand dynamometer TKK 5401), and the 20-m shuttle run.

Analyses

Longitudinal changes were analyzed using Generalized Estimating Equations (GEE) with an exchangeable correlation structure (Twisk, 2013). GEE analyses were used to account for the nested data structure of children in classes in schools. The results were presented as Beta coefficients (β) along with the corresponding 95% confidence intervals (CIs) and associated *P*-values. To determine if the effects differed

between boys and girls, effect modification was assessed by including an interaction term for time and gender. A sensitivity analysis confirmed there were no significant cohort effects. A predetermined α level of 0.05 was established as the threshold for statistical significance. All analyses were performed using SPSS software, version 26 (IBM Corp, 2017).

Ethical Approval

Student participation was enabled through a passive consent procedure, with data fully anonymized in accordance with GDPR guidelines. Parents and students were informed about the research objectives, data collection methods, and the anonymization process through personal letters, and they had the option to opt-out. The data protection plan was approved by the Amsterdam University of Applied Sciences Research Management Administration under record number HVA-759.

Results

In this Results section, we outline Echnaton's transition to becoming an HPS, detailing the interconnected changes that occurred, structured according to the four system levels of the ASM framework. The processes that led to these changes in Echnaton are summarized in Table 1. Figure 2 shows the intervention events in a timeline. For the qualitative evaluation, we performed semi-structured interviews with two project office employees selected for their crucial roles in the HPS process. The interviews, lasting 1–1.5 hours, were held either in person or via Teams, recorded with consent, and subsequently transcribed and coded in 2023.

Textbox 1: Components of the Echnaton's HPS policy as outlined in the school plan (in Dutch: "schoolgids").
"In education, the school emphasizes the importance of a healthy lifestyle. This is demonstrated not only through a variety of sports and physical activities but also by promoting healthy nutrition, raising awareness about the consequences of smoking and drinking, caring for the environment, and maintaining a safe school climate. Respect, sportsmanship, perseverance, pushing boundaries, and teamwork are integral to this approach. We have a "Healthy School Canteen" and proudly hold the title of "Healthy School." The school is also a Topsport Talent School, offering intensive support to student athletes to help them balance elite sports with academic success."

Policy Changes

After comprehensive discussions with teachers, parents, and students, the management team updated the school policy to incorporate HPS goals. This policy revision elevated health and well-being to the same priority level as educational goals. The updated objectives and structural changes aimed to foster a healthier school environment (Textbox 1) ("Schoolgids," n.d.).

System Goals and Structure Changes

To illustrate the connection between observable events and their deeper system levels of the school, we present four examples. First, Echnaton introduced water taps throughout the school. This initiative reflected and reinforced the belief that a healthy school environment actively supports and encourages healthy choices. By installing free water taps based on student feedback, the school demonstrated its commitment to health as a core value and highlighted the importance of a supportive environment for student well-being. The primary goal of installing these taps was to enhance student access to hydration and reduce the consumption of sugary drinks. Clear targets were established to track usage rates and student satisfaction, aligning with the school's broader goal of promoting healthier habits. The decision to introduce water taps was made collaboratively between students, staff, and the school administration. At the initiative of the project office, a student–staff committee was formed, allowing students to participate in selecting locations for the water taps and planning the launch event. The installation of water taps throughout the school ensured that students had easy, regular, and free access to drinking water.

A second example is the introduction of new health education lessons on healthy nutrition and PA, and especially the changes in school beliefs, goals and structures that led to these event-level initiatives. These novel classes include interactive workshops, guest lectures, and practical activities designed to teach students about healthy lifestyles. These initiatives stem from the belief that education should encompass not only academic achievement but also a holistic approach to student development. The school community, including parents and staff, supported the idea that providing students with health knowledge was essential for their overall growth and success. A clear objective was established to integrate health education into the school curriculum to enhance students' knowledge and encourage positive health behaviors. This goal was in line with the school's broader mission to enhance overall student well-being and promote lifelong healthy habits. To implement these lessons effectively, the project office played a crucial role by establishing a curriculum committee and providing training sessions for teachers. It also facilitated partnerships with local health organizations, including the municipality, Sport Service, and the University of Applied Sciences, to bring in expertise and resources. Furthermore, the project office organized workshops, monitored the progress of health initiatives, and provided logistical and financial support to ensure seamless execution. This centralized approach enabled the project office to drive

systemic changes in the school's infrastructure, resulting in the successful integration of health education lessons into the curriculum and fostering lasting improvements in students' health knowledge and behaviors.

Thirdly, the belief that a supportive physical environment is crucial for student health and engagement led the school to prioritize investments in its surroundings and actively involve the community in co-creation, fostering a sense of ownership and long-term commitment. Through brainstorming sessions with students and teachers, the idea emerged to enhance the schoolyard. Consequently, a goal was established to create a schoolyard that encouraged PA and offered diverse spaces for sports, relaxation, and social interaction. This initiative aligns with the school's broader mission to incorporate health and well-being into students' daily routines. The project office played a key role in the redesign by collaborating with external partners, including construction companies and grant providers. Significant efforts were directed towards improving the school environment, which included revamping the interior to create a more comfortable and inviting atmosphere. This transformation aimed to discourage students from leaving for the city center during breaks to purchase unhealthy snacks. The redesign also featured a new schoolyard co-created with students, integrating spaces for sports activities, relaxation areas, and vegetable gardens, all of which further encouraged PA and healthy living.

Lastly, driven by the belief in making a meaningful contribution to the neighborhood's livability, the school sought collaboration with various organizations, including three primary schools, an activity center, a daycare, a health center, a sports hall, a nursing home, and a sports service center ("Talent in Opleiding," n.d.). The aim was to enhance neighborhood livability by transforming the playground into a community hub that offers cultural, lifestyle, and recreational activities. To achieve this, a daily program was organized from 3:30 PM to 9:00 PM. Close cooperation was established between the project office and other partners, including the sports service and neighborhood organizations.

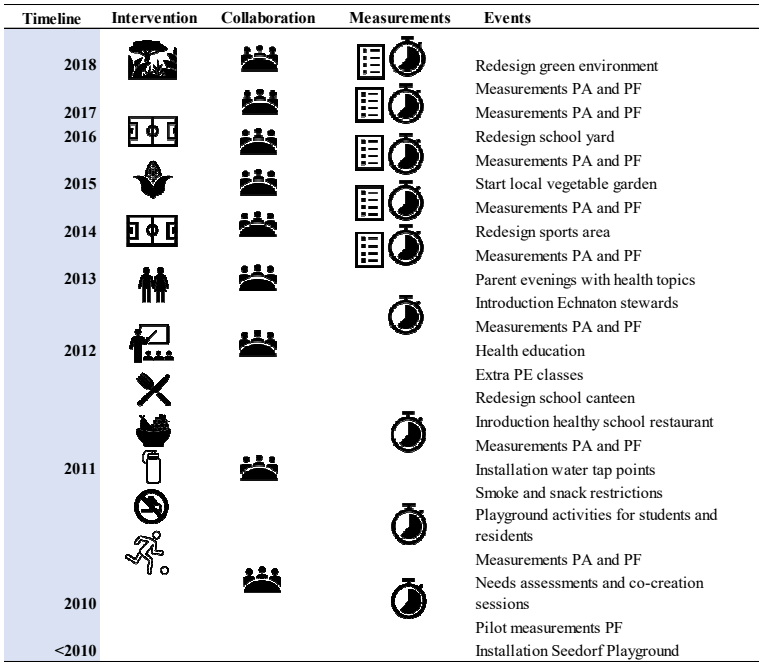

Figure 2: Overview of intervention events, collaborative activities, and measurements of physical activity and fitness levels

Impact of the Program on Students' Physical Activity and Fitness

The total study population comprised 840 students, with 62.1% being boys. The initial cohort in 2013 included 482 students, while the 2014 cohort had 358 students. The average age at the baseline measurement was 12.4 years (±0.6) (Table 2). Non-participation in the measurements was mainly attributed to student absences related to illness or injury. Table 3 provides an overview of the outcome measure scores from the baseline measurements and subsequent follow-ups. At baseline, first-year students participated in physical sports activities for an average of 5.2 h per week (95% CI: 2.9; n = 184, girls) to 6.2 h per week (95% CI: 3.1; n = 279, boys). In contrast, students spent an average of 33.1 h per week (95% CI: 19.4; n = 231, girls) to 36.8 h per week (95% CI: 19.1; n = 336, boys) engaged in screen-based activities. A relatively small number of students, comprising 43 girls and 43 boys, reported using active transportation methods, such as walking or cycling to school, dedicating an average of 1 h per week to this form of activity.

Table 1: Overview of the intervention in the school system based on key points of the ASM (Nobles et al., 2021).

	Events	Structures	Goals	Beliefs
Curriculum	Implemented changes in the curriculum: -Lessons Healthy lifestyle -Lessons taste and nutrition -Extra PE classes -Recess and after school activity programme -Internship places in school restaurant and Sport Service Center for students -Programme Topsport talents -Student and teacher involvement, participation in activities, enjoyment among participants	The project office is the connecting link in organizing dialogue sessions between school staff and between school staff and external stakeholders such as parents, school canteen employees, sports club representatives, Sport Service's (TIO) neighborhood sports coach, national top sports coordinator, partner university interns and Health Service Centre, Municipality	With the school's motto 'learning in motion' the school indicate that educational goals will be enriched by a dynamic focus on learning and that everyone in the school is involved. Noticeable changes of the curriculum are the focus on healthy behaviour including physical activity, nutrition. The organizational structure adjustments include the installation of a project office with a healthy school project leader	The school aims to renew the school policy emphasizing the importance of promoting a healthy lifestyle for students and school staff. The aim is to promote physical activities, healthy nutrition and to raise awareness about the consequences of smoking and drinking. The school aims to involve all staff and students in school-wide changes by participation in dialogue sessions, interviews and co-creation sessions with students, school staff and management team
Social-emotional environment	Implemented activities -Availability of consultancy hour for students -Co-creation sessions with students and parents -Parent evenings -Option for students to become a school steward -Mentor discussions on healthy behaviour subjects	The project office is the connecting link in organizing dialogue sessions between school staff, school management and parents	The school aims to improve the social environment as a safe school climate in connection with the school's environment)	The school aims to offer a caring and save school environment, by respecting each other, displaying sportsmanship, perseverance, pushing boundaries, and teamwork. The school aims to ensure that staff and students are involved in school-wide changes
Physical environment	The physical environment changes of the school include: -Multifunctional sport school yard -Healthy school restaurant -Free water fending machines -Redecoration of canteen -Extra sports facilities -Vegetable garden on the school yard	The project office is the connecting link in a network of funding organizations.	The school aims to noticeable change the physical environment in line with the schools' policy becoming a HPS. It tries to mobilize its own financial resources to do so and external sources to do so	The school aims to offer a learning environment that contributes to a sporty and healthy school profile
Co-creation	Organize workshops where students, teachers, parents, and local community members come together to share ideas and suggestions for activities on the playground. These workshops include brainstorming sessions	Establish co-creation committees composed of a diverse group of students, teachers, parents, and community members. These committees work by departments in the school e.g. media, retail, sports and exercise	Aim for broad and inclusive participation from all school community members in the co-creation process, ensuring representative and diverse input.	Promote the belief that collaboration and partnership between students, teachers, parents, and the broader community are essential for the success of HPS. Encourage the idea that the health and well-being of the school community is a shared responsibility, with everyone playing a role in achieving these goals.

Table 2: Population characteristics and distribution of participants in baseline and follow-up measurements

Gender	Cohort 13 (N)	Cohort 14 (N)	Total (N)	Baseline (N,%)	Follow-up 1 (N,%)	Follow-up 2 (N,%)	Follow-up 3 (N,%)	Age (yr.sd)
Boys (62.1%)	284	234	518	369 (71)	376 (73)	341 (66)	316 (61)	12.4 (±0.8)
Girls (37.9%)	198	124	322	223 (69)	231 (71)	189 (59)	186 (58)	12.3 (±0.4)
Total	482	358	840	588 (70)	607 (72)	530 (63)	502 (60)	12.4 (±0.6)

Table 3: Descriptive characteristics of the sample at baseline and follow-up for prevocational students

		Gender					
		Male			Female		
	Measurement	N	Mean	SD	N	Mean	SD
Screen time (hr week)	.	336	36.8	19.1	231	33.1	19.4
	2	328	37.7	20.3	217	35.5	20.6
	3	290	35.2	18.0	193	32.7	19.4
	4	246	34.8	18.1	172	32.5	20.5
Active transport school (hr week)	.	60	1.1	0.8	43	1.0	0.7
	2	53	1.1	0.9	36	0.9	0.5
	3	47	1.3	1.1	31	1.1	0.8
	4	30	0.9	0.7	25	1.0	0.7
Total time sport (hr week)	.	279	6.2	3.1	184	5.2	2.9
	2	258	5.8	2.6	154	4.8	2.8
	3	205	5.8	3.0	117	4.6	3.1
	4	177	5.9	2.7	98	4.5	2.4
Long jump (cm)	.	365	158	22	223	146	21
	2	376	165	24	231	142	23
	3	341	181	27	189	146	25
	4	316	192	29	186	145	28
Bent armhang Ln	.	361	2,20	1,35	227	1,39	1,48
	2	379	2,48	1,23	238	1,31	1,57
	3	345	2,77	1,08	198	1,36	1,40
	4	308	2,95	1,06	181	1,28	1,33
Mini shuttle (sec)	.	363	19,8	1,7	215	21,5	2,0
	2	369	19,4	1,4	226	21,2	2,0
	3	331	18,8	1,7	186	21,0	1,9
	4	298	18,6	1,5	172	21,1	1,8
Sit & reach (cm)	.	367	22	7	227	28	7
	2	379	22	8	239	29	8
	3	348	24	9	198	30	9
	4	324	25	9	193	30	9
Plate tapping (sec. 50 taps)	.	362	12,7	1,7	228	12,7	1,6
	2	379	11,5	1,6	238	11,8	1,6
	3	340	10,8	1,4	200	11,2	1,4
	4	320	10,3	1,8	195	10,6	1,4
Situps (number 30sec.)	.	366	22	4	227	18	4
	2	377	24	4	236	19	4
	3	343	24	4	196	20	5
	4	311	26	5	185	19	5
Grip strength (Kg)	.	366	26.8	7.0	228	25.8	5.8
	2	381	32.1	8.8	241	29.8	6.0
	3	351	39.9	9.9	204	31.4	6.4
	4	325	45.0	8.5	196	34.1	6.2
20 mtr Shuttle run (SR-score)	.	345	8.7	2.5	193	6.5	2.0
	2	367	9.2	2.5	216	6.6	2.2
	3	237	9.5	2.6	138	6.9	2.4
	4	138	9.8	2.5	69	6.3	2.3

Physical Activity Behavior and Screen Time Changes

Changes in PA and screen time are shown in Table 4. Over time, students demonstrated a significant reduction in sports activities, averaging approximately 11 min less per week each year (β = −0.18; CI = −0.30 to −0.05; P = 0.01). Conversely, there was a significant decrease in screen time over three years, with an average decline of 48.6 min per week (β = −0.81; CI = 0.17 to 1.45; P = 0.01). A small number of students participated in active transport to school, with no significant change observed over the study period (β = 0.00; CI = −0.07 to 0.06; P = 0.93). No significant gender differences were found.

Physical Fitness Changes

Participants demonstrated significant improvements in various PF measures over the three-year period (Table 4). Significant gains in the Long Jump were recorded, averaging an increase of 7.3 cm per year (β = 7.29; CI = 143.13–146.99; P = 0.00). Likewise, in the Bent Arm Hang, students initially faced challenges but showed significant improvement throughout the study (β = 0.15; CI = 0.11–0.19; P<0.001). Other notable improvements were observed in the 10x5 Shuttle test (β = −0.33; CI = −0.38 to −0.28; P = 0.00), the Sit-and-Reach test (β = 0.92; CI = 0.74–1.10; P = 0.00), Plate Tapping (β = −0.76; CI = −0.81 to −0.71; P = 0.00), and Sit-up scores (β = 0.94; CI = 0.81–1.06; P = 0.00). Grip strength also exhibited significant annual increases of approximately 5 kg (β = 4.85; CI = 4.65–5.09; P = 0.00), while improvements were observed in 20-m Shuttle run scores (β = 0.37; CI = 0.30–0.45; P = 0.00) throughout the study.

Table 4: Changes in physical activity and physical fitness in prevocational students during the 4-year healthy school intervention period. Changes over time are expressed as the Beta coefficient (β) for time, the corresponding 95% confidence interval (CI), and the associated *P*-value. Additionally, the effect modification of gender is presented. [1] model: y = b0 + β time, [2] model: y = b0 + β1 time + β2 gender + β3 time × gender

		time[1]				time *gender[2]			
	Variable	**β**	**CI-L**	**CI-U**	***P***	**β_3**	**CI-L**	**CI-U**	***P***
Physical Activity (hours/week)	Screen time	-0,81	0,17	1,45	0,01	-0,33	-1,62	0,96	0,62
	Active commuting	0,00	-0,07	0,06	0,93	-0,01	-0,14	0,13	0,93
	Total time sport	-0,18	-0,30	-0,05	0,01	-0,17	-0,41	0,08	0,18
Physical Fitness	Long jump (cm)	7,29	143,13	146,99	0,00	-11,21	-12,53	-9,90	0,00
	LN_Bent arm hang (s)	0,15	0,11	0,19	<0.001	-0,31	-0,38	-0,24	<0.001
	10X5 Shuttle run (s)	-0,33	-0,38	-0,28	0,00	0,30	0,20	0,40	<0.001
	Sit & Reach (cm)	0,92	0,74	1,10	0,00	-0,38	-0,76	0,00	0,05
	Plate tapping (s)	-0,76	-0,81	-0,71	0,00	0,09	-0,01	0,19	0,09
	Situp (n/30s)	0,94	0,81	1,06	0,00	-0,95	-1,20	-0,70	<0.001
	Grip strength (kg)	4,85	4,61	5,08	0,00	-3,42	-3,80	-3,04	0,00
	20-m-Shuttle run (level)	0,37	0,30	0,45	0,00	-0,37	-0,51	-0,22	<0.001

Discussion

This case study illustrates the development and implementation of the Dutch "Echnaton Health Promoting School" program. It focused on broadening the HPS model through co-creative participatory approaches and aiming to realize broader school systems changes rather than merely isolating health promotion activities. Additionally, the study aimed to assess the longitudinal changes in students' PA behavior and PF over five years of exposure to the Echnaton HPS intervention.

Summary of Key Results

The qualitative findings revealed significant system-level changes at Echnaton, organized across the four ASM levels: events, structures, goals, and beliefs. Key initiatives included installing water taps to encourage healthier hydration habits, introducing new health education lessons focused on nutrition and PA, and redesigning the schoolyard to encourage more PA. These changes were collaboratively developed with students, staff, and parents, emphasizing the importance of integrating health promotion into the school's culture and infrastructure. The broader community's involvement, including partnerships with local health organizations and schools, also played a crucial role. The findings underscored the school's dedication to establishing health promotion as a sustainable, community-oriented initiative. Quantitatively, students exhibited significant improvements in various PF metrics over the five-year study period. Significant improvements were observed in the standing broad jump, bent-arm hang, shuttle run, sit-and-reach test, sit-ups, and grip strength. Boys consistently outperformed girls across most fitness assessments. Regarding PA behavior, there was a slight decline in sports participation, while screen time decreased significantly. However, active commuting to school remained low and showed no significant change throughout the study period.

Comparison with the Literature

The findings are consistent with previous research indicating that schools have substantial potential to impact adolescent health (Inchley et al., 2017). Our analysis shows that the ASM offers a practical framework for implementing the Whole School, Whole Community, Whole Child (WSCC) model discussed in the literature (Chiang et al., 2015; Lewallen et al., 2015). While the WSCC model focuses on the alignment and integration of health and education systems, this study demonstrates how such integration can be effectively achieved in practice.

The co-creation approach observed in Echnaton supports the growing evidence base that participatory methods, which involve students and stakeholders during both the design and implementation phases, improve the relevance and effectiveness of school interventions (Gugglberger & Dür, 2011). This aligns with Morse and Allensworth's (2015) recommendation to place students at the center of HPS by actively involving them in decision-making and implementation (Morse & Allensworth, 2015). By incorporating co-creation into systemic changes, this study demonstrates how student-centered principles can enhance the sustainability and impact of HPS interventions.

Furthermore, the quantitative results indicate a broader trend in adolescent PA levels, highlighting ongoing concerns about declines in PA and increases in sedentary behavior (Hallal et al., 2012; Ng et al., 2014). The observed decrease in sports participation in this study may be attributed to fewer PE lessons in higher grades and a reduction in sports class hours during the project. Importantly, this study highlights improvements in screen time reductions, consistent with other findings (Ahmed et al., 2022) but differing from national trends in Dutch society (Ghekiere et al., 2019). This study identified a lack of significant change in active commuting, illustrating the difficulty of modifying certain behaviors, particularly those shaped by external factors such as

urban design and family routines (Carver et al., 2012). The city of Almere has a well-organized public transport system and has a bus stop adjacent to the school, which students frequently use.

Students' PF levels identified in this study exceeded European fitness benchmarks (>P50 percentile scores), which may help lower the risks of cardiovascular diseases and negative health outcomes (Hurtig-Wennlöf et al., 2007; Ozemek et al., 2018). The observed positive changes in PF and screen time contrast with national trends in Dutch society, indicating the effectiveness of the intervention (Anselma et al., 2020; Ghekiere et al., 2019). The improvements in PF measures, despite only modest reductions in PA, suggest that structured interventions, such as school-based physical education, can significantly improve fitness outcomes (Bailey et al., 2009).

Systems Changes

Using the ASM retrospectively provided a thorough understanding of the multi-layered changes in the HPS system. The model's distinction between events, structures, goals, and beliefs enabled a detailed analysis of how specific interventions (or actions) were incorporated into the school's broader culture and operations throughout the study period and how they were interrelated. This approach allowed for tracking how visibly related changes, such as the installation of water taps, were supported by deeper structural and ideological shifts, enabling a more comprehensive evaluation of the program's impact. By aligning the ASM with the principles of the WSCC model, this study effectively connects conceptual frameworks with practical applications. For example, establishing a project office and forming committees were crucial for embedding content-specific activities in a broader systemic strategy. This systemic view highlights how schools can move beyond isolated health interventions to develop integrated systems that promote long-term health and well-being. Non-theme-specific changes, such as establishing a project office or forming committees, played a crucial role in integrating content-specific activities (events) from a systems perspective (Rosas, 2015; Vennegoor et al., 2023). In this case study, Echnaton's belief in enhancing the livability of the neighborhood through strong structural collaboration with community organizations led to new opportunities for education (training programs), resources (funding), and social engagement among stakeholders (events for specific target groups such as older adults and girls). The supportive roles of school leadership, the HPS coordinator, and a focus on collaboration and securing funding were key success factors, aligning with other recent studies (Vennegoor et al., 2023). However, during the HPS project, a change in school management led to a reassessment of HPS goals and the organizational structure. This shift impacted financial resources and teaching hours, underscoring the vulnerability of progress in the school. Our observations suggest that sustaining implementation and fostering innovation require ongoing awareness and consensus among all stakeholders. This underscores the need for strategic planning and collaboration to sustain initiatives and innovations (Cassetti & Paredes-Carbonell, 2022; Connell & Kubisch, 1998).

Student Participation

Engaging students and staff from the beginning has been essential in driving the HPS approach forward. In this specific school context, involvement has shifted perspectives from viewing school primarily as a place for social and cognitive development to recognizing health as equally central to learning. Additionally, the perception of students has evolved from passive recipients to active participants in a collaborative school environment. Small-group discussions and brainstorming sessions fostered a student-centered climate, where students eagerly contributed ideas and new perspectives with openness and honesty. Our findings indicate a strong willingness among both students and staff to take on responsibilities in various events, such as preparing healthy meals, co-supervising activities, and reporting on HPS initiatives. These actions likely foster a sense of ownership and engagement, contributing to a positive socio-emotional environment. As a result, the school began setting new goals, which led to structural changes that ultimately benefited the students.

These findings align with the positive outcomes of active student participation in school health promotion initiatives, as highlighted in a recent systematic review (Griebler et al., 2017). Moreover, collaborative dialogue sessions played a crucial role in fostering readiness to change core values and in developing a shared vision and goals for both learning and health, as noted by Gardner et al. (Gardner & Ollis, 2015). Consequently, it is vital to create a pedagogically responsible environment where students feel safe to share their ideas and have their voices heard, ensuring that their participation is both lasting and integral to the structural changes in the school (Mafalda Silva et al., 2024). These collaborative efforts align with the principles of equity, participation, and empowerment that are central to the salutogenic model of health promotion (Eriksson & Lindstrom, 2008). This study advocates for the inclusion of such participatory approaches because they help foster support for and acceptance of change, and thereby adds to the literature as an empirical example on how to integrate co-creative interventions into HPS initiatives.

Strengths and Limitations

This five-year case study provides valuable insights into the complexities of implementing a sustainable HPS approach. Our findings suggest that ASM provides valuable insight into the complexities of an HPS transition by integrating community involvement with structural implementation processes, moving beyond the purely thematic approach often used in interventions (Chiang et al., 2015; Kearney et al., 2016; Morse & Allensworth, 2015; Rosas, 2015). However, a key limitation of retrospective analysis is the risk of recall bias and

incomplete documentation. Certain aspects of the decision-making process and stakeholder involvement may not have been fully captured, potentially impacting the accuracy of the analysis. Additionally, retrospective evaluations do not enable real-time adjustments to the intervention, potentially overlooking opportunities to optimize implementation based on ongoing feedback. To better leverage these opportunities, we suggest that applying ASM prospectively during HPS implementation could be highly beneficial.

Additionally, involving students and teachers from the beginning helped create a participatory environment, shifting long-held beliefs about the role of health in education. The use of comprehensive data collection, including both quantitative and qualitative methods, enriched the analysis of the impacts on PA and PF. Limitations include potential recall bias from retrospective interviews, the use of questionnaires to assess PA, and the time-consuming nature of administering these questionnaires. The lack of a control group limits the ability to directly attribute observed changes in PA and PF to the HPS. Despite these limitations, the study provides valuable insights into long-term HPS processes, which are crucial for policymakers, schools, and public health agencies in developing effective strategies to strengthen healthy school environments and promote positive health behavior changes among adolescents.

Conclusions

This study demonstrates that aiming for non-thematic system-level school goals and infrastructure changes can add significant value to the success and durability of HPS interventions. The case study highlights how the conceptual Whole School, Whole Community, Whole Child model can be operationalized and evaluated through a systems-based approach, using the ASM. By mapping changes across ASM levels, the Echnaton HPS intervention successfully integrated health promotion into the school's culture, infrastructure, and goals. It emphasizes the importance of co-creation, stakeholder engagement, and strategic planning in fostering a culture of health promotion.

This participatory approach aligns with the growing emphasis on placing students at the center of HPS. This study illustrates how co-creation can foster ownership, relevance, and sustainability in HPS interventions. While challenges in maintaining PA levels were encountered, the significant improvements in PF suggest that well-structured school-based interventions can lead to positive health outcomes. The prospective use of ASM can ensure that interventions align with deeply rooted goals and beliefs, facilitating more cohesive and sustainable changes.

Practical Recommendations and Suggestions for Further Research

To maximize the impact of HPS interventions in the ASM framework, several key strategies should be adopted. First, early stakeholder engagement is crucial. Involving students, parents, teachers, and community members from the beginning ensures that interventions are contextually relevant and widely supported. While securing consistent and meaningful participation from all stakeholders can be challenging, fostering inclusive dialogue early on helps cultivate a sense of ownership and commitment to the program's success.

Second, it is essential to set system-level goals that are clear, measurable, and integrated into the school's structures, policies, and core values. Instead of focusing solely on individual behavior changes, these systemic goals create a foundation for long-term interventions. However, aligning these goals with broader educational priorities may require negotiation and compromise to strike a balance between health promotion and academic objectives.

Lastly, partnerships with local health organizations and community stakeholders are essential for sustained success. These collaborations offer ongoing resources, expertise, and support, helping to ensure that interventions remain effective and adaptable. Although maintaining these partnerships can be resource-intensive, they are crucial for integrating health promotion into the school and community's core structure.

For future research, several avenues could deepen the understanding and impact of HPS interventions. One key area to explore is the proactive use of the ASM framework during the design phase of interventions. Implementing ASM from the outset enables real-time feedback and iterative adjustments, increasing the chances of successful implementation and lasting change. Additionally, research should focus on strategies to promote active commuting among students. Considering the impact of external factors such as urban design and family routines, understanding these barriers and facilitators can help develop more effective interventions to encourage walking or cycling to school.

Finally, longer follow-up periods are crucial for evaluating the sustainability of HPS interventions. Extending the monitoring period beyond five years offers valuable insights into the long-term effects on students' PA and fitness, as well as the lasting impact of system-level changes in the school. By focusing on these areas, future research can strengthen the evidence base for HPS models and further contribute to the development of healthier school environments.

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