British Journal of Medicine & Medical Research
4(7): 1526-1538, 2014

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Starting the Conversation- A Childhood Obesity Knowledge Project Using an App

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Author HBA originated the study, led the writing and all aspects of study implementations. Author BH performed statistical analyses. Author AC contributed to the literature search. All authors assisted in preparation of drafts and approved the final manuscript.

Original Research Article

Received 24th June 2013
Accepted 10th September 2013
Published 16th December 2013

ABSTRACT

Purpose: *Starting the Conversation* was a pilot project to test an intervention for childhood obesity, a major public health epidemic, using a free smartphone application (app). The primary aim was to assess students' knowledge of nutritional indicators, physical exercise and use of screen time before and after the intervention.
Methods: The study was conducted in 2011-2012. The sample, recruited from seven high schools in Snohomish County, Washington, was 65.3% minority participants. Of the 118 participants in the sample (n=118), 79 handwrote their responses (n=78) and 36 responded via the app (n=39). We compared the frequency and types of physical exercise, frequency of screen time, and nutritional variables of high school students. Participants used the cell phone app or a handwritten log to record their daily entries for 20 days.
Results: Both males (n=43) and females (n=75) grades 9-12 used the app or handwritten entries. Participants who used the app ate less fast food and exercised more, as compared with those who recorded their entries by hand. Screen time usage decreased over the course of the study, based on a comparison of the post-survey level and the pre-survey level. Knowledge of recommended daily consumption of vegetables increased post-test in the app group and knowledge of water consumption increased significantly in both groups.

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There was no significant difference in BMI pre and post-test.
Conclusions: Patterns of nutritional intake, physical exercise and knowledge of these issues varied pre and post-test. It is critical to further examine factors associated with lack of physical activity and food intake patterns of youth using social media to further address the childhood obesity epidemic. Future research should focus on specific ethnic subgroups and an intervention at the school level aimed at the students with BMI ≥ 95^{th} percentile.

Keywords: Childhood obesity; app; physical activity; nutritional intake; screen time.

1. INTRODUCTION

The increasing occurrence of pediatric obesity is a major public health concern. According to the Centers for Disease Control and Prevention (CDC), the prevalence of obesity among children and adolescents in the United States has tripled since 1980 [1,2]. The Institute of Medicine (IOM, 2006) reported that childhood prevention efforts are too few and too fragmented and that more efforts needed to reduce the percentage of obese children and adolescents [3].Estimates from the National Health and Nutrition Examination Survey (NHANES) show that 31.7% of U.S. children and teens in 2008 were either overweight or obese [4]. Being obese or overweight leads to greater risk for youths developing health and psychological problems such as diabetes, cardiovascular disease, asthma, depression, and psychological stress [5,6]. Results from the 2011 Youth Risk Behavioral Survey in the United States indicated that nearly one-third (31.1%) of high school students had played video or computer games for 3 or more hours per day on a typical school day during the previous month [7]. The lack of physical activity may contribute to childhood obesity.

Obese children are more likely to become obese adults [8-10]. A study of 2,400 children found that obese black children were more likely to remain obese as adults (83%) than obese white children [11]. Childhood and adolescent overweight may lead to psychiatric risks regardless of adult weight [12]. Also, children from lower socioeconomic backgrounds may experience social and psychological difficulties [13,14]. In adolescents, obesity and metabolic syndrome are linked to changes in brain structure as well as learning and attention span impairments [15]. In addition, the association of childhood obesity with type 2 diabetes is disproportionately seen in Hispanic, African American and Native American adolescents [16].

Ethnic minority children are at a heightened risk for obesity [16,17]. Minority youths such as African Americans and Hispanic Americans continue to be of concern for childhood onset obesity and related health consequences [4,18]. More minority youths are afflicted with being overweight or obese than are white youths. Recent data from NHANES shows only 25.6% of white girls are overweight or obese compared to 41.3% of Black girls and 38.6% of Hispanic girls [4]. Among Hispanic boys, 40% are overweight or obese, compared to 36.9% and 30.1% of Black and white boys, respectively [4].

Behavioral approaches to weight loss, which typically involve changes in diet and physical activity, are effective in helping overweight and obese children lose weight [19]. Self-monitoring, which consists of recording dietary intake and physical activity so that individuals are aware of current behaviors, is effective in promoting behavior change [20]. Self-monitoring interventions using paper diaries, web tools, and hand-held devices or smart phone applications have been tested in adults [20]. However, a meta-analysis of self-monitoring interventions found no differences in efficacy based on the method of self-monitoring used [20].

Smartphone use in 2012 is over 50% in the U.S. [21] and 23% of children age 12-17 report owning a smart phone [22]. There are more than 1,000 commercially available applications for use with a smart phone that claim to provide assistance with self-monitoring of diet, exercise, or both [23]. Emerging evidence suggests that smart phone applications are effective in helping adults lose weight through supporting behavior change [24,25]. However, we are not aware of any studies testing the effectiveness or acceptability of smart phone applications for improving knowledge and behavioral to prevent obesity in adolescents.

A recent study of 6,000 students in 40 states suggests children in states with strict laws governing the sale of snacks and sodas in schools gained less weight and stayed at healthier weights than did students in states with weaker junk-food regulations [26]. Some programs achieve success due to poor treatment adherence, high drop-out rates and low numbers of participants [27,28]. Another study using an intensive intervention of overhauling the cafeteria menu, boosting physical activity and teaching kids about health and nutrition lowered obesity rates in sixth through eighth graders [29]. A study of low-income Hispanic and white children found significant improvements in blood pressure, BMI and academic scores using dietary and lifestyle changes and physical activity monitoring [30]. Results from the Nation Survey of Children's Health (n=62,880) showed that children who attend public school and who are eligible for free or reduced lunch or breakfast programs have a higher BMI compared with students at private schools [31].

To date, most studies of adolescents have not taken into account the use of an application as an intervention tool to motivate students to increase their knowledge about nutrition and exercise as well as to measure daily nutritional and physical exercise. For example, a study by Woolford et al. sends obese teenagers daily text messages informing them about nutrition, physical exercise and diabetes prevention [32]. Another study showed that sugar sweetened beverage intake is associated with obesity in adolescents. Children may unconsciously turn to food as comfort food to combat stress, feelings of loneliness, anger and depression [33]. However, few studies have explored whether increased knowledge of water intake leads young people to replace sugar-sweetened beverages with water, leading, in turn, to potential weight loss [34].

The objectives of this study are to determine the feasibility and acceptability of a smart phone application (app) or handwritten diary to self-monitor diet, sugar-drink intake, and physical activity in a mainly minority adolescent population and to estimate the pilot effectiveness of self-monitoring in helping adolescents improve their nutritional intake and physical activity levels. This pilot study titled *Starting the Conversation* aims to provide information about the nutritional and exercise practices of high school students and their views on these topics. In addition, we examined their BMI, daily use of screen time, and a comparison of the intervention (phone app) group versus control (handwritten entries) group.

2. MATERIALS AND METHODS

2.1 Procedure

Eligible subjects were adolescents age 14-19 living in Snohomish County, Washington. The county is located in a semi-rural area with ethnically diverse and low-income populations.

We recruited participants using flyers posted in seven local public high schools and five local YMCAs as well as word of mouth. Participants were self-selected. A total of 421 students expressed interest in participating and completed the pre-survey via text, email, and sign-ups at high schools. Students and their parents completed and signed consent forms before students could participate. Students who complete the pre- and post-surveys, and using an app or handwritten entries recorded for 20 days received a $20 incentive. The study was approved by the University of Washington Institutional Review Board.

All enrolled students completed a pre-survey. The pre-survey was a questionnaire that asked about physical activity and nutritional knowledge, screen time use and types of food eaten for the past week. The pre-survey included a self-report item about height and weight from which body mass index (BMI, kg/m$^{2)}$ was calculated. Participants were also asked about daily screen time use, types of physical activity, if any, and types of food eaten during the past week. Nutritional knowledge questions such as servings of vegetables, fruits and dairy, and amount of fast food meals, chips, desserts and sweets were also asked in the pre-survey.

2.2 The Sample

There were 118 of 421 students (28%) enrolled in the *Starting the Conversation* study who completed the 20-day diaries. Among the total analysis sample of 118, age ranged from 14 to 19, with a mean of 15.9, and standard deviation of 1.3. A total of 75 (64%) were female and 43 (34%) were male (Table 1). There were 11 African Americans (9%), 34 Asian Americans (29%), 18 Latino Americans (15%), 7 Native Americans (6%), 7 multi-racial individuals (6%) and 41 White (35%). The grades were 28 (24%) in 9th grade, 41 (35%) in 10th, 21 (18%) in 11th and 28 (24%) in 12th grade. The control group (n=79) handwrote their daily entries (67%) and the experimental group (n=39) used the free app on their cell phone (33%). There is no gender, racial, grade or age difference between the two groups (Table 1). During the five month ongoing recruitment period, we had an overwhelming number of students who volunteered for the control group because they lacked cell phones with internet access.

2.3 Intervention

After completing the pre-survey, the experimental group of participants was asked to log onto their cell phone or computer using a free application (app), www.loseit.com, for 20 days. After setting up the *loseit* account using a cell phone or online using a computer, students were asked to record 20 days of daily physical activity and nutritional intake. The control group (without cell phones) handwrote their daily entries. The study was conducted in the period of October 2011 to April 2012.

2.4 Assessment

After 20 days of entries from the student logs, we conducted the post-survey and collected the logs. Of the initial sample, 118 participants finished the 20 days of diary and the post-survey, and these 118 cases formed the analysis sample presented here. Some of the questions in the post-survey include “Did the study help you with watching what you eat, help lose weight, motivate you to exercise more”, and “Did the study provide a reason to talk to your family about food and/or exercise”. The post-survey measured the same items as the pre-survey, adding questions on the use of social media such as the free app and inquiring how the study helped the participant with physical activity, nutrition, and weight loss, if any. Daily physical activity was measured in four levels: less than 30 minutes of exercise, 30-60 minutes, 60 minutes and >60 minutes daily. Screen time usage (computer, television, tablet, game console use) was measured in four levels: 0-2 hours, 2-4 hours, 4-5 hours and >5 hours daily.

Table 1. Demographic variables of the whole sample, app and handwritten groups

	Whole sample (n=118)	App group (n=39)	Handwritten group (n=79)	p value (comparison of App and handwritten groups)
Gender				0.931
Female	63.6%	64.1%	63.3%	
Male	36.4%	35.9%	36.7%	
Ethnicity				0.168
Asian	28.8%	35.9%	25.3%	
Black	9.3%	7.7%	10.1%	
Latino	15.3%	7.7%	19.0%	
Mixed	5.9%	7.7%	5.1%	
Native American	5.9%	0%	8.9%	
White	34.7%	41.9%	31.6%	
Grade				0.987
9^{th}	23.7%	23.1%	24.1%	
10^{th}	34.7%	33.3%	35.4%	
11^{th}	17.8%	17.9%	17.7%	
12^{th}	23.7%	25.6%	22.8%	
Age				0.794
14	14.4%	15.4%	13.9%	
15	28.8%	33.3%	26.6%	
16	22.0%	17.9%	24.1%	
17	20.3%	23.1%	19.0%	
18	12.7%	10.3%	23.1%	
19	1.7%	0%	2.5%	

2.5 Statistical Methods

Statistical methods used in this paper are: Chi-square test, T-test and paired T-test. For comparing categorical or dichotomous variables pre vs. post or hand-write group vs. Application group, we utilized the Chi-square test. For continuous variables between hand-write group and application group, we used T-test. For continuous variables pre vs. post among the same group, we used paired t-test.

3. RESULTS

3.1 Descriptive Analyses

Of the whole group, 74% (N=87) agreed with the statement that the study helped them to "watch what I ate", 17% (N=20) agreed with statement, "The study helps me losing weight", and 45% agreed that they had "motivation to exercise more". Also 14% (N=17) of students who completed the study said that it "provided a reason to talk to my family about food and/or exercise". In the pre-survey, we found that about 30% (N=35) of participants are either overweight or obese. Only 30.5% (N=36) of participants report fewer than 3 hours of screen time daily and 20% (N=24) report level 1 physical activity (Table 2).

3.2 App versus Hand-Writing Groups

Table 2 shows the baseline BMI, physical activity, knowledge of food intake, and screen time for the app and handwriting groups. There are a significant difference in terms of BMI pretest between the experimental app group and handwritten control group. The app group had a lower average BMI, with a higher proportion of underweight participants and a lower proportion of obese participants than the handwrite group. There is no significant difference in terms of physical activity levels, screen time and nutritional knowledge between the two groups at baseline. These differences were the same at post intervention, except that the app group had a higher proportion of participants with correct knowledge about water consumption.

Table 2. Pre-test of weight, nutrition related variables of the whole sample, app and handwritten groups

	Whole sample (n=118)	App group (n=39)	Handwritten group (n=79)	p
BMI[a]Mean (SD)	23.9 (4.9)	22.0 (4.1)	24.9 (5.0)	0.002
BMI[b]				0.010
Underweight)	8.5%	17.9%	3.8%	
Normal	61.0%	66.7%	58.2%	
Overweight	20.3%	12.8%	24.1%	
Obese	10.2%	2.6%	13.9%	
Physical activity level (daily)				0.246
<30 min/day	1.7%	0%	2.5%	
30-60 min/day	34.7%	35.9%	34.2%	
60 min/day	43.2%	48.7%	40.5%	
> 60 min/day	20.3%	15.4%	22.8%	
Knowledge of:				
Vegetables intake	89.0%	87.2%	89.9%	0.660
Water intake	54.2%	64.1%	49.4%	0.131
Screen time (daily)				0.902
0-2 hrs	30.5%	30.8%	30.4%	
2-4 hrs	42.4%	46.2%	40.5%	
4-5 hrs	14.4%	12.8%	15.2%	
> 5 hrs	12.7%	10.3%	13.9%	

[a]These are raw numbers for BMI. p values are from the T-test
[b]The p here is for the chi-square comparison of BMI levels.
BMI levels: Underweight (BMI<18.5), normal (BMI 18.5-24.9), overweight (BMI 25-29.9), obese (BMI≥30).

The app group's average BMI was also lower than the handwritten group (Table 3). Except for the knowledge about water, the relationship between the two groups did not change in the post-survey. However, there were three participants in the experimental (app) group who each lost a total of 3-6 pounds post-survey (not in table). While there is no statistical difference between knowledge of water pre-test, post-test, more participants in the app group accurately identified the correct amount of required daily water intake.

Table 3. Post-test weight, nutrition related variables of the whole sample, app and handwritten groups

	Whole sample (n=118)	App group (n=39)	Handwritten group (n=79)	p
BMI Mean (SD)	24.0 (4.8)	22.0 (4.0)	25.0 (4.9)	0.002
BMI[a] (kg/m^{2})				0.014
Underweight	8.5%	17.9%	3.8%	
Normal	63.6%	66.7%	62.0%	
Overweight	16.9%	12.8%	19.0%	
Obese	11.0%	2.6%	15.2%	
Physical activity level				0.510
<30 min/day	17.8%	12.8%	20.5%	
30-60 min/day	22.0%	23.1%	21.5%	
60 min/day	27.1%	23.1%	29.1%	
> 60 min/day	33.1%	41.0%	29.1%	
Knowledge of:				
Vegetables intake	91.5%	94.9%	89.9%	0.359
Water intake	82.2%	92.3%	77.2%	0.044
Screen time (daily)				0.163
0-2 hrs	40.7%	43.6%	39.2%	
2-4 hrs	40.7%	48.7%	36.7%	
4-5 hrs	10.2%	2.6%	13.9%	
> 5 hrs	8.5%	5.1%	10.1%	

[a]BMI levels: Underweight (BMI<18.5), normal (BMI 18.5-24.9), overweight (BMI 25-29.9), obese (BMI≥30).

3.3 Pre and Post-Surveys

There are some differences between pre and post-test between the groups. Table 4 shows comparison of pre and post on the measures of nutrition-related variables in the whole sample and the breakdown of the app group and the handwritten group. As shown in Table 4, BMI did not change over time for the whole group, or the two groups separately, from pre to post. Physical activity levels didn't change for the whole sample or the two groups separately. There were 29 students that were involved in school sports or had daily physical education (not in table). Also, since the study was self-selected, only 6 students had BMI≥ 95th percentile. Of this group, 3 students reported weight loss (not in table).

Table 4. Paired T-test results (Post to Pre difference) in weight, nutrition related variables of the whole sample, app and handwritten groups

	Whole sample (n=118)	App group (n=39)	Handwritten group (n=79)
BMI	0.07 (P=0.363)	0.08 (P=0.480)	0.07 (P=0.520)
Physical activity level	0.07 (P=0.468)	-0.13 (P=0.453)	0.17 (P=0.139)
Knowledge Veggie	2.5% (p=0.469)	7.7% (P=0.183)	0% (P=1.000)
Knowledge Water	28.0% (p=0.000)	28.2% (P=0.001)	27.8% (P=0.000)
Screen time level	-0.23 (P=0.008)	-0.33 (P=0.031)	-0.18 (P=0.090)

Knowledge about vegetable intake did not change for the whole group, nor for the two groups separately. However, knowledge about water increased from pre to post for the whole group and for the two groups separately. Knowledge of the right amount of daily water intake increased from pre to post test for the whole sample (increasing from 54% to 82% correct). It increased also for the handwritten group, from 49% to 77%, and the app group, from 64% to 92%. Screen time levels decreased significantly post-survey as compared with pre-survey for the whole sample and for the app group. There was also a trend towards decreased screen time in the handwrite group, though this did not reach statistical significance.

From the students' daily logs, the results revealed 39 (33%) of the students used the app on their phone, including 6 (5%) who also used the computer to log on to the free app. Upon being asked why they did not use the app, about half of the students (n=54, 46%) reported they preferred handwriting. Almost an equal amount of students (n=51, 43%) reported their cell phone did not have the capability to access apps and almost a quarter (n=28, 24%) indicated they did not have a computer easily available. Although *Starting the Conversation* project's main aim was to gather information about students' knowledge of physical activity and nutrition and their willingness to use a free app, the project had other benefits as well. The group as a whole did not experience lower BMI scores.

4. DISCUSSION

The *Starting the Conversation* study demonstrates the acceptability and feasibility of using self-monitoring for behavior change in a high-risk adolescent population. Participants of this pilot study noted in the post-survey that using the free app helped motivate them to eat more responsibly and to exercise. According to pre and post-surveys, participants knew more about nutrition and exercise following the study. Also, the majority of participants believed that the study increased their knowledge about nutrition and factors contributing to obesity, as shown by the post-survey. In addition, the use of screen time decreased post-test.

The pilot study suggests that the self-monitoring intervention helped increase students' knowledge of water intake, though we did not find statistically significant differences in many other items in the follow-up. Because sugar sweetened beverage intake is associated with obesity in adolescents, future research could explore whether increased knowledge of healthy water intake leads to replacement of sugar-sweetened beverages with water, and consequent weight loss [34]. The self-monitoring interventions led to a decrease in reported screen time use. The effect was larger in the adolescents using the app compared to the paper diary. Increased screen time is strongly associated with obesity in adolescents [35]. Future research should determine if the observed reduction in screen time leads to weight loss in adolescents.

There is a need for more social media-based studies on childhood obesity prevention that employ minority samples. This is especially true for studies of groups who have high obesity rates such as Native Americans, Hispanics, and African Americans, including samples from relatively recent refugee and immigrant communities. Because there is internal heterogeneity among minority ethnic groups, there is a need for larger-sample studies that focus on intra-racial and intra-ethnic variability among these minority groups. The recent and refugee and immigrant communities are likely to be at increased risk for poor diet and health care, and are therefore an important area of focus for public health research.

Overall, this study demonstrates the feasibility and acceptability of self-monitoring to improve physical activity and nutrition intake in adolescents. This project provided an opportunity for public school students with internet access, using cell phones or computers, to record and be aware of their physical activities and what they ate via a free app, and at the same time learn more about nutrition and exercise. Future research should try to use the equivalent number of participants for both groups in order to make more solid comparisons between the two groups of students. Also, schools are focal locations for organizing obesity-prevention programs. This is particularly important in low-income communities where children often receive free and reduced breakfast and lunch and where a significant proportion of their daily nutritional requirements are from the USDA National School Lunch Program [36].

5. LIMITATIONS AND IMPLICATIONS

This pilot study provided positive results and was an important first step. It was successful in obtaining recorded daily food and exercise of high school students by means of using a free app and handwritten entries. However, some limitations must be noted. First, there was a high drop-out rate among participants (421 completed the pre-survey, but only 118 completed the study, including the post-survey and 20 days of recording). It was not clear whether the students that dropped out would have responded by means of the app or by handwritten responses because they had not yet been assigned to either group. The number of participants who completed the study was similar in age, race/ethnicity/BMI to those who dropped out. This means that the remaining participants are similar to those who did not participate with regard to age, race/ethnicity, and BMI.

The second limitation was that in our self- selected sample, more female students (n=75) signed up for the study than males (n=43). Third, because the number of app users was lower than the number in the handwritten group, there was less statistical power, which may not show the differences between the two groups. However, our results showed the app users appeared to be more motivated to change their eating and physical exercise behavior than were the handwritten group. Many of these students had free and reduced lunch and also did not have cell phones with data plans. Therefore, it was more difficult for them to use the app. Fourth, the two groups were not matched based on physical activity, nutrition, or screen time. This could be a limiting factor since similar characteristics in each group may result in more measurable change.

Lastly, no continuous variables were used for this pilot study. Instead, we had a range of hours to choose from, rather than letting the students individually write down the exact hours of exercise. Therefore, we were unable to find out the exact number of hours of exercise and screen time; we only obtained the range. However, the simplified self-monitoring process may have led to higher completion rates.

Future research could explore other technological approaches, in addition to the free app, to monitoring physical activity, such as *Fitbit* (http://www.fitbit.com/) [37]. Our research added to the current literature on using a simple and free app to monitor physical and nutritional intake, by demonstrating that high school students were willing to participate. Also, our research showed that the app group, post-test, showed a slight decrease in screen time usage. It may be premature to conclude that using an app is associated with decreased screen time and BMI, but the study tends to point in this direction.

6. CONCLUSIONS

Further research should explore the effectiveness of self-monitoring in specific ethnic subgroups. Interventions which use the opportunities at school lunches and sports games to encourage healthy eating by serving healthy foods and by comparing nutritional content with regular food at the same price may be particularly effective when combined with self-monitoring interventions. Previous research shows strong evidence that multi-component school-based obesity prevention programs increase physical activity [38], and improve dietary habits [39, 40]. Also, school-based interventions can be effective, even if only short-term, in reducing childhood obesity prevalence [41]. The critical role that school programs with social media play in the childhood obesity epidemic should be further explored.

CONSENT

Written informed consent was obtained from the participants and their parents before the study began. All participants were assigned a study number and anonymously assigned to group A or B for the study.

ETHICAL APPROVAL

The study was examined and approved by the Institutional Review Board at the University of Washington for all study protocols and procedures.

ACKNOWLEDGEMENTS

This project was supported by grant number UL 1RR025014 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH) and National Institutes of Health Roadmap for Medical Research, and its content are solely the responsibility of the authors and do not necessarily represent the official view of the NCRR, NIH, or the Institute of Translational Health Sciences.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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