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Research Article

Famtastically Fit: The Effect of a Family Intervention on Body Composition, and Child Fitness

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Abstract

Purpose: The purpose of this intervention was to assess the effectiveness of a family-based fitness intervention on changes in physical activity, body composition, and child fitness status.

Methods: Participants consisted of 8 families; parents (n=9) who identified as sedentary and children (n=10) who were considered obese (> 93rd percentile). Families were asked to come once weekly for a 60-90 minute session involving separate but concurrently running exercise sessions for children and adults, parental health education, and a family group session for 10 weeks.

Results: Physical activity did not change significantly (p>.05) for parents or children over the course of the intervention. Children's sit-ups increased significantly (p=.04) by an average of 7.5 (9.5) sit-ups. Children (n=10) had significant differences in their lean mass (p=.000) and their BMC (p=.000), with females (n=4) having a slightly larger increase in lean mass (M=.85(±.48)) compared to their male (n=6) counterparts (M=.65(±.32)). Parental (n=8) changes in lean mass [M=.40(±.77), p=.18], fat mass [M=-1.3(±2.5), p=.18], and BMD [M=.005(±.01), p=.19] were all found to be not significant.

Conclusion: Teaching children basic muscular strength activities and how they can engage in physical activity throughout their day could have a positive effect on their lean mass and bone mineral composition.

Keywords: Family-based intervention; Body composition; Child fitness; Physical activity

Introduction

Childhood obesity has more than doubled in children and adolescents in the past 30 years, with more than one-third of our children considered overweight or obese [1]. Research suggests that overweight or obese children are five times more likely to become obese adults [2], and obesity-related conditions (i.e. heart disease, type 2 diabetes, and certain types of cancers) are now the leading cause of preventable death [3]. Obesity is most basically defined as having too much body fat [4] and is often measured using body mass index (BMI; body mass in kilograms divided by the square of body height in meters). Overweight for adults aged 20 and older is defined as having a BMI between 25.0 and 29.9; and a BMI of 30.0 or higher is considered obese. Children and adolescents age 2 to 20 years old are considered overweight with a BMI between the 85th to 94th percentiles and obese with a BMI in the 95th percentile or above [3].

Childhood obesity is a multifaceted phenomenon that can have detrimental effects on lifetime health. However, change in obesity status or weight loss alone may not have the most beneficial impact on overall health. Incorporating more physical activity and structured exercise into interventions to promote an increase in childhood physical fitness, compared to a decrease in weight status, could encourage more positive psychological and physiological benefits than a weight loss intervention. For example, a study examining the differences between obese individuals with high fitness levels (fitness assessed on maximal treadmill test) compared to obese individuals with low fitness levels found that the individuals with better fitness levels had lower risk (30-50%) of all-cause mortality, non-fatal and fatal heart disease, and cancer mortality than their lower fitness, obese counterparts [5]. Some research has suggested that higher aerobic fitness in childhood, independent of abdominal fat, can reduce the risk of developing metabolic syndrome by 36% compared to those children with lower levels of fitness [6].

Although physical activity and fitness are targeted in school through physical education, another avenue to increase children's fitness levels is through family-based interventions. As children's primary gatekeepers, parents' and caregivers' support for various behaviors could have a direct impact on the environment in which they create for their children. Recent family-based intervention studies have suggested that when parents are more active, their children tend to be more active [7,8]; this was found to be especially true for younger sedentary children [9] and for mothers that were more active [10]. A recent systematic review assessing the overall effectiveness of parental support and child weight loss interventions identified that face-to-face counseling was most effective in changing children's diet and group education was most effective concerning body weight, especially in low socioeconomic populations. Among the 35 studies they examined, they also found that intervention effectiveness was higher among younger children compared to older children [11]. Therefore, the purpose of this intervention was to assess the effectiveness of a face-to-face, family-based fitness intervention on changes in physical activity, body composition, and child fitness

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Table 1: Descriptive characteristics.

Measure	Children (n=10) Mean (SD)	Parents (n=9) Mean (SD)
Age (yrs)	8.5 (1.78)	38.6 (6.54)
Gender, n *Male, Female*	6, 4	8, 1
Race/Ethnicity, n *Caucasian, African American*	8, 2	8, 1
Parental Education, n *High School* *Bachelor's* *Master's* *PhD*	- - - -	2 3 3 1
Parental Work Status, n *Part-time* *Full-time*	- -	1 8
Baseline BMI*	96.9 (1.87)	33.1 (6.70)
Baseline Moves	15794(±609.8)	13137(±109.7)

Baseline BMI for children is provided as a BMI percentile as outlined by the Centers for Disease Control and Prevention classification's age- and sex-specific BMI cutoff points for 'normal weight' (84th percentile and below), 'overweight' (85th to 94th percentile) and 'obese' (95th and above).

status.

Materials and Methods

Participants and setting

Families were recruited from community *via* flyers, email blasts, and social media. All families that had a least one child between the ages of 5-12 with a BMI over the 85th percentile and at least one parent willing to participate were invited to join the study. The participating parent(s) identified as being sedentary (i.e. participating in structured exercise no more than 1 day per week). This cohort initially consisted of 8 families; 9 parents (8 mothers and 1 father) and 10 children (6 males and 4 females); however, 1 mother was unable to complete post measures due to possible pregnancy. All 9 parents consented for their family and all 10 children assented to be in the study. Ethical approval was obtained from the university's Human Research Ethics Committee prior to recruitment. Families were asked to meet once per week for approximately 60-90 minutes. The following procedures are a subset of this study's methodology and procedures that directly pertains to the physical activity, body composition, and child fitness component of this study. A detailed description of this intervention's procedures and methodology is published as a separate entity [12].

Procedures

This family-based fitness intervention consisted of once weekly sessions for 10 weeks. All sessions took place in 2 university laboratories. Orientation sessions prior to the intervention consisted of obtaining informed consent for both parent and child, completion of the Physical Activity Readiness Questionnaire (PAR-Q) for adults [13] and a PAR-Q adapted for children [14]. Baseline assessments included: demographic information from parents, height and weight assessments on both parent and children, DEXA scans for all participants, FITGRAM testing for children, and a MOVband orientation.

Sessions were approximately 60-90 minutes in duration; with the first 40-45 minutes the parents and children in separate but concurrently run sessions. Parent sessions consisted of cardiovascular and resistance-training exercises that focused on teaching basic movements (i.e. squats, lunges, planks, overhead press) that were body weight movements or used minimal equipment and how these movements could be implemented outside of the intervention. These exercise sessions were followed by short (6-10 minute) education sessions, consisting of: health implications of sedentary behavior, nutrition, goal setting, self-regulation techniques, time management, relapse prevention, social support, and reinforcements.

Child sessions were approximately 15 minutes in duration of structured lessons that focused on fitness education, motor skill development, and strategies for implementation outside of the intervention. These sessions included: how to be more active throughout your day, muscular strength oriented lessons, cardiovascular oriented lessons and child-led lessons. Muscular strength lessons focused on learning how to do various body weight exercises (push-ups, squats, lunges, sit-ups) and what area of the body each exercise was targeting (arms, stomach, legs). Cardiovascular oriented lessons focused on learning about different ways (running, quick step-ups, agility ladders, and jumping rope) to exercise their heart and lungs. Child-led lessons allowed children to design exercises that targeted different parts of the body and how they thought they could be more active throughout their day. Each 15-minute lesson was followed by approximately 25-30 minutes of free play.

For the final 15-20 minutes of each session, the family was brought back together for a group session. Group sessions consisted of going over weekly self-regulation logs and making individual and family-based goals, providing recommendations for exercise outside of the intervention, tips to help begin implementing lessons learned within the household. Every week during group sessions, a researcher helped the family develop a plan of action for the upcoming week. This action plan was in the form of a weekly calendar and included daily goals, example exercise sessions that incorporated movements learned, and family physical activity ideas (i.e. walk to park, hiking, swimming, etc.). These family action plans were created using suggestions from both parents and their children. Nutrition education was primarily focused on offering healthy options (i.e. fresh fruits, vegetable; meat, low-processed carbohydrates and water) versus food restriction.

To promote self-monitoring and completion of self-regulation logs, research personnel reviewed the previous week's logs with each individual and helped set individual and family-based goals for the upcoming week. Individual goals were personalized and based on what that individual had done previously and what they hoped to accomplish. Family-based goals were created to promote accountability within the family. Recommendations for exercise and physical activity outside of the intervention were based on what had been learned in the exercise sessions and what resources the family had available. Post-testing began 1 week following the cessation of the intervention and consisted of height and weight assessments on parent and children, DEXA scans for all participants, child FITNESSGRAM testing, and a final MOVband download.

Dual-Energy X-ray Absorptiometry

Anthropometric measures were collected prior to body composition scanning. Both parent's and children's weight were assessed with a calibrated electronic scale (Michelli Scales, Harahan, LA) to the nearest 0.1 kg and height measured to the nearest 0.25 in using a standiometer. Body composition assessment was performed prior to beginning the intervention and following the intervention employing the GE iDEXA scanner (GE Healthcare Lunar, Madison, Wisconsin). Variables for data analysis include change in overall fat mass, lean mass, segmental analysis (i.e. arms, legs, and trunk), and Bone Mineral Content (BMC) for children and Bone Mineral Density (BMD) for parents from the pre- and post-intervention assessments. BMC is reported for children because DEXA-derived BMD is an aerial BMD (aBMD) rather than a true volumetric BMD (BMD= BMC/Bone Area); therefore, irregular bone growth and size of bones in children will be found to have a lower aBMD than larger bones even if their volumetric BMD is the same, resulting in possible error when reporting BMD as opposed to BMC [15]. Qualified research personnel carried out all iDEXA measurements.

Physical Activity Data

Physical Activity data was collected using the MOVABLE MOVband3 activity tracker (Dynamic Health Solutions, LLC, Houston, Texas). The MOVband3 utilizes tri- axial accelerometery and demographic information to estimate "moves" or physical activity during a 24-hour period. Each participant's demographic information (height, weight, birth date, and sex) was used to calibrate the activity tracker. Participating parents and children were given a MOVband3 during the week prior to the intervention and were instructed to wear the activity tracker on their wrist during the day; taking the activity tracker off only for water-based activities. Participants were instructed to continue wearing the activity tracker throughout the duration of the 9-week intervention.

Fitness

Children were asked to complete the FITNESSGRAM pre- and post-intervention. The FITNESSGRAM is a series of health-related fitness activities to assess physical fitness in children. The three areas of assessment are cardiovascular endurance, muscular strength and endurance, and flexibility. Pre- and post-intervention scores on cardiovascular endurance and muscular strength and endurance were used for data analysis. Cardiovascular endurance was assessed using the Progressive Aerobic Cardiovascular Endurance Run (PACER), which is a multistage fitness test adapted from the 20-meter shuttle run test. Muscular strength and endurance was assessed using the following: the curl-up (i.e. sit-up) test, in which children were asked to do as many curl- ups as possible at a specified pace; the push-up test, in which the child did as many push- ups as possible in cadence of 20 push-ups per minute until they (a) must stop to rest (b) do not achieve a 90-degree angle with elbows each rep (c) do not maintain correct body position or (d) do not extend arms fully [16].

Table 2: Body composition measures.

Measure (kgs)	Children (n=10) Mean (SD)		Parents (n=8) Mean (SD)	
	Pre	Post	Pre	Post
BMC/BMD[a]				
Total	0.92	0.95***	0.57	0.58
Male	0.82	0.86**		
Female	1.07	1.10*		
Lean Mass				
Total	21.5	22.3***	48.2	48.6
Male	19.9	20.5**		
Female	24.0	24.9*		
Fat Mass				
Total	17.8	17.4	34.0	32.6
Male	18.0	17.6		
Female	17.5	17.1		

*[a]bone Mineral Content (BMC) given for children, Bone Mineral Density (BMD) given for parents. ***p=0.000; **p≤ 0.01; *p≤ 0.05.*

Statistical analysis

All body composition and fitness measures were analyzed using paired t-tests in IBM SPSS Statistics 23 for Windows©, while changes in daily physical activity was a subset from a linear mixed-effect regression analysis using R and R Studio. Descriptive information for participants is provided in (Table 1). All significance testing was set at p=0.05.

Results

Over the course of the intervention physical activity did not change significantly (p>.05) for parents or children. However, our results indicated some changes in child fitness as measured by the FITNESSGRAM. The children's sit-ups increased significantly (p=.04) by an average of 7.5 (9.5) sit-ups, while there were no significant differences in their PACER (p=.51) or push-ups (p=.77).

In examining body composition measures (Table 2), children (n=10) had significant differences in their lean mass (p=.000) and their BMC (p=.000), with no significant changes in overall fat mass (p=.08).

In an effort to identify where in the body these lean mass changes occurred, we conducted a segmental analysis to examine differences in the lean mass (kgs) changes in their arms, legs, and trunks. As a group, their increases in arms [M=.19(±.21), p=.10], legs [M=.59(±1.0), p=.09], and trunks [M=.06(±.82), p=.83] were not found to be significant. When examining gender differences in lean mass, female children had a significant (p=.04) increase in overall lean mass (M=.85(±.48)). Their changes in arms [M= -.03(±.08), p=.60], legs [M=.83(±1.2), p=.26], and trunks [M=.05(±.75), p=.91] were not found to be significant. Male children also had significant changes in overall lean mass [M=.65(±.32), p=.004] and arm lean mass [M=.22(±.21), p=.05], with changes in legs [M=.43(±.93), p=.31] and trunks [M=.07(±.95), p=.87] not significant. Overall the children's BMC (kgs) increased [M=.04(±.02), p=.000], with both males [M=.04(±.02), p=.008] and females [M=.03(±.02), p=.04] increasing significantly. When examining body composition in parents (n=8), changes in lean mass [M=.40(±.77), p=.18], fat mass

[M=-1.3(±2.5), p=.18], and BMD [M=.005(±.01), p=.19] were all found to be not significant.

Discussion

This study examined the effects of a family fitness intervention on physical activity, body composition, and child fitness. Our results suggested that there were no significant changes in physical activity over the duration of the intervention. However, it is important to note that the baseline physical activity suggested that all of the participants were meeting step recommendations at the onset of the intervention. All parents claimed to meet inclusion criteria of being sedentary (i.e. engaging in structured exercise no more than 1 day per week) and the average BMI percentile for the participating children was 96.9 (±1.87).Although it cannot be assumed that parents not engaging in structured exercise sessions and children classified as obese are not physically active, it is important to note the possible novelty effect that the wrist-worn accelerometer had on their motivation for exercise. Reactivity to activity monitors has been documented for both adults and children [17-19]; however, such reactivity tends to be short-lived. It is possible that the activity monitor caused a reactive response; resulting in a baseline that was not representative of their habitual physical activity behavior.

Our body composition results suggested that parents did not experience any significant changes in fat mass, lean mass, or BMD; however, children experienced a significant increase in both lean mass (p=.000) and BMC (p=.000). This prompted further investigation by conducting a segment analysis to see if there was a significant area of the body (arms, legs, trunk) where these changes occurred. Our results suggested there were no significant differences between the children's arms, legs, and trunk lean mass changes, despite a significant increase (p=.04) in sit-up scores. Within the child weekly lessons, they learned about a variety of body weight exercises (i.e. squats, push-ups, planks, etc.). If children were engaging in more static muscular strength activities, this would not have been accurately represented in the accelerometer data and could account for the significant increase in lean mass and bone mineral content despite a lack of change in physical activity.

When examining differences in male and female children's lean mass changes, female children (n=4) had a slightly larger increase in lean mass (M=.85(±.48)) compared to their male (n=6) counterparts (M=.65(±.32)). The research surrounding body composition changes in children appear to be limited, with most authors citing significant changes in body composition (lean and fat mass) after a minimum of a 6- month intervention [20,21]. Morris et al. (1997) reported a significant increase in females (aged 9-10) lean body mass after a 10-month strength- focused intervention [22], while McWhannell et al. (2008) reported only a significant increase in BMC and no changes in fat or lean mass after a 9-week structured exercise intervention [23]. Within the children's muscular strength lessons, we focused on body weight exercises such as squats, lunges, planks, and push-ups. The muscular strength-oriented activity experienced during the intervention could have amplified their lean mass response during a short-duration intervention. Additionally, a study suggested that children who had lean mass increases during a 3-week intervention had the greatest reduction in fat mass at their 5-month follow-up [24]. This invention helped children develop a repertoire of physical activity and exercise skills and a rationale for why they are important. Their significant increases in lean mass and skill development could encourage a decrease in body fat and further engagement in physical activity post-intervention. Although we were unable to report significant changes in parents' fat and lean mass; it is important to note that parents' average fat mass (kgs) was 34.0(±8.9) at baseline and 32.6(±8.8) at post-test. Parents can play a significant role in their child's weight status [25,26] as parents' change in weight status has been suggested to significantly predict their child's change in weight status [27].

Limitations

The largest limitation that had the greatest impact on this intervention study was the small sample size. For this intervention, we recruited for 5 weeks by a variety of methods and estimated to reach more than 8,000 people. We received interest from 12 families *via* email (two didn't meet inclusion criteria; two had time conflicts), which resulted in eight families that participated One of the major factors affecting our recruitment may have been the possibility that parents were unable to identify if their child met the BMI inclusion criteria (>85th percentile), as all participating children were at least 93rd percentile with the average being in the 97th percentile. This is not a recent phenomenon and has been well documented [28-31]. Secondly, the short duration of the intervention could have played a role in the lack of significant body composition findings in both parents and children. Thirdly, we decided to incorporate food and beverage intake in the weekly self- regulation logs and nutrition education to promote healthy food choices within the family. By not using nutrition data in the quantitative analysis, the results of this study are unable to expand on possible associations with body composition changes. Lastly, this family-based fitness study did not employ a control or active-control group; therefore, the findings of this study are limited by the possibility that observed findings could be due to confounding variables not examined.

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