5-2013

The Effects of Increased Dietary Fiber on School-Aged Children's Quality of Life

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THE EFFECTS OF INCREASED DIETARY FIBER ON SCHOOL-AGED CHILDREN'S QUALITY OF LIFE

by

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A Thesis Submitted in Partial Fulfillment
Of the Requirements for a Degree with Honors
(Dietetics)

The College of Health and Human Sciences

Purdue University

May 2013

West Lafayette, Indiana

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INTRODUCTION

As many as 10% of children in the United States suffer from chronic constipation [1]. Children with chronic constipation tend to have a lower self-perceived quality of life than healthy children [1]. Constipation may track from childhood into adulthood. Adults who experience continued symptoms of constipation have a lower health-related quality of life (HRQOL) than adults who no longer experience constipation [2].

One commonly used recommended prevention and/or treatment option for constipation is the introduction of high-fiber foods into the diet[3]. Dietary fiber is inherent to many plant-based foods, such as whole grains, legumes, nuts, seeds, fruits and vegetables. Increasing children's consumption of these foods can help to prevent constipation. Many foods that are naturally high in dietary fiber also have high nutrient density and are therefore considered healthy food choices for children. However, more than 50% of all children in the U.S. do not meet the governmental dietary fiber intake recommendation (adequate intake (AI)) for dietary fiber [4]: which is 26g/day for females ages 9-13 years and 31 g/day for males ages 9-13 years, based on 14 g/day per 1,000 kcal of total energy consumed [5].

Although the importance of consuming high-fiber and nutrient-dense foods has been recommended by the U.S. government for several decades [6, 7], most children consume a significant portion of their daily calories from calorically dense, low-fiber

foods. For example, the five major food types providing the majority of calories in diets of two- to eighteen- year-olds are: grain desserts, pizza, soda, yeast breads, and chicken and chicken mixed dishes [8]. Furthermore, almost 40% of total energy consumed by children in this age range is from discretionary, or so called "empty calories," namely solid fats and added sugars (SoFAS)[8]. Nationally representative studies indicate that children's dietary fiber intake can be increased by increased consumption of foods with high fiber density [9]. If low-fiber snacks currently consumed by children, such as chips and low-fiber crackers, could be replaced with snack foods that are high in dietary fiber digestive health could be improved, which may in turn lead to higher HRQOL.

To date, limited data are available to document a beneficial effect of increasing dietary fiber consumption on children's self-rated HRQOL. In order to address this gap, the current study was designed to compare the self-rated HRQOL in a group of children consuming their regular snacks at school with the self-rated HRQOL of children consuming at least two high-fiber snacks per day. Considering the benefits of fiber on digestive health, even in the absence of constipation, improving bowel health by increasing fiber intake may be beneficial to children's HRQOL. The hypothesis tested was that providing high-fiber snacks will increase dietary fiber intake, which will in turn raise children's self-reported HRQOL even in the absence of constipation.

METHODS

This study was nested within a larger, randomized controlled, community-based nutrition intervention trial. The Institutional Review Board for Human Research (IRB) at Purdue University approved this study.

Participants and Recruitment

The Tippecanoe County school board, administrators, and teachers agreed to participate in this study. Participants (n= 77) were boys and girls attending a rural elementary school in northwestern Indiana. Participating children's racial and ethnic backgrounds were representative of the school population, and reflect the demographic of this area, which is predominantly white, (Table 1). Participants were recruited from eleven 3^{rd} – 5^{th} grade classrooms. The exclusion criteria for participants in this study were food allergies, digestive diseases such as Crohn's Disease or chronic diarrhea, and use of medication(s) that would alter/affect the child's digestive function. Children were recruited by posting flyers and distributing parental consent materials to children who showed interest in the study information displayed at the elementary school. Consented child-parent dyads provided basic socio-demographic information, using a questionnaire with standard questions adopted from the National Health and Nutrition Examination Survey.

Procedures

Participants were randomized by classroom into a control group and an intervention group. The intervention group received high-fiber snacks twice a day for eight weeks while the control group consumed their usual snack foods. Children in the intervention group received their snacks at the school on weekdays. Children's snack choices and consumption of the study foods was monitored by a research assistant. To continue providing high fiber snacks during the weekend days, weekend snacks were packed out for each participant, (two options per snack occasion, two snack occasions per day) each Friday during the study. Children were instructed to return all uneaten portions of the snacks to the researchers on the following Monday.

In addition to the observation and measurement of the study snacks consumed during school hours, usual dietary intake levels were calculated pre-intervention (baseline), mid-intervention (4 weeks), and post-intervention (8 weeks) using 2, 24-hour recalls, (one on a weekday and one on the weekend). Dietary intake estimates were calculating by averaging the reported dietary intake at each time period.

Questionnaires to measure quality of life

The PedsQL^{TM} Measurement Model is a validated tool used to assess HRQOL in healthy children as well as those who have chronic health conditions [10]. This survey can be employed to obtain children's self-reports as well as parent proxy-reports.

Children and parents completed the Pediatric Quality of Life Inventory (PedsQL) assessment tool at pre-intervention and at post-intervention. Both child and parent surveys were handed out during the same time periods: a week before the intervention began and the day after the intervention was complete. All pre-intervention surveys were returned within a week before the intervention began. All child post-intervention surveys were completed the day after the intervention ended. Parents were encouraged to return surveys in a timely manner. Parent surveys were completed and returned to the researchers within no more than three weeks. The pre-intervention PedsQL data represent the children's self-perceived HRQOL at baseline, while the post-intervention PedsQL data reflect the children's wellbeing while eating a higher fiber diet.

Each PedsQL survey is comprised of 23 questions divided into 4 sub-scales: physical functioning, emotional functioning, social functioning, and school functioning. Each of the 23 items is rated by the child (or parent) on a 0-4 scale, with zero indicating that the item is *Never an Issue* and four indicating that it is *Almost Always an Issue*. Survey answers are reverse scored and linearly transformed to a 0-100 scale. With this scaling, higher scores indicate better quality of life [10]. Based on the validated methods, scores for the four individual scales may be reported as a total score or as a physical and a psychosocial summary score. The psychosocial summary score is comprised of participants' responses to questions in the emotional, social, and school health scales. For a table reflecting the scoring scheme of the HRQOL, please refer to Table 2. The change

in scores between baseline and post-intervention were determined by computing a difference for each individual participant. These differences were then averaged for the intervention and control groups, respectively, and a two sided t-test was run to test the null hypothesis that the differences between baseline and post-intervention scores were equal to 0. In addition, parents and children completed a bowel regularity survey at baseline, mid-intervention, and post-intervention, however 5 or less reported having constipation at baseline or post intervention.

Study Foods

Children in the control group continued with their usual school snack procedures, which consisted predominantly of crackers, other baked goods, or chips. The snacks that were provided to the children in the intervention group were commercially available foods that were selected because they contained between 3 and 9 grams of fiber per serving. These included breakfast cereals, breads, crackers and cereal bars. Two snacks choices were provided at each snack occasion (morning and afternoon school snack) and the combined total fiber of the snacks was between 10 and 12 grams per day regardless of which snacks were chosen. In addition to the high-fiber snacks, one cup of skim milk was provided at each snack occasion to help children meet the possible increased need for fluid intake.

Measures and Statistical Analyses

Initially, 154 PedQL 4.0 surveys were collected (77 parent/child pairs). Not all participants answered each question when filling out the survey. Per the PedsQL 4.0 guidelines for interpretation and analysis of missing data, if >50% of the questions in a particular scale were not answered, the scale score was not computed, and this was considered "missing data". If ≤50% of the questions in a particular scale were left unanswered, this was classified as "skipped data" and the mean of the completed items in the scale were imputed to replace the skipped values.

Missing post-intervention QOL scores were imputed for children who completed the PedsQL at baseline but not post-intervention (n=9, 11.7%) using a simple linear regression analysis. In short, total, physical, and psychosocial scores were plotted with baseline being the independent variable and post-intervention scores the dependent variable. Using the resulting regression equation, we calculated the missing scores

RESULTS

The sample population included children ages 7 to 11 years (mean=9.3, SD=1) with 3 (4.5%) Asian, 1 (1.5%) black, 8 (12.1%) Hispanic, 46 (70%) white, 3 (4.5%) other and 5 (7.6%) failing to report a race. This representation of race was similar to the racial demographics reported by the school. The socio-demographic characteristics of the population are shown in Table 1. The reported ethnicity of the sample population was 10

Hispanic, 47 non-Hispanic and 9 failing to respond. There were 6 participants who reported having food allergies, 3 in the control group and 3 in the intervention group.

Due to small to medium correlations between parent and child scores, particularly in the intervention group, as well as small correlations between baseline and post-intervention scores for parents of children in the control group, and because subjects were of an appropriate age to reliably self-report HRQOL, the analysis was focused on children's responses[11]. Seven child participants (9.1%) were excluded from analysis due to missing PedsQL data at baseline or at both baseline and post-intervention, and 4 (5.2%) were removed due to outlying HRQOL values. Twenty-nine participants had missing data at either baseline *or* 8 weeks, with more missing data noted among parents (n=17) as opposed to children. Furthermore, 38.5% of parents in the control group had missing data, as compared to only 15.79% of parents in the treatment group. This may be because parents in the control group felt less involved in the study as their children did not receive any intervention aside from the questionnaires.

Nine participants exhibited skipped data, of these the majority were children (n=8). This likely resulted from children not feeling comfortable answering some questions, or not understanding how to interpret questions. When comparing frequency of skipped questions among the sub scales, we noted that children skipped 6 questions in the "physical functioning" section, 5 questions in the "emotional functioning" section, 2

questions in the “social functioning” sections and 2 questions in the “school functioning” section. After dropping 7 participants due to missing data and removing 4 participants with outlying PedsQL scores, there were 66 children with n= 32 boys. There were 33 participants in both the control and the intervention groups.

Fiber intake

Average daily dietary fiber intake is shown in Table 3. In diet-compliant participants who also completed the PedsQL assessment at baseline, fiber intake significantly increased in the intervention group by 2.41 grams (*p=0.0277)* from baseline to mid-intervention but returned to baseline levels after the intervention. The average fiber intake in the control group was maintained at approximately 10 grams/day throughout the study period. At baseline, fiber intake in the intervention group was significantly higher than in the control group (1.93 ± 4.41g, *p=0.035*), and due to the high-fiber study foods at mid-intervention fiber was 4.59 ± 4.52 g higher in the intervention vs. control group, (*p<0.001*). The change in average fiber intake from baseline to mid-intervention in the intervention as compared to the control group approached statistical significant as well, (2.53 grams, *p=0.0468*). Likewise, there was a significant difference in average fiber consumption (3.65 grams, *p=0.0138)* between mid-intervention and post-intervention for the intervention group. *See Figure 1*.

Health Related Quality of Life

The baseline PedsQL physical, psychosocial and total summary scores of the children were all compared between intervention and control. The psychosocial scores had a mean of 80.67 (±10.79) for the intervention and a mean of 78.13 (±15.6) for the control. The physical scores had a mean of 86.08 (±12.28) for the intervention group and a mean of 89.39 (±9.11) for the control group. The total scores had a mean of 82.55 (±10.51) for the intervention group and a mean of 82.95 (±11.89) for the control group. *See Figure 2.*

The post-intervention physical, psychosocial and total summary scores of the children were compared between the intervention and control groups as well. *See Figure 2.* The psychosocial scores had a mean of 85.88 (±9.76) for the intervention and a mean of 82.71 (±16.26) for the control. The physical scores had a mean of 93.01 (±6.78) for the intervention group and a mean of 91.33 (±10.76) for the control group. The total scores had a mean of 88.38 (±7.77) for the intervention group and a mean of 86.76 (±11.72) for the control group. For both the intervention and control groups, all scores increased significantly from baseline to post-intervention, with the exception of the control group physical score.

No significant differences between the intervention and the control group were observed for the three scale scores at baseline or at post-intervention. An ANOVA analysis on the difference between baseline and intervention physical scores using gender

and ethnicity as covariates showed no statistically significant effect on HRQOL. When the mean differences between baseline and post-intervention PedsQL scores for the intervention and control groups were compared, the changes in the total and psychosocial health summary scores were not significantly different between groups. However, the difference in the change in the physical health score was significantly greater in the intervention vs. control group, ($p=0.0309$). *See Figure 2.*

DISCUSSION

The study showed a significant increase in dietary fiber consumption when children were provided with two high-fiber snacks per day. HRQOL, as measured by the PedsQL, increased in children in the intervention group, which may be due to increased dietary fiber consumption. Children in the intervention group had a significantly greater increase in physical health scores post-intervention as compared to the control group. This finding was expected, as constipation likely has a greater effect on physical quality of life than on relationships and emotions. While only a few of the participants in this study reported suffering from constipation, it is plausible that increased dietary fiber would improve gastrointestinal function over-all, as reflected in higher physical HRQOL scores.

The study results show that children will consume more dietary fiber when high fiber snacks are served in school. However, nationally representative data analysis indicates that the vast majority of children do not usually consume high-fiber foods[12]. Changes

in school-feeding policies to increase the provision of high-fiber options to children at school during snacks and lunches would be highly beneficial in increasing dietary fiber intake. For instance, school cafeterias could serve sandwiches made with high fiber bread, rather than the refined-grain alternatives or high-fiber cereals at breakfast or snack time.

Constipation negatively affects physical well-being in children and when untreated, results in poor adult HRQOL as well. Increased dietary fiber intake has been found to help treat or prevent constipation. For instance, consumption of a fiber supplement containing up to 5g of fiber per day has been shown to alleviate functional constipation in children [13]. While this benefit is known, the most frequently consumed foods children are eating are high in calories and low in nutrients, including fiber [8].

As all dietary intervention studies, this study too had limitations. The length of the intervention (8 weeks) might have been too short to have shown the full possible effect of increasing dietary fiber intake on school-age children's physical and psychosocial well-being. Also, although the researchers tried to maximize the response rates for the questionnaires, several participants had to be excluded from the analysis due to missing data.

CONCLUSIONS

This study indicates that serving high-fiber snack foods at an elementary school was effective in significantly increasing consumption of dietary fiber and led to a higher physical quality of life score. Further research is needed to examine if the effect could be maximized by offering high fiber breakfast and lunch meals. Furthermore, longer intervention periods might potentially lead to greater reported health benefits.

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Table 1. Demographic Characteristics of the Sample Population and the School's Population

	Intervention (n=33)	Control (n=33)	Total Sample (n=66)	School Population (%) (n=1062)
Age				
Average	9.4	9.2	9.3	
SD	1.09	0.9	1	
Range	7-11	7-11	7-11	
Gender				
Male	15 (45.5)	17 (51.5)	32 (48.5)	
Female	18 (54.5)	16 (48.5)	34 (51.5)	
Race				
White	23 (69.7)	23 (69.7)	46 (69.7)	63.8
Black	0	1 (3.0)	1 (3.0)	4.6
Asian	3 (9.1)	0	3 (4.5)	7.8
Hispanic	3 (9.1)	5 (15.2)	8 (12.1)	17.9
Other	2 (6.1)	1 (3.0)	3 (4.5)	5.7
Missing	2 (6.1)	3 (9.1)	5 (7.6)	
Ethnicity				
Hispanic	4 (12.1)	6 (18.2)	10 (15.2)	
Non-Hispanic	27 (81.8)	20 (60.1)	47 (71.2)	
Missing	2 (6.1)	7 (21.2)	9 (13.6)	
Free/Reduced price meals*				
Free meals				432
Reduced price				57
Paid meals				573

* no information available for sample population, only for school-wide enrollment in the program

Table 2. Scoring scheme: Point allocation for each available response choice

	Never	**Almost Never**	**Sometimes**	**Often**	**Almost Always**
Raw Scores	0	1	2	3	4
Scaled Scores	100	75	50	25	0

Table 3. Fiber intake in the study population before, during, and after the nutrition intervention

Average Daily Dietary Fiber Intake (grams) (SD)					
Intervention group (n=34)			**Control Group (n=37)**		
Baseline	**Intervention**	**Directly post-intervention**	**Baseline**	**Intervention**	**Post Intervention**
12 (4.4)	14.5 (5)	11.1 (4.7)	10.1 (4.4)	9.9 (4)	9.9 (4.3)

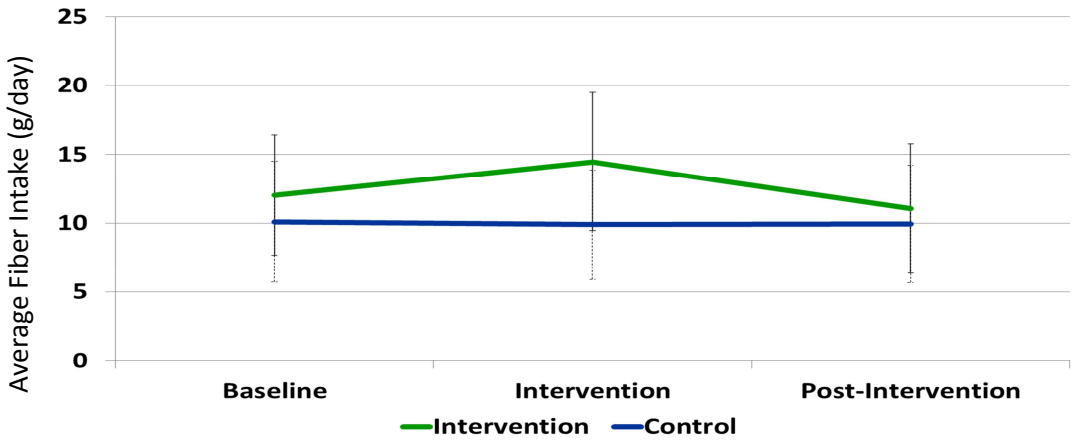

Figure 1. Fiber intake in intervention and control group at all time points

Total fiber increased significantly (p= 0.047) at week 4 in intervention group but went down significantly (p=0.014) post-intervention. Average fiber intakes are for all diet compliant participants from the larger study. Control Group: n=37 at baseline and intervention n=36 at post-intervention Intervention Group: n=34 at baseline and intervention n=32 at post-intervention.

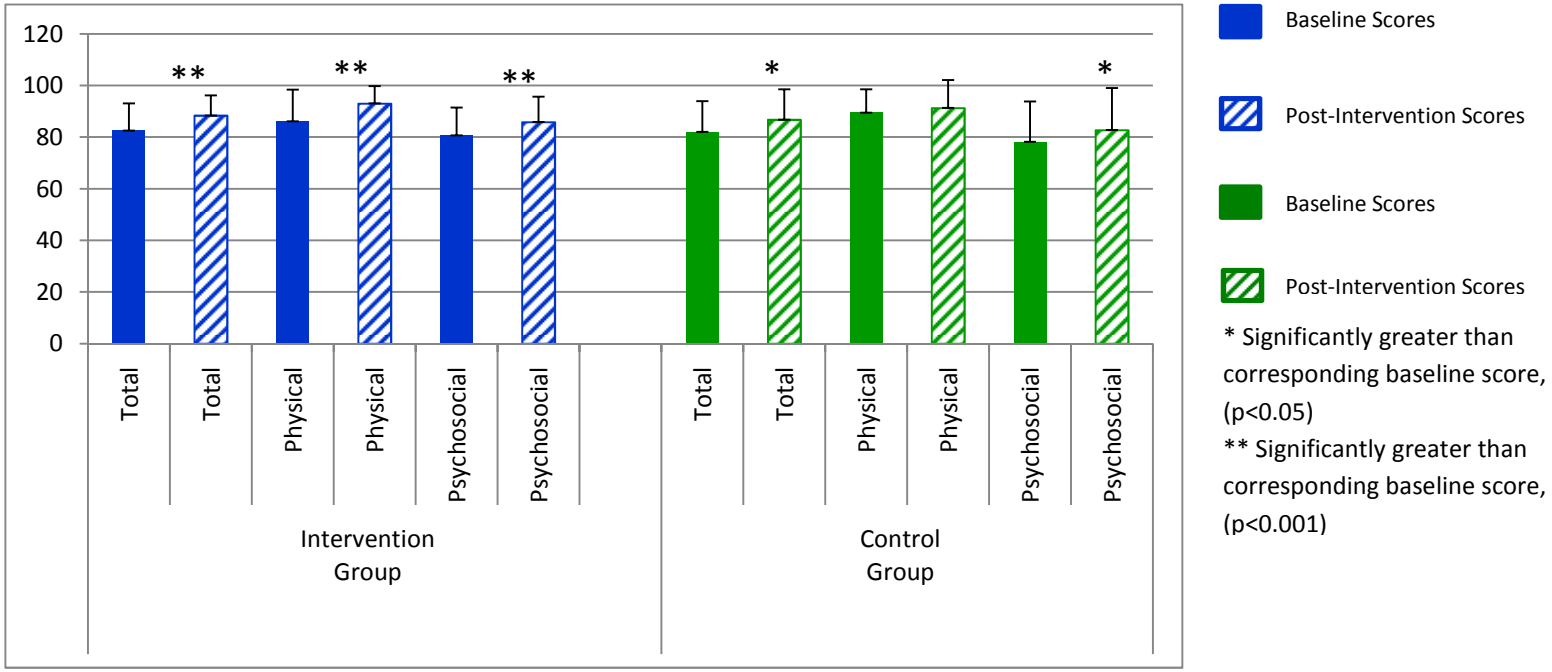

Figure 2. Total, Physical and Psychosocial PedsQL Scores all rose significantly from baseline to post-intervention in both the intervention and the control group, with the exception of the control group physical score.

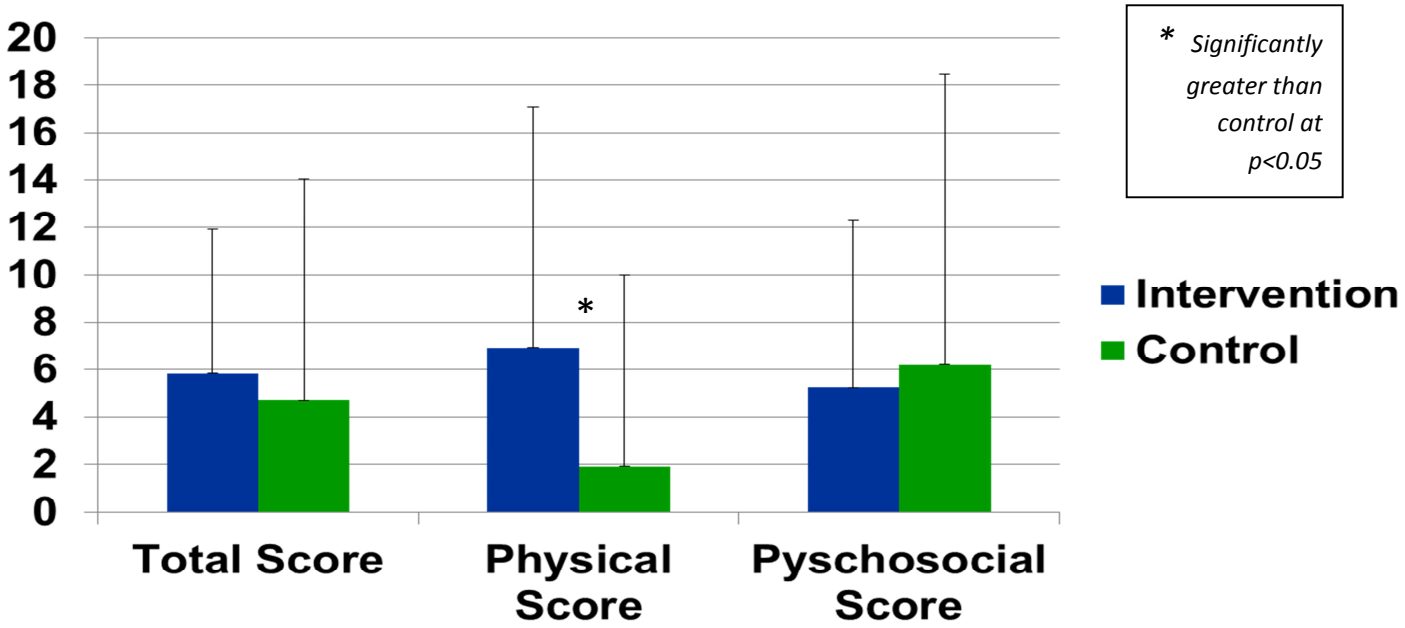

Figure 3. Mean Differences Between Baseline and Post-Intervention PedsQL Scores for intervention as compared to control group

For both control and intervention groups, all scores increased significantly from baseline with the exception of the physical score for the control group. The mean difference in physical score was significantly higher for intervention than control (p=0.031).