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Effect of a Parasite Game on the Hand-Washing Behavior of Children with Disabilities

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Abstract

Self-hygiene is considered one of the most essential self-management skills necessary for children with disabilities to acquire and perform independently. With this in mind, we developed an Android-based mobile application intended to teach children how to eliminate parasites. To assess its effectiveness, three children with developmental disabilities were tested prior to and after playing the game. The results indicated that the children's knowledge of health behaviors and health-related self-efficacy improved after playing the game. Implications for health education and management are discussed.

Keywords: *Developmental disability, parasites, health games, special education*

1. Introduction

Self-hygiene is not only fundamental to well-being, but is also a vital component in an individual's integration into the broader society. Hygiene affects a child's growth, health, and emotions, and can further influence his or her learning as well as social acceptance [1]. However, because germs, parasites, and viruses cannot be visually detected by the naked eye, children with developmental disabilities often have difficulty understanding and remembering the need to practice proper self-hygiene, resulting in comparatively more health problems than children without disabilities [2].

In the current study, we explored the effect of a digital game on increasing hand-washing behavior. To maintain or regain health, health-related behavior must be acted upon [3]. For example, an individual must wash their hands to keep them hygienic, exercise to lose weight, take medicine to treat a disease, and restrain from alcohol use to overcome alcoholism. Bandura [4] suggests that to increase health behavior, self-efficacy, which is the personal sense of control, should first be gained or increased. As a whole, self-efficacy is built upon knowledge [4]. People must *know* about their disease, health condition, or lifestyle, to be able to manage or change their health. Therefore, knowledge and self-efficacy are necessary conditions for positive health behavior. One effective way to help children acquire knowledge and gain self-efficacy is through playing interactive games. Bandura [4] suggests that interactive media enables two-way communication between the supplier and the demander of knowledge. Such communication can affect the self-efficacy of the demander through active participation in gaining knowledge.

A few studies have investigated the effect of digital games on children's health behavior. For example, Lieberman [5] used a Nintendo game titled "Packy and Marlon" to study how playing a game about diabetes affected the health management behaviors of children with diabetes. The researcher found that after playing the game for six months, the number of emergency visits to hospital was reduced by 77%. In contrast, the number of visits by children who did not play the game decreased by only 7%. In addition, children that played the game were more likely to talk to their caretakers about their diabetic conditions and demonstrated less resistance to accepting their

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illness. Similarly, in another study [6] researchers examined the effect of playing a cancer fighting game on children with cancer. The game was intended to teach children how chemotherapy acted upon the human body. The researchers reported that after playing the game there was an increase in children's knowledge and self-efficacy related to the management of cancer and side effects.

2. The Game, "Parasite Wars"

Our team was sponsored by a non-profit organization for children with disabilities and we developed an Android-based mobile application titled "Parasite Wars." "Parasite Wars" is an innovative and informative game intended to assist children with developmental disabilities in gaining a visual understanding of why cleanliness is important. We focused on parasites for several reasons. First, parasites are relatively large compared to bacteria or viruses and many can be spotted with the naked eye. This makes parasites more interesting and concrete for children with developmental disability. Second, when compared to viruses or bacteria, children can use relatively simple behavioral measures in their daily lives to protect themselves against parasites.

In the game "Parasite Wars," four areas of the body are infected by different parasites: eyes, brain, intestines, and blood. Ten different types of parasites are introduced and, consistent with reality, each has to be eliminated in its own way. For example, the eye worm has to be removed with a surgical knife, while the stomach worm can be extinguished with boiling water. The blood parasite has to be eliminated with medicine, whereas the worm can be destroyed with soap. When each parasite is introduced, children listen to a story about how the main character, Ethan, is infected by the new parasite. The game is made up of 40 levels and has been made accessible to players with varying levels of developmental disability through the generous choices of items available to eliminate various parasites.

3. Research Method

3.1. Participants

The participants were three male children (ages 8, 9, and 11) with developmental disabilities, who satisfied the following conditions: (a) able to read and understand text; (b) immediate need for self-hygiene, especially washing hands; (c) such need expressed in the child's individualized educational plan (IEP); (d) able to play the game; and (e) has parental consent.

3.2. Research Design

To research the effect of the self-hygiene mobile game on hand-washing behavior, a multiple-probe single-subject design was used. This type of design is often used with children with disabilities to measure observable, behavioral effects, because each participant acts as his or her own control [7]. To compare the effects of the game on knowledge and self-efficacy, a pre-test was conducted prior to gameplay and a post-test was completed following play.

3.3. Measurements

3.3.1. Self-hygiene Knowledge Test: We developed the knowledge test based on the "Parasite Wars" game. The test included both text and pictures to help children understand questions and potential answers. The researcher read the multiple-choice question to the student and showed them the possible responses in both picture and text formats. The participant could then choose from the multiple-choice answers either orally or by pointing at the picture representing the answer. An example of a question is, "What should you do when you are infected by a parasite?" Examples of potential response options are, "Go to the doctor" or "Exercise daily." The

knowledge test included a total of eight questions. Four questions asked about the infection path, three questions asked about prevention, and one question asked about treatment.

3.3.2. Self-hygiene Related Self-efficacy Test: We developed the self-efficacy test based on several health behavior self-efficacy scales [8]. The self-efficacy test posed six questions: three about prevention and three about treatment. The response was to be rated on a Likert scale ranging from 1 "do not agree" to 5 "strongly agree." The scale was reviewed by two special education experts with doctoral degrees and was tested on five children with developmental disabilities who were not included in the study.

3.3.3. Hand-washing Behavior Observation: Hand-washing behavior was measured at school and home. Since hand-washing is essential for individual hygiene, we developed a protocol that counted both voluntary and involuntary hand-washing. If the participant did not wash their hands when it was absolutely necessary to do so, we asked the teacher or the parent to provide verbal prompt [9]. The situations where verbal prompts should be given were: before meals, immediately after returning home from outside, immediately after using the restroom, and whenever the hands were visibly dirty. Teachers counted the instances of hand-washing while the child was at school; caregivers counted while the child was at home.

3.4. Procedure

Before beginning the intervention, participants were trained how to play games using a smartphone. "Parasite Wars" was designed with a walkthrough, which was used as a teaching tool. Children were taught to find the application on the smartphone, start it, understand the rules of the game, and close the application. Each participant underwent 5 to 7 training sessions that were each 15 minutes in duration.

After training, baseline data were collected. In a single-subject design, a minimum of three stable data points must be gathered [7]. For participant A, baseline data were gathered three times, participant B five times, and participant C seven times. Before the intervention, the knowledge and self-efficacy pre-tests were conducted. During the intervention, participants played the mobile game for a total of one hour a day between classes and during recess for five consecutive days. The intervention effect was observed immediately after the first exposure to the game. Therefore, five data points were gathered during the five-day intervention phase.

After intervention, post-tests were performed in the same manner as the pre-tests. Maintenance period 1 was observed for five consecutive days the day following the final day of the intervention. Maintenance 2 was observed two weeks after the intervention.

4. Results

4.1. Knowledge and Self-efficacy

Results revealed that all participants gained greater knowledge of parasites after playing the game. Participant A gained from 12.50% to 100%, B gained from 37.50% to 100%, and C gained from 25% to 75%. The average pre-test score was 21.88% and mean post-test score was 90.65%, representing a mean gain of 68.77% (Table 1). It can be inferred from the results that participating children gained knowledge about parasites from playing the game.

With regard to self-efficacy, the mean pre-test and post-test scores were 26.88% and 65.63%, respectively. Thus, there was a 38.75% increase in participant self-efficacy scores. Individually, Participant A gained from 32.50% to 70%, B gained from 20% to 67.50%, and C gained from

30% to 62.50% (Table 1). It can be inferred from these results that self-efficacy regarding parasite treatment and prevention was increased after playing the game (Figures 1 and 2).

Table 1. Knowledge Gains and Changes in Self-efficacy before and after Playing the Game

	Knowledge		Self-efficacy	
	Pre	Post	Pre	Post
Participant A	12.50%	100%	32.50%	70%
Participant B	37.50%	100%	20%	67.50%
Participant C	25%	75%	30%	62.50%

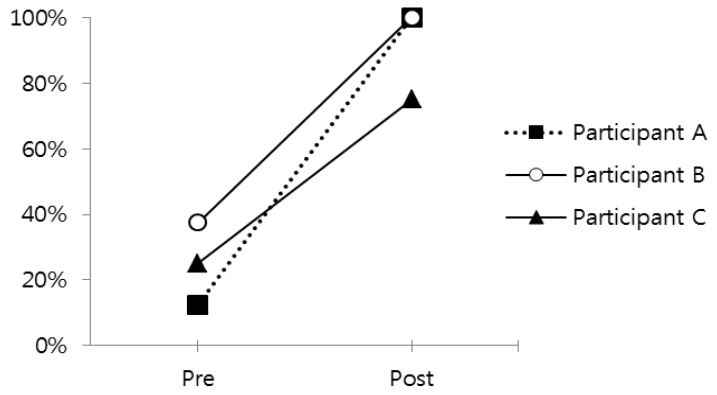

Figure 1. Knowledge Change Pre and Post Game-play

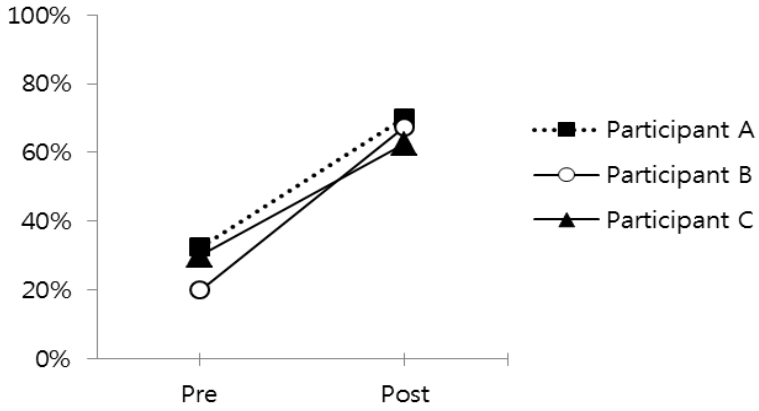

Figure 2. Self-efficacy Change Pre and Post Game-play

4.2. Hand-washing Behavior

Data for hand-washing behavior was gathered in two ways: voluntary hand-wash and verbally prompted hand-wash. In terms of voluntary hand-washing behavior, participant A averaged .3 times before gameplay, 2.6 during the intervention, 2.8 immediately after gameplay (maintenance

1), and 1.7 two weeks after gameplay (maintenance 2). Participant B averaged .2 times before game-play, 2.2 during the intervention, 2.6 during maintenance 1, and 2.0 during maintenance 2. Although participant C demonstrated no voluntary hand-washing before gameplay, he averaged 1.6 times during the intervention, and 1.4 and 0.7 in maintenance periods 1 and 2, respectively. Table 2 shows the range and means of voluntary hand-wash counts while Figure 2 charts Participant A, B, and C's daily voluntary hand-washing behavior data.

Table 2. Voluntary Hand-wash during Baseline, Intervention, and Maintenance

Participant	Data	Baseline	Intervention	Maintenance 1	Maintenance 2
A		.3	2.6	2.8	1.7
		(0-1)	(2-4)	(2-5)	(1-3)
B	Voluntary	.2	2.2	2.6	2.0
	hand-wash	(0-1)	(2-3)	(1-4)	(1-3)
C		0	1.6	1.4	0.7
		(0)	(1-3)	(1-3)	(0-2)

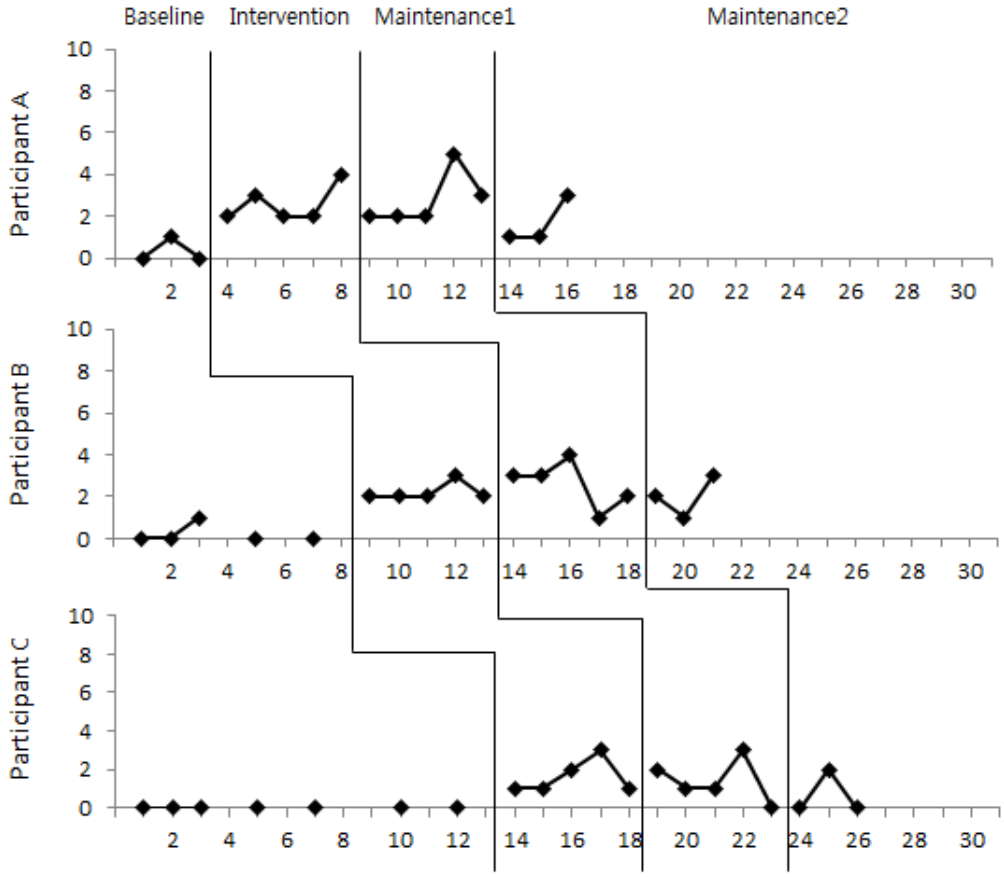

Figure 3. Daily Voluntary Hand-wash Data for Participants A, B, and C

For prompted hand-wash, participant A averaged 1.7 times during baseline, 3.6 during intervention, 4.2 during maintenance 1, and 3.3 during maintenance 2. On average, participant B washed hands after verbal prompting 1.0 times before gameplay, 3.6 during intervention, 3.2 for a week after gameplay and 3.0 two weeks after game-play. Participant C washed hands .9 times

before gameplay, 4.4 during intervention, 3.4 during maintenance 1, and 4.0 during maintenance 2. Table 3 shows the mean and range of each participant's prompted hand-wash data while Figure 4 shows the daily data points.

Table 3. Verbally Prompted Hand-wash during Baseline, Intervention, and Maintenance

Participant	Data	Baseline	Intervention	Maintenance 1	Maintenance 2
A	Verbally prompted hand-wash	1.7 (1-2)	3.6 (2-5)	4.2 (4-5)	3.3 (2-4)
B		1.0 (0-2)	3.6 (2-5)	3.2 (1-5)	3.0 (2-4)
C		.9 (0-2)	4.4 (4-6)	3.4 (2-5)	4.0 (2-6)

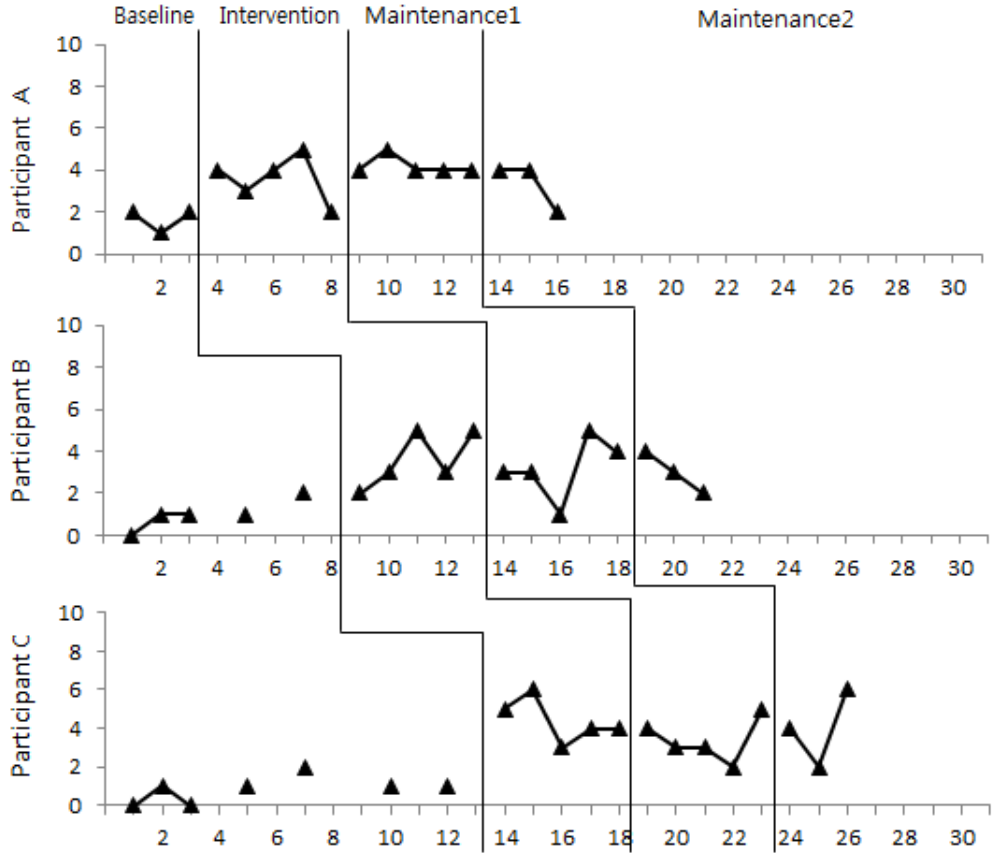

Figure 4. Daily Verbally-prompted Hand-wash Data for Participants A, B, and C

5. Discussion

The results suggest that the practical mobile health game we developed enhanced players' knowledge of parasites, health-related self-efficacy, and hand-washing behavior. According

to Bandura [4], knowledge and self-efficacy must first be addressed for changes in health behavior to occur. We believe that by playing the game, children attained and increased knowledge of parasites that, in turn, enhanced health-related self-efficacy. The behavioral changes observed in the study continued to be observed two weeks after the intervention, which also suggests that participants had attained a stronger sense of self-efficacy throughout the process. For children with developmental disabilities, it is rare to see substantial behavioral changes in such a relatively short period of time. Consequently, the results of our study imply that there is tremendous potential for growth through serious games such as this one designed with a focus on learners with developmental disabilities, and hence, unique learning and health behavioral challenges.

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