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Board game-based education on helminthiasis knowledge of elementary school students: An effectiveness study

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Original Article

ABSTRACT

Background: School-aged children are particularly vulnerable to soil-transmitted helminths (STH) infections due to frequent exposure to contaminated soil during play and poor personal hygiene practices. Although games have been widely used as educational tools in health promotion, there is limited research on the effectiveness of board games specifically designed to prevent STH infections in children.
Objective: This study aimed to evaluate the effectiveness of a board game-based educational intervention in enhancing knowledge of STH among elementary school students.
Methods: Analytical experimental design using a pre-test and post-test intervention approach without a control group was employed. The subjects of this study were elementary school students in grades 3 to 6 who met specific criteria. A total of 94 students participated. Knowledge was assessed using questionnaires. The intervention involved small-group sessions (4–6 students per group) using a custom-designed educational board game about STH. The collected data were analyzed using a dependent t-test, while multivariate ordinal regression was employed for multivariate analysis.
Results: The average test score improved from 0.60 (± 0.15) to 0.74 (± 0.14) post-intervention, representing a significant 14% increase in knowledge (p = 0.00). Age was not a significant predictor of post-test performance (β = 0.310; p = 0.429). Male students (β = 1.068; p = 0.013) and those in grade 4 (β = 2.031; p = 0.036; OR = 7.62, 95% CI: 1.15–50.56) were significantly more likely to achieve higher post-test scores.
Conclusion: Board game-based education effectively improved knowledge about soil-transmitted helminth infection among elementary school students. This study offers novel evidence supporting the use of board games for helminthiasis prevention.

INTRODUCTION

Soil-transmitted helminths (STH) infection is an infection of the human intestine caused by several parasitic worms transmitted through the soil. The worms consist of *Ascaris lumbricoides, Trichuris trichiura*, *Strongyloides stercoralis*, and Hookworms *(Necator americanus and Ancylostoma duodenale).*[1] According to the World Health Organization (WHO), STH infections are the most common infections worldwide, affecting 1.5 billion people or 24% of the global population, across all age groups in 204 countries and territories from 1990 to 2021.[2] The prevalence of STH infections is influenced by several factors affecting the life cycle of the worms,

including inadequate environmental sanitation, poor personal hygiene, and socio-economic demographic conditions of surrounding areas.[1] Tropical countries, characterized by warm and moist climates, are primary regions where STH is found. However, STH is considered one of the neglected tropical disease (NTD).[3]

According to the Ministry of Health of the Republic of Indonesia, STH infection in several provinces of Indonesia is approximately 30% to 90% and mostly occurs in children aged 1 to 12 years old.[4] In Indonesia, the prevalence of STH infection ranges from 2.5% to 62%, mainly affecting socially disadvantaged groups with poor sanitation.[5] Helminthiasis cases caused by STH infections are known to have a higher incidence in school-aged children than in preschoolers. Current data show that more than 260 million preschool children worldwide are infected with worms, with the largest group being school-aged children, of whom 654 million are infected.[6,7]

School-aged children are more susceptible to contracting STH. This increased risk may stem from greater exposure to contaminated soil during activities such as playing, walking barefoot, ingesting soil, and a lack of proper personal hygiene practices.[8] Severe STH infections have been associated with a high incidence of morbidity as well as malnutrition, anemia, and disruptions in the physical and cognitive development of children. To date, the control of STH infections has primarily focused on administering large-scale anthelmintic drugs, such as albendazole and mebendazole, to school-aged children. However, these drugs have proven ineffective against *Strongyloides stercoralis* infection. Therefore, preventive actions are also necessary to reduce several risk factors that contribute to worm infections in children through appropriate educational media.[9]

Health education media are tools that support the dissemination of health messages to the community. One effective method in health promotion is the use of games, which enhance attention, support learning, and help children understand the future consequences of their actions. Board games, in particular, involve moving pieces on a patterned board according to specific rules and structures.[10] The primary advantages of board games include improved communication and active learning facilitated by players' engagement. Participation in a board game involves manipulating game pieces on designated boards following specific patterns. Nonverbal interactions often occur during board games, fostering a sense of connection and encouraging individuals to engage in enjoyable activities with others. These aspects can contribute to the reinforcement of social networks and offer protective effects against cognitive decline.[11]

A review of 11 studies that employed board games to enhance knowledge indicated that board games, as an educational tool, can improve knowledge comprehension, foster interpersonal interactions among participants, and boost motivation. Several studies have utilized board games for health education, including a study by Chiang et al. on food and nutrition education[12], a study by Wulanyani et al. on taeniasis[13], and a study by Dorcas B. Bassey et al. on helminth infections.[14] Furthermore, board games have been shown to facilitate learning by enhancing both participant motivation and social interactions.[15]

Monopoly is a game designed for two to five players. It was selected for its six key advantages: it is enjoyable and engaging, promotes active participation in learning, offers immediate feedback, and enables the application of concepts and social roles in real-life situations.[16] A study conducted by Khastini et al. on the development of the Monopoly board game as a learning medium for the digestive system demonstrated that It can be effectively used in the learning process.[17] Another research conducted by Maramis et al. utilized the Monopoly board game as a medium to enhance elementary school students' knowledge of oral health, showing an improvement in knowledge outcomes following the intervention.[18] Therefore, this study introduces different educational material on personal hygiene and the Worm Monopoly game setup. This study assessed changes in knowledge levels before and after the board game intervention to evaluate the effectiveness of board games as a medium for STH infection education.

METHODS

Study Design and Population

This study employed an analytical experimental design using a pre-test and post-test intervention approach without a control group. The study was conducted at SD IT Al Marhamah, Kampung Dalam, Padang Pariaman Regency. The target population consisted of all students in grades 3to 6 of the elementary school. The sample was a subset of this population, selected based on the following inclusion criteria: Indonesian citizenship (verified by an identity card), and currently enrolled as a grade 3 to 6 student (verified by a student ID card or other form of identification). The exclusion criteria included inability to understand or use the Indonesian language; not residing in the sampling area; inability to speak (mute), hear (deaf), see (blind), or read (illiterate); having a mental disorder; being uncooperative during the study; or having previously received comprehensive education on STH infections. The sample was determined using the total sampling method. The study involved educating students regarding STH infection through board game media designed with monopoly game rules. A total of 94 students participated in this study. The students were divided into several groups, each consisting of 4 to 6 students.

Assessment

In this study, we first collected demographic data (age, sex, class) and asked whether the participants had ever received information about worm infections and their sources. This research employed a questionnaire to assess levels of knowledge, attitudes, and behaviors regarding worm infections. The questionnaire used in this study was adapted with permission from the research conducted by Alyssa in 2018.[19] The questionnaire was tested for validity on 38 elementary school students. It consisted of several items grouped into two sets of questions: the first set included general and demographic data, while the second set contained questions to assess students' knowledge levels about worm infections. After the pre-test, education was conducted using a board game as a medium, and participants' knowledge levels were reassessed through a post-test. The pre-test and post-test results were transformed into percentages ranging from 0 to 100%, which were then categorized into three groups: 76-100% for the good category, 60-75% for the fair category, and less than 60% for the poor category.[20] The collected data were analyzed using a dependent t-test. Multivariate analysis employing ordinal regression was used to explore the association between gender, age, and grade with post-test outcomes.

Development of the Board Game

The worm infection board game was designed based on the basic rules of the Monopoly game. The board consists of several complexes and specific places related to health and worm infections. The game components include a game board, two dice, 50 green-colored houses, 15 chance cards containing challenges and rewards, 13 public fund cards with questions about worm infection events, property ownership cards for each property, and play money as the purchasing tool in the game (Figure 1).

The board game was used as an instrument to convey messages and information about personal hygiene and worm infections. The media contain linguistic messages in the form of text and graphic elements, such as pictures, charts, graphs, diagrams, and maps. Visual standards, including illustrations, colors, typography, and layout, were formulated as references for each designed item, providing information about worm infections caused by STH. The original version was developed in Bahasa Indonesia.

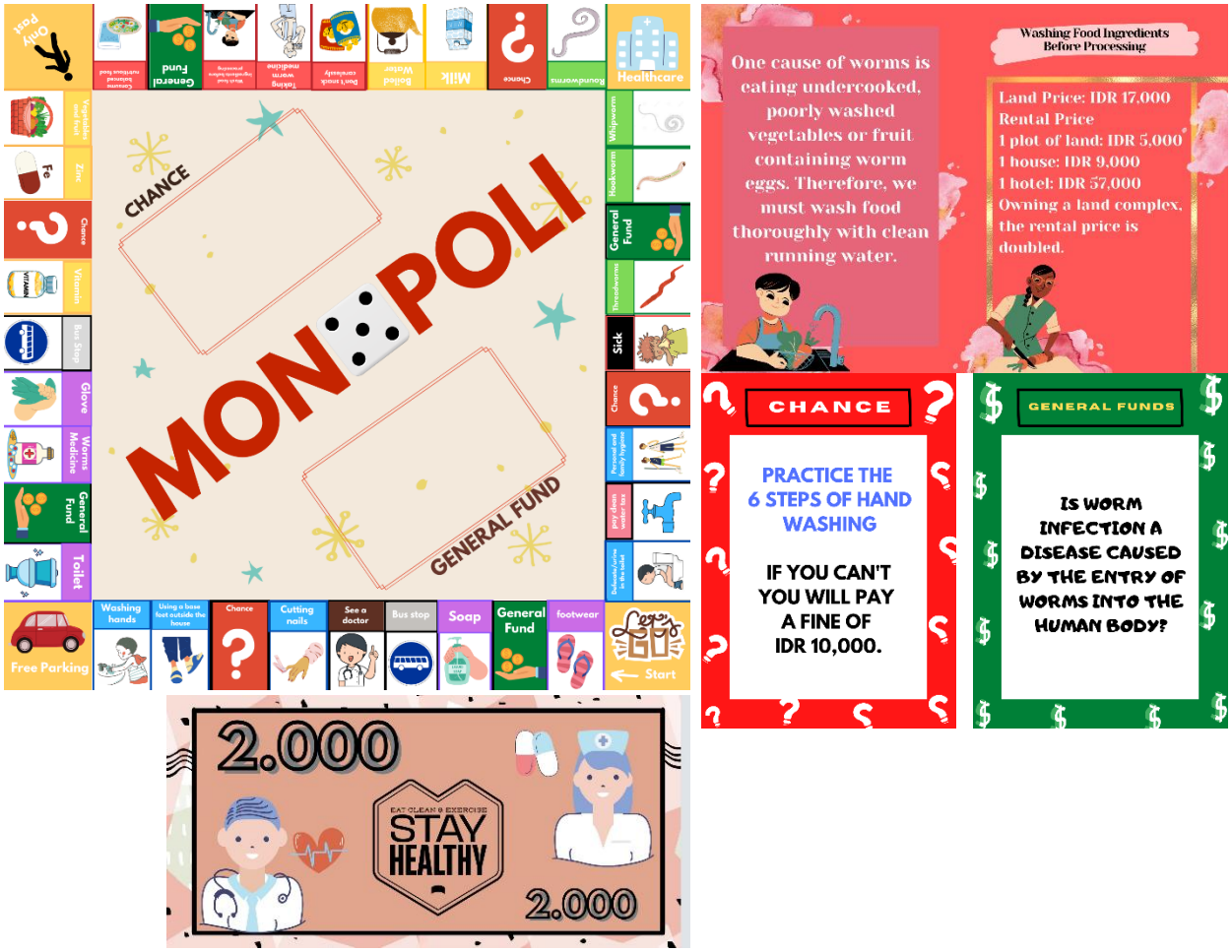

Figure. 1 Design of the board game-based education on helminthiasis

Implementation of the Board Game

The game session lasted approximately 30 minutes and was completed in a single sitting. The researchers ensured that the duration was sufficient for all player groups to read each question and receive the corresponding correct answer. Before starting the game, the moderator shuffled the public fund and chance cards and placed them face down in the designated area. Each player was given play money equivalent to 200,000 Rupiah at the beginning of the game. All property ownership cards, and the remaining money were held by the moderator, who acted as the banker. Each player had the opportunity to roll dice at the beginning of the game, and the player with the highest cumulative score moved first. When a player landed on an unoccupied area, they had the right to purchase that area. However, if a player landed on an area owned by another player, they had to pay rent for that area according to the rules. Players could also land on specific places, such as public fund and chance areas, as well as jail or hospital.

The game was considered over when a player had accumulated the most properties and money after a certain period, or when a specific condition was met, such as reaching a certain number of rounds. At the end of the game, the player with the most properties and money was declared the winner. Throughout the game, participants developed strategies to accumulate as many properties as possible, manage their finances, and interact with other players. The moderator was responsible for facilitating the game, guiding the players, and managing financial transactions, including property purchases, sales, as well as handling of public funds and chance cards.

Knowledge-related elements were incorporated in the public fund and chance cards, which players received upon landing on the respective spaces. These cards contained several items,

each presenting questions or information that the player had to answer, thereby stimulating the player's critical thinking skills. In addition to knowledge, aspects related to attitudes and habits were embedded in the property cards, which players received upon purchasing properties. These property cards provided information about attitudes and behaviors related to parasitic infections.

Statistical methods

The data obtained from the pre- and post-tests were initially entered into Microsoft Excel and then analyzed descriptively using SPSS (version 15.0). Subsequently, a paired t-test was conducted to compare students' knowledge levels before and after the intervention using the board game as a medium. The significance level was set at $p < 0.05$. In this study, multivariate analysis using ordinal regression was employed to explore the association between gender, age, and grade with post-test outcomes. The results are presented in a table containing the estimates, standard errors, Wald statistics, p-values, and oods ratios (OR) with 95% confidence intervals (CI).

Ethical statement

This research was approved by the Ethics Commission of the Faculty of Medicine, Universitas Andalas (approval number: 71/UN.16.2/KEP-FK/2023). Research data collection was conducted after obtaining permission from Al Marhamah Islamic Elementary School and approval from the research subjects. Participant involvement was carried out after obtaining consent from the school and the students' parents. Willingness to sign an informed consent form was required as a condition for participation in the interview process, and the ability to participate from the beginning to the end of the study was required as a form of consent to participate.

RESULTS

Table 1 shows that the research subjects were aged 8 to 12 years. Based on the age distribution, the majority of respondents were 10 years old, while the fewest were 12 years old. In terms of gender, most respondents were female. Regarding grade level, the highest number of respondents were in grade 3, while the fewest were in grade 6. This table also indicates an increase in knowledge after the intervention across all variables, as evidenced by the changes and percentages in knowledge levels.

Table 1. Knowledge levels in the pre-test and post-test among students based on their characteristics

Variable	N	%	% Level of Knowledge				Improvement (%)
			Pre-test		Post-test		
			Mean±SD	Category	Mean±SD	Category	
Age							
8	9	9.6	71±19	fair	75±9	fair	4
9	28	29.8	61±18	fair	78±14	good	17
10	33	35.1	58±14	poor	69±15	fair	11
11	22	23.4	60±12	fair	76±13	good	16
12	2	2.1	50±7	poor	52±12	poor	2
Gender							
Male	39	41	60±14	fair	70±14	fair	10
Female	55	59	61±16	fair	76±15	good	15
Grade							
3rd	29	30.9	67±17	fair	78±14	good	11
4th	26	27.7	54±13	poor	69±14	fair	15
5th	28	29.8	59±13	poor	72±15	fair	13
6th	11	11.7	62±10	fair	77±12	good	15

Based on univariate analysis, the average percentage of correct answers in the pre-test was 0.60 (± 0.15), and the average percentage of correct answers in the post-test was 0.74 (±

0.14). The mean pre- and post-test scores were then compared using a paired t-test, which yielded statistically significant results with a p-value of 0.00. The most substantial improvement in knowledge was observed among students aged 9 years, while the least improvement occurred in those aged 12 years.

Table 3. Association between gender, age and grade with post-test outcomes

Variable	Estimate	SE	Wald	p-Value	OR 95% CI
Age	0.310	0.392	0.625	0.429	1.36; 95% CI 0.63 – 2.94
Gender					
Male (vs female)	1.068	0.431	6.145	*0.013	2.91; 95% CI 1.25 – 6.77
Grade					
3rd	1.281	1.187	1.164	0.281	3.60; 95% CI 0.35 – 36.89
4th	2.031	0.966	4.417	*0.036	7.62; 95% CI 1.15 – 50.56
5th	1.382	0.802	2.969	0.085	3.98; 95% CI 0.83 – 19.20

*p<0,05 = significant result

Based on Table 3, the analysis showed that male was significantly associated with higher odds of achieving a better post-test category compared to females (β = 1.068; *p* = 0.013). The odds ratio (OR) of 2.91 (95% CI: 1.25–6.77) indicates that male participants were approximately 2.9 times more likely to attain a higher post-test category than their female counterparts. In addition, students in grade 4 were also found to have a significant association with improved post-test outcomes (β = 2.031; *p* = 0.036), with an OR of 7.62 (95% CI: 1.15–50.56). This suggests that fourth-grade students had a substantially greater likelihood of achieving better post-test results compared to sixth-grade students. The data also indicate an overall improvement in knowledge across age groups following the intervention. Conversely, age (β = 0.310; *p* = 0.429), grade 3 (β = 1.281; *p* = 0.281), and grade 5 (β = 1.382; *p* = 0.085) did not demonstrate a statistically significant association with post-test outcomes. These findings suggest that gender and certain grade levels may influence post-intervention learning outcomes.

DISCUSSION

The results of the study in Table 1 show that health education intervention using board game media increased the knowledge of elementary school children at Al Marhamah Islamic Elementary School, indicating a successful improvement in knowledge of helminthiasis prevention. Overall, a 14% increase was observed (Table 2), with statistically significant results (p = 0.00). This shows that education regarding soil-transmitted helminth infections using board game media has a positive impact on increasing the level of knowledge of elementary school students. Increased knowledge will result in new behaviors focused on healthy and clean living, which is a key method to prevent the transmission of helminth infections.[21] Prevention through health education has intensified to reduce the prevalence of helminthiasis in primary school children. Health education is a community-friendly intervention that has been shown to reduce helminthiasis treatment cost.[22] The results indicate an increase in average knowledge levels from the pre-test to post-test across all characteristics of the study subjects (Table 1). Students aged 8, 9, 10, 11, and 12 years exhibited percentage increases in knowledge of 4%, 17%, 11%, 16%, and 2%, respectively. This shows a knowledge increase in each age group following the the intervention. Among the male students, an increase of 10% was observed, while female students showed a 15% increase. This shows that both males and females improved their knowledge levels after the intervention. Several studies have reported that knowledge improvement among females tends to be higher than that among males following educational interventions. For instance, Ogunsile and Ogundele found that female students achieved higher knowledge, attitude, and practice (KAP) scores than their male counterparts after receiving health education through a board game.[23] A similar finding by Feng et al., stated that girls scored higher in both the pre-test and post-test during an educational board game intervention on nutrition, although the difference was not statistically significant.[12] In terms of grade levels, knowledge increases were

also observed in Grade 3 students by 11%, Grade 4 by 15%, grade 5 by 13%, and Grade 6 by 15%.

Notably, knowledge improvement was also observed across various subgroups, such as among 9-year-old students, who showed a 17% increase (Table 1). This result in line with study conducted by Ni Made Swasti, et al., on elementary school students from grades 3 to 6, which aimed to enhance knowledge about taeniasis using a board game (snakes and ladders). The study showed an increase in knowledge from 40.3% before the game to 58.8% after the game.[13] Similarly, research conducted by Dorcas B. Bassey, et.al in six public primary schools clarify that the prevalence of STH decreased from 25.0% to 10.4% three months after the intervention using board game media in the form of Snakes and Ladders, and the prevalence further decreased to 5.6% after six months of intervention. There was a significant increase in STH control and prevention ($p < 0.05$), from 5.2% to 97.9%, in the intervention group. Additionally, the research conducted by Thaha, et al, on healthy snack education using a Snake and Ladder board game for elementary school students in Makassar, Indonesia, showed an increase in the percentage of students with a good level of knowledge, from 30.4% to 54.4%.[24] Another study by Amelia et al. on the use of board games as an educational medium for promoting dengue prevention attitudes in schoolchildren also showed a significant improvement in both fever management attitudes and dengue prevention strategies.[25]

Common problems encountered among school-aged children include poor personal hygiene and health habits, as well as developmental, behavioral, and learning difficulties. One effort to improve clean and healthy living habits is through health education, which plays a vital role in shaping healthy behaviors and preventing disease.[26] In general, factors influencing health knowledge include personal factors (such as age) and environmental factors (such as education). Omar et al. stated that the older the child, the better their health knowledge.[27] In contrast, the present study found different results. A pre- and post-test on health knowledge was conducted among elementary school students aged 8, 9, 10, 11, and 12 years. The respective increases in knowledge scores were 4%, 17%, 11%, 16%, and 2% (Table 1). The most substantial improvement was observed among 9-year-old students, while the smallest increase occurred in 12-year-olds. This suggests that the improvement in knowledge among elementary school children was not directly associated with increasing age. Furthermore, ordinal logistic regression analysis showed that age ($\beta = 0.310$; $p = 0.429$) was not significantly associated with post-test knowledge category. Although knowledge improved across all age groups after the intervention, age did not appear to influence the level of knowledge gained.

The analysis showed that male students were significantly more likely to achieve higher post-test categories compared to female students ($\beta = 1.068$; $p = 0.013$). This finding is consistent with research by Hurlock in 2013, which suggested that boys are often encouraged by their environment to take more risks and are motivated by parents and teachers to demonstrate greater originality and initiative. As a result, boys tend to exhibit more creative thinking compared to girls.[28] Similarly, Nurmasari et al. emphasized that male students fulfilled four aspects of creative thinking—fluency, flexibility, originality, and evaluation—while scoring lower on the elaboration indicator. In contrast, female students fulfilled three indicators—fluency, flexibility, and originality—but were less likely to meet the criteria for elaboration and evaluation.[29]

Based on the current data, fourth-grade elementary students demonstrated significantly better post-test outcomes compared to students in other grade levels. This pattern may be associated with a decline in student engagement in higher grades. Fredricks, Ye et al. reported that U.S. fifth-grade students begin to show a noticeable decrease in engagement with learning activities.[30] Similarly, Archambault and Dupéré in 2016 found that among Canadian elementary students, the decline in engagement starts as early as fourth grade, with engagement defined as the interaction between students and the learning context and materials.[31] Boekaerts (2016) further conceptualized engagement as a multidimensional construct involving behavioral, cognitive, and emotional interactions with the learning environment.[32] These findings suggest that children in fourth grade are at a developmental stage where engagement with instructional content remains high, potentially leading to more effective learning and better performance post-

intervention. Conversely, as students advance to fifth grade and above, overall engagement may decline, which could partially explain the lower outcomes observed in those cohorts.

There is still limited research on the use of board game media for educating about soil-transmitted helminth infections. These findings indicate that board game interventions can effectively enhance students' understanding of STH infections. Interactive educational tools, such as board games, have been shown to promote active learning, increase engagement, and improve knowledge retention among children by providing visual, tactile, and experiential learning opportunities. The use of game-based methods also encourages peer learning and repeated exposure to key messages in an enjoyable format, which may contribute to long-term behavior change and increased awareness of disease prevention strategies, including hygiene and sanitation practices essential for preventing STH.[14,33]

This suggests that children tend to learn best in interactive environments, where the use of board game medium enables them to develop emotional, physical, and interpersonal skills. Through board games , children also have the opportunity to develop their reasoning abilities, helping them to become more mature and focused, including in understanding the occurrence of infections.[13] Other studies also indicate that board games are both effective and enjoyable for delivering health and safety education to elementary school students, in contrast to conventional teaching methods that often focus only on knowledge transfer, making the learning process monotonous and reducing children's interest.[8,34]

By using a modified Monopoly game format, this research not only introduced an innovative educational approach but also provided participants with an engaging playing experience while conveying messages related to personal hygiene and worm infections prevention. However, this study had certain limitations, including a relatively small sample size, limited geographic scope, and short-term evaluation period, which may restrict the generalizability of the findings. Further investigation is recommended to explore additional factors that may contribute to post-test performance in the study population. Future studies are also recommended to include a control group and to analyze other potential factors that may affect the results.

CONCLUSION

The activities conducted provided education on soil-transmitted helminths to improve students' knowledge. Following the board game intervention, students' knowledge of soil-transmitted helminth infections increased, with measurable knowledge gain indicating that the intervention was successful in enhancing awareness and understanding. Further research is needed to assess long-term knowledge retention and to determine whether this translates into sustained behavior change. To scale up this program, collaboration with local education offices and health authorities is recommended. Integration into existing school health curricula, training for teachers, and adaptation of the board game for wider age ranges and regional contexts may support broader implementation and sustainability.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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DATA AVALABILITY

The research data can be accessed by contacting the corresponding author.

SUPPLEMENTAL DATA

No additional supplemental data are provided for this study. All relevant data supporting the findings of this research are included within the main article.

AUTHOR CONTRIBUTION

SRR, GSH, MF, MNAJ, MU, and RR designed the initial research. W, ARY, SA, NFK, and SFS revised the initial design and coordinated the implementation in the field. GSH, MF, MNAJ, and MU processed the research data. GSH, MF, MNAJ, MU, and RR drafted the manuscript, and it was revised by SRR. All authors provided feedback and final manuscript approval.

DECLARATION OF USING AI IN THE WRITING PROCESS

The authors used artificial intelligence to improve the writing of sentences.

LIST OF ABBREVIATIONS

STH: Soil-transmitted Helmiths; IBM SPSS: International Business Machines – Statistical Package for the Social Sciences; WHO: World Health Organization; NTD: Neglected Tropical Disease; ID Card: Identity Card; OR: Odds Ratio; KAP: Knowledge, Attitude, and Practice

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