

BRIEF REPORT

Enterovirus board game for elementary school children: A pilot study

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Abstract

Objective: To evaluate the effect of an enterovirus board game on improving knowledge of enterovirus for elementary school children in Taiwan.

Design: A pilot study with a one-group pretest-posttest design.

Sample: Using convenience sampling, 27 children were recruited from a single elementary school in Taiwan in June 2020.

Measurements: Demographic data were collected and the children completed an enterovirus knowledge questionnaire. Statistical analyses included descriptive statistics, McNemar test, and Wilcoxon test.

Intervention: Each experimental group of four to five children participated in a 40-min enterovirus board game.

Results: After using the board game, the children had significantly higher mean scores for enterovirus knowledge. Specifically, the children had a higher proportion of correct answers for seven questions related to enterovirus after playing the game compared to before.

Conclusions: Board games designed for elementary school-aged children can support public health education and help prevent outbreaks of infectious diseases such as enterovirus.

KEYWORDS

board game, children, enterovirus, health education, knowledge

1 | BACKGROUND

The subtropical location of Taiwan makes it a potential enterovirus (EV) hotspot every year. Young children are at high risk for EV infection with severe complications, and the reported mortality rate ranges from 1.3% to 33.3%. The most effective means of preventing EV is by increasing public awareness (Taiwan Centers for Disease Control, 2020). Conventional means of public health education include informational leaflets, posters, and films, which are often targeted at primary caregivers. However, such methods may not be effective for young children. In addition, their teachers and primary caregivers may have limited understanding of EV, which may then limit their ability to effectively explain such information (Luo & Kang, 2018). For effective

prevention of EV, public health education campaigns should specifically target young children, and innovative health education methods designed specifically for this age group are worth investigating.

Board games are an innovative and popular health education method because they have been shown to be effective in attracting the interest of young learners and increasing their knowledge, health behaviors and biological health indicators. (Gauthier et al., 2019; Wu & Su, 2019). Schools are an important channel of health education because large numbers of children can be reached efficiently and under controlled conditions. Board games appear to be a feasible tool for educating students on appropriate health habits and behaviors during a virus outbreak, and they may be more effective than conventional methods of health promotion education (Amaro et al., 2006).

However, no previous studies have discussed the use of EV board games for health education purposes during an outbreak. Therefore, in this study, we developed an EV board game and evaluated its efficacy in elementary school-aged children in Taiwan.

2 | METHODS

2.1 | Study design

This study used a one-group pre- and post-test design. The participants were students recruited by convenience sampling from a single elementary school in Taiwan. The researchers contacted the principal of the elementary school in advance of this study to inform him of the purpose of the study and to obtain permission to visit. After consenting to the study, the principal arranged for the research team to visit a class of second-grade elementary school students in June 2020.

2.2 | The game

The board game was designed to educate children about EV and treatment, as well as the recommended behaviors for preventing EV in their daily life activities. The mascot of the board game is "Soap Warrior", the nemesis of EV. Soap Warrior is green, because green is a natural color that represents the concepts of health, rejuvenation, and energy (Cherry, 2021), and if you wash your hands frequently with soap it will protect you from EV. To attract the interest of children, the words on the cover of the board game are written in Mandarin and Pinyin in a large font accompanied by vivid colorful illustrations. The contents of the game include a cloth game board, role cards, EV prevention cards, instructions, and one dice.

2.2.1 | Cloth game board: disease from the mouth

Enterovirus is the general term for a group of viruses that mainly reproduce in the intestine. The cloth game board depicts an outline of the human digestive tract (Figure 1a). Within the outline are 71 squares. Each square is labeled with one of four places where children often go in their daily life activities: home, school, park, or hospital. In addition, the squares appear in seven different colors, with each color representing a category of EV information: green squares in the "soap" category, dark blue squares in the "disinfection" category, dark gray squares in the "EV" category, brown squares in the "knowledge" category, light blue squares in the "command" category, purple squares in the "mission" category, and pink squares in the "destiny" category.

The biggest features are green soap grids, disinfection grids and EV grids, which are similar to a traditional "Snakes and Ladders" board game. If a player lands on a green "soap" square or on a dark blue "disinfection" square, the player advances 1–3 squares. If a player lands on an "EV" square, the player goes back 1–3 squares. If a player lands on an

EV knowledge, command, mission, or destiny square, the player must draw one card (knowledge, command, mission, or destiny) and answer the question on the card.

2.2.2 | Role card

At the beginning of the game, each participant must choose one of seven roles in the prevention and treatment of EV: child (boy or girl), student, teacher, family member (grandfather or grandmother, father or mother), medical staff (physician or nurse), teacher, and patient (male or female) (Figure 1b).

2.2.3 | EV prevention card

The design of the game is based on the current literature on EV-related knowledge, attitudes and behaviors according to a comprehensive literature review [1, 5]. The game includes a total of 149 cards: 80 knowledge cards, 45 command cards, 12 mission cards, and 12 destiny cards.

Knowledge cards

Soap Warrior appears on the front of each card in one of the four environments (home, school, park, and hospital). On the back of the card is an EV knowledge question (i.e., a question about definitions, symptoms, the current epidemic, prevention, treatment or policy) that must be answered in the context of the one of the four places (home, school, park, or hospital) (Figure 1c). The questions are in binary choice format (true/false) or multiple-choice format.

Command cards

The cards for the 12 roles (boy, girl, classmate, teacher, family member (grandfather, grandmother, father, mother), medical staff (doctor, nurse), male patient, and female patient) are accompanied by command cards that prompt the player to make appropriate statements for each role in order to cultivate the correct attitude about EV (Figure 1d). For example, if the role card is "family member", a player who lands on the light blue square draws a command card for "family member". The command card may then require the player to (for example), "Say, *I don't touch anyone without washing my hands*, three times".

Mission cards

Mission cards ask open-ended task-related questions that require the players to answer a question orally or to perform a task, such as, "Please answer this question. Where do you need to disinfect?" (Figure 1d).

Destiny cards

The players move forwards and backwards depending on the use of correct and incorrect behaviors to deepen the players' concept of correct and incorrect behaviors in preventing EV. For example, the card may state, "Say, *disinfect our toys regularly*", and then the player can move forward one square (Figure 1d).



FIGURE 1 (a) Cloth game board: disease from the mouth. (b). Role cards. (c). The cards of knowledge. (d). The cards of command, mission, and destiny

2.2.4 | Game instructions

With Soap Warrior as the background, the game instructions explain the rules of the game in detail, so that the players understand how to play.

2.2.5 | Game play

The game is designed for 4–5 players. The objective of the game is to be the first player to advance from the starting point (mouth) to the end (rectum). At the beginning of the game, each participant must choose one role and roll a six-sided dice. The number rolled on the dice is the number of squares the player can advance if the player answers a question correctly. Therefore, each player can advance 1–6 squares per turn. After advancing the number of squares indicated on the dice, the player must pick a card from a deck of cards. Each card contains a question that the player must answer or an action that the player must perform as described above. If the answer is correct, the player can move to that square. If the answer is incorrect, the player must return to the original square. The first player to reach the end (rectum) wins.

2.3 | Measurements

A structural questionnaire was developed based in the literature (Taiwan Centers for Disease Control., 2020a/b) and consisted of two major parts. The first part contained five questions on basic information of the participants (including gender, age and medical history), and the second part contained 15 questions on EV knowledge (Table 1). Questions 1–10 were multiple-choice, and questions 11–15 were binary (yes/no) questions. Correctly answered questions were scored 1 point, and incorrectly answered questions were scored 0 points. The total possible score ranged from 0 to 15, with a higher score indicating higher knowledge of EV. Six experts in related fields, including two pediatric physicians, a school nurse, and two pediatric professors were invited to evaluate the validity of the questionnaire and to improve the clarity, importance, and appropriateness of the items. The content validity index (CVI) was 0.96, and the KR-20 was 0.71.

2.4 | Data collection and analysis

After receiving consent from the principal to conduct the study, the research team visited the school. The researchers explained the purpose and procedure of the study to the participants. Before being enrolled in the study, each participant read and signed an informed consent form. In addition, each participant was given an informed consent form to be reviewed and signed by at least one parent or guardian. When the participant returned the signed consent form to the researcher, the participant was asked to complete a pre- and post-test questionnaire immediately before and immediately after playing one round of the game, respectively. The pre- and post-test questionnaires

each required approximately 10 min to complete. After the pre-test questionnaire, the researchers explained how to play the game. The participant then played one round of the game, which required approximately 40 min. Data were analyzed using SPSS software for Windows version 19.0. Descriptive statistics were used to describe the overall characteristics and performance of the participants. For each question, the McNemar test was used to evaluate changes in the proportion of correct answers by all students before and after playing the game. The Wilcoxon test was used to identify changes in total scores obtained by all students before and after playing the game. A p value less than .05 was considered to be statistically significant.

3 | RESULTS

3.1 | Demographic characteristics of the study subjects

Of the 27 participants, one was excluded due to incomplete data. Of the remaining participants, the mean age was 8.6 years. Nearly half (53.8%) were male, and 53.8% had a history of EV. All had received education about EV in the past. Half of the students reported that a family member had been infected with EV in the past.

3.2 | Knowledge of EV before and after the participants completed the board game intervention

The mean score for EV knowledge significantly increased from 11.19 before the board game to 14.50 after the board game ($p < .001$). Table 1 shows that, from pre-test to post-test, the proportion of correct answers significantly increased for seven questions (questions 3, 4, 6, 7, 12, 14, and 15).

4 | DISCUSSION

Although all age groups are susceptible to EV, children are particularly vulnerable and are associated with severe complications and mortality. Therefore, educating young children about EV infection knowledge and prevention behavior is essential. Elementary school students are quick to absorb new knowledge and build healthy behaviors. The learning experience at this stage has been shown to have a key influence on disease prevention behavior and health status (Davis-Temple et al., 2014). Researchers have reported that board games on preventing infectious diseases (such as dengue fever and taeniasis) had positive results in increasing the knowledge of children (Beinner et al., 2015; Wulanyania et al., 2019). By incorporating the elements of play and interaction, board games have potential as an effective teaching aid for children (Wulanyania et al., 2019). Health education for children is most effective when it is focused and simple (Amaritakomol et al., 2019). Therefore, the board game in this study focused on specific aspects of EV, such as “washing hands with soap”, “disinfection”, “human digestive

TABLE 1 School children' knowledge about EV before and after board game intervention (*n* = 26)

Questions	Correct answer	Number of participants with correct answer (%)		<i>p</i> -value
		Pre-test	Post-test	
1. Which is the time to wash your hands?	All of above	22 (84.6)	25 (96.2)	.250
2. What is the first thing I do when I get home before I eat?	Wash hands	24 (92.3)	26 (100)	.500
3. What symptoms might the baby get EV?	All of above	17 (65.4)	25 (96.2)	.008*
4. Which of the following is the best hand-washing item to prevent EV?	Soap	16 (61.5)	25 (96.2)	.012*
5. What are five steps to washing hands? (Please arrange in order)	Wet, Rub, Rinse, Hold, Dry	22 (84.6)	25 (96.2)	.375
6. What kind of behavior can't be done when getting EV?	Go to school	17 (65.4)	25 (96.2)	.021*
7. Which of the following is correct for the most prevalent month of EV?	April to September	15 (57.7)	25 (96.2)	.002*
8. What should I do first after playing the amusement equipment?	Wash hands	24 (92.3)	26 (100)	.500
9. Which is that most commonly EV type which cause severe symptoms?	EV type 68 or 71	21(80.8)	25 (96.2)	.219
10. Which of the following is the main infection route of EV?	Contact route	19(73.1)	25 (96.2)	.070
11. It should be rubbed your hands with a soap at least 20 s when you wash hands. Correct or wrong?	correct	26 (100)	26 (100)	1.00
12. Taiwan may be infected with EV throughout the year. Correct or wrong?	correct	14 (53.8)	25 (96.2)	.003*
13. Toys do not need cleaning and disinfection. Correct or wrong?	Wrong. To prevent EV, toys usually need cleaning and disinfection	24 (92.3)	26 (100)	.500
14. EV can live for more than 24 h in a normal environment. If children touch daily necessities contaminated with EV, they may be infected. Correct or wrong?	correct	14 (53.8)	26 (100)	.001*
15. When two students get EV in the class within a week, school need to suspend classes. Correct or wrong?	correct	16(61.5)	26 (100)	.039*
Overall mean score (SD) for knowledge of EV		11.19 (2.21)	14.50 (1.77)	< .001

tract", and "EV". The board game rewards and reinforces the EV knowledge of the students by allowing them to advance one square after a correct answer. The game uses the local language and incorporates illustrations (more pictures and less words) to enhance the effectiveness of health education delivery to the children. The illustrations on the cards are all hand-painted and vivid, which can attract the attention of the children.

Comparisons of test scores before and after the intervention confirmed that the students significantly increased their EV knowledge by playing the board game, which is consistent with an earlier report that an interactive educational board game improved knowledge of acute diseases (e.g., dengue fever) in elementary school students (Beinner et al., 2015). Interestingly, scores for seven of the 15 knowledge questions significantly improved from pre-test to post-test. The

content of these questionnaire items included EV characteristics, symptoms, health policy, and hand washing recommendations (i.e., frequency and duration of hand washing, hand washing materials, etc.). A possible explanation for the improvements in these scores is that the EV-related education previously received by the participants focused on symptoms of EV, whereas the board game in this study emphasized the prevention of EV during an epidemic, that is, hand washing materials and behavior, disinfection of the environment, and health policy. Understanding policy is especially important. In Taiwan, children infected by EV are required to stay at home to prevent cluster infections (Taiwan Centers for Disease Control, 2020). However, some children with EV still go to school and cause cluster infections. Moreover, the board game in this study integrated knowledge into four environmental themes of home, school, park, and hospital, places where



children often go (Taiwan Centers for Disease Control, 2020). The effectiveness of public health education for children can be increased by teaching them how health-related knowledge can be applied in their daily life activities. In addition, EV knowledge was presented on the knowledge cards as multiple-choice or “true/false” questions, and as open questions on the mission cards. This variety helped to increase the fun of the game.

According to the theory of game design, a game can promote healthy behavior changes through reward mechanisms, feedback mechanisms, provision of meaning, role play, and the formation of peers (Epstein et al., 2021). In our game, each participant is required to choose a card that depicts a character (child, student, teacher, family member, medical staff, teacher, and patient) to role play during the game. The command cards contain instructions to develop the role and tasks of each character, and cultivate the correct attitude of the player towards the prevention and treatment EV via role-play. In terms of behaviors, daily behaviors are integrated into command cards and destiny cards. The forward and backward steps of the game deepen the children's impression of what they should and should not do to fight EV, such as: Wash toys regularly, go one step forward; Don't wash your hands before eating, go two steps backward. Amaritakomol et al. demonstrated that using an interactive board game could improve self-care behavior (Amaritakomol et al., 2019). Even when children know what behaviors are recommended during an EV outbreak, direct measurement is needed to confirm their actual practice of these behaviors.

All participants in this study had previously received education in EV. This pilot study indicates that a board game may be useful as a supplementary learning aid in EV health education. The innovative design of the board game developed in this study enabled the children to learn the good hygiene habits needed to prevent an infectious disease such as EV at an early age.

A limitation of this study is that the board game was only tested in a population of children 8 years of age. Interactive board games may be applicable for providing health education in broader populations such as family members in all generations. In addition, this board game involved knowledge, attitudes and behaviors. Other game studies have also reported improvements in behaviors and health indicators (Amaritakomol et al., 2019; Gauthier et al., 2019). However, this study only focused on knowledge outcomes after playing the game. Additional longitudinal studies are needed to confirm the results obtained in this study and to evaluate the potential use of a board game in children in other countries.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author [MFC] upon reasonable request.

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