EFFECT OF DANCE DANCE REVOLUTION ON ENERGY EXPENDITURE AND ENJOYMENT IN SEVERELY OVERWEIGHT CHILDREN COMPARED TO ALTERNATIVE FORMS OF ACTIVITY

by

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Dance, Dance Revolution (DDR) is an innovative product that combines the popularity of video games with a dance activity component. DDR has the potential to be an activity that results in sufficient energy expenditure (EE) and one children will find enjoyable. Research is necessary to quantify and provide more adequate data on the EE of DDR. In addition, to date there are no published data on the enjoyment of DDR. **PURPOSE:** To examine the EE and enjoyment of a single bout of DDR in severely overweight children compared to alternative forms of physical activity. **METHODS:** Twenty severely overweight (body mass percentile for age and sex = 98.3±0.86%) children (10 boys and 10 girls) between 9 and 12 years of age (10.6±1.23 years) performed experimental trials for three separate modes of activity; treadmill walking, in-home walking video, and DDR. Each testing session consisted of a single activity bout that was 15 minutes in duration. EE was assessed using indirect calorimetry with data summed over the 15 minute activity session. Perceived enjoyment was assessed immediately after each testing session using the Physical Activity Enjoyment Scale. **RESULTS:** No significant differences were found for EE (p=0.115) among modes of activity. Separate comparisons revealed DDR elicited a statistically lower EE than the walk video (70.84±16.58 vs. 60.65±15.95 kcal; p=0.010) and a non-statistically lower EE than the treadmill walk (78.0±34.42 vs. 62.30±15.53 kcal; p=0.093). Significant differences were found for enjoyment (p=0.598)

among mode of activity. DDR elicited a higher level of enjoyment than the treadmill walk and walk video (71.45±10.72 vs. 64.25±9.71 vs. 66.75±11.85; p=001). No gender effect was observed for EE (p=0.446) or enjoyment (p=0.468) across modes of activity. **CONCLUSIONS:** The present investigation was the first to investigate the EE and enjoyment of DDR in severely overweight children. It was also the first to compare the EE and enjoyment of DDR to alternate forms of activity. Thus, future research should further investigate the EE and enjoyment of DDR and how this compares to alternate forms of activity. Findings from such research may assist in further understanding how interactive video games such as DDR may be successfully used in interventions to promote physical activity in children.

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CHAPTER 1.0

INTRODUCTION AND RATIONALE

1.1 Introduction

Estimates of childhood obesity in the United States are alarming and reveal that the prevalence is increasing, with the percentage of children (ages 6 to 11) who are overweight tripling since 1980 (10). Approximately eight million young Americans, which represents almost 15% of all children, are obese and 30% are overweight. Overweight and obesity in youth presents a serious public health concern. Severely overweight children have physical and psychosocial morbidity as a result of their excessive body weight (29). Physical consequences can range from tiredness, shortness of breath, heat rashes, skin irritation and infection, impaired mobility, obstructive sleep apnea, asthma, and orthopedic complications. Moreover, there is an increased prevalence for elevated cardiovascular risk factors, insulin resistance, impaired glucose tolerance, type 2 diabetes mellitus, and hypertension. Childhood obesity has an immediate impact on a child's physical appearance, which can result in additional psychosocial consequences, such as lowered self-esteem, social isolation, lack of self-confidence, and depression. In addition, being obese as a child increases the risk of adult cardiovascular disease and mortality (29), and this may be a result of estimates that 50% of overweight children and 70% of overweight adolescents will be obese in adulthood (36). This illustrates the importance of targeting youth obesity as a public health priority.

Emerging evidence indicates that physical activity is beneficial to the health of children. Low levels of physical activity and increased sedentary behavior are primary factors contributing to childhood obesity, resulting in an imbalance between energy intake and energy expenditure

(15). Moreover, physical activity is inversely associated with a number of cardiovascular disease risk factors, such as elevated blood lipids and hypertension, while positively associated with physical fitness, HDL cholesterol, bone mass, and psychological well-being (47). Despite the negative health consequences associated with childhood obesity and the positive health benefits of regular physical activity, many youth are not meeting the current minimum physical activity guidelines of participating in at least 60 minutes of moderate intensity physical activity on most, preferably all, days of the week set forth by the Center for Disease and Control (CDC) (10, 46-48).

In the United States, 33% of children are physically inactive (54). This level of sedentary behavior may be a result of children preferring to engage in activities involving technology such as television viewing and video games (57, 66). On average youth spend 5.5 hours per day using various types of electronic media (41). Therefore, attempting to incorporate these highly used electronic technologies into physical activity interventions may provide an opportunity to decrease sedentary behavior and increase physical activity levels in overweight and severely overweight children. The use of television viewing combined with video games may result in an increase in the enjoyment of physical activity. This is an important consideration because enjoyment is a primary reason identified by youth for engagement in activity and has been positively associated with physical activity in this age group (5, 32, 46).

Dance, Dance Revolution (DDR) is an interactive video game that combines the popularity of video games with physical activity. DDR may be a channel to increase energy expenditure in children and promote enjoyment of physical activity. Currently, the energy expenditure resulting from DDR when used by severely overweight children is unknown compared to other forms of physical activity. Moreover, it is unknown if children will find DDR

to be an enjoyable activity and how this level of enjoyment will compare to other forms of activity. Therefore, the purpose of this study was to examine these research questions in severely overweight children.

1.2 Rationale

Enjoyment is a primary reason youth engage in activity and has been positively associated with physical activity level among children (5, 32, 46). However, many children, especially the severely overweight, do not perceive physical activity as enjoyable, preferring to engage in technology related sedentary activities rather than being physically active (21). Aside from sleeping, television viewing and video game use occupy the greatest amount of leisure time during childhood (20, 34, 39). The *Surgeon General's Report on Physical Activity and Health* conclude that video games and television are more appealing choices to children than physical activity (26). This may contribute to obesity by negatively influencing energy balance. Television viewing has been shown to reduce the metabolic rate of children (10, 28), as well as promote an increase in energy intake (12, 42, 49, 52, 61). Moreover, most video games require children to remain relatively sedentary when playing these games, contributing to reductions in total daily energy expenditure and favoring a positive energy balance.

Reducing sedentary behaviors can contribute to increased energy expenditure if replaced with behaviors that are more physically active. Aerobic activities increase energy expenditure and provide numerous health benefits such as increased flexibility and stamina, enhanced muscle and bone strength, improved posture, balance, agility, coordination, and motor skills, and reductions in stress and tension (11). Being physically active has also been shown to protect against diabetes, hypertension, heart disease, osteoporosis, and depression. Dance is a mode of aerobic activity and thus, can be used to increase energy expenditure and achieve such beneficial

health outcomes. Combining the popularity of television and video games with the aerobic and enjoyable nature of dance may be a means to promote physical activity and provide an effective intervention strategy to address childhood obesity.

DDR is an innovative product that combines the popularity of video games with a dance activity component. DDR features a game pad with four sensor arrows on which a player stands. The player's movements correspond to cues on a screen that instruct a player when and onto which arrows to step. The steps correspond to the rhythm of music played from the game and the objective is to dance the correct steps in sync with the on-screen cues and recorded music. Players earn points according to their ability to use the cues given on the screen to accurately step on the corresponding sensor arrows. The level of difficulty increases as a player improves with the music becoming faster and the arrows on the screen scrolling more rapidly. DDR has the potential to be an activity children find enjoyable, as it includes lively, upbeat music and dance with the competitive and engaging nature typical of a video game.

Very little research has been conducted on DDR. Currently, only two studies have investigated the energy expenditure of DDR, examining if the intensity of playing DDR results in an energy expenditure in agreement with the ACSM recommendations for developing cardiovascular fitness and weight loss (1, 8). However, additional research was necessary to quantify and provide more adequate data on the energy expenditure of DDR in severely overweight children. In addition, to date there are no published data on the enjoyment of DDR, yet enjoyment is highly associated with physical activity participation in youth. Thus, research was warranted to examine the enjoyment level of DDR compared to other forms of physical activity in severely overweight children.

1.3 Specific Aims

This study examined the following specific aims:

1. To examine the energy expenditure of a single bout of DDR in severely overweight children compared to alternative forms of physical activity.
2. To examine the enjoyment of DDR in severely overweight children compared to alternative forms of physical activity.

1.4 Research Hypothesis

The following research hypotheses were proposed to answer the stated specific aims:

1. A single bout of DDR would elicit an energy expenditure that would exceed the energy expenditure of alternative forms of physical activity in severely overweight children.
2. DDR would be a more enjoyable activity for severely overweight children when compared to alterative forms of physical activity.

1.5 Significance

Childhood obesity is increasing in the United States at epidemic rates, with approximately eight million young Americans, almost 15% of all children, being classified as obese (10). Childhood obesity is a major public health concern and thus, there is an urgent need to develop and implement effective means of targeting and attenuating youth obesity. Obesity is the result of a positive energy balance in which energy intake exceeds energy expenditure (58). Physical activity is a key component of energy balance contributing to an individual's total daily energy expenditure (20, 56), and therefore affecting energy balance. Despite the importance of physical activity in weight management, many youth do not meet the minimum physical activity

recommendations (46). This may be a result of children being more likely to choose sedentary activities (i.e., television viewing and video games) over freely available forms of physical activity (31, 33, 53). Such choices contribute to reductions in energy expenditure and increases in energy intake, favoring a positive energy balance and contributing to weight gain.

The current investigation offers a unique examination of the effectiveness of an interactive video game (DDR) as a method of energy expenditure. Thus, this investigation examined the energy expenditure of a single bout of DDR in severely overweight children compared to alternate forms of physical activity. In addition, this study examined the enjoyment level of DDR compared to these alternate forms of physical activity in this population. If these results are promising, this may lead to the implementation of DDR as a strategy for future weight control interventions targeting severely overweight youth.

CHAPTER 2.0

REVIEW OF LITERATURE

2.1 Introduction

The prevalence of obesity in children and adolescents in the United States exceeds 17%. This may partially be explained by the reduction in energy expenditure, resulting in a positive energy balance and weight gain. Boreham, et al. (6) reported that children have become less physically active in recent decades, with children expending approximately 600 kilocalories (kcals) less per day than their counterparts 50 years ago. It has been suggested that an explanation for this trend may be that youth find some sedentary activities more reinforcing than physically active alternatives (21).

When given equal access to sedentary or active alternatives, overweight and severely overweight children prefer to be sedentary (21). Advancements in technology over the past 30 years have lead to an increased access to entertaining sedentary behaviors such as television viewing and video games (9), and it has been reported that youth often pursue these sedentary pastimes at the expense of other, more active behaviors (21). Aside from sleeping, the majority of leisure time is spent in television viewing and playing video games (20, 34, 39). Therefore, identifying opportunities to incorporate television viewing and video game playing in modes of activity that result in sufficient energy expenditure to control weight and health-related outcomes in children would be advantageous.

Dance, Dance Revolution (DDR) is a video game that requires the individual playing the game to actively participate in an interactive manner. Thus, DDR may provide an innovative alternative to traditional forms of sedentary activity that may result in substantial energy

expenditure. Therefore, this study examined the energy expenditure resulting from DDR and compared this to the energy expenditure resulting from other forms of physical activity (treadmill walk, walk video) in severely overweight children. In addition, this investigation examined if severely overweight children reported that DDR was more enjoyable than the other forms of physical activity examined.

2.2 Sedentary Behavior in Children

2.2.1 Television Viewing

Television viewing consumes a larger portion of a child's free time. Results from the Third National Health and Nutritional Examination Survey (NHANES III) indicate that 67% of children watch at least 2 hours of television per day, with this exceeding four hours per day for 26% of children (4). This is problematic because television viewing time has been associated with childhood obesity (14, 16, 25, 42), with approximately 60% of the attributable risk of overweight in children linked to television viewing (23). Moreover, overweight is increased by 4.6 times for youth who watch television more than 5 hours per day compared to those children who watch television 2 hours or less per day, with each additional hour of television viewing increasing the risk for obesity by two- to three-fold (48). Andersen, et al. (4) reported that there was an increase in body fatness in children aged 8-16 years who watched greater than four hours of television per day compared to those who watched less than two hours per day, and these results are consistent with an observation in Canadian children (55). These cross-sectional findings provide evidence to support an association between television viewing and obesity in children.

Television viewing has also been associated with childhood obesity in prospective observational studies. For example, Dietz and Gortmaker (23) found that time spent watching television at a younger age (6 to 11 years) was predictive of obesity at an older age (12 to 17 years). This is consistent with the findings of Proctor, et al. (40) who reported that duration of television viewing was a significant predictor of change in measures of body fatness from preschool to early adolescence. At the end of follow-up, BMI was highest for children who watched the most television ($\geq$ 3.0 h/day) and lowest for those who watched the least ($<$ 1.75 h/day) (20.9 vs. 18.6 kg/m^2, respectively; $p \leq 0.05$). The results were similar for triceps skinfold (16.2 vs. 20.3 mm, respectively; $p \leq 0.05$) and sum of five skinfolds (76.5 vs. 106.2 mm, respectively; $p \leq 0.05$). These results demonstrate that increased television viewing is associated with an increase in measures of body fatness.

It is important to better understand how television viewing contributes to the development of childhood obesity. A potential mechanism that may explain this association is the possibility that children substitute this lower energy expenditure activity (i.e., television viewing) for higher energy expenditure activities (i.e., play, sports, etc.), resulting in an overall reduction in daily energy expenditure. Thus, developing techniques and strategies that increase energy expenditure in children during television viewing may also have an impact on body weight, and this warrants investigation.

2.2.2 Playing of Video Games

Video game play is increasing in popularity. A survey evaluating the impact of video games on leisure time physical activity in school-aged children revealed that 22% of children played video games between 3 to 6 hours per week, while 15% spent more than 6 hours per week playing video games (22). Although there is limited research in this area, this increase in video

game play in children has most likely contributed to an increase in childhood obesity. Stettler and colleagues (48) reported nearly a two-fold increased risk for obesity in children for each hour per day spent playing video games. Additional research has demonstrated that a higher amount of time playing video games was associated with a higher BMI in children (63). A potential mechanism that may partially explain these observed associations is the effect that video game playing has on leisure-time physical activity. Studies investigating video game use in children have reported an inverse relationship between time playing video games and daily physical activity (28), likely contributing to weight gain through a reduction in daily energy expenditure.

2.3 Mechanisms Relating Sedentary Behavior to Obesity

Television and video games are a large part of a childs' leisure time and are associated with an increase in the prevalence of childhood obesity (19, 18, 34, 39). There are several mechanisms hypothesized to relate sedentary behaviors to obesity. Sedentary behaviors can influence energy balance by reducing energy expenditure relative to other leisure time activities, by increasing energy intake, or by a combination of both. Research has consistently demonstrated that time spent watching television and playing video games is negatively related to time spent in more energy expending activities (14, 16, 17, 23, 58). For example, a study by Dietz and Gortmaker (23) observed that children who watched more television were less likely to participate in vigorous physical activity compared to those who watched less television. This provides evidence that sedentary activities displace time to be physically active, resulting in a decrease in activity and energy expenditure and potentially leading to weight gain.

The literature also supports a relationship between television viewing and energy intake. Research suggests that environmental cues can prompt eating, and repeatedly pairing eating with

watching television, or other sedentary behaviors, can lead to a conditioned response of eating when engaging in such behaviors (27, 64). Therefore, it is not surprising that sedentary behavior has been associated with an increased energy intake and a greater consumption of high-calorie, high-fat foods with poor nutritional content in youth (49). More specifically, weekly television viewing hours have correlated significantly with children's caloric intake ($r = 0.34$, $p = 0.001$) (52). Youth watching a greater number of hours of television have demonstrated significantly higher energy intakes (42, 51, 61). Utter and colleagues (61) reported that boys who reported high television viewing ($\geq$ 4 hours per day) consumed almost 400 kcal more per day than those reporting low television viewing ($\leq$ 1 hour per day), whereas girls who reported high television viewing consumed greater than 300 kcal more per day compared to those reporting low use. Moreover, for both boys and girls, dietary fat consumption was significantly increased in high television viewers compared to those watching less television ($p < 0.05$). This pattern is supported by findings from a prospective observational study that reported an increase in energy intake of 167 kcal for each hourly increase in television viewing (65).

The effect of sedentary behavior on energy expenditure and energy intake has been reported by Epstein and colleagues (19). Results of this study demonstrated that increasing screen time in the form of television viewing and playing video games resulted in a 21% decrease in activity energy expenditure (99.8 $\pm$ 154.4 kcal) and an 82% increase in energy intake (152.0 $\pm$ 248.2 kcal). The combined effect of a decrease in energy expenditure and an increase in energy intake would result in a positive energy balance of approximately 250 kcal per day. Assuming one pound is the equivalent of 3,500 kcal, consistently engaging in this pattern of behavior could result in an additional increase in body weight of 0.5 pounds per week, or approximately 26 pounds per year. Thus, examining strategies to increase energy expenditure

and/or reduce energy intake during periods of television viewing and video game playing could significantly impact weight control efforts in children prone to overweight and obesity.

Further support for the impact of reducing sedentary behavior on the development of obesity can be observed from randomized, controlled trials (18, 42). A trial targeting reductions in television viewing and video game use among third and fourth graders resulted in relative reductions in body fatness (42). Children who reduced their television and video game use compared to controls who continued their usual use had significant decreases in BMI (adjusted difference = -0.45 kg/m^2, $p = 0.002$), triceps skinfold thickness (adjusted difference = -1.47, $p = 0.002$), waist circumference (adjusted difference = -2.30 cm, $p < 0.001$), and waist-to-hip ratio (adjusted difference = -0.02, $p < 0.001$). Results from a randomized, controlled study demonstrated significant reductions in standardized BMI (*z*-BMI) at 6 (-0.99 *z*-BMI) ($R = 0.62$, $p < 0.001$) and 12 months (-0.78 *z*-BMI) ($R = 0.52$, $p < 0.002$) in obese 8-12 year old children who substituted active behaviors for sedentary behaviors (e.g., watching television or VCR/DVDs, playing video games, or using the computer for non-school-related activities) (18). These findings support that a reduction in sedentary behaviors may be an independent strategy for improving the weight status of overweight and severely overweight children.

2.4 Enjoyment of Physical Activity

Physical activity recommendations for youth emphasize the accumulation of 60 minutes of moderate to vigorous physical activity on most days of the week (10, 46-48). However, national surveys indicate that large percentages of youth are not meeting these recommendations (35, 38, 43). These low activity levels are contributing to the current epidemic rates of childhood obesity, highlighting the importance of implementing successful strategies to increase physical activity in youth to target childhood obesity (10). To accomplish this it is important to

understand factors of physical activity that influence the activity behaviors of youth. Enjoyment is an intrinsic, affective component of motivational theories of behavior and has a proximal (rather than distal) and tangible (rather than abstract) influence on behavior, providing an immediate reward for being physically active (44). Enjoyment is the most commonly reported reason why youth participate in physical activity (54), supporting that children who participate in an activity they enjoy are more likely to continue in that activity than are those who do not (13, 15). Hence, increases in enjoyment should lead to an increase in physical activity (58).

Enjoyment of physical activity may be the most important predictor of physical activity among youth (5, 15, 31, 50, 54, 56, 57, 59, 66), with enjoyment being identified as the only consistent predictor of physical activity participation in youth (15). Consistent with this finding is a national sample of 1,054 children in grades 4 through 12 that identified enjoyment as a strong and consistent factor related to children's physical activity, generalized across all ages and genders ($p < .05$) (45). In a descriptive study of 6,078 children aged 11-19 years, the perception that physical activity was fun significantly related to higher levels of physical activity ($p < 0.001$) (7). Furthermore, a cross-sectional study on factors motivating middle school boys and girls to be physical activity found that personal fulfillment, which included the factor of enjoyment, was the strongest and most consistent motivating factor for physical activity ($p < 0.001$) (24). Experimental evidence from a randomized controlled trial support these findings, observing that an increase in the enjoyment of physical activity led to an increase in physical activity participation (16). These collective findings demonstrate enjoyment as a consistent and significant predictor of youth physical activity. Thus, initiatives to increase physical activity in youth should consider focusing on promoting activities that children find enjoyable, which may increase the adoption and maintenance of physical activity and significantly impact body weight.

2.5 Current Research on *Dance, Dance Revolution* (DDR)

DDR is a dance simulation video game gaining popularity in the United States. Dance is a form of physical activity that can result in an increase in energy expenditure. However, the energy expenditure while engaging in DDR has not thoroughly been investigated, with only two published studies conducted in this area (51, 59). Tan, et al. (51) examined an active, aerobically fit, adolescent population and reported a mean heart rate of 137 beats per minute (bpm) while playing DDR, corresponding to an intensity of 70% of maximal heart rate (HR_{max}). Unnithan, et al. (59) examined overweight children and reported that subjects had a mean heart rate corresponding to an intensity of 64% $HR_{max.}$ These results suggest that DDR can elicit heart rates similar to the 55-85% of HR_{max} recommended by the ACSM to improve cardiorespiratory fitness and result in cardiovascular health benefits.

The ACSM recommends an exercise program that promotes an energy expenditure of 300-500 kcal per day and 1000–2000 kcal per week for weight loss (51, 59). Tan, et al. (51) reported that adolescents had to play DDR at a moderate intensity for 43 minutes per session on 3 days a week or 29 minutes per session on 4 days a week to meet these guidelines. Unnithan, et al. (59) concluded that when playing the least difficult stages of the DDR game, overweight youth had to play for a minimum of 65 minutes per day to elicit an energy expenditure consistent with these recommendations. Substituting DDR for at least some of the 5.5 hours per day that children spend watching television or playing other forms of video games may be a reasonable strategy to increase energy expenditure in children. Thus, addition research on the effect of DDR in overweight and severely overweight children may provide important information on the utility of this strategy for weight control in this population. A primary objective of the proposed study was to examine the energy expenditure of DDR compared to alternate forms of physical

activity (treadmill walk, walk video) in severely overweight youth. In addition, this study examined if severely overweight children reported higher levels of enjoyment for DDR compared to the alternative forms of physical activity that were examined.

2.6 Summary

The association between time spent in sedentary behaviors (watching television and playing video games) and obesity in children has been noted in numerous cross-sectional epidemiological studies (61). Intervention studies have demonstrated that decreasing time spent in these sedentary activities can be an effective component of targeting youth obesity through increases in energy expenditure and decreases in energy intake (42). Furthermore, research strongly supports the most important factor influencing youth participation in physical activity is whether a child reports an activity to be enjoyable. Enabling children to participate in physical activities in which they experience a sense of enjoyment can be an important way to increase and sustain physical activity levels and reduce the prevalence of youth obesity. DDR is a dance simulation video game that may provide a fun and enjoyable opportunity for children to engage in physical activity. There is some evidence that DDR can result in improvements in cardiorespiratory fitness and significant increases in energy expenditure (51, 59). However, research on DDR as a modality for improving physical activity and energy expenditure in severely overweight children is limited. Therefore, the purpose of this study was to examine and compare the energy expenditure of DDR to other forms of physical activity in severely overweight children. In addition, this study examined if severely overweight children reported higher levels of enjoyment for DDR compared to the other forms of physical activity that were examined.

CHAPTER 3.0

METHODS

3.1 Introduction

Enjoyment is a primary reason youth engage in activity and has been positively associated with physical activity among youth (5, 32, 46). However, many children do not perceive physical activity as enjoyable, preferring to watch television or play video games to being physically active (20, 34). On average youth spend 5.5 hours per day using these various types of media (41). Time spent engaged in such sedentary activities has been positively correlated with an increased risk of youth obesity (29), and this may contribute to weight gain by negatively influencing total daily energy expenditure. Television viewing has been shown to reduce the metabolic rate of children (12, 30), as well as promote an increase in caloric intake (12, 42, 49, 52, 61), and most video games require children to remain relatively sedentary when playing these games. Moreover, the "displacement" of physical activity by these sedentary behaviors, a mechanism widely hypothesized to explain the relationship between sedentary behavior and obesity, further contributes to reductions in total daily energy expenditure (17, 19, 23, 33).

Reducing sedentary behaviors can contribute to increased energy expenditure, especially if replaced with behaviors that are more physically active (29). Furthermore, if replaced with an activity that is fun and enjoyable overweight and severely overweight youth will be more motivated to participate (29). Dance, being an aerobic activity, has numerous health benefits, has been shown to be an activity enjoyed by children, and can be a significant energy expending activity (10). Thus, *Dance, Dance Revolution* (DDR) combines the popularity of video games

and the enjoyable, lively nature of dance. Encouraging children to participate in DDR may provide an opportunity to reduce sedentary behavior, promote enjoyment in physical activity, and increase energy expenditure, which may be an effective weight management strategy for overweight and severely overweight youth. Therefore, the purpose of this study was to examine and compare the energy expenditure and enjoyment level of DDR to other forms of physical activity in severely overweight children.

3.2 Subjects

A total of 20 healthy, sedentary, severely overweight children (10 boys and 10 girls) between 9 and 12 years of age were recruited to participate in this study. Individuals were considered eligible if they had a body mass at or above the 97th percentile for age and sex based on the CDC's BMI-for-Age-Growth Charts (11). No exclusion criteria were based on gender, race, or ethnicity.

3.2.1 Exclusion Criteria

Individuals meeting the following criteria were considered ineligible for participation in this investigation:

1. Classified as high risk (e.g., cardiovascular, pulmonary or metabolic disease or serious orthopedic issues).
2. Body mass below the 97th percentile for age and sex.
3. Taking medication that could affect heart rate, blood pressure, or energy expenditure responses to exercise.
4. Any physical disability or injury preventing optimal participation in the required activity sessions (e.g., heel spurs, severe arthritis).

3.2.2 Recruitment

Subjects were recruited using various media resources including: 1) advertisements in local media (i.e., television, etc), 2) targeted mailings and pamphlets to parents and children involved in various community programs hosted by the University of Pittsburgh (PAWS, Saturday Kids, etc.). The parents of eligible subjects were informed to contact the University of Pittsburgh Physical Activity and Weight Management Research Center. Upon contacting the research center, a general description of the investigation was provided and, in order to determine initial eligibility, the parent was asked to participate in a brief telephone interview (See Appendix A). Children identified as eligible based on this initial screening were invited to attend an orientation session with their parent/guardian, where additional information related to this study was provided. Only those meeting the initial inclusion criteria were able to take part in the orientation/screening procedures to determine final eligibility. During this session, the child's parent/guardian was required to complete a physical activity readiness questionnaire (PAR-Q) (See Appendix B) for their child, as well as a detailed medical history questionnaire to determine if any medical conditions were present that indicated exercise would be unsafe for their child. Written consent and assent was obtained from eligible subjects and their parent/guardian (See Appendix C) prior to further participation in the investigation.

3.3 Experimental Design

This investigation was a cross-sectional study in which subjects participated in laboratory trials for three separate modes of activity; treadmill walking, an in-home walking video (*Kid's Walk*), and an interactive video game (DDR). Twenty subjects consisting of 10 boys and 10 girls between the ages of 9-12 years were recruited to participate in this study. This investigation consisted of an orientation/screening session and three experimental testing sessions (See Figure

3.1). A counter-balanced design was used to randomly assign the order of the experimental testing sessions. These experimental testing sessions are described in detail below in Section 3.4.2, which outlines the procedures of each experimental session.

Figure 3.1 Experimental design and timeline

Initial Screening	**Orientation and Screening Session**	**Experimental Trial 1**	**Experimental Trial 2**	**Experimental Trial 3**
• Telephone interview • Physician Clearance	• Explain experimental procedures • Medical history • Informed consent and assent • Screening procedures to determine final eligibility • Familiarization session for Experimental Trial 1 (mode dependent on counter balanced order)	• Activity Session based on counter balanced order • Enjoyment Questionnaire • Familiarization Session for Experimental Trial 2	• Activity Session based on counter balanced order • Enjoyment Questionnaire • Familiarization Session for Experimental Trial 3	• Activity Session based on counter balanced order • Enjoyment Questionnaire

3.4 Experimental Procedures

3.4.1 Orientation/Screening Session

Prior to the experimental testing sessions, subjects and their parent/guardian were scheduled for an orientation session at the University of Pittsburgh Physical Activity and Weight Management Research Center if their self-reported demographic information (age, height, weight) and preliminary screening information indicated they may be eligible. This orientation session lasted approximately thirty minutes and was used to provide individuals with a detailed description of the purpose and overall procedures of the study. Potential subjects and their parent/guardian were encouraged to ask any questions they had regarding participation in the

study. At the conclusion of the orientation, the parent/guardian of interested subjects completed a detailed medical history form and a Physical Activity Readiness Questionnaire (PAR-Q) for their child. In addition, prior to baseline assessments and study participation, eligible and interested subjects provided written informed consent and the parent/guardian provided written informed assent, with height and weight verified.

Upon completing all medical and consent/assent forms, subjects deemed eligible and willing to participate in the study remained at the facility and underwent a series of screening procedures to determine final eligibility that included height, weight, and resting blood pressure. Height and weight were objectively measured to accurately determine eligibility based on body mass criteria for this study. From these measurements, Body Mass Index (BMI) was calculated using the CDC's BMI-for-Age-Growth Charts (11).

After final eligibility was determined, subjects underwent a familiarization session to orient them to the procedures to be used at the first experimental trial. In addition, in order to orient subjects to the equipment utilized during each experimental session, subjects were fitted for the indirect calorimetry equipment that was used to assess energy expenditure.

3.4.2 Experimental Trials

Following the orientation/screening session, subjects were required to return to the laboratory for three experimental trials; treadmill walking, an in-home walking video (*Kid's Walk*), and *Dance, Dance Revolution* (DDR). Prior to participation in each experimental trial, subjects were asked to abstain from food and caffeine intake for four hours, and vigorous exercise for 24 hours. All subjects were asked to wear standardized clothing (short sleeve cotton t-shirt and shorts) during each activity session. Indirect calorimetry was used during each session to determine energy expenditure (see description of this procedure below). The activity

during any one of the three experimental trials was terminated if the subject exceeded a heart rate of 170 beats per minute. After each experimental trial, subjects were oriented to the mode of activity that would be performed for the next experimental session. Sessions were performed in random, counter-balanced order.

Treadmill Walk Experimental Trial

Subjects performed a 15 minute walking session on a motorized treadmill. Energy expenditure during this activity was measured using indirect calorimetry (Viasys Oxycon Mobile). In addition, heart rate was measured using a Polar Heart Rate Monitor. These techniques are described in detail below. The protocol for this experimental session (See Appendix D) involved the following:

- Upon entering the testing laboratory, the child was weighed and fitted with the Viasys Oxycon Mobile and the Polar Heart Rate Monitor.
- The child was seated in a resting position for 5 minutes to allow for acclimation to the testing environment and the metabolic testing equipment and Polar Heart Rate Monitor. The child was instructed to remain as still as possible during this period of time.
- The child walked on a motorized treadmill for a period of 15 minutes. Walking occurred at 3.0 mph at 0% grade. During this walk session energy expenditure was measured using indirect calorimetry (Viasys Oxycon Mobile) and heart rate was measured at each minute using a Polar Heart Rate Monitor.
- The child was seated in a resting position for a 5 minute cool-down to insure that heart rate and blood pressure had returned to pretesting levels. During this time energy expenditure and heart rate continued to be monitored.

- At the conclusion of this session the child provided a rating of perceived enjoyment of the activity using the Physical Activity Enjoyment Scale.

Walk Video Experimental Trial

The child performed a 15 minute activity session of *Kid's Walk*, an in-home walking video. This is a commercially available video that uses choreographed routines for walking in place and is designed for use by children. Energy expenditure during this activity was measured using indirect calorimetry (Viasys Oxycon Mobile). In addition, heart rate was measured using a Polar Heart Rate Monitor. These techniques are described in detail below. The protocol for this experimental session (See Appendix E) involved the following:

- Upon entering the testing laboratory, the child was weighed and fitted with the Viasys Oxycon Mobile and the Polar Heart Rate Monitor.
- The child was seated in a resting position for 5 minutes to allow for acclimation to the testing environment and the metabolic testing equipment (Oxycon Mobile) and Polar Heart Rate Monitor. The child was instructed to remain as still as possible during this period of time.
- The child performed the activity in the *Kid's Walk* indoor walk video for a period of 15 minutes. During this activity session energy expenditure was measured using indirect calorimetry (Viasys Oxycon Mobile) and heart rate was measured at each minute using a Polar Heart Rate Monitor.
- The child was seated in a resting position for a 5 minute cool-down to insure that heart rate and blood pressure had returned to pretesting levels. During this time energy expenditure and heart rate continued to be monitored.
- At the conclusion of this session the child provided a rating of perceived enjoyment

of the activity using the Physical Activity Enjoyment Scale.

Interactive Video Game Experimental Trial

The child performed a 15 minute activity session of DDR. DDR is a music video game that is commercially available and produced by Konami. The game is played on a dance pad with four arrow panels: left, down, up, and right. These panels are pressed using the player's feet, in response to arrows that appear on the screen in front of the player. The arrows are synchronized to the general rhythm or beat of a chosen song, and success is dependent on the player's ability to time his/her steps accordingly. Energy expenditure during this activity was measured using indirect calorimetry (Viasys Oxycon Mobile). In addition, heart rate was measured using a Polar Heart Rate Monitor. These techniques are described in detail below. The protocol for this experimental session (See Appendix F) involved the following:

- Upon entering the testing laboratory, the child was weighed and fitted with the Viasys Oxycon Mobile and the Polar Heart Rate Monitor.
- The child was seated in a resting position for 5 minutes to allow for acclimation to the testing environment and the metabolic testing equipment (Oxycon Mobile) and Polar Heart Rate Monitor. The child was instructed to remain as still as possible during this period of time.
- The child performed activity using DDR for a period of 15 minutes. During this activity session energy expenditure was measured using indirect calorimetry (Viasys Oxycon Mobile) and heart rate was measured at each minute using a Polar Heart Rate Monitor.
- The child was seated in a resting position for a 5 minute cool-down to insure that heart rate and blood pressure had returned to pretesting levels. During this time

energy expenditure and heart rate continued to be monitored.

- At the conclusion of this session the child provided a rating of perceived enjoyment of the activity using the Physical Activity Enjoyment Scale.

3.5 Assessments

3.5.1 Procedures for Using Indirect Calorimetry to Measure Energy Expenditure

Indirect calorimetry was used as the criterion measure of energy expenditure. A Viasys (Yorba Linda, CA) Oxycon Mobile Metabolic Measuring System was used to assess energy expenditure during all activity sessions. This system was calibrated prior to each activity period using known gas volumes and gas concentrations according to the procedures outlined by the manufacturer. Expired gas volumes and concentrations were assessed on a breath-by-breath basis, and these values were averaged at one minute intervals. Oxygen uptake was converted to kcal/min based on the non-protein caloric equivalent, which was based on the respiratory quotient.

3.5.2 Heart Rate During Physical Activity Sessions

Heart rate was assessed during all of the activity sessions described above using a Polar portable heart rate monitor. This system allowed the monitoring of heart rate at one-minute intervals and stored minute-by-minute heart rate data. This allowed us to estimate the intensity of each physical activity sessions. NOTE: Monitoring heart rate during these sessions allowed us to enhance the safety of these exercise sessions. The exercise sessions was terminated if the subject exceeded a heart rate of 170 beats per minute.

3.5.3 Activity Enjoyment

At the conclusion of each activity session the child provided a rating of perceived enjoyment of the activity using the Physical Activity Enjoyment Scale (See Appendix G), a 5-point Likert Scale (1 = disagree a lot, 3 = do not agree or disagree, 5 = agree a lot). Of the 16 items included in this questionnaire, reverse scoring was used for questions 2, 3, 5, 7, 12, 13, and 16. The score for each item was summed to calculate a total enjoyment score for each mode of activity performed, in which the maximum enjoyment score was 80.

3.5.4 Demographic and Eligibility Variables

Body Weight: Body weight was measured by a calibrated balance-beam scale (Health-O-Meter Inc., Bridgeview, IL) to the nearest 0.25 lb (0.1 kg) and was assessed at the screening session as well as prior to each experimental trial to allow for an accurate assessment of energy expenditure. Subjects were weighed wearing light clothing (t-shirt and shorts) with their shoes removed.

Height: Height was measured during the screening visit using a calibrated, wall mounted stadiometer (Perspective Enterprises, Inc., Kalamazoo, MI) to the nearest 0.1 centimeters. Subjects were instructed to remove their shoes and stand with their back and heels of their feet against the wall.

Body Mass In dex (BMI): BMI was calculated based on current weight and height measurements using the CDC's BMI-for-Age-Growth Charts (11).

3.6 Statistical Analysis

Statistical analyses were performed using SPSS software (Version 14.0), with statistical significance defined at $p \leq 0.05$. Data was initially analyzed to provide descriptive data on

subject characteristics (age, body weight, body composition, etc.). A repeated measures analysis of variance (ANOVA) was performed with mode of activity being the within-subject repeated measure. Separate analyses were performed for the main experimental variables, energy expenditure and enjoyment, and exercise heart rate.

In addition, exploratory analyses were conducted to examine if the results of this study were affected by gender. Again, separate analyses were performed for the experimental variables, energy expenditure and enjoyment. Repeated measures analysis of variance (ANOVA) was performed with mode of activity being the within-subject repeated measure, and gender (boy or girl) the between-subject factor.

3.7 Power Analysis

To our current knowledge, the comparison of energy expenditure and enjoyment of the activities selected for this study have not been examined in severely overweight children. Thus, there was insufficient data to adequately conduct a power analysis for this proposed study. Therefore, we proposed a sample of 34 subjects for this study, which allowed us to detect a difference with an effect size of approximately 1.0 for either energy expenditure or enjoyment between the three modes of activity with 80% power when the type I error rate is set at 0.05. However, to allow for a 10% attrition rate, 38 subjects were attempted to be recruited for this investigation.

Recruitment efforts resulted in 56 individuals expressing interest in their child participating in this study. Of these 56 potential subjects, 20 were eligible and participated, 14 were eligible but did not participate, and 22 were ineligible. Thus, recruitment efforts resulted in fewer subjects than anticipated, which potentially suggests that this study was underpowered. However, because the energy expenditure and enjoyment of DDR compared to treadmill walking

and a walk video have not been examined in severely overweight children, this study will provide data to determine the appropriate sample size for a larger study to adequately examine this area of research.

CHAPTER 4.0

RESULTS

4.1 Introduction

The purpose of this study was to examine and compare the energy expenditure and enjoyment level of Dance, Dance Revolution (DDR) to alternate forms of physical activity (treadmill walk, walk video) in severely overweight children. In addition, this study compared level of enjoyment in participating in DDR, treadmill walk, and walk video in severely overweight children.

4.2 Subject Characteristics

The subjects in this investigation were 20 healthy, sedentary, severely overweight children (boys = 10 and girls = 10) between 9 and 12 years of age, with a body mass at or above the 97^{th} percentile for age and sex based on the CDC's BMI-for-Age-Growth Charts. Descriptive statistics are presented in Table 4.1. This was a counter-balanced, cross-sectional study in which subjects participated in laboratory trials for three separate modes of physical activity; treadmill walking, an in-home walking video, and an interactive video game (DDR). Of the 20 subjects who participated in all three trials, several testing sessions were excluded in the statistical analysis due to data collection failure. Therefore, the total number of subjects providing valid treadmill, walk video, and DDR data were 20, 13 and 15, respectively.

Table 4.1 Characteristics of Subjects (mean ± standard deviation)

Variable	All Subjects (N= 20)	Subjects with Valid Treadmill Data (N = 20)	Subjects with Valid Walk Video Data (N = 13)	Subjects with Invalid Walk Video Data (N = 7)	Subjects with Valid DDR Data (N = 15)	Subjects with Invalid DDR Data (N= 5)
Age (years)	10.6 ± 1.23	10.6 ± 1.23	10.6 ± 1.39	10.6 ± 0.98	10.7 ± 1.33	10.2 ± 0.84
Height (cm)	150.1 ± 9.55	150.1 ± 9.55	149.7 ± 9.93	150.9 ± 9.51	150.9 ± 10.47	147.8 ± 6.38
Weight (kg)	68.7 ± 14.95	68.7 ± 14.95	68.8 ± 14.39	68.3 ± 6.25	71.6 ± 15.83	59.9 ± 7.00
Age and Gender Specific Body Mass Index Percentile	98.3 ± 0.86	98.3 ± 0.86	98.4 ± 0.96	98.1 ± 0.69	98.5 ± 0.92	97.8 ± 0.40
Minority Representation	N = 9 (45%)	N = 9 (45%)	N = 6 (46%)	N = 3 (43%)	N = 8 (53%)	N = 1 (20%)
Gender Representation						
Males	N = 10 (50%)	N = 10 (50%)	N = 8 (62%)	N = 2 (29%)	N = 8 (53%)	N = 2 (40%)
Females	N = 10 (50%)	N = 10 (50%)	N = 5 (38%)	N = 5 (71%)	N = 7 (47%)	N = 3 (60%)

4.3 Comparison of Total Energy Expenditure Between Modes of Physical Activity

Energy expenditure data measured by indirect calorimetry were summed across each 15 minute activity session to compute total energy expenditure. Total energy expenditure across the 15 minute session was used for statistical analyses. A repeated measures ANOVA was performed to assess differences in total energy expenditure between modes of activity, with mode of activity considered as a within-subject variable in this analysis (ANOVA table found in APPENDIX H.1). The ANOVA revealed no significant differences for energy expenditure between the modes of physical activity ($p = 0.115$) for the 13 subjects with energy expenditure data for all three modes of physical activity (see Figure 4.1.).

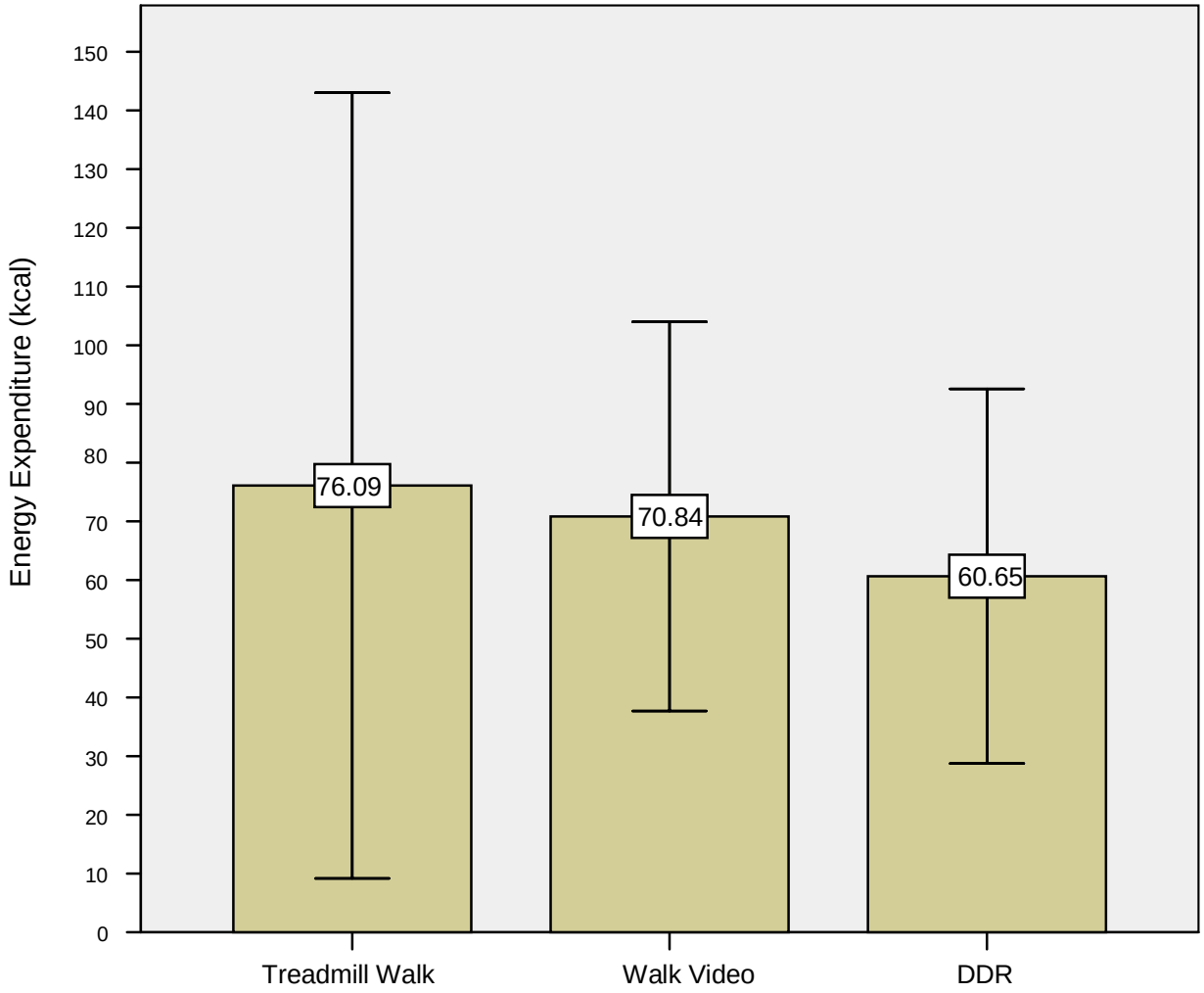
Since the number of subjects with energy expenditure varied by type of exercise, separate comparisons were also performed using dependent t-test to compare energy expenditure for DDR vs. the treadmill walk, DDR vs. the walk video, the treadmill walk vs. the walk video. A

significant difference was observed for energy expenditure between the walk video and DDR ($p = 0.010$), with the walk video producing a significantly higher energy expenditure (kcal/exercise session) than DDR. These results are presented in Table 4.2. There was a trend towards statistical significance for the difference in energy expenditure for DDR vs. the treadmill walk ($p = 0.093$), but no statistically significant difference in energy expenditure for the treadmill walk vs. the walk video ($p = 0.496$).

Table 4.2. Comparison of Total Energy Expenditure Between Modes of Physical Activity.

Exercise Comparison	Energy Expenditure for Treadmill Walk (kcal)	Energy Expenditure for Walk Video (kcal)	Energy Expenditure for DDR (kcal)	Difference Score	p-value for difference
Treadmill Walk versus Walk Video (N = 13)	76.09 ± 33.46	70.84 ± 16.58	********	5.25 ± 26.97	.496
Treadmill Walk versus DDR (N = 15)	78.0 ± 34.42	*******	62.30 ± 15.53	15.67 ± 33.68	.093
Walk Video versus DDR (N = 13)	*******	70.84 ± 16.58	60.65 ± 15.95	10.19 ± 12.12	.010

Figure 4.1 Total Energy Expenditure Between Modes of Physical Activity (N = 13).



Repeated measures ANOVA was also performed to examine potential differences in the exercise heart rate elicited by each of the modes of activity. This analysis included the 18 subjects with valid heart rate data for all three modes of physical activity that were examined, and revealed a significant difference between modes of activity. Post-hoc comparisons using dependent t-tests revealed that the mean heart rate during DDR was significantly lower when compared to the heart rate during both the treadmill walk (134.2 ± 12.1 beats per minute vs.

124.8 ± 12.3 beats per minutes; p = 0.014) and the walk video (130.7 ± 10.7 beats per minute vs. 124.8 ± 12.3 beats per minutes; p = 0.039).

4.4 Comparison of Total Energy Expenditure By Gender

An analysis was conducted to examine if there was an effect of gender on energy expenditure between modes of physical activity. Repeated measures ANOVA was performed, with mode of activity as the within-subject repeated measure and gender as the between-subject factor (ANOVA tables found in APPENDIX H.2). There was also no significant gender effect or gender X exercise interaction effect, suggesting the pattern of difference in energy expenditure across modes of activity were not significantly different between boys and girls (p = 0.446). These results are presented in Table 4.3.

Table 4.3 Comparison of Total Energy Expenditure Between Genders for Modes of Physical Activity (N: Boys = 8, Girls = 5).

Gender	Energy Expenditure			P-Values		
	Treadmill Walk (kcal)	Walk Video (kcal)	DDR (kcal)	Gender	Exercise	Gender X Exercise
Girls	77.9 ± 41.88	65.1 ± 16.4	50.8 ± 9.15	0.490	0.079	0.446
Boys	74.9 ± 30.46	74.6 ± 16.7	66.8 ± 16.59			

4.5 Comparison of Enjoyment Between Modes of Physical Activity

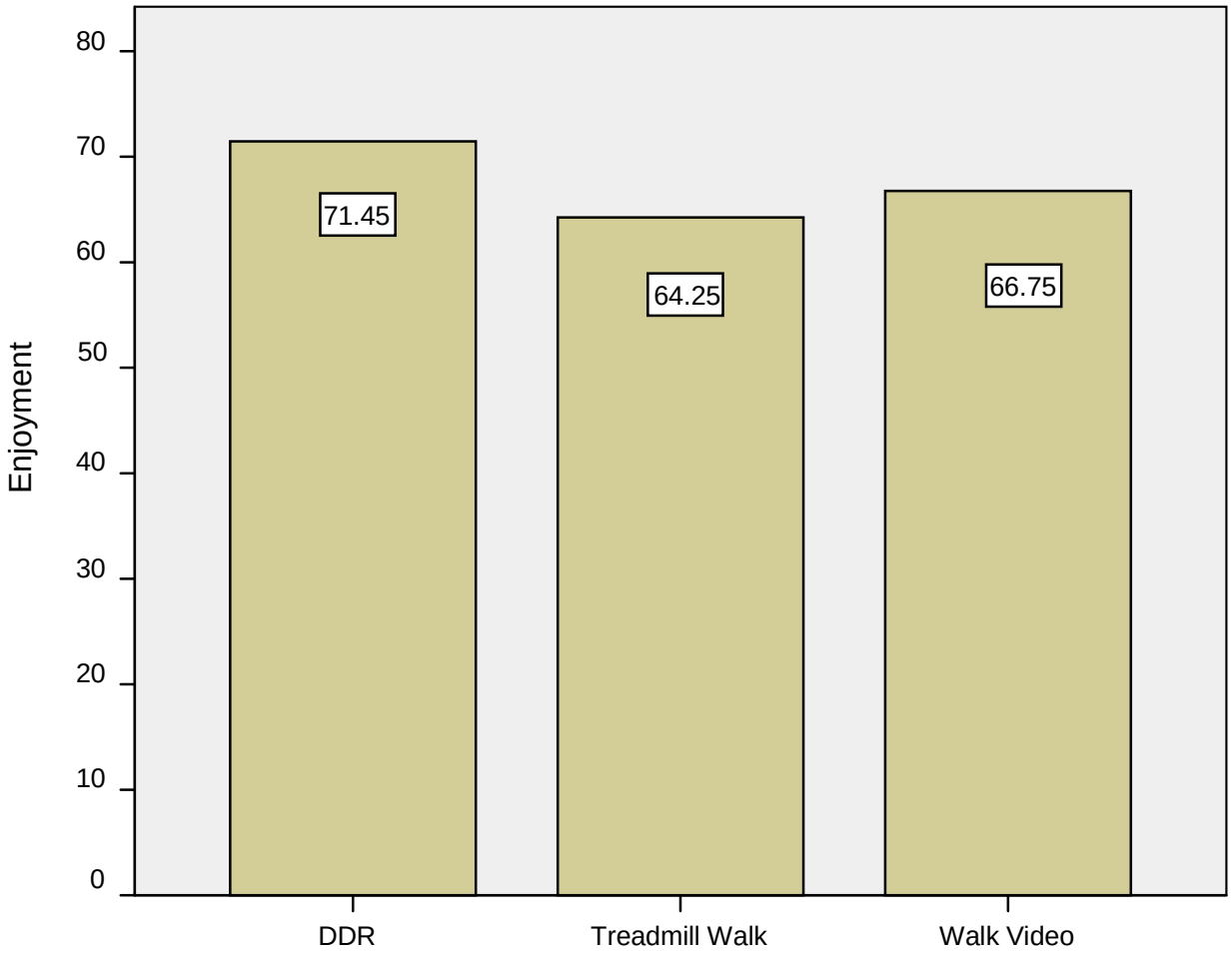
A repeated measures one-way ANOVA was performed to assess differences in enjoyment across modes of physical activity, with mode of activity considered as a within-subject factor in this analysis (ANOVA table found in APPENDIX H.3). Results of this analysis

revealed a significant difference for enjoyment among mode of activity ($p = 0.001$) (see Figure 4.2.). A series of dependent t-tests were performed and significant differences were observed in enjoyment for DDR vs. the treadmill walk ($p = 0.002$) and DDR vs. the walk video ($p = 0.008$). No significant difference was observed for the treadmill walk vs. the walk video ($p = 0.184$). These results are shown in Table 4.4.

Table 4.4 Comparison of Enjoyment Scores Between Modes of Physical Activity

Exercise Comparison	Enjoyment Score for Treadmill Walk	Enjoyment Score for Walk Video	Enjoyment Score for DDR	Difference Score	p-value for difference
Treadmill Walk versus Walk Video (N = 20)	64. 25 ± 9.71	66.75 ± 11.85	********	- 2.50 ± 8.11	0.184
Treadmill Walk versus DDR (N = 20)	64.25 ± 9.71	*******	71.45 ± 10.72	- 7.20 ± 8.97	0.002
Walk Video versus DDR (N = 20)	*******	66.75 ± 11.85	71.45 ± 10.72	- 4.70 ± 7.15	0.008

Figure 4.2 Enjoyment Between Modes of Physical Activity (N = 20).



4.6 Comparison of Enjoyment By Gender

An analysis was conducted to examine if there was an effect of gender on enjoyment between modes of physical activity. Repeated measures ANOVA was performed, with enjoyment as the within-subject repeated measure and gender as the between-subject factor (ANOVA tables found in APPENDIX H.4). The ANOVA revealed no significant gender effect ($p = 0.562$) or gender X exercise interaction, suggesting that the pattern of enjoyment did not differ between boys and girls ($p = 0.461$). These results are further confirmed by a series of independent t-test, with results presented in Table 4.5.

Table 4.5 Comparison of Enjoyment Scores Between Genders for Modes of Physical Activity.

Exercise	N	Enjoyment Score for Boys	Enjoyment Score for Girls	Difference Score	p-value for difference
Treadmill Walk	20	64.4 ± 10.12	64.1 ± 9.78	0.3 ± 4.46	0.947
Walk Video	20	64.8 ± 14.37	68.7 ± 9.03	- 3.9 ± 5.37	0.477
Dance, Dance Revolution	20	68.3 ± 12.96	74.6 ± 7.26	- 6.3 ± 4.70	0.197

4.7 Summary

There were no significant differences for energy expenditure between modes of physical activity, rejecting the primary hypothesis that a single bout of DDR would elicit an energy expenditure that would exceed the energy expenditure of the treadmill walk and the walk video. When separate comparisons were performed, the walk video produced a significantly higher energy expenditure than DDR and a trend for statistical significance was observed for differences in energy expenditure for DDR vs. the treadmill walk. However, there was no statistically significant difference in energy expenditure for the treadmill walk vs. the walk video. Findings support the second primary hypothesis that a single mode of DDR would be more enjoyable when compared to the treadmill walk and the walk video, in which separate comparisons revealed a significant difference in enjoyment for DDR vs. the treadmill walk and DDR vs. the walk video. However, there was no statistically significant difference in enjoyment for the treadmill vs. the walk video. Findings also suggest that the pattern of energy expenditure and enjoyment did not differ between boys and girls.

CHAPTER 5.0

DISCUSSION

5.1 Introduction

There is an increasing prevalence of childhood obesity in the United States (10) and this presents a serious public health concern. Advancements in technology over the past three decades have lead to an increased access to sedentary behaviors such as television viewing and video games (9), and youth often pursue these sedentary pastimes at the expense of other, more active behaviors (21). For example, aside from sleeping, the majority of leisure time is spent in television viewing and playing video games (20, 34, 39). Increased time spent in such sedentary activities, in combination with low levels of physical activity, may be primary factors contributing to childhood obesity (15). Thus, identifying opportunities to incorporate commonly used electronic technologies (i.e., video games, television, etc.) into modes of activity that result in sufficient energy expenditure may provide an opportunity to decrease sedentary behavior and increase physical activity levels in overweight and obese children. Furthermore, the use of television viewing combined with video games may result in an increase in the enjoyment of physical activity compared to other forms of physical activity in children. This is an important consideration because enjoyment is a primary reason identified by youth for engagement in activity and has been positively associated with physical activity in this age group (5, 32, 46).

Dance, Dance Revolution (DDR) is an innovative product that combines the popularity of video games with a dance activity component. DDR has the potential to be an activity that results in sufficient energy expenditure and one that children will find enjoyable, as it includes lively, upbeat music and dance with the competitive and engaging nature typical of a video

game. However, very little research has been conducted on the energy expenditure of DDR, with the existing research examining if DDR results in an energy expenditure in agreement with the ACSM recommendations for developing cardiovascular fitness and weight loss (1, 8). Additional research is necessary to quantify and provide more adequate data on the energy expenditure of DDR in severely overweight children. In addition, to date there are no published data on the enjoyment of DDR, yet enjoyment is highly associated with physical activity participation in youth. Thus, research is warranted to examine the enjoyment level of DDR compared to other forms of physical activity in children.

5.2 Conclusions

5.2.1 Total Energy Expenditure Between Modes of Physical Activity

A primary aim of this study was to examine and compare the energy expenditure of DDR to alternate forms of physical activity (treadmill walk, walk video) in severely overweight children. Results of this investigation revealed no significant differences in energy expenditure between 15 minutes of participation in each of these modes of physical activity ($p = 0.115$). Thus, findings demonstrate that a single bout of DDR produced an energy expenditure similar to that of a single bout of either the treadmill walk or the walk video (60.7 ± 15.95 vs. 76.1 ± 33.46 vs. 70.8 ± 16.58 kcal per activity session), resulting in the rejection of the first primary hypothesis that DDR would elicit a greater energy expenditure in severely overweight children. In addition, a further analysis of separate comparisons revealed the walk video produced a statistically significantly greater energy expenditure than DDR (70.84 ± 16.58 kcal vs. 60.65 ± 15.95 kcal; $p = 0.010$) and the treadmill walk elicited a non-statistically greater energy expenditures as compared to DDR (78.0 ± 34.42 vs. 62.30 ± 15.53; $p = 0.093$).

The finding that DDR consistently resulted in a lower energy expenditure compared to either the treadmill walk or the walk video may have been the result of several factors. DDR is an interactive video game involving precise timing, a higher level of coordination and adequate reaction time. The player is required to identify the scrolling arrows on the screen and coordinate an appropriate, synchronized response in time to step on and depress the corresponding arrow on the dance pad located on the floor. DDR is designed to begin at an easy level, provide feedback on performance, and increase the level of difficulty based on player progress. However, for standardization for this study, the DDR game was not individualized based on subject skill level. This resulted in each subject performing the same pre-selected difficulty level regardless of skill level and prior experience playing this game. While this study is unable to determine the effect of initial skill level on the energy expenditure elicited for the DDR activity, the investigators did attempt to standardize the skill level by having all subjects practice the game before the experimental session. However, this may not have been sufficient. Thus, the results of this study only reflect the energy expenditure for beginning levels of DDR without controlling for skill level of the children to play this game. DDR is designed to score a player based on their ability to accurately step on the dance pad arrow that corresponds to the scrolling arrow on the television screen. Thus, a potential way to minimize variability in player skill level may be to require subjects to meet a specific total score on the DDR familiarization session. Future studies should be conducted to determine differences in energy expenditure from DDR across different skill levels of children and across different levels of difficulty as programmed into the DDR game.

Another potential explanation that may account for the lower energy expenditure for DDR compared to the treadmill walk and the walk video may be reflected in the assessment of

heart rate during these activities. Heart rate during DDR was significantly lower when compared to heart rate during both the treadmill walk (134.2 ± 12.1 bpm vs. 124.8 ± 12.3 bpm; $p = 0.014$) and the walk video (130.7 ± 10.7 bpm vs. 124.8 ± 12.3 bpm; $p = 0.039$). Whether a comparable energy expenditure for DDR compared to the other activities would have been observed had the DDR activities elicited a comparable heart rate is unable to be determined from this study.

Of the few studies conducted that have examined the energy expenditure of DDR, Unnithan, et al. (59) concluded that when playing the least difficult stages of DDR, overweight youth had to play a minimum of 65 minutes per day to elicit an energy expenditure consistent with the ACSM recommendations of 300-500 kcal per day for weight loss (51, 59). When the data from the current study of 60.65 kcal per 15 minutes of playing DDR are extrapolated to the time to expend 300 kcal or 500 kcal, the children would have to play DDR at the level studied for 74.2 and 123.4 minutes, respectively, to elicit these energy expenditures. By comparison, treadmill walking at the level examined in this current study (78.0 kcal for 15 minutes) would need to be performed for 57.7 to 96.2 minutes to elicit an energy expenditure of 300 to 500 kcal; whereas the walk video (70.84 kcal for 15 minutes) would need to be performed for 63.5 to 105.9 minutes to elicit the 300 to 500 kcal of energy expenditure as recommended by ACSM. The importance of activities eliciting similar doses of energy expenditure may be important to allow flexibility in the type of activity severely overweight children select to perform. The "Guidelines for Appropriate Physical Activity for Elementary School Children" proposed by the National Association for Sport and Physical Education (NASPE) support the need to provide a variety of activities for children aged 6 to 12 years to promote physically active lifestyles (67).

5.2.2 Enjoyment Between Modes of Physical Activity

Another aim of this investigation was to examine and compare the enjoyment of DDR to alternate forms of physical activity in severely overweight children. Results of this study revealed statistically significant differences in enjoyment among mode ($p = 0.001$) during a 15 minute bout of activity. Thus, despite a lower energy expenditure, a single bout of DDR produced higher levels of enjoyment when compared to a single bout of either the treadmill walk or the walk video (71.45 ± 10.72 vs. 64.25 ± 9.71 vs. 66.75 ± 11.85), resulting in the acceptance of the second primary hypothesis.

To date there are no published data examining the enjoyment of DDR, and therefore the results of this study can not be compared to what other investigators of DDR may have observed. Moreover, because enjoyment was only examined from a single bout of activity it is difficult to determine whether there would be differences in enjoyment between modes of activity across a longer intervention period. This may be important because enjoyment is a primary reason identified by youth for engagement in activity and has been positively associated with physical activity in this age group (5, 32, 46). Thus, identifying an activity or a variety of activities that are perceived to be enjoyable by severely overweight children may enhance participation and long-term adherence to a physically active lifestyle.

Enjoyment of an activity has been linked to perceived competence (68, 69). In a study conducted by Baron and Downey (2007), in each of the 3 activities examined (games, gymnastics, and dance in physical education) enjoyment was positively correlated to perceived success, a finding consistent with other research (68, 69). These findings support children with enhanced perceptions of success in an activity will in turn have enhanced feelings of enjoyment in the activity performed. Taking this into consideration, the current investigation did not assess

perceived success for the examined activity modes, limiting our ability to understand the role of perceived competence played in the enjoyment reported by subjects for the activities performed. Higher levels of enjoyment may have been observed for DDR due to a higher level of perceived competence for playing DDR as compared to walking on the treadmill walk and performing the walk video. Future research should consider assessing the perceived competence of subjects when examining the enjoyment of DDR, the treadmill walk, and the walk video in severely overweight children in order to better understand how perceived competence impacts the enjoyment of these activities.

The finding of this investigation that there was no a significant difference in self-reported enjoyment scores between the modes of activities, with DDR producing higher levels of enjoyment. This may suggest that DDR is a preferred mode of activity for severely overweight children to perform as compared to walking on the treadmill or performing an in-home walking video. This is important because enjoyment is the most commonly reported reason why youth participate in physical activity (54), and this may result in continued participation in these forms of enjoyable activity (13, 15). In addition, NASPE emphasizes the importance of providing enjoyable activities for children in order to increase the likelihood of adherence to physical activity (71, 72). Therefore, initiatives to increase physical activity in youth should consider focusing on promoting activities that children find enjoyable, which may increase the adoption and maintenance of physical activity and significantly impact body weight in severely overweight children. Thus, findings from this investigation reveal that DDR can be a valuable strategy to incorporate into interventions aimed at promoting physical activity and adherence to exercise in severely overweight children.

5.2.3 Total Energy Expenditure By Gender Between Modes of Physical Activity

An additional analysis was performed to examine the potential effect of gender on energy expenditure across modes of activity. Results demonstrated no significant difference in energy expenditure between boys and girls across activity mode, indicating that each mode elicited similar energy expenditures regardless of gender. Non-significant results may have been due to a failure to account for confounding variables. Body mass and composition are major predictors of energy expenditure (76-79), and Zakeri, et al. (78) reported that both body weight and FFM were predictors of energy expenditure during treadmill walking (2.5 mph at 0% grade) in a study 833 children (N = 423 boys and 410 girls). The lack of a significant difference between boys and girls in this current study may be the result of all participants being within a similar BMI range, which minimized the potential differences in body size that may influence energy expenditure. Therefore, the non-significant findings for energy expenditure between boys and girls across modes of activity should be interpreted with caution. Future investigations should scale for all factors that have been shown to confound the energy cost of physical activity to better understand differences in energy expenditure across a wide range of physical activities in severely overweight boys and girls.

5.2.4 Enjoyment By Gender Between Modes of Physical Activity

An additional analysis was performed to examine the potential effect of gender on enjoyment across modes of activity. Results demonstrated no significant difference in enjoyment between boys and girls across activity mode. Thus, enjoyment did not depend on gender, as all subjects had similar perceived levels of enjoyment for DDR, the treadmill walk, and the walk video. This finding may be related to the age range selected for this investigation. Perceived competence is an individual's judgment about their ability in a particular area. In the

context of physical activity, considerable evidence shows that youth who report stronger beliefs about their physical competencies are more likely to enjoy activity and sustain interest in continuing involvement than children who report lower levels of physical competence (73, 74). Gender differences in criteria for judging physical competence do not emerge until the high school years and likely the result of differential socialization experiences among adolescent males and females (75). Thus, the age range selected in this investigation may potentially explain the lack of gender differences observed for enjoyment in the activity modes examined. Future research should expand this age range to allow for the study of adolescents to better understand differences in enjoyment across a wide array of physical activities.

5.3 Limitations and Recommendations for Future Research

This investigation is not without limitations, which may affect the application of the observed findings. Future studies should address the following factors when examining the energy expenditure and enjoyment level of DDR to alternate forms of physical activity in severely overweight children:

1. The present study consisted of 20 subjects, with only 13 subjects providing complete energy expenditure data for the walk video and 15 subjects for DDR. Thus, future studies may need to enhance the sample size to provide a more thorough and complete understanding of how DDR may differ in energy expenditure compared to other forms of physical activity.
2. Subjects in this investigation were severely overweight children ranging from 9 to 12 years of age. Future studies should expand this age range to allow for the study of young children and older adolescents to better understand differences in energy expenditure and enjoyment across a wide array of physical activities.

3. All subjects in the present investigation were volunteers, rendering it vulnerable to self-selection bias. There is the potential this investigation attracted volunteers who may have been particularly deviant form the norms of the population from which they were drawn. For example, there is the potential that some of the children, but not all, who volunteered to participate in this study had a higher level of motivation to be physically active and a greater overall enjoyment of physical activity as compared to those who did not volunteer, characteristics directly related to an objective of this investigation. Thus, subjects participating in the current study may not have been completely representative of the general severely overweight youth population, limiting the application of the findings of this investigation.
4. The design of this study examined a single bout of activity that was 15 minutes in duration. It is not known whether performing these modes of activity for longer durations or consistently over a period of weeks or months would alter the finding related to physical activity enjoyment. Future research should examine the potential influence activity bouts of longer duration or the effect of activity performed as part of a longer (i.e., weeks or months) intervention period on enjoyment of physical activity in severely overweight children.
5. The design of this study examined activity performed at a fixed intensity for a 15 minute period. However, there is a need to further examine the energy expenditure and the enjoyment of physical activity across a broader spectrum of exercise intensity in severely overweight children.
6. This study was limited to the examination of severely overweight children. However, it is unclear if differing levels of body weight and/or overweight status in children would

alter the findings that were observed. Therefore, future studies should consider including children across a wider range of body weight and overweight status.

5.4 Summary

The results of this investigation did not support the hypothesis that a single bout of DDR would elicit an energy expenditure greater than that of alternative forms (treadmill walk, walk video) of physical activity in severely overweight children. To the contrary, the dose of DDR in this study resulted in a lower total energy expenditure compared to the treadmill walk and the walk video. Results also did not support the hypothesis that DDR would be a more enjoyable activity for severely overweight children when compared to alterative forms of physical activity, with enjoyment being similar for all modes examined in this study. These findings related to energy expenditure and enjoyment were not affected by gender (boys vs. girls) for the severely overweight children that participated in this study. However, it must be noted that this study had a small sample size and thus, was potentially underpowered. Therefore, conclusions of a lack of significance in the observed findings should be viewed with caution until appropriately powered studies are conducted.

Although the present investigation is not without limitations, this is the first study to investigate the energy expenditure and enjoyment of DDR in severely overweight children. It is also the first study to compare the energy expenditure and enjoyment of DDR to alternate forms of activity (treadmill walk, walk video). Thus, future research should take into consideration the limitations of this investigation and further investigate the energy expenditure and enjoyment of DDR and how this compares to alternate forms of activity. Findings from such research may assist in further understanding how interactive video games such as DDR may be successfully used in interventions to promote physical activity in children.

APPENDIX A

RECRUITMENT FORM/TELEPHONE SCREEN INTERVIEW

RECRUITMENT FORM:

1. Thank you for your interest in our program. My name is _____ and I would briefly like to tell you about this research program.

2. **Procedure for Describing the Study and Obtaining Verbal Consent to Conduct the Phone Screen:** A description of the study will be read to participants, and this description includes important components of the informed consent process (see attached script). Individuals who express an interest in participating in this study will be told the following to obtain verbal consent:

> ***Investigators Component of Informed Consent:*** *This study is being conducted by Drs. Marcus, Jakicic, Kalarchian and colleagues at the University of Pittsburgh.*
>
> ***Source of Support Component of Informed Consent:*** *Funding for this study is provided by internal funds through the University of Pittsburgh Mind/Body Institute.*
>
> ***Description Component of Informed Consent****: We are interested in recruiting 40 children 9-12 years of age to participate in this study. This study will focus on examining how effective different types of physical activity are for burning calories in children, and how much children enjoy these activities. To do this, eligible children will be required to come to our University of Pittsburgh offices on the South Side on 6 different occasions. During these 4 of these visits the child will be required to participate in an activity session that include walking on a treadmill, following an exercise video, or playing a video game. Each of these sessions will last approximately 1 hour. In addition, your child will be required to participate in 2-weeks of home-based activity using either the exercise video or the video game. Your child can earn up to $45 in gift cards for completing all aspects of this study.*
>
> *If you are interested in your child participating in this study, I will need to ask you a few questions about your child's physical health to determine if he/she appears to be eligible to participate in this study. It will take approximately 5 minutes to ask you all of the questions. If we complete the interview, I will ask you for some specific information (your complete name, date of birth, and mailing address) so that we can contact you regarding your child's participation in this study. I will then schedule you and your child to attend an orientation session that will explain all of the procedures of this study in greater detail. The average time to complete this Phone Screen is approximately 5 minutes.*"
>
> ***Risks and Benefits Component of Informed Consent:*** *The only known risk to you for completing the Phone Screen is that it will take a few minutes of your time and you may experience disappointment if it is determined that you are not eligible to participate in the larger study. It is likely that you will experience one or both of these situations by completing this Phone Screen, which means that this occurs in more that 25% of people (more than 25 out of 100 people). The benefit of completing this Phone Screen is that you may be able to participate in the exercise study that I described to you.*

Costs and Payments Component of Informed Consent: *You will not incur any cost nor will you receive any payment for participating in the Phone Screen.*

Confidentiality Component of Informed Consent: *If your answer to a particular question tells me clearly that your child will not be eligible for this study, I will stop the interview, and not ask you any more personal questions.*

Right to Participate or Withdraw from Participation Component of Informed Consent: *Your participation in this phone screen is voluntary. You may refuse to answer any of the questions asked. Your responses to these questions are confidential, and the information related to your child's health history or current behaviors that you are about to give me will be destroyed after this interview.*

Do you have any questions related to any of the information that I have provided to you? Staff member will answer any questions or will defer these questions to the Principal Investigator or Co-Investigator when appropriate prior to proceeding. If the individual would like to think about their participation prior to proceeding with the Phone Screen, they will be provided with the telephone number that they can call if they decide to participate in the future.

Voluntary Consent Component of Informed Consent: *Do you agree that the procedures that will be used to conduct this Phone Screen have been described to you, all of your questions have been answered, and you give me permission to ask you questions now as part of the initial Phone Screen?* If "YES" indicate the participant's agreement with this statement on the top of the next page, and sign your name and date the form, and then complete the Phone Screen. If "NO", thank the individual for calling and <u>do not</u> complete the Phone Screen.

Phone Screen Interview

The caller gives verbal permission to conduct the Phone Screen:
_____ YES _____ NO

Verbal Assent was given to:

_____
Staff Member Signature

_____
Date Verbal Consent was given:

Eligible based on telephone screening: θ Yes θ No
If "No", list reason for ineligibility: _____

Ask the following questions about the child.

1. Gender: θ Male θ Female

2.a. Age: θθ **(9-12)** 2.b. Date of Birth: θθ/θθ/θθ

3. Which of the following best describes your child's racial heritage? (you may choose more than one category):
   - θ American Indian or Alaska Native
   - θ Asian
   - θ Black or African-American
   - θ Hispanic, Latino, or Cape Verdean
   - θ Native Hawaiian or Other Pacific Islander
   - θ White
   - θ Other (Specify:_____)

4. Current Weight: θθθ pounds ***Office Use: BMI Percentile for Age and Gender*** = _____

5. Current Height: θ feet θθ inches

6. Is your child able to walk for exercise? θ **YES** θ No
   If "no", specify reason: _____

7. Have you ever been told by a doctor or other medical person that your child has any of the following conditions? If "yes", Specify:

a. Heart Disease	θ Yes	θ **NO**	_____
b. Angina	θ Yes	θ **NO**	_____
c. Hypertension	θ Yes	θ **NO**	_____
d. Heart Attack	θ Yes	θ **NO**	_____
e. Stroke	θ Yes	θ **NO**	_____
f. Diabetes (sugar)	θ Yes	θ **NO**	_____
g. Cancer	θ Yes	θ **NO**	_____

9. Is your child presently being treated by a doctor or other medical person for any other physical or psychological problems? θ Yes θ **NO**
   If "yes", specify: _____

10. Does your child take any prescription medications? θ Yes θ **NO**
    If "yes", specify the following:

Medication Name	Used to Treat:

15. Is your child currently participating in other research studies? θ Yes θ **NO**
    If "yes", specify: _____

Contact Tracking Form

** THIS PAGE IS COMPLETED ONLY IF THE RESPONDENT APPEARS TO QUALIFY FOR PARTICIPATION IN THIS STUDY AND IS SCHEDULE FOR THE ORIENTATION VISIT. **

4. **Date: ____/____/____ Staff Member Completing Form: _____**

Name of Parent: _____

Name of Child: _____

Street Address: _____

City: _____ State: ___ Zip Code:_____

Home Phone: _____ Work Phone: _____

OFFICE USE ONLY:

Eligible: θ Yes θ No

Invited to Orientation: θ Yes θ No

Date of Orientation:____/____/____

If eligible schedule the participant for their group orientation session based on the schedule of available dates. A follow-up reminder will be send via the mail.

PAGE 1 WILL BE RETAINED FOR DEMOGRAPHIC STATISTICS

PAGES 2-3 MUST BE SHREDDED AT THE CONCLUSION OF THIS INTERVIEW

APPENDIX B

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

Physical Activity Readiness Questionnaire (PAR-Q)

Subject ID: _____

Please read the questions carefully and answer each one honestly: check YES or NO

1. Has your doctor ever said that your child has a heart condition and that he/she should only do physical activity recommended by a doctor?

   oyes ono

2. Does your child feel pain in his/her chest when he/she does physical activity?

   oyes ono

3. In the past month, has your child had chest pain when he/she was not doing physical activity?

   oyes ono

4. Does your child lose his/her balance because of dizziness or does he/she ever lose consciousness?

   oyes ono

5. Does your child have a bone or joint problem that could be made worse by a change in his/her physical activity?

   oyes ono

6. Is your doctor currently prescribing drugs (for example, water pills) to your child for blood pressure or a heart condition?

   oyes ono

7. Do you know of any other reason why your child should not do physical activity?

   oyes ono

Reference: American Medical Association: Guides to the Evaluation of Permanent Impairment. AMA, Chicago, 1990.

APPENDIX C

CHILD AND PARENT/GUARDIAN CONSENT FORM

Approval Date: February 29, 2008
Renewal Date: February 28, 2009
University of Pittsburgh
Institutional Review Board
IRB #0704004

CONSENT FOR A CHILD TO BE A PARTICIPANT IN A RESEARCH STUDY

TITLE: Energy Expenditure in Severely Overweight Children

PRINCIPLE INVESTIGATOR: Marsha D. Marcus, Ph.D.
Professor of Psychiatry and Psychology Chief,
Behavioral Medicine and Eating Disorders Program
Western Psychiatric Institute and Clinic,
University of Pittsburgh Medical Center
Telephone: 412-246-6371

CO-INVESTIGATORS: John M. Jakicic, Ph.D.
Chair and Associate Professor,
Department of Health & Physical Activity
Director, Physical Activity and Weight Management Research Center
University of Pittsburgh
Telephone: 412-488-4182

Melissa A. Kalarchian, Ph.D.
Assistant Professor of Psychiatry and Psychology
Western Psychiatric Institute and Clinic,
University of Pittsburgh Medical Center
Telephone: 412-647-6530

SOURCE OF SUPPORT: Pittsburgh Mind Body Center

What is this study about and why is it being done?

Drs. Marcus, Jakicic, and Kalarchian are conducting a study of severe overweight in children aged 8 to 12. In this study, a definition of severe overweight in children will be based on BMI (body mass index), a measure of weight based on height. Children will be considered to have met the criterion for severe overweight if BMI is equal to or above the 97th percentile for the child's age and sex. This research study is for the purpose of developing techniques for helping overweight children become more physically active.

Who is being asked to take part in this research study?

You and your child have been invited to participate in this study of approximately 30 children because your child is between the ages of 8 and 12 and suffers from severe overweight.

What procedures will be performed for research purposes?

This study will include a total of 6 visits to the clinic: one orientation session (including some screening procedures) and two phases. Phase 1 will consist of three separate clinic visits. Each visit, including the orientation session, will take approximately one hour to one hour and fifteen minutes, and all clinic visits, including introductory screening visit, must be at least 24 hours apart and not more than one week apart. One visit will be to pick up equipment that your child will use, Dance, Dance Revolution or the Kid's Walk indoor walking video, and Sony Play Station or DVD player, for Phase 2 activities. Lastly, one final visit will be for the purpose of returning study equipment to the clinic and completing questionnaires after Phase 2 is complete (explained below).

Screening Procedures:

During the orientation session, you and your child will attend a staff-led introduction. To confirm eligibility, your child will then have some screening measurements taken (height and weight), and you will complete a physical activity readiness questionnaire that will assess his or her medical history and readiness to complete physical activity. This is known as the PAR-Q, and will be completed prior to his or her participation in this study.

If your child exhibits any of the following, your child will be ineligible to participate in this study:

- orthopaedic, musculoskeletal, neurological, and/or medical conditions which prohibit exercise; this refers to injuries or disorders pertaining to bones, muscles, nerves, tendons, ligaments, joints, cartilage and spinal disc, or the nervous system;
- diabetes, hypothyroidism (an insufficient production of the thyroid hormone), or other medical conditions that affect energy metabolism;
- a history of cardiac conditions, also known as, heart conditions;
- systolic blood pressure (pertaining to the contraction phase of heart beat or the "top" number) greater than or equal to 140 mmHg or diastolic blood pressure (pertaining to resting or relaxation phase of heart beat or the "bottom" number) greater than or equal to 90 mmHg;
- is taking medication that may affect his or her heart rate or blood pressure;
- is classified as "high risk" with respect to cardiovascular (related to the heart and blood vessels), pulmonary (related to the lungs), metabolic (related to chemical reactions in the body, specifically nutrient absorption) disease, or orthopedic issues;

- any inability to complete the exercise sessions for this study.

Experimental Procedures:

In Phase 1, if eligible, your child will be introduced to both our measurement procedure of his/her energy expenditure and the first activity that he or she will complete, treadmill walking, during the orientation session. Before completing any activity, your child will sit still in a resting position during which he or she will be instructed not to move so that he or she can get used to the testing environment and any equipment we will be using, Viasys Oxycon Mobile, Sensewear Pro Armband, and Polar Heart Rate Monitor, which will be explained in further detail below.

During each of the following three clinic visits (all part of Phase 1), your child will partake in one of three physical activities: walking on a treadmill, exercising using "Dance, Dance Revolution", and exercising using "Kid's Walk" indoor walking video. During each visit, we will also adjust a piece of study equipment called SenseWear Pro Armband™ used to measure your child's unique energy expenditure so that we can get it ready for you to use for home assessments, which will take place in Phase 2 (explained below).

In addition, we will measure energy expenditure, the amount of energy, measured in calories, that your child uses, or calories your child "burns" using a method called indirect calorimetry. In order to do this, your child will wear the SenseWear Pro Armband™ and a face mask (Viasys Oxycon Mobile) while he or she performs the various study activities. A Polar Heart Rate Monitor will also be used to measure your child's heart rate while performing these activities.

In Phase 2 of the study, your child will be randomly assigned (a method using the same odds as flipping a coin) to participate in one of two activities that he or she preformed during Phase 1, either "Dance, Dance Revolution" or "Kid's Walk" indoor walking video. Dance, Dance Revolution is a music video game series that is commercially available and produced by Konami. The game is played on a dance pad with four arrow panels: left, down, up, and right. These panels are pressed using the player's feet, in response to arrows that appear on the screen in front of the player. The arrows are synchronized to the general rhythm or beat of a chosen song, and success is dependent on the player's ability to time his/her steps accordingly. Kid's Walk, by Leslie Sansone, is a commercially available video that uses choreographed routines for walking in place and is designed for use by children.

Your child will be instructed how to correctly perform the activity he or she is being assigned to complete and will be provided with the necessary equipment, Sony Play Station or DVD player and DVD/video, to perform these activities. You will be responsible for providing your child access to a TV that will allow

connection for this equipment. The equipment we provide your child in order to complete these tasks must be returned to the investigator at the end of the study.

Your child will then complete the task he or she was assigned, Dance, Dance Revolution or Kid's Walk, for a period of at least 30 minutes on 5 days during each week (10 days total across the 2 week period). During each activity session, your child will be instructed to wear the SenseWear Pro Armband that will record data, allowing us to have a record of your child's participation.

At the end of the two week period and no more than one week later, your child will complete a questionnaire evaluating his or her enjoyment of the activity assigned, as well as how well he or she adhered to the exercise plan and instructions. The questionnaire will take approximately 10 minutes to complete, and is included in the one hour to one hour and fifteen minute time expectancy for this visit.

What are the possible risks, side effects, and discomforts of this research study?

The risks of participation in the treadmill exercise sessions for children are those associated with any recreation program, including the possibilities of injury, soreness or fatigue as a result of play or structured activity. Additional risks of participating in these exercise sessions may include falling, muscle sprains, general muscle fatigue, and other common injuries that may occur with exercise. In the event that any of these occur during the exercise session, the exercise session will be terminated and you and your child will be advised to seek medical advice from your primary care physician. In the event that any of these result in a serious medical condition (e.g., broken bone, etc.) emergency medical personnel will be contacted to provide your child with appropriate medical treatment.

In addition, during exercise, your child's heart rate and blood pressure will increase, and under extreme conditions, this can lead to a serious cardiac event (i.e., heart attack). The risk of experiencing a serious cardiac event (e.g., heart attack) is rare (occurs in less than 1% or 1 out of 100 people). The possibility of experiencing a serious cardiac event has been estimated to be less than 1 per 20, 000 in exercising adults, with the risk being even lower in children. In the event that a serious cardiac event occurs, CPR will be initiated and continued until emergency medical personnel arrive to take over emergency procedures.

When energy expenditure is assessed, your child may experience a dry mouth due to the nature of the mouthpiece on the face mask (Viasys Oxycon Mobile). To minimize additional risks, study equipment will be sterilized prior to each use. There are no expected discomforts associated with the measurement of energy expenditure.

When wearing the Sensewear Pro Armband™ some people may experience mild skin irritation at the site where the armband is worn. One cause of skin irritation may be the build-up of sweat that can be trapped between the skin and the armband, which can cause pink pustules on a pink base of various sizes and shapes to appear. To minimize this risk, the sensing unit will be wiped with rubbing alcohol and dried thoroughly before each use.

Should your child experience any negative side effects during the study procedures, he or she will be able to stop the activity at any time.

What are the possible benefits from taking part in this study?

You or your child will receive no direct benefits for taking part in this research study. You may, however, benefit from gaining knowledge related to the exercise and activity monitors used in this research study.

If I agree to take part in this research study, will I be told of any new risks that may be found during the course of the study?

If any new information, good or bad, about the treadmill, "Kid's Walk" indoor walking video, or "Dance, Dance Revolution" comes to light that may affect your willingness to participate, you will be told.

Will my insurance provider or I be charged for the costs of any procedures performed as part of this research study?

None of the services and/or procedures, such as the exercise program and the monitoring of heart rate and energy expenditure, you receive during this research study will be billed to you or your health insurance. If you receive a bill or believe that your health insurance has been billed for something that is part of the research study, notify a member of the research team or UPMC Patient Billing Services.

Will I be paid if I take part in this research study?

You will receive $25 upon completion of each of two study phases and $50 upon completion of the study (after returning study equipment). These payments are intended to help with the expense of coming to the University for assessment appointments. Your child will receive $10 gift certificates upon completion of

each of two study phases and a $25 gift certificate upon completion of the study (after the returning study equipment).

How will my child's privacy rights be protected?

Under the Health Insurance Portability and Accountability Act (HIPAA), your child's records cannot be used for the research purposes of this study without your permission. You will be informed of the specific uses and disclosures of your child's records and medical information for the purpose of this research study and who will have access to your child's information. Your child will be assigned a unique ID number which will be used to identify his or her data without using his/her name. However, information linking your child's identifiable information to his or her unique ID number will be kept in a secure and locked location that only the Investigators and study staff will have access to.

Will this research study involve the use or disclosure of my child's identifiable medical information?

This research study will involve the recording of current and/or future identifiable medical information from your child's hospital and/or other (e.g., physician office) records. The information that will be recorded will be limited to information concerning your child's energy expenditure in calories and his or her heart rate. This information will be used for the purpose of measuring energy expenditure in overweight children during a heightened physical activity session and evaluating the accuracy of the device that we use to measure energy expenditure.

This research study will result in identifiable information that will be placed into your child's medical records held at the University of Pittsburgh Medical Center. The nature of the identifiable information resulting from your child's participation in this research study that will be recorded in your child's medical record includes all information collected for the study, including questionnaires.

Who will have access to my child's records or medical information related to his/her participation in this research study?

In general, research records are kept confidential. Paper records are stored in locked cabinets and computerized records are passwords protected. There are, however, some disclosures of your child's research-related medical information that may occur.

In addition to the investigators listed on the first page of this authorization form and their research staff, the following persons may have access to your child's

identifiable private health information related to your child's participation in this research study.

- Authorized representatives of the University of Pittsburgh Research Conduct and Compliance Office may review your child's identifiable research information (which may include his or her identifiable medical information) for the purpose of monitoring the appropriate conduct of this research study. In unusual cases, the investigators may be required to release identifiable information (which may include your child's identifiable medical information) related to his or her participation in this research study in response to an order from a court of law. If the investigators learn that your child or someone with whom your child is involved is in serious danger or potential harm, they will need to inform, as required by Pennsylvania law, the appropriate agencies.

- Authorized representatives of the sponsor of this research study, the Pittsburgh Mind Body Center, will review and/or obtain identifiable information (which may include your child's identifiable medical information) related to his or her participation in this research study for the purpose of monitoring the accuracy and completeness of the research data and for performing required scientific analyses of the research data.

  Authorized representatives of the study sponsor may also be present during your participation in certain research procedures. While the study sponsor understands the importance of maintaining the confidentiality of your child's identifiable research and medical information, the UPMC and University of Pittsburgh cannot guarantee the confidentiality of this information after it has been obtained by the study sponsor.

  The investigators involved in the conduct of this research study may receive funding from the sponsor to perform the research procedures and to provide the sponsor with identifiable research and medical information related to your participation in the study.

- Authorized representatives of the University of Pittsburgh Institutional Review Board. The IRB is responsible for assuring the ethical conduct of research at Children's Hospital of Pittsburgh. The IRB sometime asks for names and addresses and telephone numbers of research subjects. By agreeing to participate in this study, you also agree that representatives of the IRB can contact you. Of course, you don't have to answer the committee's questions if you don't want to.
- Authorized representatives or the Office for Human Research Protections (OHRP) may review and/or obtain your child's identifiable health information for the purpose of ensuring that the research is being conducted according to the Department of Health and Human Services Guidelines. While the OHRP has provided its assurance that it will not release your child's identifiable

medical information to anyone else, the University of Pittsburgh cannot guarantee this.

In unusual cases, the investigators may be required to release your child's research information in response to a court order. Research investigators may be required under Pennsylvania law to report any suspicion of child abuse to child protection services. If the investigators learn that your child or someone with whom your child is involved is in serious danger of potential severe harm, they may need to warn those who are in danger and contact other agencies to ensure safety.

May I have access to my child's records resulting from participation in this research study?

In accordance with the UPMC Notices of Privacy Practices document that you and your child have been provided, you are permitted access to your child's information (including information resulting from his or her participation in this research study) contained within his or her medical records filed with his or her health care provider unless otherwise specifically stated below.

May I stop my child's participation in this study and may I withdraw permission for the use of my child's medical information for the purpose of this research study?

You have the right to stop your child's participation in this study at any time. Additionally, you may withdraw, at any time, your permission for the use of your child's medical information for the purpose of this research study. Of course, if you withdraw your permission for the use of your child's health information, your child may no longer participate in this research study. To the extent that researchers have already used your child's health information in data analysis and/or scientific publication, this information cannot be withdrawn (although any publication of information will be such that your child's information will not be identifiable). If you decide to withdraw your permission you should notify one of the investigators listed on the front page of this document in writing along with the date of your decision. Your decision to withdraw your permission for the use of your child's private health information for this research study will have no effect on you or your child's current or future medical care at UPMC hospitals or affiliated health providers or the University of Pittsburgh.

If agree to have my child participate in this study, can he or she be removed from the study without my consent?

Your child may be removed from the study without your consent if your child does not follow instructions given to them by the study investigator.

For how long will the investigators be permitted to use my child's identifiable health information?

The investigators may continue to use and disclose, for the purposes described above, identifiable information (which may include your child's identifiable medical information) related to your child's participation in this research study until the end of this study. Also, it is a University policy that all research records must be maintained for at least 5 years following study completion.

Will there be any compensation if my child is injured or becomes ill as a result of participating in this study?

University of Pittsburgh researchers and their associates who provide services at University of Pittsburgh Medical Center (UPMC) recognize the importance of your voluntary participation in their research studies. These individuals and their staffs will make reasonable efforts to minimize, control, and treat any injuries that may arise as a result of this research. If you believe that your child is injured as a result of the research procedures being performed, please contact immediately the Principal Investigator listed on the first page of this form.

Emergency medical treatment for injuries solely and directly related to your child's participation in this research study will be provided to him or her by the hospitals of UPMC. It is possible that UPMC may bill your insurance provider for the costs of this emergency treatment, but none of these costs will be charged directly to you. If your child's research-related injury requires medical care beyond this emergency treatment, you will be responsible for the costs of this follow-up care unless otherwise specifically stated below. There is no plan for monetary compensation. You do not, however, waive any legal rights by signing this form.

****

****

VOLUNTARY CONSENT AND AUTHORIZATION

I have read this form, or it has been read to me. All of my current questions have been answered. I will be given a copy of this form for future reference. I understand that throughout my child's participation in this research, I am encouraged to ask any additional questions I may have about the research and use of my child's identifiable private health information. Dr. Marsha Marcus (412-246-6371), Dr. John Jakicic (412-648-4517), or Dr. Melissa Kalarchian (412-647-6530) will be available for questions about this research, my child's rights, and any possible research-related injury. I may also call the Human Subjects Protection Advocate at the University of Pittsburgh IRB Office (1-866-212-2668) concerning questions about my child's rights as a research subject. By signing this form, I agree to permit my child to participate in this research.

Consent for Child's Participation

Printed Name of Child (Research Subject): _____

Printed Name of Parent(s) or Guardian(s): _____

_____

I understand that, as a minor (age less than 18 years), the above-named child is not permitted to participate in this research study without my consent. Therefore, by signing this form, I give my consent for his/her participation in this research study.

_____ _____
Parent or Guardian's Signature Date

_____ _____
Parent or Guardian's Signature Date

CERTIFICATION of INFORMED CONSENT

"I certify that I have explained the nature and purpose of this research study to the above-named individual(s), and I have discussed the potential benefits and possible risks of study participation. Any questions the individual(s) have about this study have been answered, and we will always be available to address future questions, concerns or complaints as they arise. I further certify that no research component of this protocol was begun until after this consent form was signed."

_____	_____
Printed Name of Person Obtaining Consent	Role in Research Study
_____	_____
Signature of Person Obtaining Consent	Date

APPENDIX D

TREADMILL WALK DATA FORM

Treadmill Protocol

ID#: _____ Date: _____

DOB: _____ Age: _____ Dominant hand (circle): R or L Armband #: _____

Height (cm): _____ Height (in): _____ Weight (lbs): _____ Weight (kg): _____

Time (minutes)	Speed (mph)	Grade (%)	Heart Rate (bpm)
0:00 – 1:00	Seated		
1:00 – 2:00	Seated		
2:00 – 3:00	Seated		
3:00 – 4:00	Seated		
4:00 – **5:00**	Seated		
5:00 – 6:00	3.0	0.0	
6:00 – 7:00	3.0	0.0	
7:00 – 8:00	3.0	0.0	
8:00 – 9:00	3.0	0.0	
9:00 – 10:00	3.0	0.0	
10:00 – 11:00	3.0	0.0	
11:00 – 12:00	3.0	0.0	
12:00 – 13:00	3.0	0.0	
13:00 – 14:00	3.0	0.0	
14:00 – 15:00	3.0	0.0	
15:00 – 16:00	3.0	0.0	
16:00 – 17:00	3.0	0.0	
17:00 – 18:00	3.0	0.0	
18:00 – 19:00	3.0	0.0	
19:00 – **20:00**	3.0	0.0	
20:00 – 21:00	Seated		
21:00 – 22:00	Seated		
22:00 – 23:00	Seated		
23:00 – 24:00	Seated		
24:00 – **25:00**	Seated		

** Be sure to timestamp Armband at when at 0:00, 5:00, 20:00 and 25:00 minutes

Additional Comments:

APPENDIX E

WALK VIDEO DATA FORM

Walking Video Protocol

ID#: _____ Date: _____

DOB: _____ Age: _____ Dominant hand (circle): R or L Armband #: _____

Height (cm): _____ Height (in): _____ Weight (lbs): _____ Weight (kg): _____

Time (minutes)	Walk Segment	Heart Rate (bpm)
0:00 – 1:00	Seated	
1:00 – 2:00	Seated	
2:00 – 3:00	Seated	
3:00 – 4:00	Seated	
4:00 – **5:00**	Seated	
5:00 – 6:00	Kids Walk	
6:00 – 7:00	Kids Walk	
7:00 – 8:00	Kids Walk	
8:00 – 9:00	Kids Walk	
9:00 – 10:00	Kids Walk	
10:00 – 11:00	Kids Walk	
11:00 – 12:00	Kids Walk	
12:00 – 13:00	Kids Walk	
13:00 – 14:00	Kids Walk	
14:00 – 15:00	Kids Walk	
15:00 – 16:00	Street Walk	
16:00 – 17:00	Street Walk	
17:00 – 18:00	Street Walk	
18:00 – 19:00	Street Walk	
19:00 – **20:00**	Street Walk	
20:00 – 21:00	Seated	
21:00 – 22:00	Seated	
22:00 – 23:00	Seated	
23:00 – 24:00	Seated	
24:00 – **25:00**	Seated	

** Be sure to timestamp Armband at when at 0:00, 5:00, 21:00 and 25:00 minutes

Additional Comments:

APPENDIX F

DANCE, DANCE REVOLUTION DATA FORM

DDR Protocol

ID#: _____ Date: _____

DOB: _____ Age: _____ Dominant hand (circle): R or L Armband #: _____

Height (cm): _____ Height (in): _____ Weight (lbs): _____ Weight (kg): _____

Time (minutes)	Dance Song	Heart Rate (bpm)
0:00 – 1:00	Seated	
1:00 – 2:00	Seated	
2:00 – 3:00	Seated	
3:00 – 4:00	Seated	
4:00 – **5:00**	Seated	
5:00 – 6:00	Kelly Clarkson	
6:00 – 7:00	Funkytown	
7:00 – 8:00		
8:00 – 9:00	Video Radio Star	
9:00 – 10:00	Let's Shout	
10:00 – 11:00		
11:00 – 12:00	Battle	
12:00 – 13:00	Centerfold	
13:00 – 14:00		
14:00 – 15:00	Turn on the Radio	
15:00 – 16:00	Let's Dance	
16:00 – 17:00		
17:00 – 18:00	Do You Wanna	
18:00 – 19:00		
19:00 – **20:00**	Kelly Clarkson	
20:00 – 21:00	Seated	
21:00 – 22:00	Seated	
22:00 – 23:00	Seated	
23:00 – 24:00	Seated	
24:00 – **25:00**	Seated	

** Be sure to timestamp Armband at when at 0:00, 5:00, 21:00 and 25:00 minutes

Additional Comments:

APPENDIX G

PHYSICAL ACTIVITY ENJOYMENT QUESTIONNAIRE

Office Use Only			
Subject ID #:		**Assessment #:**	

Physical Activity Enjoyment Scale

	Disagree a Lot	Disagree	Do Not Agree or Disagree	Agree	Agree a Lot
1. When I participated in this activity I enjoy it.	☐1	☐2	☐3	☐4	☐5
2. When I participated in this activity I felt bored.	☐1	☐2	☐3	☐4	☐5
3. When I participated in this activity I disliked it.	☐1	☐2	☐3	☐4	☐5
4. When I participated in this activity I found it pleasurable.	☐1	☐2	☐3	☐4	☐5
5. When I participated in this activity it was no fun at all.	☐1	☐2	☐3	☐4	☐5
6. When I participated in this activity it gave me energy.	☐1	☐2	☐3	☐4	☐5
7. When I participated in this activity it made me sad.	☐1	☐2	☐3	☐4	☐5
8. When I participated in this activity it was very pleasant.	☐1	☐2	☐3	☐4	☐5
9. When I participated in this activity it made my body feel good.	☐1	☐2	☐3	☐4	☐5
10. When I participated in this activity I got something out of it.	☐1	☐2	☐3	☐4	☐5
11. When I participated in this activity it was very exciting.	☐1	☐2	☐3	☐4	☐5
12. When I participated in this activity it frustrated me.	☐1	☐2	☐3	☐4	☐5
13. When I participated in this activity it was not at all interesting.	☐1	☐2	☐3	☐4	☐5
14. When I participated in this activity it made me feel successful.	☐1	☐2	☐3	☐4	☐5
15. When I participated in this activity it felt good.	☐1	☐2	☐3	☐4	☐5
16. When I participated in this activity I felt like I would rather be doing something else.	☐1	☐2	☐3	☐4	☐5

Adapted from: Motl et al. Measuring enjoyment of physical activity in adolescent girls. *Am J Prev Med*. 2001; 21(2): 110-117.

APPENDIX H

STATISTICAL TABLES

H.1 Comparison of Total Energy Expenditure Between Modes of Physical Activity

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
EnergyExpenditure	Sphericity Assumed	1602.616	2	801.308	2.372	.115	.165
	Greenhouse-Geisser	1602.616	1.147	1397.445	2.372	.144	.165
	Huynh-Feldt	1602.616	1.189	1347.429	2.372	.143	.165
	Lower-bound	1602.616	1.000	1602.616	2.372	.149	.165
Error(EnergyExpenditure)	Sphericity Assumed	8106.308	24	337.763			
	Greenhouse-Geisser	8106.308	13.762	589.043			
	Huynh-Feldt	8106.308	14.273	567.961			
	Lower-bound	8106.308	12.000	675.526			

H.2 Comparison of Total Energy Expenditure by Gender

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
EnergyExpenditure	Sphericity Assumed	1951.718	2	975.859	2.850	.079	.206
	Greenhouse-Geisser	1951.718	1.155	1689.161	2.850	.112	.206
	Huynh-Feldt	1951.718	1.323	1475.639	2.850	.105	.206
	Lower-bound	1951.718	1.000	1951.718	2.850	.119	.206
EnergyExpenditure * Gender	Sphericity Assumed	574.380	2	287.190	.839	.446	.071
	Greenhouse-Geisser	574.380	1.155	497.111	.839	.394	.071
	Huynh-Feldt	574.380	1.323	434.273	.839	.407	.071
	Lower-bound	574.380	1.000	574.380	.839	.379	.071
Error(EnergyExpenditure)	Sphericity Assumed	7531.929	22	342.360			
	Greenhouse-Geisser	7531.929	12.710	592.608			
	Huynh-Feldt	7531.929	14.549	517.698			
	Lower-bound	7531.929	11.000	684.721			

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	172398.042	1	172398.042	169.810	.000	.939
Gender	517.007	1	517.007	.509	.490	.044
Error	11167.635	11	1015.240			

H.3 Comparison of Enjoyment Between Modes of Physical Activity

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Enjoyment	Sphericity Assumed	534.533	2	267.267	8.128	.001	.300
	Greenhouse-Geisser	534.533	1.875	285.099	8.128	.002	.300
	Huynh-Feldt	534.533	2.000	267.267	8.128	.001	.300
	Lower-bound	534.533	1.000	534.533	8.128	.010	.300
Error(Enjoyment)	Sphericity Assumed	1249.467	38	32.881			
	Greenhouse-Geisser	1249.467	35.623	35.074			
	Huynh-Feldt	1249.467	38.000	32.881			
	Lower-bound	1249.467	19.000	65.761			

H.4 Comparison of Enjoyment By Gender

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Enjoyment	Sphericity Assumed	534.533	2	267.267	8.456	.001	.320
	Greenhouse-Geisser	534.533	1.931	276.795	8.456	.001	.320
	Huynh-Feldt	534.533	2.000	267.267	8.456	.001	.320
	Lower-bound	534.533	1.000	534.533	8.456	.009	.320
Enjoyment * Gender	Sphericity Assumed	111.600	2	55.800	1.765	.186	.089
	Greenhouse-Geisser	111.600	1.931	57.789	1.765	.187	.089
	Huynh-Feldt	111.600	2.000	55.800	1.765	.186	.089
	Lower-bound	111.600	1.000	111.600	1.765	.201	.089
Error(Enjoyment)	Sphericity Assumed	1137.867	36	31.607			
	Greenhouse-Geisser	1137.867	34.761	32.734			
	Huynh-Feldt	1137.867	36.000	31.607			
	Lower-bound	1137.867	18.000	63.215			

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	273240.017	1	273240.017	940.471	.000	.981
Gender	163.350	1	163.350	.562	.463	.030
Error	5229.633	18	290.535			

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