

**Table S1.** Methodology of the included interventions

Author/Year	Intervention group	Control group	Study design	Research tools	Measurement	Duration of intervention	Interventions Outcomes
Braga- Pontes et al. (2022) [44]	3-6 years old preschool children 3 intervention groups: (1) digital game (n=34) (2) storybook (n=37) (3) story book & stickers (n=39)	3-6 years old preschool children (n=29)	cluster-randomised study	observation	Assessment of vegetables knowledge Assessment of 5 vegetables consumption	5 weeks	Every intervention was effective in increasing vegetable consumption over both short and medium durations without statistically significant differences, compared to the control group. Notably, stickers exhibited a more pronounced impact in the short term as opposed to the medium term.
Costa et al. (2019) [45]	3-4 years old children in daycare center (n=39)	-	quasi-experimental study	observation sheet	Observing children's healthy behaviors for nasal hygiene	2 weeks	The intervention led to a positive enhancement in the adherence to six healthy nasal hygiene behaviors tested among children.
de Droog et al (2013) [46]	4-6 years old children (n=104)	4-6 years old children (n=56)	randomized experimental study	interviews, questionnaires, observation sheet	Children were interviewed individually and they completed a questionnaire on a touchscreen notebook. Observation sheet (regarding the activity of children during the intervention and vegetable consumption after the intervention). Anthropometric measures were applied.	5 days	Children in the experimental groups consumed nearly twice as much carrots (in proportion to other foods consumed). The impact of intervention on carrot consumption did not spill over to other vegetables.

Fastring et al. (2019) [47]	4-5 years old children (n = 341)	4-5 years old children (n = 93)	quasi- experimental study	picture cards, parental survey	Fruits and vegetables recognition was measured by showing children 16 picture cards (eight fruits and eight vegetables). Anthropometric measures were applied.	12 weeks	There was an improvement in fruit and vegetable recognition scores, and in the number of “tried and liked” fruits and vegetables. According to parents, children in the intervention group engaged in less screen time post-intervention and were playing more physically active games.
Kim & Kim (2019) [48]	5-6 years old preschool children (n=333)	5-6 years old preschool children (n=319)	cluster- randomised study	oral survey with open- ended and closed-ended questions	Oral survey about knowledge of risks associated with smoking, attitudes towards smoking, and coping behavior.	4 months	Participation in the intervention resulted a significant improvement in the knowledge of smoking prevention, attitudes toward smoking, and the ability to practice smoking prevention measures among children aged five and six.
Kobel et al. (2019) [49]	3-4 years old kindergarten children (n=318)	3-4 years old kindergarten children (n=240)	cluster- randomised study	Parental questionnaire	Anthropometric measurements, Endurance capability parental questionnaire about socio-demographic data, physical activity, screen media use and dietary patterns	10 months	The intervention group spent significantly more days engaging in 60 min of moderate to vigorous physical activity compared to children in the control group The consumption of sweetened beverages decreased to a greater extent in the intervention group.
Kornilaki et al. (2021) [50]	4-5 years old children (n=184)	4-5 years old children (n=145)	cluster- randomised study	picture-based tests, questionnaires, Healthy Eating and Sustainability (HES) assessment	Anthropometric measurements Healthy Eating and Sustainability (HES) assessment: Assessment of activities and foods depicted in the images through dichotomous evaluation	4-6 weeks	The intervention group demonstrated a significant increase in their awareness of the correlation between healthy living and sustainability. They maintained elevated consumption of fruits and vegetables immediately after the intervention and exhibited increased levels of physical activity

					and their subsequent pairing. EPAQ: Eating and physical activity questionnaire (for parents)		three months later.
Min et al. (2019) [51]	5 years old children in kindergartens in Seoul (n=212)	-	quasi-experimental study	parent reports on survey questionnaires; Korean CDC Growth Chart, Godin Leisure-Time Exercise Questionnaire, Psychological Need Satisfaction in Exercise Scale	Anthropometric measurements; Parental questionnaires: children's leisure time activity, psychological effects of the exercise on the children.	6 weeks	Significant statistical differences were observed in the children's physical activity levels and their satisfaction of psychological needs related to exercise before and after the intervention. Following the intervention, about half of the children increased their physical activity levels and developed a greater enthusiasm for exercise. Furthermore, the children notably increased their psychological need satisfaction through engagement in exercise.
O'Dwyer et al. (2013) [52]	3-5 years old children (n=109)	3-5 years old children (n=131)	cluster-randomised study	Accelerometer; Parental Characteristics Questionnaire	Children wore an accelerometer for 7 days at baseline, directly after and at 6-month post-intervention for measuring physical activity and sedentary time.	6 weeks	Significant intervention effects were not detected in terms of sedentary time or physical activity.
Robinson et al. (2018) [53]	3-4 years old children (n=36)	3-4 years old children (n=36)	randomized experimental study	SOFIT = System for Observing Fitness Instruction Time	The SOFIT objectively quantifies three aspects related to the physical education setting: (1) children's physical activity levels; (2) lesson context; (3) teacher behavior.	9 weeks	Children in CHAMP (Children's Health Activity Motor Program) spent more time walking and more time in moderate-to-vigorous PA (MVPA), furthermore less time standing compared with those in a traditional movement program.

Samuel et al. (2020) [54]	3-5 years old preschool children Study group: all three interventions (n=140)	“Active control” group (n=140): tooth brushing and oral health education;  “Negative control group (n=140)”: only oral health education	cluster-randomised study	dental/oral examination	The children's oral health was evaluated by two dentists,	one week in every 6 months (2 years)	The main outcome of the study was to assess the decrease in mean caries increment over a two-year period, with reduction in plaque accumulation.
Schindler et al. (2013) [55]	5-6 years old children (n=29)	5-6 years old children (n=29)	quasi-experimental study	questionnaire, observation survey	Identifying fruits and vegetables; Children's willingness to try fruit and vegetables was assessed by presenting four vegetables and four fruits	5 months	At the end of the program, children showed improved identification of fruits, regardless of the school they attended. However, unlike fruits, there was no improvement in the identification of vegetables at either school.
Vaughn et al. (2021) [56]	3-4 years old children from childcare centers (n=853)	-	cluster-randomised study	demographic surveys by parents; Diet Observation in Child Care protocol; food diary (parents); Healthy Eating Index (HEI);	Children's dietary intakes on two weekdays and one weekend day were assessed; Anthropometric measurements; Children's physical activity was measured by accelerometer.	4x6 weeks during a 8-month period	No significant changes were observed in any of the outcome measures, with the exception of modest improvements in children's sodium intake.

ActiGraph GT3X+ accelerometers.							
Wiseman et al. (2016) [57]	3-5 years old preschool children (n=40)	3-5 years old preschool children (n=42)	quasi- experimental study	Demographic Questionnaire, Child Participant Questionnaire	Nutrition and physical activity knowledge and preference were assessed using an interactive, age- appropriate photo-pair food and exercise questionnaire. A day-night stroop test was used to assess two components of executive function, including working memory and impulse control.	12 weeks	In the intervention group, there was a notable improvement in overall knowledge of healthy lifestyle behaviors after the intervention, especially in distinguishing between healthy and unhealthy food choices. However, there was no concurrent change in behavioral preferences.

**Table S2.** Content of the included interventions

Author/Year	Study Aim	The intervention	Conclusion
Braga- Pontes et al. (2022) [44]	To assess the effectiveness of three nutrition education strategies on the consumption of various vegetables among preschool children.	Veggies4myHeart project: The intervention consisted of 20-minute educational sessions held once a week for a duration of 5 weeks. During these sessions, one of the randomly assigned educational strategies was applied "Portuguese Food Wheel Guide" (control), digital game, storybook, or storybook accompanied by a reward system (stickers). Every group was consistently exposed to various vegetables in all sessions. Pre- and post-tests were administered to measure vegetable consumption, and a follow-up assessment was conducted after a 6-month period.	The nutritional education strategies linked to repetitive exposure demonstrated their effectiveness in encouraging vegetable consumption among preschool children. Utilizing stickers could be suitable to stimulate the consumption of vegetables that are less recognized by children.
Costa et al. (2019) [45]	To assess the impact of an educational and playful intervention on nasal hygiene behaviors in preschool children aged 3 to 4 years.	Two 60-minutes group-based educational sessions about nasal hygiene behaviors were held: (1) story-based activity about the importance of nasal hygiene, (2) card game with illustrations of six healthy behaviors for nasal hygiene	The educational playful intervention enhanced the autonomy of young children to adopt healthy nasal hygiene behaviors.
De Droog et al. (2014) [46]	To explore whether and how a picture book promoting carrots can contribute to the increase young children's carrot consumption.	Picture book was read for the children in a quiet room near their class on five consecutive days each group. The health message of the picture book was that "eating carrots makes you fit and strong". The reading style (passive or interactive) and characters (rabbit or turtle) in the book were manipulated in a 2x2 between-subject design.	The effectiveness of (health) communication interventions aimed at young children – like picture books – depends largely on how educators, parents or other important caregivers maximize the positive impacts of these interventions.
Fastring et al. (2019) [47]	To evaluate a physical activity and nutrition education program in a Head Start setting about the recognition and consumption of	The "Color Me Healthy" program provides 4-5 years old children opportunities to learn about healthy eating and physical activity through interactive, fun, classroom experiences.	Head Start programs may be more effective in addressing overweight and obesity issues by involving parents in the process.

	fruits and vegetables, reduce screen time, and increase physical activity.		
Kim & Kim (2019) [48]	To assess the efficacy of tobacco-smoking hazard prevention programs connected to the standard curriculum for preschool children in South Korea.	Smoking prevention programs for preschool children linked to the Nuri curriculum (South Korea) in two waves (2016, 2017).  Age-specific activities for 5-6 years old children were carried out.	It is essential to continuously expand and implementing smoking preventions programs to early childhood curricula.  “Children may be able to make an appropriate decision and protect themselves through building healthy habits when they are exposed to tobacco by nearby smokers or a harmful environment.”
Kobel et al. (2019) [49]	To analyze the impacts of the health promotion program “Join the Healthy Boat”, on body composition, physical activity, nutritional habits and screen media consumption among kindergarten children in South-West Germany.	“Join the Healthy Boat” is a health promotion program which supports healthy lifestyle of kindergarten children and the prevention of obesity. The three key topics of the program are: (1) promotion of physical activity, (2) reduction of screen media consumption, (3) healthy eating including the reduction of sweetened drinks and an increased fruit and vegetable intake.	The program, which does not demand additional time and is accessible to all kindergartens, is perfectly suited for integrating health promotion into the daily routines of children and the training of kindergarten educators, enabling them to take appropriate interventions.
Kornilaki et al. (2021) [50]	To enrich children’s knowledge of active play, healthy eating and environmental sustainability through play-oriented activities.	<u>Preschool/kindergarten curriculum intervention design:</u> (1) implementing the curriculum experiences in the morning when most cognitively alert; (2) use a combination of three identified play types – open-ended play; modelled play; and purposefully framed play (3) conduct the curriculum activities 2–3 times per week for between 4 and 6 weeks; (4) use a range of real-life props as resources for the curriculum experiences.	The results underscore, that young children have the capacity to develop their understanding of health and sustainability principles, enabling them to make more informed decisions regarding healthy eating and physical activity. The preschool environment can contribute to health promotion and foster essential environmental awareness among young children.
Min et al. (2019) [51]	To customize the NASA Mission X intervention program for preschoolers in South Korea.	The adapted Mission-X curriculum included various physical activity topics and incorporated two nutrition education modules from the standard NASA Mission X	The program proved to be both viable and successful in encouraging physical activity among kindergarten children, while also positively

		program, which originally consisted of 18 modules. Each daily activity required approximately 40–60 minutes, and children had the option to engage in these activities with their teacher two or more times per week.	influencing the attitudes and beliefs of parents regarding their children's physical activity in South Korea.
O'Dwyer et al. (2013) [52]	To explore how a school-based active play intervention impacts sedentary time and physical activity among preschool children.	In each intervention school, one teacher underwent training from active play experts to implement a 6-week active play program. Meanwhile, comparison schools maintained their regular routines.	While the intervention was adequately intense, a 6-week active play program proved to be insufficient to bring about any notable changes in sedentary time and physical activity engagement, both in the short term and over a longer duration.
Robinson et al. (2018) [53]	To assess the impact of a conventional and mastery-oriented (CHAMP) movement program on physical activity levels and lesson context among preschoolers.	<p>Children's Health Activity Motor Program [CHAMP]</p> <p>All participants were enrolled in a 30-minute movement program, encompassing motor skills and physical activity, conducted twice a week over a span of nine weeks. Each session followed a pattern of a 2 to 3-minute warm-up activity, 24 minutes dedicated to planned motor skill instruction and practice, and finally, a 2 to 3-minute closure activity.</p> <p>Within the CHAMP program, children autonomously navigated through two skill stations, each offering a minimum of three difficulty levels. The traditional movement program employed a direct instructional approach that did not incorporate the autonomous learning characteristic of the mastery approach.</p>	<p>Engagement in CHAMP leads to higher levels of moderate-to-vigorous physical activity (MVPA) in preschool-aged children when compared to a traditional movement program."</p> <p>The Children's Health Activity Motor Program allocated more classroom time for skill practice, presenting an innovative approach that seems to have a positive impact on physical activity engagement and has the potential to enhance children's overall health.</p>
Samuel et al. (2020) [54]	To evaluate the efficacy of school-based interventions in preventing early childhood caries among preschool children from very low socioeconomic backgrounds over a two-year duration.	At the beginning of the trial, the principal investigator conducted a one-week oral health education program for both children and teachers. PowerPoint presentations, videos, and flash card demonstrations were used to instruct participants on proper oral hygiene practices. Additionally, the children received an oral health care kit and informational pamphlets. This comprehensive health education process was reiterated every six months for all	Prohibition of sugary snacks in school and daily supervised tooth brushing, with or without oral health education is effective in preventing caries among preschool children experiencing health neglect in extremely resource-constrained environments.



three groups participating in the trial.			
Schindler et al. (2013) [55]	to assess the effectiveness of providing fruit and vegetable exposure within a school nutrition program.	Kindergarten children were exposed to interactive activities about healthy eating. Children in the experimental group were exposed to a variety of fruits and vegetables, the control group participated in the program but did not get food exposure.	It is crucial to highlight the importance of introducing children to a diverse range of vegetables, in addition to fruits, in order to enhance their acceptance of these foods.
Vaughn et al. (2021) [56]	To assess the efficacy of a social marketing intervention focused on nutrition and physical activity within an early childhood education (ECE) setting.	Healthy Me, Healthy We (HMHW) is a 8-month social marketing campaign on the diet and physical activity behaviors of preschool children (3–4 years old), their parents, and child care providers. The campaign is delivered by the child care center and includes branded classroom and at-home activities and materials.	The study provides edification about the importance and challenges of effective parent engagement which is substantial for considerable changes in children’s health behaviors.
Wiseman et al. (2016) [57]	To explore how exposure to a settings-based healthy lifestyle programme influences knowledge and preference of food and physical activity in young children.	Intervention groups: Get Up and Grow lifestyle programme (12-week period) with 4x45 minute physical play sessions and 8x30 minute nutrition sessions	Age-appropriate lifestyle interventions can lead to improved children’s knowledge of healthy lifestyle choices, yet an increase in knowledge about healthy behaviors may not automatically result in favorable changes in their food and activity preferences.

**Table S3.** Summary of Risk of Bias in cluster-randomized studies

	Braga- Pontes et al. (2022) [44]	Kim & Kim (2019) [48]	Kobel et al. (2019) [49]	Kornilaki et al. (2021) [50]	O'Dwyer et al. (2013) [52]	Samuel et al. (2020) [54]	Vaughn et al. (2021) [56]
Randomisation process	+	+	+	+	+	+	+
Risk of bias arising from the timing of identification or recruitment of participants	+	+	+	+	+	+	+
Deviations from intended interventions	-	+	+	+	-	+	+
Missing outcome data	+	+	+	+	+	+	+
Measurement of the outcome	+	+	+	+	+	+	+
Selection of the reported result	-	+	+	+	+	+	+
Overall Bias	-	+	+	+	-	+	+



some concern



low

**Table S4.** Summary of Risk of Bias in quasi-experimental studies

	Costa et al. (2019) [45]	Fastring et al. (2019) [47]	Min et al. (2019) [51]	Schindler et al. (2013) [55]	Wiseman et al. (2016) [57]
Bias due to confounding					
Bias in selection of participants into the study					
Bias in classification of interventions					
Bias due to deviations from intended interventions					
Bias due to missing data				No information	
Bias in measurement of outcomes					
Bias in selection of the reported result					
Overall bias				No information	














low



moderate

**Table S5.** Summary of Risk of Bias in randomized experimental studies

	De Droog et al. (2014) [46]	Robinson et al. (2018) [53]
Randomisation process		
Deviations from intended interventions		
Missing outcome data		
Measurement of the outcome		
Selection of the reported result	No information	
Overall Bias		



some concern



low