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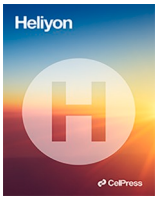

Research article

Peer education program to improve fluid consumption in primary schools—lessons learned from an innovative pilot study

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ABSTRACT

Background: Although it is widely recognized that more attention needs to be paid to children's fluid intake, there is little information on how to improve it. Peer education has been suggested as an effective approach to changing health behaviors among school children. As a new approach, our study piloted a peer education program to improve children's fluid intake in primary schools.
Methods: University students were prepared for their role as peer educators in an elective university course, including the concept of peer education and different pedagogical methods. The peer educators evaluated the training process by completing a questionnaire. The intervention took place during a School Health Day led by the peer educators. An anonymous survey with a questionnaire on knowledge of fluid intake was administered two weeks before, at the end of, and 15 weeks after the intervention. Changes in hydration knowledge were tested using repeated measures ANOVA.
Results: The pilot program showed increased knowledge about fluid consumption ($p < 0.001$) in lower and upper primary school children ($N = 326$) at the end of the School Health Day compared to pre-intervention measures. A positive change was observed after 15 weeks only in upper primary students. Feedback from peer educators was useful for fine-tuning the program.
Conclusions: This innovative program induced positive changes in knowledge about fluid intake in primary school children. The persistence of the changes differed between lower and upper primary school children. Based on the results, the intervention should be replicated to adapt the program to the needs of lower primary school children. Because the training of peer educators and the peer education program appeared to be successful, this program is worthy of international replication. This approach may also be suggested for other behavior change issues.

1. Introduction

Non-communicable diseases (NCDs) are a global health problem, yet most NCDs are preventable through interventions that address five key modifiable risk factors: tobacco use, nutrition, physical activity, alcohol consumption, and hygiene. Schools are a prime location for NCD prevention through life skills education and can provide a supportive, healthy environment for children to develop

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and apply life skills [1]. Schools are increasingly recognized as a key setting for promoting children and adolescents' health, well-being, and development. Globally, most children and adolescents are enrolled in school, and an increasing proportion are continuously enrolled from primary to secondary school. At their best, schools are safe and secure places where students can acquire the knowledge, attitudes, behaviors, skills, and experiences that are the foundation for becoming healthy, educated, and engaged citizens [2].

Various approaches and initiatives have shaped the concept of peer education from antiquity to the present day, and its popularity has increased over the years [3,4]. These forms of education became particularly popular in health education in the second half of the 20th century, mainly in higher education institutions in the USA, intending to improve health behavior and reduce risky sexual behavior, as well as preventing drug abuse and HIV infection [5–9]. The effectiveness of peer education could be explained by several psychological and sociological theories, e.g. Social Learning Theory [10], Differential Association Theory [11], and Diffusion of Innovation Theory [12]. With proper supervision and preparation, peer educators can have a substantial effect on their peers. Peer education programs in health education are not only cost-effective but can also have long-term effects [3]. Moreover, peer education is beneficial for peer educators too, in the sense of prosocial behavior, self-esteem, and empowerment [6,7]. Key concepts in the research about peer education include the quality of the tutor-tutee relationship [13], the success of tutoring [14], the personality of the tutor, and the specific areas of tutoring [15].

There is an increasing number of methodological and descriptive analyses of peer education programs in health education, although more qualitative measures of effectiveness are needed [16,17]. Empirical evidence of effectiveness is still scarce [3], and models for evaluating program effectiveness are urgently needed [6].

Adequate fluid intake is essential for the physical and mental functioning of the human body. In severe cases, not drinking enough fluid can lead to dehydration or even death [18]. In children, reduced fluid intake can impair cognitive performance and increase the risk of dehydration [19]. An increasing number of studies have looked at children's water and fluid intake [20–26] and children's knowledge of fluid intake [27], but we did not find any studies that looked at differences between lower and upper primary school children. With some exceptions [28], studies generally have focused on healthy eating and obesity prevention [29–31] and not on fluid intake separately.

The dramatic increase in the number of obese schoolchildren [31,32], in the consumption of sugar-sweetened beverages [33], and obesity-related diseases [34] calls for the study of fluid intake in children [25–30,35–37]. This is supported by the results of a study conducted in 13 countries, which found that children, especially adolescents, are most negatively affected by inadequate fluid intake [38].

The Hungarian Study, Teach, and Understand (STAnD) program was funded by the Hungarian Academy of Sciences (ethical approval number: ETT TUKEB No 18240-2/2017/EKU) from 2015 to 2021 [39]. The aim was to develop an innovative program to improve the health education of children and young adults, applying a complex peer education project with quality effectiveness measurement. Another goal was to sensitize students in teacher training and health sciences to health promotion and give them practical experience in this field. The program included health education topics such as hydration, hand hygiene, internet use, and resuscitation, with a focus on developing appropriate health knowledge, attitudes, and behaviors. Four age groups were targeted: children in kindergarten (3–5 years), lower primary school (6–10 years), upper primary school (11–14 years) and secondary school (15–18 years). The education took place in kindergartens through playful activities and in schools through a Health Day in the classroom. The topics were the same, but the methodology was different. The interventions were carried out by peer educators who had attended a special preparatory university course. They were supported in their preparation by tutors with professional backgrounds as a teacher, health visitor, psychologist, sociologist, or a university lecturer in health sciences or education. A detailed description of the program has been published previously [39].

To the best of our knowledge, there are no studies on peer education programs that jointly measure schoolchildren's knowledge about fluid consumption and the effectiveness of health education.

This study aimed to test the feasibility and effectiveness of a new peer education program on fluid consumption developed within STAnD. Our pilot peer educator program aimed to improve primary school children's knowledge of hydration and our objectives were to (1) assess the usefulness of the university-based training course for peer educators, (2) evaluate students' knowledge of hydration at the start of the program, and (3) measure the positive impact of the program on students' knowledge of hydration immediately and then 15 weeks after the program.

2. Materials and methods

2.1. Peer educators' training

After reviewing the relevant literature, we developed a multilevel educational model of the peer education program, organized as a university course [35]. University students prepared for their role as peer educators in an elective university course (5 sessions, 24 contact hours). The preparatory course covered the following topics: age-related characteristics of health promotion; the theoretical background of fluid consumption essential for the healthy development of school children; and age-specific differentiated pedagogical methodologies for peer education and children with difficulties. The most important professional and methodological bases for the planning, implementation, and evaluation of a modern, differentiated school health promotion program were presented in the practical lessons, as well as possible ways of dealing with conflicts through drama-based pedagogy activities and case discussions. This course also introduced them to the STAnD program and the students acquired the knowledge to be taught at the Health Day and presented their educational plan. Completion of this course was a prerequisite for participation in the program as a peer educator. We

measured satisfaction with the course using questionnaires. The questionnaires, which were mainly self-developed and self-administered, contained both closed and open questions.

Four dimensions were used to assess satisfaction with the five-session courses:

1) Comments on the content of the course, asking about the novelty and quantity of the material, the ratio of theory to practice, the time devoted to each topic, the pedagogical methods used, and the professional knowledge of the instructors.
2. Questions about the course as a whole, e.g. „Do you feel disappointed to have enrolled in this course?"; „Do you consider the course average compared to other higher education courses?"; „Do you look forward to the next week of the course?"
3. Statements related to group formation and group dynamics, the main purpose of which was to measure, in the course of teaching, how well students perceived their peer teaching team to be formed and how well they perceived their team members to be cooperative.
4. To measure satisfaction with the delivery and organization of the course.

The questionnaire was completed by the participants each time.

The full program of the 4-h peer education school program was prepared by the students (peer educators) during the course, in consultation with a university lecturer (tutor).

2.2. Participants in peer education

The pilot program was carried out in two schools in Budapest for both lower and upper primary school children. Schools were selected from historically determined high and low social status districts in the capital city that predicted the different SES statuses of the children surveyed. The education level, income, and average life expectancy at birth of the district residents were the primary guiding factors. The novelty of the health promotion pedagogy method and the selected health promotion topic ensured the commitment of the schools. No formal sampling procedure was used: selected classes in the participating schools were included and all children whose parents consented were allowed to complete the questionnaire.

The research is ethically acceptable following the World Medical Association's Declaration of Helsinki and the requirements of all applicable local and international standards. The Medical Research Council has approved this research (ETT-TUKEB No 18240-2/2017/EKU). Teachers and parents were informed about the research, and parents voluntarily gave written informed consent for their children to participate. In addition to obtaining written informed consent from parents for their children to participate, teachers and peer educators informed participants about Health Day and the research. Participants had the opportunity to refuse to participate at any time during the program. We asked participants to provide their kindergarten sign and their birth month and day to link the three questionnaires from the three data collections. Based on this information, we were able to link the students' questionnaires for analysis without violating anonymity.

2.3. Peer education accomplishment

On the School Health Day, four peer educators per class delivered an interactive, participatory session on fluid consumption in four lessons. The work of the peer educators was supervised by a tutor. The tutor monitored whether all important health-related information was presented. At the end of the Health Day, the tutors evaluated the session with the peer educators.

2.4. Data collection

Data collection took place in the participating classrooms in 2018. Three measurements were made using the same questionnaire: two weeks before the intervention (Baseline), at the end of the intervention (T1), and 15 weeks after the intervention (T2). Questionnaires were administered on paper, and completion was voluntary and anonymous, taking approximately 20 min.

2.5. Instruments

The questionnaire was constructed using questions from both validated [40] and non-validated [41,42] questionnaires. Non-validated questions were developed by a panel of experts (including psychologists, pedagogical researchers, teachers, and sociologists) based on a literature review. There were 14 closed questions with yes/no, true/false, single and multiple choice, or Likert-scale question types, and eight questions requiring numeric or open-ended responses. We pre-tested the items of the questionnaire among primary school students ($n = 10$) recruited through convenience sampling.

In addition to identification questions, five items were used to collect sociodemographic data, and ten items were used to assess knowledge, attitudes, and behaviors related to fluid consumption. In this study, the responses to the following questions are analyzed: (1) "How much fluid do you think a child should consume a day to be healthy?" (herein referred to as recommended daily fluid intake), (2) "What do you think about the following statements? Choose between false and correct!" (statements on fluid consumption), (3) "How can you know you don't drink enough?" (symptoms of inadequate fluid intake), and (4) "How many of these drinks do you think you can drink a day?" (the recommended amount of the different types of beverages). International and national guidelines [43–45] were consulted to determine the recommended amount.

To assess the socioeconomic status of the schoolchildren, we used questions on the educational level of both parents and household

assets (number of cars and bathrooms).

2.6. Statistical analysis

Descriptive data analyses were used to summarize the characteristics of the sample and knowledge of fluid consumption in the sample of lower and upper primary school children. Descriptive statistics were reported as frequencies and percentages for categorical variables and means and standard deviations for continuous variables.

To examine the short and long-term effects of the peer education program considering the age of children, we used repeated measures ANOVA for knowledge of fluid consumption. To analyze changes over time in fluid consumption, we used the three measurements of the knowledge of fluid consumption as a within-subjects factor (Time) with three levels: two weeks before the intervention (Time = Baseline), at the end of the intervention (Time = T1), and 15 weeks after the intervention (Time = T2). In the model, the age of children, lower and primary school children was used as a between-subjects factor (Group). This model can remove the variability due to the individual differences between subjects from the within-group variability. We analyzed the main effect of Time and the interaction of Time × Group calculating partial eta squared as an effect size measurement. The level of significance was set a priori at 5% for all tests. IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, N.Y., USA) was used for data analysis.

3. Results

3.1. Peer educators' training

Thirty-five students and 11 tutors from the Faculty of Health Sciences of Semmelweis University and the Faculty of Primary and Pre-School Education of Eötvös Loránd University participated in the satisfaction survey of our peer educator training, which took place in the spring of 2017.

A large proportion of the participants (92.3%) rated the professionalism of the tutors involved in the preparation course positively. 88.9% or more were looking forward to the next week's course. At least 91.9% of the students reported satisfaction and absolutely no disappointment with their enrollment in the course on the first three occasions (but 71.4% reported this on the last two occasions). The majority (77.1%) rated the course as innovative, although this rating became more negative on the last two occasions. A larger proportion (over 54.1%) rated the training as more interactive, except on the second occasion when it was 41.0% (this time it was a theoretical approach covering the steps, evaluation criteria, and tools for planning, assessing, and evaluating a health promotion program in schools, presumably the students would have expected this to be more interactive). Especially in the first three sessions, the majority of the students considered the information as useful (session 1: 94.8%; session 2: 67.5%; session 3: 77.8%) and new (session 1: 79.5%; session 2: 60.0%; session 3: 66.7%). 87.5% of the participants disagreed with the statement "This optional course was quite average, nothing extra."

3.2. Characteristics of the schoolchildren sample

A total of 326 schoolchildren participated in the study. The socio-demographic characteristics of the 110 lower primary school children and the 216 upper primary school children are summarized in Table 1. The data show some minor differences between the groups of schoolchildren in terms of their socioeconomic status.

3.3. Knowledge of fluid consumption at baseline

Based on the responses, the mean recommended daily fluid intake in dl was 17.89 (SD = 7.68, min-max = 8–52) for lower primary school children and 19.58 (SD = 7.34, min-max: 5–63) for upper primary school children. Considering that the recommendations for daily fluid intake are between 20 and 25 dl, one-third (33.3%) of the lower primary school children and more than half of the upper primary school children (53.2%) gave a correct answer. Descriptive statistics of the items are shown in Table 2.

For the five statements about fluid consumption, there was an equal number of correct markings in the lower and upper primary school children (Table 2).

For the six items on symptoms of inadequate fluid intake, there was an equal number of correct markings in the lower and upper primary school children (Table 2).

For the nine items on the recommended amount of different types of beverages, there was an equal number of correct markings from lower and upper primary school children. Descriptive statistics for the items are shown in Table 3.

3.4. Knowledge of fluid consumption in T1 and T2

There was a significant time effect ($F(2,298) = 50.940$, $p < 0.001$, $\eta_p^2 = 0.26$) and a Time × Group interaction ($F(2,298) = 10.692$, $p < 0.001$, $\eta_p^2 = 0.07$) on the proportion of correct markings for the fluid consumption statements. Both groups showed a significantly

Table 1
Sociodemographic in the lower and upper primary school children.

	Lower primary school children (n = 110)	Upper primary school children (n = 216)
Gender- n (%)		
female	51 (51.0)	106 (52.2)
male	49 (49.0)	97 (47.8)
Age - mean (SD)	8.72 (0.95)	12.63 (1.16)
Levels of education: mother- n (%)		
primary/secondary school	2 (4.0)	6 (3.7)
technical/vocational school	6 (12.0)	22 (13.6)
high school	17 (34.0)	39 (24.1)
university	25 (50.0)	95 (58.6)
Levels of education: father- n (%)		
primary/secondary school	1 (2.3)	1 (0.6)
technical/vocational school	6 (13.6)	16 (9.9)
high school	12 (27.3)	43 (26.5)
university	25 (56.8)	102 (63.0)
Household assets: number of cars- n (%)		
none	14 (14.9)	34 (16.9)
one	41 (43.6)	71 (35.3)
two	34 (36.2)	74 (36.8)
three or more	5 (5.3)	22 (11.0)
Household assets: number of bathrooms- n (%)		
none	2 (2.0)	0 (0.0)
one	66 (66.0)	122 (60.7)
two	21 (21.0)	52 (25.9)
three or more	11 (11.0)	27 (13.4)

Table 2
Items of statements about fluid consumption and symptoms of inadequate fluid intake in the lower and upper primary school children (the correct markings are marked with a grey background).

Statements about fluid consumption	Lower primary school children (n=110)		Upper primary school children (n=216)	
	False – n (%)	True – n (%)	False – n (%)	True – n (%)
1. We only need to drink when we are thirsty.	92 (92)	8 (8.0)	184 (90.2)	20 (9.8)
2. When we talk about the fluid consumed in a day, we only mean the different beverages.	80 (80.8)	19 (19.2)	176 (87.1)	26 (12.9)
3. It is healthiest if most of the fluid consumed daily is water.	6 (6.0)	94 (94.0)	7 (3.4)	198 (96.6)
4. There is also liquid in vegetables and fruits.	1 (1.0)	99 (99.0)	6 (3.0)	197 (97.0)
5. Sugar-sweetened drinks are delicious and healthy.	98 (99.0)	1 (1.0)	192 (96.5)	7 (3.5)
Total score	min-max	mean (SD)	min-max	mean (SD)
	2-5	4.65 (0.54)	3-5	4.67 (0.62)
Symptoms of inadequate fluid intake				
1. headache	5 (5.1)	93 (94.9)	12 (5.9)	192 (94.1)
2. hair loss	86 (91.5)	8 (8.5)	191 (95.0)	10 (5.0)
3. nicer skin	90 (94.7)	5 (5.3)	189 (93.1)	14 (6.9)
4. diarrhea	69 (75.0)	23 (25.0)	184 (92.0)	16 (8.0)
5. dark yellow urine	17 (17.5)	80 (82.5)	54 (27.1)	145 (72.9)
6. dry mouth	3 (3.1)	94 (96.9)	9 (4.4)	194 (95.6)
Total score	min-max	mean (SD)	min-max	mean (SD)
	3-6	5.38 (0.74)	1-6	5.43 (0.79)

Table 3
Items of the recommended amount of the different types of beverages in the lower and upper primary school children (the correct markings are marked with a grey background).

	Lower primary school children (n=110)				
	do not drink	one glass	2-3 glasses	4-5 glasses	any amount
	n (%)				
tap water	3 (3.2)	9 (9.5)	10 (10.5)	19 (20.0)	54 (56.8)
non-carbonated mineral water	0 (0)	7 (7.5)	24 (25.8)	15 (16.1)	47 (50.6)
carbonated mineral water	4 (4.3)	41 (43.6)	28 (29.8)	17 (18.1)	4 (4.2)
milk	2 (2.1)	11 (11.7)	35 (37.2)	18 (19.2)	28 (29.8)
energy drinks	61 (66.3)	22 (23.9)	5 (5.4)	2 (2.2)	2 (2.2)
coffee	49 (51.6)	35 (36.8)	9 (9.5)	0 (0)	2 (2.1)
iced tea	9 (9.5)	43 (45.2)	32 (33.7)	6 (6.3)	5 (5.3)
carbonated soft drinks	33 (35.1)	49 (52.1)	8 (8.6)	2 (2.1)	2 (2.1)
freshly prepared juices	1 (1.1)	5 (5.3)	19 (20.2)	22 (23.4)	47 (50.0)
Total score	min-max			mean (SD)	
	1-8			4.28 (1.68)	
	Upper primary school children (n=216)				
	do not drink	one glass	2-3 glasses	4-5 glasses	any amount
	n (%)				
tap water	6 (3.0)	13 (6.5)	35 (17.4)	27 (13.4)	120 (59.7)
non-carbonated mineral water	1 (0.5)	5 (2.4)	25 (12.2)	44 (21.5)	130 (63.4)
carbonated mineral water	6 (2.9)	38 (18.5)	92 (44.9)	33 (16.1)	36 (17.6)
milk	1 (0.5)	56 (28.0)	74 (37.0)	33 (16.5)	36 (18.0)
energy drinks	135 (67.8)	51 (25.7)	8 (4.0)	2 (1.0)	3 (1.5)
coffee	106 (52.0)	76 (37.2)	18 (8.8)	2 (1.0)	2 (1.0)
ice tea	14 (6.9)	84 (41.4)	79 (38.9)	17 (8.4)	9 (4.4)
carbonated soft drinks	54 (27.0)	90 (45.0)	43 (21.5)	7 (3.5)	6 (3.0)
freshly prepared juices	1 (0.5)	6 (3.0)	55 (27.2)	68 (33.7)	72 (35.6)
Total score	min-max			M (SD)	
	0-9			3.95 (1.84)	

higher proportion of correct markings at T1 than at baseline; however, the proportion of correct markings decreased at T2 compared to T1. There was a non-significant difference between baseline and T2 in both groups. The changes were greater in lower than in upper primary children (Fig. 1).[1]

There was also a significant time effect ($F(2,320) = 3.612$, $p = 0.028$, $\eta_p^2 = 0.02$) and a Time × Group interaction ($F(2,320) = 3.572$, $p = 0.029$, $\eta_p^2 = 0.02$) on the number of correct markings of the five fluid consumption statements. The significantly higher mean number of correct markings at T1 and T2 compared to baseline was observed only in the upper primary children. The lower primary children did not show significant changes (Fig. 2).

The number of correct markings to the six statements about symptoms of inadequate fluid intake showed a not significant time effect ($F(2,288) = 1.480$, $p = 0.229$, $\eta_p^2 = 0.01$) and a marginally significant Time × Group interaction with a small effect ($F(2,288) = 2.756$, $p = 0.065$, $\eta_p^2 = 0.02$). Only the upper primary children had a significantly higher mean number of correct markings at T2 than at baseline (Fig. 3).

The number of correct markings of the nine statements on recommended daily intake of beverages showed a significant time effect ($F(2,102) = 13.572$, $p < 0.001$, $\eta_p^2 = 0.21$), the Time × Group interaction was marginally significant with a small effect ($F(2,102) = 2.532$, $p = 0.084$, $\eta_p^2 = 0.05$). Only the upper primary children showed a significantly higher mean number of correct markings at T1 and T2 than at baseline, but there was no difference between T1 and T2. In the lower primary school children, there were no significant changes in the means for the recommended daily intake of beverages (Fig. 4).

[1] Only participants who provided data at all three time points were included in the analysis of change. Therefore, the figures show different case numbers compared to the baseline.

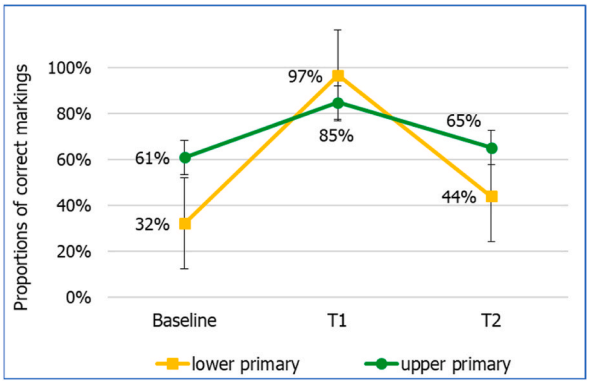

Fig. 1. Changes in the proportions of correct markings of recommended daily intake in lower and upper primary children ($N_{lower} = 59$; $N_{upper} = 92$; error bar: standard error).

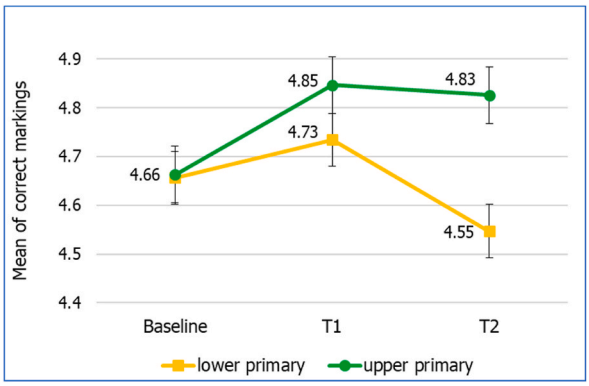

Fig. 2. Changes of the mean of the correct markings of the five statements about fluid consumption ($N_{lower} = 64$; $N_{upper} = 98$; error bar: standard error).

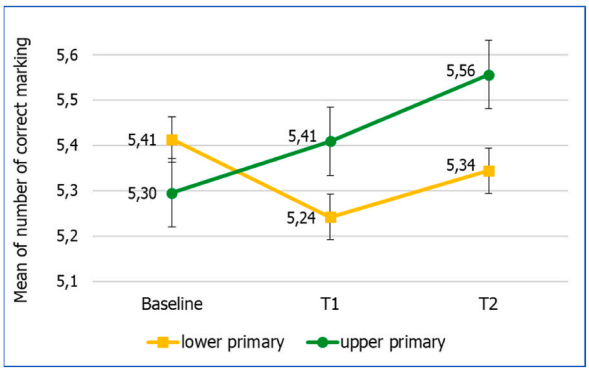

Fig. 3. Changes of the mean of the correct markings of symptoms of inadequate fluid intake ($N_{lower} = 58$; $N_{upper} = 88$; error bar: standard error).

4. Discussion

The peer educators found their preparation course very useful: they were satisfied with the content of the course and the teaching method and rated it as positive and innovative. According to their experience, there is a need to focus more on modern pedagogical methodology in order to strengthen group cohesion during the course, reduce the workload of students, and to define their tasks and responsibilities more precisely. Feedback from the peer educators was useful in fine-tuning the program. The results of the pilot program, recorded at the end of the School Health Day, showed an increase in one of the four themes related to fluid consumption in the lower primary school children and an increase in all themes in the upper primary school children compared to the pre-intervention

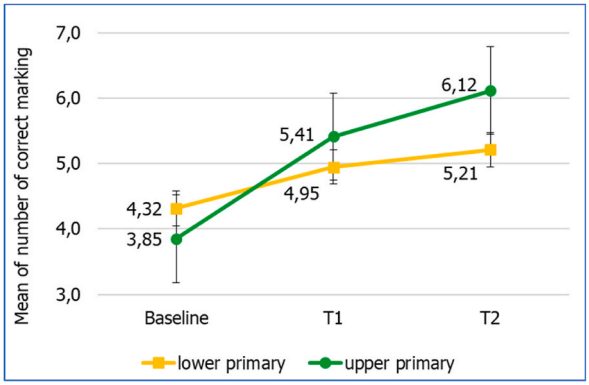

Fig. 4. Changes of the mean of correct markings of recommended daily intake of types of beverages based on nine statements ($N_{lower} = 19$; $N_{upper} = 34$; error bar: standard error).

measurements. After 15 weeks, positive change was observed in only one subject area in the lower grades and all but one subject area in the upper grades.

At the start of the program to improve primary school students' knowledge of hydration, unexpected results were that three of the four questions - basic knowledge of hydration; symptoms of dehydration; recommended daily intake of different types of fluids - had almost the same number of correct markings from lower primary and upper primary children, Similarly to other research results [26] only the recommended daily intake of fluids being significantly better known by upper primary children. The lack of knowledge in upper primary grades seems to be a particular problem because the survey examined questions that would be professionally appropriate for students to know even in lower primary school, such as the recommended fluid intakes advised by the guidelines [45–47]. This may be because teachers and health promotion professionals (e.g. school nurses, school doctors) are probably not very familiar with this topic. The situation is probably similar in parenting. This deficit is exacerbated by advertising aimed at children to influence their fluid intake.

According to our findings, teachers and school health professionals can do much more to support the implementation of peer education programs by being involved in planning, organizing, and integrating them into school programs; communicating them to children and parents; advising and supporting tutors and peer educators; and monitoring and evaluating the programs. The overall effectiveness of health education in schools can be improved not only by teaching health-related topics, but also by organizing health-related extracurricular activities such as workshops, health promotion days, weeks, camps, and parent meetings and forums.

Complementary elements of programs aimed at involving parents could probably make a major contribution to improving the effectiveness of the program. These could include feedback on the results of peer education and the gaps in children's learning, and interactive sessions in schools to inform parents. This approach is supported by other studies [23,27,48,49]. As some studies suggest that interventions in the home environment have a significant impact [27], we believe that if our peer education program had been complemented by tasks to be done with parents at home, it may have also contributed to the success of the program [46].

At the community level, schools need to deliver basic health knowledge, including fluid intake. For example, how much and what kind of fluid to drink each day to be healthy [28]. In this way, schools can help spread the desirable health literacy among the population so that school children can pass on the right knowledge to their families and apply it themselves as adults.

The improvement in knowledge of recommended daily fluid intake was not sustained in any age group. The temporary improvement is more a reflection of them remembering what they heard and not fully understanding the abstract concept of the recommended amount and its importance to their health. The pilot program did not achieve the important goal of ensuring that all students know their daily fluid intake needs and then, as a next step, meet them to maintain their health.

Except for recommended daily fluid intake, where less than one-third of primary school students answered correctly at baseline. It should be noted, however, that for two items the average response score was already close to the maximum at baseline, so there was a small room for improvement. In the item on statements about fluid intake, their average score was close to 5 on a scale of 1–5, and in the item on inadequate fluid intake, it was just under 5.5 on a scale of 1–6. In planning a future survey, it is therefore advisable to revise some of the questions.

There was a sustained improvement in knowledge of fluid intake and symptoms of inadequate fluid intake in the upper grades, but not in the lower grades. These results may also be due to the difficulty in gaining a deeper understanding of the concepts used in the questions due to a lack of basic knowledge. This is consistent with the experience finding that where there is more background knowledge, it is easier to learn new information.

We observed a steady improvement in the knowledge of estimating the daily amounts of different beverages that can be consumed in both age groups. The naming of each drink, as well as the specific quantity (glass) used, helped the students to translate the questions for themselves, to place the concepts in the questions in their everyday reality. This ease of interpretation of the task explains the effectiveness of peer education on this topic.

Our experience shows that a large amount of basic knowledge about hydration justifies extending the duration of peer education to several sessions. The need for more sessions is also recommended by other studies [30].

Based on our positive experience, we would like to see the program and measurement tools tested in other countries and cultures in the future. It should be noted, however, that the design of the program, the development of the measurement tools, the training of peer educators, and the implementation in schools require considerable resources. Taking into account the resources available, care must be taken to ensure that the program is adapted to the educational system and cultural context.

It is important to develop strategies to ensure that the knowledge and habits acquired through such programs are retained and applied by students throughout their lives. On the one hand, there is a need to increase knowledge about healthy lifestyles in the classroom, and on the other hand, out-of-school activities should be used to increase knowledge and motivation (e.g., school or class competitions). The physical and social environment outside school, such as the family or the media, also plays a role in reinforcing knowledge and habits.

In designing and developing future programs, it seems particularly important to apply the pedagogical principle of taking into account the kinds of tools, products, and concepts that the target group encounters in their everyday lives.

Identifying which educational practices and health promotion interventions, including peer education programs, are most appropriate to improve hydration knowledge among school children could be very useful to the international professional community.

Each study has its limitations, of course, but as with other nutrition education interventions [27,30,46,47], the experience of our program offers scope for further fine-tuning to improve effectiveness in both age groups.

Due to the pilot nature of the study, the university students involved in the peer education represented only two disciplines and the study covered only two schools in the capital, so the generalizability of the results may be limited. A sample of schools covering different types of settlements is justified by the results showing significant differences between the diets of urban and rural school-children [50]. A geographically and socioeconomically diverse sample would also be warranted because classroom peer effects were found to be heterogeneous across subgroups [51].

Although the number of children who participated in the peer education and the immediately following survey was high, the third survey, conducted 15 weeks later, was able to collect responses from relatively few students.

The effectiveness of the "peer effect" may have been dampened by the large age difference between the children and the peer educators – a factor that may have been even more influential in the results for lower primary school children – and by the presence of university lecturers and occasionally the school teachers observing the peer educators in the program lessons.

Unfortunately, although school teachers and health staff play an important role in shaping students' knowledge about fluid consumption, our research could not assess their knowledge and attitudes or that of their parents.

At this stage of our research, the behavioral aspect of fluid consumption was only measured at baseline, but in future larger and controlled studies, it will need to be measured at all study time points. Furthermore, it would be important to investigate how students' knowledge and attitudes regarding this topic affect their drinking habits. This will allow a better evaluation of the effectiveness of the peer education program.

5. Conclusions

To the best of our knowledge, this is the first time that a peer education program to improve hydration knowledge among primary school children has been piloted and evaluated. It should be emphasized that the development of peer-led hydration education can be an effective element in reducing childhood obesity, and can also be used to prevent other major public health problems.

It seems that an optional university course provides an appropriate framework for training peer educators. As an alternative to a traditional role for university students, this could be a very effective form of knowledge transfer and experience that would appeal to students at any university.

Since many diseases and health problems among school children can be prevented by drinking the right drinks in the right quantities, it is appropriate to use as many different approaches as possible to increase children's knowledge about fluid consumption. Therefore, as suggested by our results, peer education, which is widely used in other settings, should be introduced as a new tool in school health promotion.

Data availability

Question: Has data associated with your study been deposited into a publicly available repository?
Answer: No.
Question: Has data associated with your study been deposited into a publicly available repository?
Answer: The authors do not have permission to share data.

CRediT authorship contribution statement

Zs Soósné Kiss: Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **J. Vitrai:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **J. Takács:** Writing – review & editing, Writing – original draft, Supervision. **J.Á. Lukács:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Writing – review & editing, Writing – original draft, Supervision. **A. Falus:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Falus, A. reports financial support was provided by the Hungarian Academy of Sciences. Feith, H.J. reports financial support was provided by the Hungarian Academy of Sciences. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e26769.

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