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ORIGINAL ARTICLE

THE USE OF A BOARD GAME IN DENGUE HEALTH EDUCATION IN A PUBLIC SCHOOL

O USO DE JOGO DE TABULEIRO NA EDUCAÇÃO EM SAÚDE SOBRE DENGUE EM ESCOLA PÚBLICA

EL USO DE JUEGO DE MESA EN LA EDUCACIÓN SANITARIA DEL DENGUE EN ESCUELA PUBLICA

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ABSTRACT

Objective: to evaluate the efficacy of a board game about dengue played by young children in elementary schools in southeastern Brazil. ***Methods:*** schoolchildren were randomly assigned to participate in a board game group (BGG) or control group (CG). A questionnaire was designed to assess knowledge and attitudes about dengue fever and applied to both the BGG and CG groups before and after post-intervention. The research was approved by the Research Ethics Committee of UFMG by the CAAE nº 0106.0.203,00009. ***Results:*** the BGG demonstrated changes in attitudes ($p<0.05$) across all questions except one. The BGG showed increased knowledge about dengue as indicated by correct responses compared to the CG in 12 out of eighteen selected test questions. ***Conclusion:*** Educational tools such as a board game can be specifically designed to improve knowledge and attitudes about dengue in different classroom settings. ***Descriptors:*** Games, Experimental; Debriefing; Dengue Fever; Knowledge; Schoolchildren.

RESUMO

***Objetivo*:** avaliar a eficácia de um jogo de tabuleiro sobre a dengue jogado por crianças em escolas públicas. ***Método*:** escolares de duas escolas foram randomizados, aleatoriamente, para participar do grupo do jogo de tabuleiro (GJT) ou do grupo controle (GC). Um questionário foi construído para avaliar os conhecimentos e atitudes sobre a dengue e aplicado tanto ao GJT quanto ao GC antes e póx-intervenção. O projeto de pesquisa foi aprovado pelo Comitê de Ética em Pesquisa da UFMG, CAAE nº 0106.0.203,00009. ***Resultados*:** o GJT demonstrou mudanças de atitudes ($p <0,05$) em todas as questões, exceto uma. O GJT mostrou maior conhecimento sobre a dengue, como indicado pela proporção de respostas corretas em relação ao GC, em 12 das 18 perguntas. ***Conclusão*:** ferramentas educacionais, como um jogo de tabuleiro, podem ser projetadas especificamente para melhorar o conhecimento e as atitudes sobre a dengue em diferentes contextos em escolares. ***Descritores*:** Jogo Experimentais; Questionário; Dengue; Conhecimento; Escolares.

RESUMEN

Objetivo*:** evaluar la eficacia de un juego de mesa sobre el dengue que desempeñan los niños en las escuelas primarias. ***Método*:** los estudiantes fueron asignados aleatoriamente a participar en el juego de mesa (JM) o grupo control (GC). Se construyó un cuestionario para evaluar los conocimientos y actitudes sobre el dengue y aplicado tanto a JM en el GC antes y después de la intervención. La investigación fue aprobada por el Comité de Ética en Investigación de la UFMG con el CAAE nº 0106.0.203,000-09. ***Resultados*:** el JM demostró cambios en las actitudes ($p < 0,05$) en todas las cuestiones excepto uno. El JM mostró un mayor conocimiento sobre el dengue, según lo indicado por las respuestas correctas en comparación con el GC en 12 de las dieciocho preguntas. ***Conclusión: las herramientas educativas tales como un juego de mesa pueden ser diseñadas específicamente para mejorar los conocimientos y actitudes sobre el dengue en los diferentes contextos de aula. ***Descriptores*:** Juego de Mesa; de Concursos; El Dengue; El Conocimiento; Estudiantes.

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INTRODUCTION

Dengue is the most important arboviral disease affecting mainly the tropical countries. The World Health Organization estimates that three billion people live in areas at risk of dengue worldwide.[1] It is estimated that each year 50 million people are infected, with 500,000 cases of Dengue Hemorrhagic Fever (DHF) and 21,000 deaths, mainly in children.[1] It is an RNA Arbovirus virus pertaining to the genus Flavivirus of the family Flaviviridae. Currently, there are four known serotypes: DENV 1, DENV 2, DENV 3 and DENV 4.[2] Dengue is an acute febrile illness, which can present itself in humans as either benign or as a serious life-threatening condition, depending on the stage of infection: asymptomatic infection, classic dengue (DC), dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS). Currently, dengue is the most important arboviral disease affecting humans, constituting a serious public health problem worldwide.[2] It occurs and spreads especially in tropical countries, where environmental conditions favor the development and the proliferation of *Aedes aegypti*, the principal mosquito vector.[3]

In-school dengue prevention programs targeting knowledge, attitudes and practices are a challenge. However, a school environment is appropriate for the development of prevention programs, because of captive populations divided by age and teaching levels that permit testing sophisticated and age-specific programs.[4] Presence of a collaborative teacher staying with the same children all year favors maintenance of initial sensitization, information, and motivation and induces continuous participation in the reduction of larval habitats in homes. This is very important because sporadic, inconsistent exposure to new information will not change behavior.[4]

Dynamic, fun games have successfully transmitted knowledge and changed attitudes of adolescents and children in school settings with respect to a range of health issues including dengue.[5-6] A game becomes a learning tool when competitive elements stimulate a child's interest in mastering it. Games, whether they are printed forms or produced as videos, also link information with fun and pleasure.[7] Video games are a recent innovative tool for changing children's behavior.[8]

A prime example of the use of video games is Moore et al. [9] study which examined whether a video game was an effective health education tool as a nutrition education program on children's nutrition knowledge, self-care practices, activity levels and nutrition status. Using a pretest-posttest, quasi-experimental design, 126 fourth- and fifth-grade students from experimental and control schools were compared. The intervention program incorporated an online component www.MyPyramid.gov, Orem's Self-Care Deficit Nursing Theory, and consisted of six classes taught over a 3-month period.[10] Results indicated that the program increased nutrition knowledge in the control group. Furthermore, it increased activity time from pretest to posttest and decreased systolic blood pressure for children in both groups. The findings indicate that Color My Pyramid video game can be successfully employed in school settings and thus support school nursing practices.

These are relatively high technology examples. However, as we point out below, board games, when challenging at the child's grade level, fun to play and played on a continuous basis, can accomplish the same results with a serious health issue like dengue fever at much lower cost. It should also be noted here that all classroom-initiated educational games possess another advantage in that in-class group dynamics based on game playing strategies improve school--community interaction when schoolchildren transmit knowledge to parents, relatives, neighbors and friends.[11] This is especially true when the game is also played in the home.[12]

Board game strategies, when properly implemented, have been shown to be a recommended strategy to effectively teach health behaviors about preventing diseases like dengue fever.[6] An example is a study of Venezuelan children aged 8 to 16 years.[5] In nine schools, children played a board game and received a lecture about dengue theory and control. One set of control groups received dengue theory lectures while another set of control groups received only standard dengue information. The experimental board game/lecture groups recorded the biggest increase in knowledge about preventing dengue fever. The authors concluded that their board games can effectively increase dengue knowledge as well as coping skills and change attitudes when used with in-class educational material. The object of our work was to evaluate the effectiveness of a board game about dengue played by young children in elementary schools situated in neighborhoods where dengue is highly endemic.

METHOD

This was an experimentally, randomized study conducted in 2012 in two urban community school districts in Belo Horizonte, in the State of Minas Gerais, Brazil, both of which are endemic areas for dengue. The two districts have irregular construction of homes and small, family commercial businesses. The populations and numbers of elementary schools in Providencia and Heliopolis are 10,657 and 11,326, and 2 and 2, respectively. One public administered elementary school was randomly selected from each district based on their high numbers of *Aedes aegypti* larvae reported in these areas by city health officers, according to larva counts in resident's homes and abandoned lots.[13] Thus, the two selected schools were: CAC in Providencia and HRM in Heliopolis.

Prior to the study, there was no implementation of a program to prevent dengue in these communities. The climate of this region is tropical with temperatures ranging from 21ºC to 35ºC year round, the rainy season between October and March. Larva counts in October, 2011 were 1.0 and 4.4 per each 100 residences in Providencia and Heliopolis, respectively. These results are considered moderate to high (alert) according to the Rapid Larva Index Assay (LIRA) surveillance criteria.[13] Moderate numbers of *A. aegypti* are responsible for the following numbers of reported cases of dengue in the two districts: 352 and 295 confirmed cases in Providencia and Heliopolis in 2011, respectively, with one death reported due to dengue fever related complications.[13]

Study subjects were between the ages of 10 to 13 years, enrolled in the fifth grade at CAC and HRM and had not received educational information on control and prevention of dengue fever in school or from the media. This age group was selected because educational and board games are appropriate for their cognitive level.[14] The CAC was randomized to a board game group (BGG) and eligible students participated in a game activity described below; HRM became a control group (CG), and students there received standard Brazilian government dengue fever information. This includes brochures and flyers on the importance of dengue fever control and prevention in the community and home. No other information was presented.

Seventy-five schoolchildren in three class rooms played the dengue board game (BGG): 59 schoolchildren in two classes received the standard informational package (CG). The three game playing classes were randomly selected from six available classes in the BGG school. In the HRM school, two CG classes were randomly selected from five to receive standard dengue prevention information. The minimum sample size was determined from the maximum estimation error from a range of 95% confidence interval for the difference between the proportion of correct answers after exposures to the game in the BGG classes and the standard package in the CG classes. Due to the number of game participants (a maximum of six per board game), the sample size of the BGG was in multiples of six. The proportions of correct answers in a pilot test at a different, but similar school with respect to similar social economic characteristics resulted in 40% and 20% correct responses in the BGG and CG groups, respectively. Thus, a minimum sample of 60 students in each group would provide an error estimation of the difference between these proportions of a maximum of 16%. This allowed for detection of differences equal to or greater than the amount mentioned.

The educational intervention consisted of the application of the board game developed by our research group to children in an elementary school. The game "Everyone against Dengue" was the result of a needs assessment to meet the increasing demands for a better means to educate youngsters about the dengue epidemic. A list of questions about knowledge and practice was drafted. Each question was classified according to level of difficulty (easy to moderate and difficult). The questions were tested to see if they transmitted information to the schoolchildren building on knowledge or practices about control and prevention of dengue.

The game consists of a board, six pawn pieces, one six-sided dice, a set of 34 green game cards with easy to moderate level questions, a second set of 25 yellow game cards with moderate to difficult level questions, a dengue glossary card, and a small "Rules and Instructions" pamphlet. The game was developed to be played by small groups (3-6 participants) of students in schools and in health care settings. A facilitator is always present. The BGG played the game in class during two 50-minute sessions.

To evaluate the learning process in both groups, a structured questionnaire (Table 1) designed to assess attitudes toward and perceptions (6 questions) and knowledge of dengue fever (30 questions) was answered by students. There were a combination of true or false, multiple choice, and subjective questions. For clarity, the questions were

divided into three categories: 1) evaluating attitudes and perceptions concerning dengue fever; 2) evaluating knowledge concerning dengue fever; and for the BGG, 3) evaluation of the board game (4 questions apart from the 36 questions listed on the post-test questionnaire). Prior to the study we conducted pilot test which allowed for minor modifications in the wording and terminology of the questionnaire and game cards.

To evaluate the statistical significance of differences of the impact of treatments (BGG and CG) before and after the interventions, McNemar's chi-square test for dependent samples was used.[15-16] Significance level was 5%. A positive and negative impact ratio was used to compare the two effects. If the ratio impacts on a question were greater than 1, the positive impact of treatment on a question was greater than the negative impact. Data were analyzed using the statistical computing environment R. [16] To assess differences in proportions of correct answers by BGG and CG, and by gender after intervention, we used the X^2-test. [16] For tests with p-values < 0.05, change in proportions was considered statistically significant. The magnitude of differences between groups, when considered statistically significant, was done using the odds ratio of success.

RESULTS

As indicated, 75 schoolchildren from three class rooms played the dengue educational board game (BGG). All 75 subjects responded to the questionnaire before playing the board game and after seven days. Fifty-nine schoolchildren of the same age distribution formed the CG and responded to the same questionnaire before they received and discussed, with their teacher, the government's dengue brochures and leaflets and after seven days. Average age and standard deviation (± SD) of the BGG and CG was 11.6 ± 0.64 and 11.5 ± 0.54 years, respectively. There were 37 (50%) females in the BGG and 25 (40.7%) females in the GC.

♦ Attitudes and perceptions

The children's attitudes towards and perceptions of dengue are shown in Table 1.

Table 1. Open-ended questionnaire of attitude and perception responses from schoolchildren before and after in the board game group (BGG) and control group (CG).[1]

Questions[2]	Board game group			Control group		
	Before	After	p*	Before	After	p*
What do you think or feel when you hear the word dengue? No response.	14(19.4)	17(23.6)	.250	12(20)	27(45)	.001
What do you think or feel when you hear the word dengue? Feel bad; sorry; terrible.	30(41.7)	7(9.7)	.001	32(53.3)	30(50)	.500
Do you consider dengue to be a grave disease? Damages health; a threat to one's life.	61(80.3)	74(97.4)	.001	49(81.7)	46(76.7)	.250
Do you consider dengue to be a grave disease? People infected with dengue can transmit it to others.	7(9.2)	1(1.3)	.031	2(2.3)	2(2.3)	†
What can you do to stop dengue? Avoid accumulation of water; prevent the accumulation of water in tires, cans and other objects.	27(35.5)	35(46.1)	.008	21(35)	27(45)	.031
What can you do to stop dengue? Treat and store potable water; maintain roof-top water tanks clean and covered; chlorinate water.	70(92.1)	64(84.2)	.031	49(81.7)	47(78.3)	.500
Who takes care of your home so that mosquitoes do not reproduce there? Mother/Father.	42(55.3)	23(30.3)	.001	21(35)	22(36.7)	1.00
Who takes care of your home so that mosquitoes do not reproduce there? Other family members.	15(19.7)	32(42.1)	.001	4(6.7)	3(5)	1.00
Who takes care of your home so that mosquitoes do not reproduce there? All family members.	27(35.5)	35(46.1)	.008	24(40)	22(36.7)	.500

*McNemar's chi-square test for dependent samples ($p<0.05$).
[1]Responses are number of schoolchildren and their percentages in parenthesis.
[2]Responses to the questions were cited as the most common among respondents.
†Sample size too small to calculate p.

The board post-test game group demonstrated significant increases ($p<0.05$) in correct answers across all questions except the question "What do you think or feel when

you hear the word dengue?" Students assigned to the CG demonstrated significant increases in correct answers to only two of six questions before and after an interval of seven days post-test. There was a small but significant increase (p = 0.03) in correct responses by the CG after the intervention (21 and 27 students pre- and post-test, respectively) to the question "What can you do to stop dengue?" The question "Who takes care of your home so that mosquitoes do not reproduce there?" was responded to correctly (members of the family) by only three students. There was a significant decrease in the response "mother/father" from 42 (55.5%) pre-test to 23 (30.3%) after intervention (p = 0.001) by the BBG. The responses "Other family members" and "All family members", to the same question, showed significant post-test increases by BGG participants. There were no significant differences between groups regarding questions Q10 and Q11 (not shown in table). In Q10 "If you see accumulated water in your area and it represents a breeding ground for dengue fever, what should you do?", more than 90% of the responses to the question before/after, in both groups, were correct ("I must report dengue fever breeding grounds to my local department of Zoonosis"). On question Q11 "Who is responsible to help control dengue fever?" both groups proportionally gave the correct answer ("It is everyone's responsibility to control dengue fever").

♦ Knowledge about Dengue

To conserve space, we present responses to 18 of 40 knowledge questions that showed significant group differences. Reponses to other questions were either not significantly different or both groups demonstrated a high level of correct knowledge before and after interventions.

We examined the BGG and CG groups' knowledge of dengue fever, through multiple choice questions. Results in Table 2 show the BGG group gained more knowledge.

Table 2. Post study proportion of correct answer responses to knowledge related questions by the board game group (BGG) and control group (CG) schoolchildren.

Questão	GJT (C/I)[3]	Total[1]	GC[2] (C/I)[3]	OR*	p**
Q12. Who needs to protect against dengue?	18/5	23	30/29	3.4	0.04
Q16. Which sex mosquito bites and feeds on blood: male or female?	44/3	47	31/28	13.2	0.00
Q18.1. In addition to dengue, *Aedes* can transmit which other disease?	32/22	54	42/17	0.6	0.24
Q18.3. Is it common to find *Aedes* in dark and humid places?	39/19	58	29/30	2.1	0.06
Q20. When does *Aedes* typically feed on blood?	50/8	58	34/25	4.6	0.00
Q22. Dengue is a disease caused by:	51/5	56	40/19	4.8	0.01
Q23. Where does the mosquito *Aedes* deposits its eggs?	44/0	44	50/9	†	0.01
Q25. Which period of the year does the number of dengue cases increase?	26/16	42	29/30	1.6	0.32
Q27. How long can the eggs deposited by *Aedes* survive without water?	35/12	47	32/27	2.5	0.05
Q32. Can a pregnant woman transmit dengue to her child?	46/16	62	25/34	3.9	0.00
Q33. How many times can a person become infected with dengue?	34/11	45	24/35	4.5	0.00
Q34. Associate the signs and symptoms according to the type of dengue fever.	18/9	27	19/40	4.2	0.01
Q38. In which phase is dengue infectious?	23/24	47	23/36	1.5	0.41
Q41.1. Is there a vaccine available against dengue?	27/24	51	11/48	4.9	0.00
Q41.3. Only dengue hemorrhagic fever can cause death?	42/14	56	35/24	2.1	0.11
Q41.4. True or false: there exists medication to treat signs and symptoms of dengue, but not cure it.	42/15	57	32/27	2.4	0.05
Q42. The Department of Health Zoonoses Control professionals will visit an area only when there is a suspected outbreak of dengue?	31/10	41	29/30	3.2	0.01
Q46. Which regions of Brazil is dengue prevalent?	40/11	51	30/29	4.6	0.01

[1]Absolute number of responses by schoolchildren reflects total number of groups that explored game cards. Not all the groups (BGG) were exposed to all of the game cards during play.
[2]N = 59 for CG.
[3]C/I: Correct/Incorrect.
*Odds ratio (BGG/CG).
**Significant at p<0.05, McNemar's chi-square.
†Could not be calculated.

This is indicated by comparing absolute correct responses to incorrect responses with the CG group in twelve of eighteen selected test questions. Absolute differences in responses (C/I) between the BGG and CG groups were not significant with respect to questions 18.1 "In addition to dengue, *Aedes* can transmit which other disease?"; Q25 "Which period of the year does the number of dengue cases increase?"; Q38 "Which phase can dengue become infectious?" and; Q41.3 "Only dengue hemorrhagic fever can cause death?" The BGG did better in responding to question Q16 "Which sex mosquito bites and feeds on blood: male or female?" compared to the CG (p = 0.00; OR 13.2). The BGG also

responded with a higher proportion of significantly correct/incorrect responses to questions Q22, 23, 34 and 42.

♦ Debriefing

Responses to "Did the game teach you something that you did not know before?" are presented in Table 3.

Table 3. Question - Did the game teach you something that you did not know before?

Response item category	Total
1 – Yes	45
2 – Yes, but did not include response	11
3- No	19
Total	75
a. Specific aspects about the mosquito and virus	22
a.i. The meaning of vector	6
a.ii. The scientific name of the mosquito	2
a.iii. The period during the day when mosquito feeds	5
a.iv. That there exists four serotypes of dengue	3
a.v. The dengue reproduction cycle	3
a.vi. The predators that attack the mosquito	1
a.vii. Only the female mosquito feeds on its victims	3
b. Methods for control and prevention	16
b.i. Where the mosquito can lay their eggs	6
b.ii. Avoid accumulation of water	7
b.iii. Alert local zoonoses in case you find larva in water	2
b.iv. The use of insecticides	1
c. Types of dengue fever	3
c.i. Difference between dengue classic and haemorrahagic fever	1
c.ii. Both types of dengue can result in death	2
d. Dengue coverage	4
d.i. Anyone can be infected by dengue	1
d.ii. Dengue is endemic in most parts of Brazil	2
d.iii. Dengue cases rise during the rainy season	1
e. Other	2
e.i. The board game taught many things about dengue	2
Total	47*

*One student included more than one answer.

Results are according to four categories of interest: "Specific aspects of the mosquito and virus", "Means of control and prevention", "Types of dengue fever" and "Dengue coverage." The category with the most positive responses was "Specific aspects about the mosquito and virus." Within this category, "What is the vector" and "The period during the day when mosquito feeds" received the most positive responses. The category "Methods for control and prevention" had the second number of positive responses. The questions "Where the mosquito can lay their eggs" and "Avoid accumulation of water" received the most positive responses. Nineteen of 75 children responded that they did not learn anything about dengue after playing the board game. Eleven students responded "yes" but did not specify what was learned.

After playing the board game, children evaluated the game process. Seventy-seven percent (57) of the children responded yes to "Did you learn from the game?" while the rest said no. Fourteen, 60 and 1 (0.01%) of the children said that the "Level of game instruction difficulty" was respectively, easy, moderate or difficult. Virtually all participants (97.3%) indicated that the dengue education game was interesting. Finally, when asked to rate the "Level of game questions", 26 (35.1%) responded that the game questions were easy and 43 (58.1%) responded that questions were both easy and difficult.

DISCUSSION

To our knowledge this was the first time that a board game was used as an educational tool for transmitting new attitudes, perceptions and knowledge about dengue fever to elementary school children in Brazil. No material like this has been used to educate youngsters about the importance of dengue control and prevention in Brazilian schools. Games are thought to be more effective than top down forms of health education. Several recent studies have been published using gaming as in-school educational tools.[17-18] Games are: adaptable; stimulate interaction between participants; fun to play; and both motivate and support learning.[19] However, their effectiveness is largely anecdotal. Our educational board game played by elementary school students in a class room setting showed a significant positive impact on attitudes, knowledge and potential behavior changes related to dengue fever control and prevention. Our board game can be played by up to six students per board. It is a targeted intervention to increase knowledge and change attitudes about control and prevention of dengue fever. School teachers participating

as monitors confirmed that bringing these issues to the children was absolutely necessary for them as facilitators of information about dengue fever. Thus, the teachers were positive about the feasibility and utility of the game as a teaching device.

♦ Attitudes about dengue

Exposure of the schoolchildren to the dengue board game resulted in an increase in positive attitudes about control and prevention of dengue according to the questionnaire (Table 1). For example, we compared responses pre- and post-intervention regarding the question "Who takes care of your home so that mosquitoes do not reproduce there?" At pre-test, more than half of the schoolchildren indicated that their parents were responsible for ensuring that mosquitoes did not reproduce at home. One week later, there was an attitude shift as the children responded that "Other family members" and "All family members" must do their part to control and prevent propagation of larva growth in contrast to the control group, in which there was virtually no change in attitude. This is an important step towards behavior change in which all members of the family and community engage in household and personal actions to control this vector. Such actions are personal or community tasks rather than the government's responsibility.

♦ Knowledge about dengue fever

All children demonstrated little knowledge about prevention and transmission of dengue fever on the pre-test. Knowledge increased after playing the educational board game intervention (Table 2). However, results showed that BGG students continued to lack a firm understanding about questions Q18.1, Q25, Q38 and Q41.3, in Table 2. Lack of measurable learning on those specific board game questions may underscore a weakness in the playing card questions and/or require closer examination of the teacher-pupil learning process, not done in this study. Time spent playing the game by students was limited to two class periods of fifty minutes. Repeated game sessions would have contributed to increased dengue fever knowledge retention.[20]

Although level of knowledge remained similar between groups for most questions, the BGG behaved differently after play, indicating that gaining information during play left them satisfied and happy about the learning experience. The authors from an earlier study [5] found significant increases of knowledge about dengue fever after Venezuelan schoolchildren played a board game about the disease using game cards and visual aids. Our study was different, because the board game was used as a stand-alone educational tool without lectures. This may indicate that the combination of a board game and lecture, as in Venezuela, may be the best way to increase knowledge and change attitudes.

As previously stated, we conducted a brief post-game debriefing with the students shortly after their participation. According to the authors in their study [19], discussion sessions or debriefings serve to put the simulation in proper perspective and are the most important part of the task educationally. About three quarters of the students responded that they learned from playing the dengue board game, with sixty percent of the students (45) giving specific responses to the debriefing question compared to 25,3% (19) of the students who said they did not learn anything from the game.

We believe the latter group of students is mistaken. Much of the knowledge in our game card questions would be difficult to find in any government dengue education material. In fact, we edited one green card question because the fourth dengue serotype (DEN-4) was reported in Brazilian territory a week before the study began. The students did not possess knowledge of the recent arrival of the fourth serotype of dengue in Brazil before they played the game. Of course the other possibility is that students did not understand the game, they found it boring and thus did not pay attention, or the method of teaching in the game was not consistent with their learning style.

Thus the improved knowledge performance of most participants at post-test suggests that there was acquisition of new knowledge. However, the subjects may not have perceived this learning of the information given initially or simply failed to recall it when responding to the questionnaire. Subject participation in this educational activity allowed them to verbally express their doubts freely. In studies that use feedback which explores the opinions about gaming, students understanding about dengue fever can be explored, permitting the participant the ability to further engage in reflection on a subject and the information presented during the activity.

Level of student game satisfaction post game play revealed that 77% of the students responded positively to the question "Did you learn from the game?" and 97.3% considered their game participation "interesting". The use of games improves student satisfaction and can improve retention of information.[21]

These results conform with many authors who claim that games are as effective as more traditional educational methods. But as noted, games are rarely evaluated, with positive claims being largely based on anecdotal evidence.[22]

One limitation was the absence of a second control group that received only a traditional lecture (as opposed to government print information). Thus our study did not allow comparing traditional learning models against the board game as was done in the Venezuela study.[5] However, as the authors point out, the Venezuela study did not evaluate the potential for the game as a stand-alone intervention to produce outcome changes.[23] Other limitations, not assessed, are long-term game effects and the effects of multiple play sessions. Studies that evaluate longer term effects of educational board games are available in the literature [5, 24-25] The authors of the Venezuelan study of an educational board game involved multiple "doses" of game playing over a 60 day period.[5] A forthcoming study in Brazil will evaluate learning effects post 30 day gaming in schoolchildren and their parents.

CONCLUSION

Our study agrees with other experimentally controlled health educational studies that attitudes and knowledge can be increased solely by the play of the board game.[23,26] The dengue board game is relatively simple to construct, flexible, sustainable and inexpensive to use in large scale school projects changing attitudes and knowledge about health issues, be it in class rooms, study halls, after-school programs or in community center settings. Models like the dengue board game are advantageous for developing countries with scarce human and material resources.[23]

Implication for school health

In Brazil, state education planners look to produce copies and distribute them in endemic areas. Future studies will evaluate schoolchildren's knowledge and attitude interaction with their parents after application of the dengue board game in schools. Public health prevention efforts must concentrate on developing education and action programs that identify barriers to action and more importantly show how to translate knowledge about dengue into positive preventive practices to reduce the transmission of dengue in endemic areas of the world.

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