

Original article

# Impact of interactive dance games on urban children's physical activity correlates and behavior

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## Abstract

The fast growth of interactive games has a great impact on school-based physical activity programs. This study was designed to examine the effects of Dance Dance Revolution (DDR) on urban children's exercise correlates (i.e., self-efficacy, outcome expectancy, social support) and physical activity participation. Specifically, the purpose of this study was to examine the effects of DDR on urban school children's self-efficacy, outcome expectancy, perceived social support, and daily physical activity levels. A total of 101 participants responded to questionnaires assessing their self-efficacy, outcome expectancy, social support, and 1-week physical activity levels in August 2008 (pretest). Then fourth graders were assigned to the intervention group (3 30-minute DDR sessions/week), while the fifth graders were placed in the comparison group. The outcome variables were measured again in May 2009 (posttest). The MANOVA with difference scores yielded a significant main effect for intervention. Follow-up tests indicated that the intervention children reported significantly greater increased self-efficacy ( $p < 0.05$ ), social support ( $p < 0.05$ ), and daily physical activity levels ( $p < 0.05$ ) than the comparison children over time. The results suggested that the implementation of DDR could have a significantly positive effect on children's self-efficacy, social support, and daily physical activity levels across time. The findings of the study can facilitate health professionals' design of effective interventions to promote urban children's exercise correlates and physical activity levels.

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*Keywords:* Outcome expectancy; Physical activity participation; Self-efficacy; Social support

## Introduction

The physical and social well-being of urban children and adolescents from families of lower socioeconomic status continues to be a challenge in the United States.<sup>1</sup> Urban children's physical activity opportunities have been affected by motorized transportation, the limited availability of recreational programs and facilities, and the growth of sedentary leisure activities such as television viewing.<sup>2</sup> In addition, they

have limited opportunities for moderate and vigorous physical activity due to the lack of safety of playing sports or games in the neighborhood and their exposure to criminal activity when traveling to or from recreational activities within or outside of the neighborhood.<sup>1</sup> As is well known, the lack of physical activity participation among children is a risk factor for being overweight, as well as for subsequent cardiovascular disease and obesity as adults.<sup>3–5</sup> Given the fact that urban youth's physical activity participation has been found to be significantly low,<sup>1</sup> research is needed to examine the effectiveness of innovative interventions that provide motivating physical activity opportunities for underserved urban children.

Participating in regular physical activity has been identified as an important contributor to the prevention of and reduction

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in overweight and obese children.<sup>6</sup> Therefore, motivating urban children to participate and adhere to physical activity is very important. To this end, it is critical to understand the specific reasons why urban children are reluctant to be physically active.<sup>1</sup> Social cognitive theory represents a viable theory of physical activity correlates to predict children's participation in physical activity behaviors.<sup>7,8</sup> According to this theory, self-efficacy and outcome expectancy comprise major personal correlates of behavior. Self-efficacy refers to beliefs about one's capabilities to learn or perform behaviors at designated levels, whereas outcome expectancy refers to a person's beliefs concerning the likely outcomes of a behavior and perceived value of the behavior to the individual.<sup>8</sup> Social support refers to a wide cross section of concepts including, "belonging, bonding, and binding; attributes of groups, relationships, and persons; and processes that are social, behavioral, and affective in nature".<sup>9</sup> This support can be derived from significant others such as parents, peers, and teachers. To date, empirical studies have found that individuals' self-efficacy and outcome expectancy are major correlates of behavioral intention and behaviors in physical activity.<sup>10–12</sup> Substantial evidence also supports that social support plays an important role in determining individuals' exercise behaviors.<sup>10,12,13</sup>

Knowing the influences of interventions on children's physical activity correlates is an important first step in designing intervention programs to promote physical activity participation among children. The fast growth of interactive video games has led to the development of new interactive communication strategies, which in turn has a great impact on school-based physical activity programs.<sup>14–16</sup> For example, recent research has suggested that interactive dance games such as Dance Dance Revolution (DDR) provide adequate energy expenditure compared to treadmill walking and sedentary behavior.<sup>17–20</sup> DDR is an interactive video game that combines real physical dancing, requiring fast-foot movement, with energetic music and visuals. It has capitalized on children's interest in computer and video interaction by combining interactive exercise equipment and activities to get children moving and physically active. DDR has a built-in workout mode that allows players to track how many calories they burn as they play and therefore is considered a supplemental aerobic exercise to help solve the obesity problem. Accordingly, DDR has been proposed by researchers as an innovative and fun solution to promoting a healthy lifestyle and fighting childhood obesity.<sup>17–20</sup> However, most empirical studies within interactive video games have been conducted in laboratory settings with very small samples,<sup>17,18,20</sup> which tremendously limits the generalizability and practical implications of the research findings. Second, most current studies appear to be one-dimensional (e.g., effect of DDR on physical activity levels or energy expenditure) and do not explain the effects of interactive video games on the various aspects of child development, such as psychosocial aspects like physical activity correlates. Furthermore, few known studies have been conducted to compare the effects of DDR with other free play activities at school settings.

Therefore, the purpose of this study was to examine the effect of DDR, as compared with other free play activities, on urban children's daily physical activity participation and physical activity correlates. Based on the literature review and previous studies, the following hypotheses were proposed: (1) children in the intervention group would have greater increased daily physical activity participation than those in the comparison group; and (2) children in the intervention group would exhibit greater increased physical activity correlates (self-efficacy, outcome expectancy, and social support) than those in the comparison group.

## Methods

### *Study population and design*

The participants were 126 fourth and fifth grade children recruited from an urban predominantly Latino elementary school in the Mountain West region of the United States, aged 9–11 years. The average class size was approximately 28. The sample included all the fourth and fifth graders at the school site. The majority of the participants (approximately 71%) were children of Latino immigrant families; 89% of these children came from economically disadvantaged families (receive free/reduced meals). There was no regular physical education at this school. The children only had 30 minutes of recess (2 sessions of 15-minute recess) every school day. This population had a disproportionately high risk of being overweight or suffering from obesity, Type II diabetes, and cardiovascular disease. Prior to the start of the study, permission was obtained from the University Institutional Review Board, the school district, the school principal, and all the participants and their parents/guardians.

In this 9-month quasi-experimental study, the participants' baseline daily physical activity levels and physical activity correlates were measured at the beginning of 2008 school year (August; pretest). Participants were assigned to different groups with grade as the experimental unit. Specifically, the fourth graders were assigned to the DDR intervention group: three 30-minute DDR sessions during recess periods per week, while the fifth graders were placed in the comparison group: no DDR session. After the intervention was completed at the end of school year (May 2009), the same quantitative data were collected again (posttest).

### *Intervention*

For the fourth grade children, the DDR program was offered and monitored by the researchers and research assistants during three 30-minute recess periods every weekday. When playing DDR, a player must move his or her feet to a set pattern, stepping in time to the general rhythm or beat of a song. While the game is in play, there are four stationary, transparent arrows at the top of the screen. Other arrows scroll up from the bottom of the screen and pass over the stationary arrows. When the scrolling arrows overlap the stationary ones, the player must step on the corresponding arrows on the dance

pad. A “jump” step will involve pressing two arrows simultaneously. In this way, the game encourages the student to dance a prechoreographed series of steps to the beat of the music.

In this study, initial practice on DDR focused on developing rhythm and tempo via the Tutorial Mode. Before children were successful in playing DDR, they mastered how to step in response to the beat of a song. Later, the Game Mode was utilized to facilitate children through a process of learning to play the game. This process was helpful for children to move from rhythm lessons to actual game play. A total of eight DDR stations were set up in this study. For each station, there were two master (electronic) dance pads (connected to the monitor) and two practicing dummy dance pads. As a result, a group of up to four children worked on the same station with two on the master dance pads and two on the dummy dance pads. After playing a song, children on the master dance pads switched to the dummy dance pads and *vice versa*. In this way, all children had the opportunity to play on the master dance pads. In regards to the comparison group, the fifth grade children did not participate in the DDR program. Rather, they only had the conventional unstructured recess in the classroom (i.e., sitting or walking) or the outside field (i.e., playing in the playground). The recess was usually monitored by the respective classroom teachers.

## Measures

### Physical activity levels

The physical activity questionnaire for children was used as a means for students to self-report their overall physical activity over the past 7 days. Students reported how many times in the previous week they had participated in a wide range of physical activity behaviors such as recreational activities, sports, and other types of exercise. Other physical activity behaviors related to students' physical education class, free time, recess, extracurricular sports, weekend activities, and evening activities were also addressed within this instrument. Summed scores were calculated and then averaged across the different categories within the instrument. A final overall score, ranging 1–5, was obtained as an indicator of activity level for the students. The physical activity questionnaire for children was appropriate for elementary school-aged children (Grades 4–8; approximately aged 8–14 years). The validity and reliability of this instrument among fourth grade and beyond have been established.<sup>21,22</sup>

### Self-efficacy

The physical activity confidence scale<sup>23</sup> was used to assess children's self-efficacy. This was a six-question inventory and has demonstrated validity and reliability among adolescents.<sup>23</sup> The stem used in the survey is: “Rate how sure you are that you can do physical activity in each situation”. A five-point Likert scale, ranging from 1 = *I am sure I can't* to 5 = *I am sure I can*, was utilized for all responses. Sample questions are: (1) “do physical activity even when you feel sad or stressed”; (2) “do physical activity even when your family or friends want you to do something else”; and (3) “do physical

activity even when you have a lot of schoolwork”. The mean of these items were used as children's self-efficacy.

### Outcome expectancy

The measure of outcome expectancy was from a recently established seven-point Likert-type scale.<sup>24</sup> In particular, outcome expectancy was formed by the interaction of outcome likelihood and outcome values. To measure children's perception of outcome likelihood, children rated the likely occurrence of 10 different possible outcomes of participating in physical activity on a seven-point Likert-type scale (1 = *very unlikely*, 7 = *very likely*). Sample outcomes included exercise to improve health, cooperate, and to develop a nice body and/or physically condition oneself. To measure children's perception of outcome values, students rated each of the outcomes in terms of its value for them on a seven-point Likert-type scale (1 = *very unimportant*, 7 = *very important*). The products of outcome likelihood and outcome value were calculated for each of the outcome expectancies, and the mean of these 10 outcome expectancies was then used as an overall indication of outcome expectancy.

### Social support

To assess children's social support, a five-point Likert-type scale was adopted from a recent study.<sup>12</sup> The social support scale comprised parental support, parental encouragement, peer support, and teacher support. Children were asked to rate the level of agreement with the 11 items to indicate their perceived social support, by responding to the stem, “How often...” A five-point Likert scale, ranging from 1 = *strongly disagree* to 5 = *strongly agree*, was used for all responses. Sample statements included: (1) “does your mom or dad take you to exercise or play sports”; (2) “does your mom or dad tell you to exercise or play sports”; (3) “do your friends exercise or play sports with you”; and (4) “does your teacher tell you to exercise or play sports”. Items of each subscale were summed and divided by number of items per subscale to represent the mean score for each construct. The mean score of the four constructs was used for children's perceived social support. The evidence of this scale's reliability and validity has been demonstrated by Ommundsen et al.<sup>12</sup>

### Statistical analyses

Cronbach  $\alpha$  coefficients were computed to ensure the internal consistency of the self-reported measures of physical activity correlates and physical activity levels over time. Second, descriptive statistics were used to describe the difference scores (posttest – pretest) of the outcome variables (self-efficacy, outcome expectancy, social support, and physical activity levels). Additionally, a one-way (intervention) multivariate analysis of variance (MANOVA) was used to analyze the difference scores of all the outcome variables.

## Results

### Descriptive analyses

Due to the attrition rate (19.8%) over the school year, the final sample comprised of 101 children ( $Mean_{age} = 10.36$ ;  $SD = 0.98$ ). The ethnic distribution of the sample was as follows: 12% White American, 9% African American, 71% Latino American, and 8% Asian American. The final sample was comprised of 52 boys and 49 girls, which broke down into 50 fourth graders and 51 fifth graders. In regard to scale reliability, Cronbach  $\alpha$  coefficients of the physical activity correlates and physical activity level measures exceeded 0.70 (0.75–0.86 for pretest and 0.78–0.84 for posttest) and represented acceptable internal consistency values.<sup>25</sup> Therefore, the self-reported measures were deemed appropriate for the participants in this study. Descriptive statistics of the difference scores are reported in Table 1. Interestingly, children in the intervention group had increased physical activity levels whereas children in the comparison group demonstrated slightly decreased physical activity participation. In contrast, children displayed increased physical activity correlates, as all mean scores of the psychosocial variables were positive for both the intervention group and the comparison group.

### MANOVA

The MANOVA yielded a significant main effect for intervention, Wilks' Lambda = 0.83,  $F(4, 96) = 4.85$ ,  $p < 0.01$ ,  $\eta^2 = 0.17$ . Follow-up tests indicated that children in the intervention group also displayed significantly higher 1-week daily physical activity levels [ $F(1,99) = 4.69$ ,  $p < 0.05$ ] than those in the comparison group. In addition, children in the intervention group (fourth graders) reported significantly greater increased self-efficacy [ $F(1,99) = 6.50$ ,  $p < 0.05$ ] and social support [ $F(1,99) = 4.25$ ,  $p < 0.05$ ] than those in the comparison group (fifth graders) over one school year. There was no significant difference on the change of outcome expectancy between the two groups.

## Discussion

Participation in regular physical activity has been linked to decreased overweight rates, improved health-related physical fitness and improved mental health.<sup>6</sup> This study investigated whether regularly playing interactive dance games is clearly

a necessary part of the solution to promoting daily physical activity participation and physical activity correlates, with the goal of reducing the childhood obesity epidemic among underserved urban children. Prior to the main analyses, support was provided for the internal consistency of the self-reported measures used in this study.

The first hypothesis proposed that children in the intervention group would have greater increased daily physical activity participation than those in the comparison group. The data demonstrated that the intervention children showed significantly greater increased 1-week physical activity levels than the comparison children over the school year. The result supports the research hypothesis and corroborates the notion indicating interactive dance games (e.g., DDR) have been effective in increasing children and youth's physical activity participation.<sup>17–20</sup> For example, Graf et al<sup>18</sup> found that healthy children aged 10–13 years had twofold increase in energy expenditure when playing DDR than watching TV. Murphy et al<sup>19</sup> also revealed significant improvements in exercise time, weight and peak  $VO_2$  among the overweight children in the DDR treatment group compared with those in the delayed-treatment group. Apparently, interactive dance games, such as DDR, can capitalize on children's interest in computer and video interaction by combining interactive exercise equipments and/or activities to get children moving and have them to be more physically active.<sup>26</sup> In this study, DDR served as an important bridge that caught children's interest and got them interested in a physically active lifestyle. As a result, intervention children's self-reported daily physical activity levels increased significantly over time.

While the majority of empirical studies investigating the psychological benefits of interactive video games utilized qualitative methodology,<sup>27,28</sup> more quantitative research has emerged in this area of inquiry. These quantitative studies primarily examined the relationships between individuals' psychosocial attributes (e.g., intrinsic motivation, interest) and physical attributes (e.g., physical activity levels) in interactive video games.<sup>29–31</sup> For example, Gao<sup>29</sup> indicated that adolescents were highly motivated to play DDR, but their moderate to vigorous physical activity was relatively low; and that adolescents' intrinsic motivation was a positive predictor of their physical activity levels. Thus far, nevertheless, no known study is available to explore the effects of interactive video game intervention on children's psychosocial attributes from social cognitive perspectives. The present study, therefore, was designed to fill the gap in the field. According to the second

Table 1  
Descriptive statistics of mean scores ( $n = 185$ ).

Variable	Fourth grade			Fifth grade		
	Pretest	Posttest	Change scores	Pretest	Posttest	Change scores
Self-efficacy	3.62	4.14	0.52*	3.48	3.67	0.19**
Outcome expectancy	5.16	5.49	0.33	5.10	5.69	0.59
Social support	3.05	3.76	0.71*	2.78	3.16	0.38**
Physical activity	3.40	4.16	0.76*	3.20	3.12	-0.08**

\*\*\*Significant difference between the groups,  $p < 0.05$ .



research hypothesis, children from the intervention group would report significantly greater increased physical activity correlates (self-efficacy, outcome expectancy and social support) than children from the comparison group. This hypothesis was partially supported in that the results revealed the fourth graders in the intervention group reported significantly greater increased scores in their self-efficacy and social support over time as compared to the fifth graders in the comparison group. As mentioned earlier, children in the intervention group learned how to play DDR gradually through practice in the Tutorial Mode, which may benefit their mastery experiences and enhance their confidence over time. Children also received simultaneous feedback from the DDR system and timely comments from their peers and teachers. In addition, children were allowed to play DDR at their specific difficulty levels, which would prevent the decrease of their self-efficacy in face of difficult dances. Finally, children in the intervention group mimicked the dance movements of the dance figures on the screen. That is, the dance figures in the DDR system served as the role model in this study. According to Bandura,<sup>8</sup> self-efficacy, as a product of a complex process of self-persuasion, relies on cognitive processing of diverse sources of efficacy information including mastery experiences, vicarious experiences (e.g., role modeling), and verbal persuasion (e.g., feedback). Therefore, it is not surprising that the intervention children were more likely to enhance their self-efficacy as compared to those in the free play activities in which neither formal instruction nor structured activity was offered.

Similarly, children in the intervention group displayed significantly greater increased scores in perceived social support. The effects of different physical activity interventions on individuals' perceptions of social support have been inconclusive. Specifically, only one study found that social support significantly increased in the intervention group but not the control group.<sup>32</sup> Another study<sup>33</sup> found that social support significantly increased from baseline to posttest and follow-up. Other studies, however, suggested that social support in the intervention group significantly decreased from baseline to follow-up relative to the control group<sup>34</sup> or that there were no significant differences between intervention and control groups.<sup>35</sup> We speculate that the different findings are due to the research design, the nature of the intervention, length of the intervention and target population. In the present study, children in the intervention group were placed into eight DDR groups with up to four within each group. The children had more opportunities to interact with one another or the instructors in this structured DDR program. In other words, social support from important others (peers, teachers) was more prevalent than in the free play activities. As a result, children in the intervention group tended to have greater increased scores in perceived social support.

Lastly, the changes of children's self-reported outcome expectancy did not vary significantly between the intervention group and the comparison group. In fact, as the comparison group, the fifth graders also reported higher outcome expectancy by the end of the year. It is possible that they became

more aware of the benefits of physical activity as they grew up. Also, despite many of the advantages of interactive video games, DDR did not tap any of the health outcomes in the intervention program. It may be part of the reason that leads to the nonsignificant differences between the intervention group and the comparison group. Future study is warranted to further explore the in-depth information underlying this phenomenon through qualitative methodology, such as interviews or focus groups.

#### *Implications and limitations*

This study has potential for documenting positive effects of interactive dance games (e.g., DDR) on children's daily physical activity participation and physical activity correlates for school health professionals. Playing interactive video games has potential to be a wonderful vehicle to promote physical activity participation among the United States school children whose obesity problem has already become an epidemic.<sup>17,20</sup> Interactive video games can also be responsive and culturally sensitive to minority children, because compared to non-Latino White children, minority children spend more time watching TV and playing sedentary video games.<sup>6</sup> Therefore, the study is imperative for the school health professionals to achieve the goal of promoting a physically active lifestyle and reducing the prevalence of obesity. Second, this project is very important and practical in physical activity and health fields as it aims to alleviate many of the health disparities that are common in underserved urban communities. Additionally, this study allows us to examine the psychosocial processing of exercise behaviors of school children from ethnically diverse and underserved backgrounds. Health professionals should focus their endeavors on promoting these children's physical activity participation and physical health.

However, this study has several limitations. First, due to school schedule conflicts, space limitation, and resistance from one fifth grade teacher, only the fourth graders were placed in the intervention group while the fifth graders were placed in the comparison group in this study. It is not possible to examine the potential confounding effect that grade had on the results. Future study should adopt randomized controlled trials. That is, it is important to randomly assign children from each grade to the intervention group and the comparison group. Second, the participants came from one predominantly Latino urban school and data contamination was not controlled. It somewhat limits the generalizability of the findings of this study. Accordingly, the intervention might be implemented with a larger sample of multiple school sites with one school as the intervention unit in future research.

Findings of this study add to the growing body of literature on the effects of interactive dance games on urban children's physical activity participation and physical activity correlates. Although the implementation of DDR could have a significantly positive effect on children's self-efficacy, social support, and daily physical activity levels, the DDR program could not significantly improve children's perceived outcome expectancy

of participating in physical activity. The findings support the need for innovative interventions enhancing children's self-efficacy and social support in an effort to improve their physical activity participation. In addition, the findings of the study can inform health professionals about how to more effectively promote urban children's exercise motivation and physical activity participation through interactive video games, with the goal of promoting the health status of this population.

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