

# Effects of the *Quest to Lava Mountain* Computer Game on Dietary and Physical Activity Behaviors of Elementary School Children: A Pilot Group-Randomized Controlled Trial



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## ARTICLE INFORMATION

### Article history:

Submitted 9 July 2014  
Accepted 17 February 2015  
Available online 23 April 2015

### Keywords:

Computer games  
Dietary habits  
Nutrition education  
Elementary school children  
School-based health promotion

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<http://dx.doi.org/10.1016/j.jand.2015.02.022>

## ABSTRACT

**Background** Computer-based educational games present an opportunity for health education in school; however, their feasibility in school settings and effectiveness in changing behavior are poorly understood.

**Objective** To evaluate the feasibility, acceptability, and effects of the *Quest to Lava Mountain* (QTLM) computer game on dietary behaviors, physical activity behaviors, and psychosocial factors among ethnically diverse children in Texas.

**Design** Quasi-experimental group-randomized controlled trial conducted during the 2012-2013 school year.

**Participants/setting** A total of 107 children in fourth and fifth grade consented. There was an attrition rate of 8.8% with a final sample size of 44 children in three intervention schools, and a sample of 50 children in three comparison schools. Dietary intake was measured using two random 24-hour recalls, whereas child self-report surveys measured diet, physical activity, and psychosocial factors before and after the intervention. Process data on QTLM usability and back-end server data on QTLM exposure and progress achieved were collected.

**Intervention** QTLM was implemented as part of the in-school or afterschool program. Recommended game exposure duration was 90 min/wk for 6 weeks.

**Statistical analysis** Analysis of covariance or logistic regression models evaluated effects of QTLM on diet, physical activity, and psychosocial factors. Post hoc exploratory analysis examined the changes before and after the intervention in outcome variables among children in the intervention group. Significance was set at  $P < 0.05$ .

**Results** Children played an average of  $274 \pm 110$  minutes (approximately 4.6 hours) of QTLM during the 6 weeks (51% of recommended dosage). Compared with the comparison group, children in the intervention group reported decreased sugar consumption ( $P = 0.021$ ) and higher nutrition/physical activity attitudes ( $P = 0.041$ ) pre- to postintervention. There were no significant effects of QTLM on physical activity. However, post hoc analysis showed that higher QTLM exposure and gaming progress was associated with increased frequency of physical activity ( $P < 0.05$ ).

**Conclusions** QTLM has some promising acceptability and initial effects on diet and physical activity behaviors among children in elementary school.  
J Acad Nutr Diet. 2015;115:1260-1271.

**N**ATIONAL-LEVEL DATA INDICATE THAT VIRTUALLY 100% of public schools in the United States have one or more instructional computers, with a student-to-computer-with-Internet-access ratio in public schools of approximately 3:1.<sup>1</sup> Computer technology is integrated rigorously into instruction and is considered beneficial because it allows students to work individually and at their own pace.<sup>2</sup> There is now burgeoning interest in the education and motivation potential of video game technology to target child and adolescent learners, and in the formal

research and development of socially conscious games serving humanitarian and education efforts to facilitate health education. Game formats have been used to successfully enhance knowledge, self-efficacy, attitudes, and behaviors in varied education and health domains.<sup>3-8</sup>

Intake of fruits and vegetables (F/V) continues to be a public health problem, with fewer than half of children aged 4 to 18 years reportedly consuming the recommended amount of F/V daily.<sup>9</sup> Low intake of healthy foods such as F/V and whole grains and high intake of added sugars have been

linked to obesity and several diet-related chronic diseases. Disparities exist among low-income and Hispanic and African-American children who have the lowest intake of F/V and higher intake of sugar-sweetened beverages compared with higher income groups and other ethnic groups,<sup>10,11</sup> highlighting a critical need to address these dietary behaviors in these populations. Whereas school and afterschool settings have been shown to have potential as a setting to intervene on children's diets, data have indicated the existence of barriers to successful program implementation, including rapid staff turnover and inexperienced teaching staff.<sup>11</sup> Innovative approaches are needed that overcome these barriers while still engaging children. Computer-based education games present an opportunity to provide hands-on, interactive multimedia activities that can be easily implemented within the school day and require little teacher oversight in comparison to more traditional didactic activities. Such games have the potential to modify behaviors by enhancing children's knowledge and skills,<sup>12,13</sup> and a handful of studies indicate that computer-based games can significantly improve dietary and physical activity behaviors of elementary school children.<sup>14-16</sup> However, the evidence base in this area is sparse; few games are backed by behavior change theory and have been empirically tested for feasibility, acceptability, or influence on dietary or physical activity behaviors in ethnically diverse children.

*Quest to Lava Mountain* (QTLM) is a theoretically grounded, web-based computer game that helps children understand and apply five core concepts: food is fuel; food and physical activity are related; healthy foods and beverages such as fruits, vegetables, whole grains, low-fat dairy, and water provide nutrients for optimal performance and stamina; a healthy diet includes consuming a variety of healthy foods in moderation; and a physically active lifestyle helps to maintain optimal health. The purpose of this study was to pilot test QTLM for feasibility, acceptability, and usability in ethnically diverse children in fourth and fifth grade. Furthermore, influence of QTLM on child diet and physical activity behaviors was also tested.

## METHODS

For this pilot study, a quasi-experimental study design using a group-randomization scheme was used to determine the feasibility and effect of QTLM. A convenience sample of six public schools in the Dallas, TX (four schools), and Houston, TX (two schools), areas was recruited by project staff and matched into pairs based on size, percent children receiving free/reduced price lunch, and ethnic distribution (total three pairs), and one school from each pair was randomly assigned to intervention or comparison group (three intervention schools and three comparison schools). Recruitment was done through study presentations to the principals and administrators. Two classrooms per school in fourth and fifth grade were randomly selected and all children within these classrooms were invited to participate in the study. A total of 180 children across the six schools were eligible, 107 of whom consented to participate in the study (recruitment rate of 59.4%; n=53 children at three intervention schools and n=54 children at three comparison schools). The six participating schools were middle- to low-income schools (20% to 85% of children on free/reduced price in the National School

Lunch Program). The Consolidated Standards of Reporting Trials diagram in the [Figure](#) presents the study progress and flow. Participants were recruited through study flyers and information meetings with parents. Written informed consent was obtained from parents and assent was given by children before measurement. Children were given a \$10 gift card to a local retail store for their participation in measurement. Approval for the study was obtained from the institutional review boards at the University of Texas School of Public Health, Committee for Protection of Human Subjects, and at The Cooper Institute.

## Intervention Implementation

QTLM was developed by The Cooper Institute in 2010, in partnership with the Texas Department of Agriculture, to promote healthy eating behaviors among children aged 8 to 12 years. It is one of the first three-dimensional education video games targeting nutrition/physical activity for elementary school students.<sup>17</sup> A detailed description of QTLM is available elsewhere.<sup>17</sup> Briefly, QTLM is an immersive three-dimensional action adventure game founded on Social Cognitive Theory<sup>18</sup> and the Theory of Reasoned Action<sup>19</sup> that requires children to make simulated appropriate food choices and stay physically active to move steadily through the game and succeed. Consumption of healthy food such as fruits, vegetables, and whole grains (including gathering and cooking healthy food and creating healthy recipes) affects child avatar health and enables obstacles to be overcome and quests to be successful. Game components include mazes, interactive activities, and simulations to integrate nutrition concepts. These are designed to influence psychosocial determinants of knowledge, self-efficacy, behavioral capability, outcome expectancy, perceived norms, and intentions toward healthy eating and physical activity. Avatars experience low performance in completing quests upon choosing foods/beverages and recipes containing added sugars and fats. Progress in the game is tied to the levels achieved within the game based on tasks completed. The game starts with easy levels and progresses to increasingly challenging and more complex levels.

Once baseline measurements and randomization were complete, QTLM was implemented in all the fourth- and fifth-grade classrooms or as part of an afterschool program in each of the three intervention schools. QTLM is a web-based game of approximately 10 hours' duration that is hosted on a server at The Cooper Institute. Unity Player software (version 3.2, 2010, Unity Technologies) was downloaded onto intervention school computer hard drives to allow playability of QTLM. At each of the intervention schools, program study staff did a standardized teacher training on QTLM implementation. The teachers previewed QTLM and were invited to play it to familiarize themselves with the game elements and troubleshooting aspects of the game to assist children with game setup and play. QTLM-trained project staff worked with the teaching and school staff to develop a schedule that ensured each intervention child received an opportunity to play the game for a minimum of 90 min/wk for 6 weeks, which was the recommended dosage based on the maximum 10 hours of available QTLM game play. Students played QTLM on school computers and the game was available to the children as part of their regular computer instruction time at the school computer lab,

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