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Improving Physical Activity in Daycare Interventions

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Abstract

Background: The aim of the study was to objectively determine whether the Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC) program improved physical activity levels during the school day.

Methods: The study compared the physical activity levels of subjects from 26 daycare centers, randomized into treatment ($N = 13$) and control ($N = 13$) groups. The subjects were 3 to 5 year olds ($N = 209$, 104 males and 105 females; age [years] $= 3.85 \pm 0.8$ [mean $\pm$ standard deviation]), and accelerometry was used to determine the subjects' physical activity levels. Accelerometers were attached to each subject for 2 days before and immediately after a 6-month intervention. Height, mass, and waist were also measured.

Results: Regression analyses indicated that the treatment group demonstrated significant increases in moderate and vigorous physical activity, as compared to the control group ($F(1, 207) = 6.3$, $p < 0.05$, Cohen's $d = 0.30$; $F(1, 207) = 4.7$, $p < 0.05$, Cohen's $d = 0.25$, respectively). The treatment group also showed significant increases in total physical activity ($F(1, 218) = 12.4$; $p < 0.05$) from pre- to post-test with significant increases in moderate and vigorous intensity physical activity ($F(1, 218) = 18.6$, $p < 0.05$; $F(1, 218) = 23.3$, $p < 0.05$, respectively). Regression analyses revealed significant increases in height for both groups from pre- to post-tests, but no differences were noted between groups.

Conclusions: Implementation of the NAP SACC program in treatment daycare facilities resulted in significant increases in objectively measured physical activity levels, compared to the control group, demonstrating physical activity improvement in the treatment daycare centers.

Introduction

Interventions that prevent obesity and promote physical activity in preschool children are rapidly emerging and are evidence of a new and developing research area.[1] In 2011, the Institute of Medicine (IOM) released its *Early Childhood Obesity Prevention Policies*.[2] Its recommendations were made from a daycare context because of the recognition that interventions within this environment are conducive to addressing the obesity problem and to building healthy physical activity and nutritional behavior patterns in preschoolers. One of its recommendations that children should receive 15 minutes of physical activity for every hour they are at daycare specifically focuses on the daycare environment, which differs from the 60 minutes of predominantly moderate and vigorous daily physical activity that the US Department of Health and Human Services (USHHS) recommends for children.[2,3] Whether the IOM or the USHHS physical activity recommendations are being used as a basis for measuring physical activity, previous research indicates that children in daycare are generally inactive and not meeting these recommendations.[4–7]

Physical inactivity has been recognized as a major contributing factor to the obesity epidemic, indicating a large portion of US children and adolescents do not engage in the USHHS recommended amount of moderate and vigorous physical activity.[3–5,8] More than 20% of children between 2 and 5 years of age are overweight or obese,[2] and previous research has indicated that children in a daycare environment were more apt to be sedentary and did not meet the previous USHHS recommendations of 60 minutes of daily physical activity.[6,7,9] Childhood physical inactivity is not just a national problem, but an international worldwide epidemic with short- and long-term health implications.[10–14] Special attention is needed to promote healthy physical activity behavior in daycare to eliminate the

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widening gap between overweight/obese children's mass status and their normal mass counterparts.[15–17]

The introduction of accelerometers as a research instrument has greatly improved the objective quality of physical activity investigation.[18,19] Moreover, reliability, as compared to trained observers, is moderate to strong ($0.50 \leq r \leq 0.70$) for preschool children.[8,20] Objective physical activity research of this age group is important to determine whether similar physical inactivity problems exist as they do in their older, primary-school counterparts,[21] especially if these preschool children are in daycare facilities, either part or full time.[22]

One intervention that is directed toward the young in daycare facilities is the Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC) program. It was developed as an approach to promote healthy weight environments in preschool settings.[23] Its purpose is to help facilitate gradual change and promote continuous quality improvement, and it is one of the few interventions that targets both physical activity and nutrition.[24] From a behavioral standpoint, it is far easier to adapt to and accept smaller behavioral changes over time than larger ones.[25] The program has generated broad interest in a number of states and institutions. Policy makers familiar with the intervention model state that the program shows promise in daycare settings, but requires additional evaluation using more-objective outcome measures to determine its effectiveness.[26,27]

The main aim of this trial study was to objectively determine whether the NAP SACC program would improve physical activity levels in randomly selected licensed Louisiana daycare centers. The project also examined the relationships of physical activity to anthropometric variables, height, body mass, waist measurement, and BMI. The study hypothesized that implementation of the NAP SACC program would improve physical activity levels at the daycare treatment centers.

Methods

Louisiana State University Health Sciences Center School of Public Health (LSUHSC-SOPH) and the Office of Public Health–Maternal and Child Health Department of Louisiana (OPHMCHD) partnered in the Childhood Obesity Child Care Initiative. As part of the initiative, randomly selected child care facilities were asked to implement the NAP SACC program.

The proposed project was approved by the LSUHSC Institutional Review Board. Thirty child care facilities in the state initially agreed to participate; however, before the main study began, four of the facilities decided not to participate because of limited staff and difficulties in scheduling data collection measurements and workshops. The remaining 26 facilities were then randomly divided into 13 treatment centers and 13 control centers. The control centers were given access to the NAP SACC program after completion of the project. Consent forms were signed by a parent/guardian of all participants before research data were collected.

Subjects

The subjects consisted of pre-school children ($N = 209$, 104 males and 105 females), ages 3–5 years (mean ± standard deviation [SD] = 3.85 ± 0.8; Table 1). Subject inclusion required that the child be 3–5 years of age and be a student at one of the study's daycare facilities. The parent/guardians were informed of the confidential nature of the project and noted that all subject data were anonymous and secured in a locked location.

Turnover rate and part-time status of the students at the daycare centers detracted from data collection during scheduled visits. Initially, the study began with 251 subjects; however, subjects were excluded if they were not present for any segment of data collection. After completion of the postintervention measurements, 209 subjects had completed all data measurements for an attrition rate of 17%.

Procedures

The project consisted of a pre- and postintervention design with randomized treatment and control groups. The project limited the number of daycare centers to no more than 30 facilities. The criteria for facility selection required that the daycare center possess state licensure and agreed to the terms of the study. Letters from the Louisiana State Department of Public Health were mailed to licensed child care facilities, which stated that participation and completion of the NAP SACC project could be substituted for participation in a mandatory annual state safety seminar to maintain their state licensure. The first 30 facilities that responded positively were included in the study. To avoid bias, the facilities were randomly designated to either the treatment or control group by a LSUHSC-SOPH team member using simple randomization without knowledge of the facilities' names, demographics, or location.

Table 1. Baseline Physical Characteristics

	Treatment	Control	Total
Subjects (*N*)	110	99	209
Male (*n*)	55	49	104
Female (*n*)	55	50	105
	Mean±SD		
Age, years	3.81 ± 0.75	3.9 ± 0.85	3.85 ± 0.78
Mass, kg	17.5 ± 3.7	17.3 ± 3.6	17.4 ± 3.6
Stature, cm	102.2 ± 7.7	101.7 ± 7.2	102.0 ± 7.5
Waist, cm	53.9 ± 4.9	53.3 ± 4.6	53.6 ± 4.8
BMI	16.6 ± 2.0	16.7 ± 2.2	16.6 ± 2.1

SD, standard deviation.

Four dietitians with physical activity training experience were contracted to become NAP SACC certified and implement the program. The NAP SACC consultants delivered to the staff of each treatment facility four workshops that demonstrated the importance of physical activity and nutrition. The workshop topics included overweight, nutrition, physical activity, and growing healthy kids. The consultants maintained regular contact with the treatment facility staff and provided support in addressing any barriers that would prevent achievement of their specific facility improvement plan. They also distributed educational information to the parent/guardians that focused on physical activity and nutrition recommendations at home.

Each treatment facility director completed the NAP SACC self-assessment tool that assessed their center on 14 key areas in physical activity and nutrition, with response options ranging from ''minimal'' to ''best practice.''[27] Based on the responses, the facility director with guidance from the NAP SACC consultant chose three to four areas for improvement and prepared a unique facility improvement plan (Table 2).

Instruments

Actigraph GT3X+ accelerometers (Actigraph Corporation, Pensacola, FL) were attached on the right hip of each subject for 2 days beginning at 8:30 am and ending at 3:00 pm to yield a total of 9 ''clean'' hours of physical activity behavior (two 6.5-hour daily sessions, less nap times and intervals longer than 10 minutes with zero digital counts per minute). Physical activity levels were calculated using a van Cauwenberghe protocol, which consisted of cutpoints defining sedentary levels as <373 counts/15-second epochs, low physical activity levels as 373–584 counts/15-second epochs, moderate physical activity levels as 585–880 counts/15-second epochs, and vigorous physical activity levels as >880 counts/15-second epochs.[28] The physical activity data collection sessions were generally conducted on successive days, but no greater than 1 week apart from each other for each subject.

Table 2. NAP SACC Key Assessment Areas

NAP SACC key assessment areas	
(Select three to four areas to develop Facility "Best Practices" Improvement Plan)	
Nutrition	**Physical activity**
Fruits and vegetables	Active play and inactive time
Meats, fats, grains	Play environment
Beverages	Supporting physical activity
Menus and variety	Physical activity education
Feeding practices	Physical activity policy
Foods outside of meals and snacks	
Supportive healthy eating	
Nutrition education	
Nutrition policy	

NAP SACC, the Nutrition and Physical Activity Self-Assessment for Child Care.

A Tanita TBF-300A scale (Tanita Corporation of America, Inc., Arlington Heights, IL) was used to measure mass. A portable stadiometer was used to measure height, and a tension-controlled tape measure was used to measure waist circumference. Standard procedures were used to collect anthropometric data. Subjects were clothed with their shoes on when measured at least twice, both pre- and post-, for mass, stature, and waist measurements.

One tester collected all of the accelerometry and anthropometric data using the same instruments at each of the 26 daycare centers. The tester was an American College of Sports Medicine (ACSM) certified heath fitness specialist. Measurement dates and times at the facilities were mutually agreed upon by a facility staff member and the research team administrator.

After the preintervention data measurement was completed in all 26 facilities, a 6-month NAP SACC intervention was implemented in the 13 treatment group facilities. Upon completion of the intervention, the tester began postintervention data measurements on all subjects in the 26 daycare facilities, which were identical to the preintervention measurement phase.

Statistical Analyses

Statistical Program for Social Services (SPSS) software (Version 19; IBM SPSS Statistics, Armonk, NY) was used to perform the statistical analyses for the project. The data collected during the project consisted of 209 sets of anthropometric data (pre- and postdata of height, mass, and waist measurements) and accelerometer data (9 hours of preintervention and 9 hours of postintervention accelerometer measurements). Simple linear regression was used to compare variables, and Pearson's correlations were employed to examine relationships among variables. Simple linear regression analyses were used to compare differences in physical activity levels over time within and between groups and compare differences over time of anthropometric variables. Statistical significance was set at $\rho < 0.05$.

Results

A CONSORT flow diagram of the analysis is provided in Figure 1. It illustrates the process of the current facility-randomized, parallel study and details the phases of both the treatment and control groups before, during, and after the intervention of the treatment group that led to the comparative analysis of the study.

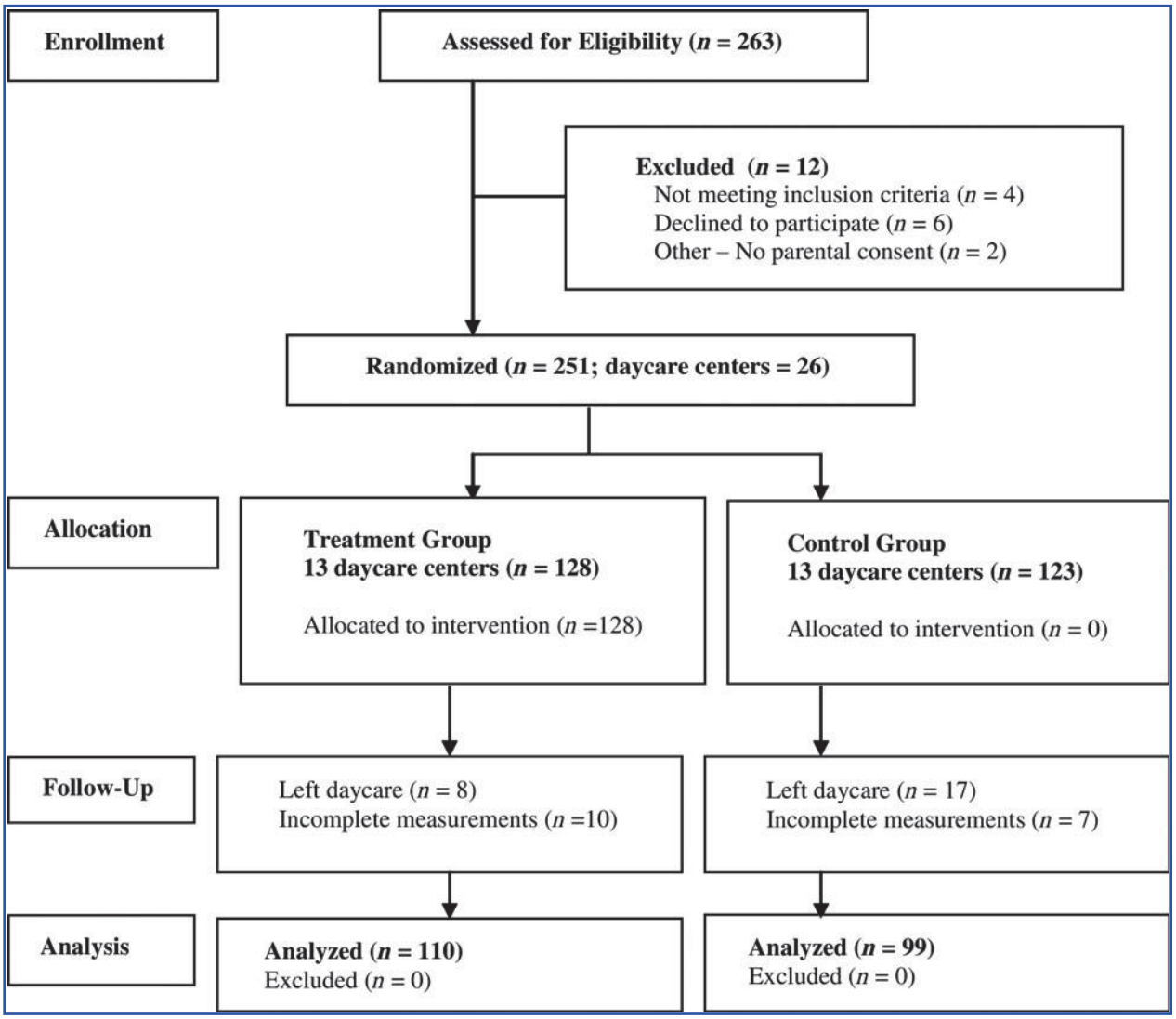

Figure 1. CONSORT flow diagram.

Simple linear regression was used to compare physical activity intensity level differences (outcome variable) by group (predictor variable). These analyses demonstrated significant increases in moderate and vigorous physical activity differences over time (pre- to post-) in the treatment group, as compared to the control group ($F(1, 207) = 6.3$, $p < 0.05$; $F(1, 207) = 4.7$, $p < 0.05$, respectively). Observed power for moderate and vigorous physical activity level comparisons were 0.707 and 0.581, respectively (Table 3).

Intervention effects were determined by computing Cohen's *d* values by comparing the pre- and post-differences between the treatment and control groups for moderate, vigorous, and moderate PLUS vigorous physical activity levels. The Cohen's *d* values were 0.30, 0.25, and 0.29, respectively, indicating moderate intervention effects.

There was also a significant increase in total physical activity from pre- to postmeasurements within the treatment group ($F(1, 218$: pre- vs. post-$) = 12.4$; $p < 0.05$; observed power $= 0.939$), including significant increases in vigorous and moderate physical activity within the treatment group ($F(1, 218$: pre- vs. post-$) = 23.3$, $p < 0.05$, observed power $= 0.998$; $F(1, 218$: pre- vs. post-$) = 18.6$, $p < 0.05$, observed power $= 0.990$, respectively; Table 3).

Regression analyses of the anthropometric variables for participants revealed significant increases for both groups in height ($F(1, 218$: treatment$) = 10.9$, $p < 0.05$, observed power $= 0.998$; $F(1, 196$: control$) = 12.8$, $p < 0.05$, observed power $= 0.628$, respectively) from the preintervention measurements to the postintervention measurements, with no differences noted between groups (Table 4). These results were expected because the subjects were in the growth and development stage of life. In regard to the subjects' mass, waist, and BMI measurements, regression analyses revealed no significant changes ($p > 0.05$) from pre- to postmeasurements for either group (treatment or control) and no significant differences ($p > 0.05$) between groups (treatment or control) (Table 4).

Pearson's correlation coefficients were calculated to examine relationships among the anthropometric variables

Table 3. Pre- and Postintervention Physical Activity Level Results

Physical activity level values							
			Minutes (mean+SD)		Mins	Mins/Hr	
Groups	*N*	PA levels	Preintervention	Postintervention	Diff	Pre-	Post-
Treatment	110	Sedentary	488.0±20.7	476.6±26.6**	−11.4	54.2	52.9
		Light	27.7±9.6	29.9±13.3	+2.2	3.1	3.3
		Moderate	17.1±8.4	22.7±10.4**	+5.6*	1.9	2.5
		Vigorous	7.2±4.7	10.8±6.3**	+3.6*	0.8	1.3
		Mod+Vig	24.3±6.5	33.5±8.4**	+9.2*	2.7	3.8
		Total PA	52.0±20.9	63.4±26.6**	+11.4	5.8	7.1
		Total	540	540	—	60.0	60.0
Control	99	Sedentary	482.8±40.4	480.3±36.1	−2.5	53.7	53.4
		Light	27.7±16.2	29.8±17.3	+2.1	3.1	3.3
		Moderate	19.1±16.1	19.1±12.6	+0.0*	2.1	2.1
		Vigorous	10.4±11.2	10.8±8.4	+0.4*	1.1	1.2
		Mod+Vig	29.5±13.6	29.9±10.5	+0.4*	3.2	3.3
		Total PA	57.2±40.5	59.7±36.1	+2.5	6.4	6.6
		Total	540	540	—	60.0	60.0
Total	209	Sedentary	485.6±31.7	478.4±31.4	–7.2	53.9	53.1
		Light	27.7±13.1	29.9±15.3	+2.2	3.1	3.3
		Moderate	18.0±12.6	20.9±11.6	+2.9	2.0	2.3
		Vigorous	8.7±8.5	10.8±7.4	+2.1	1.0	1.3
		Mod+Vig	26.7±10.6	31.7±9.5	+5.0	3.0	3.6
		Total PA	54.4±30.2	61.6±31.1	+7.2	6.1	6.9
		Total	540	540	—	60.0	60.0

*Significant, as compared to the associated intensity level of the other group.

**Significant, as compared to its associated preintervention value.

Level of significance: $p < 0.05$.

Cohen's $d = 0.30$, 0.25, 0.29, respectively, for moderate, vigorous, and moderate plus vigorous intervention effects by comparing pre- and post–physical activity differences between groups.

SD, standard deviation; Mins, minutes; Hr, hour; PA, physical activity; Mod, moderate; Vig, vigorous.

(height, mass, waist, and BMI) and the physical activity levels for both the pre- and postintervention measurements. All of the coefficient values for both pre- and postintervention measurements were weak ($-0.095 < r < 0.133$).

The study timeline allowed for a 12-week measurement interval to collect baseline height, mass, waist, and accelerometry measurements in September, October, and November 2012 and, 6 months later, postintervention measurements during a similar 12-week interval in March, April, and May 2013. Because the pre- and post measurement months were similar in temperature and humidity, the study was less likely to experience differential seasonal effects, which minimized the influence on physical activity levels.

Discussion

The study hypothesis that physical activity levels would improve in the treatment group was supported. The NAP SACC intervention in the current study increased total physical activity in the treatment group by 21.9%, as compared to a 4.4% increase in the control group, significantly increased vigorous physical activity by 50% in the treatment group, compared to 3.8% in the control group, and significantly increased moderate physical activity by 32.7% in the treatment group, compared to 0% in the control group. Within the treatment group, there were significant increases in total, vigorous, and moderate physical activity levels from pre- to postmeasurements.

Table 4. Pre- and Postintervention Anthropometrics

Treatment and control group anthropometrics					
		(mean+SD)			
Group	*N*	Height (cm)	Mass (kg)	Waist (cm)	BMI
Preintervention data					
Treatment	110	102.2±7.7	17.5±3.7	53.9±4.9	16.6±2.0
Control	99	101.7±7.2	17.3±3.6	53.3±4.6	16.7±2.2
Total	209	102.0±7.5	17.4±3.6	53.6±4.8	16.6±2.1
Postintervention data					
Treatment	110	105.5±7.1*	18.3±3.7*	53.4±5.4	16.3±2.1
Control	99	105.3±6.9*	18.2±3.7*	53.1±4.6	16.3±1.9
Total	209	105.4±7.2*	18.2±3.7*	53.2±5.0	16.3±2.0

*Significant, as compared to its corresponding preintervention measurement value.

Level of significance: $p < 0.05$.

SD, standard deviation.

The control group showed no significant changes in physical activity and remained relatively unchanged during the same time period (Table 3).

The high level of inactivity in the findings of the current study highlights one of the contributing factors to the obesity epidemic and corroborates the research noted in the introduction that a large portion of children do not meet either the IOM or USHHS recommended physical activity levels.[5,8] Preintervention results revealed the subjects for both groups combined were sedentary 89.9% of the time (53.9 minutes/hour).

The current findings were consistent with previous research regarding inactivity.[6,7,9] In a study similar to the current study, Poest and colleagues indicated that 500 preschoolers in daycare did not engage in vigorous activity throughout the year.[7] Pate and colleagues studied 281 preschool children from nine different preschools and concluded that preschool children exhibited low levels of vigorous physical activity and high levels of inactivity.[18] Durant and colleagues also found that preschoolers displayed high levels of physical inactivity.[9]

The current study's correlation results indicating only weak relationships among physical activity levels and anthropometric variables (height, mass, waist measurement, and BMI) reaffirm the complex and indeterminate relationships between physical activity and body mass and between physical activity and adiposity. Although the current results indicated high sedentary rates for both treatment and control groups, CDC BMI-for-age growth charts revealed that the BMI mean values of the current study for both groups (treatment and control, pre- and post-) were in the healthy 70th–80th percentile range.[29] Similarly, previous findings of associations between physical activity levels and body composition subcomponents in preschoolers have not produced consistent results. Collings and colleagues found a strong inverse relationship ($r = -0.92$) between vigorous physical activity and adiposity in nearly four hundred 4-year-old children,[16] and Roemmich and colleagues concluded that physical activity intensity,[30] and not physical activity hours, was inversely related to fat mass ($r = -0.35$). In contrast, a 3-year study of 3 to 4 year olds revealed that BMI was positively associated with physical activity in year 1 ($r = 0.03$) and negatively associated in years 2 ($r = -0.17$) and 3 ($r = -0.21$).[17] In addition, Wilks and colleagues found no association ($r = -0.01$) between physical activity and fat mass and suggested that neither the duration nor the intensity of physical activity was the key determinant of unhealthy weight gain in children.[31] Reilly concluded that although evidence is supportive of the hypothesis that physical activity is protective against preschool obesity and sedentary behavior is "obesogenic," definitive dose-response relationships remain unclear.[32] However, Trost and colleagues have noted that daycare policy and environment dictates physical activity levels of its students.[33]

Implementation of the NAP SACC program demonstrated that physical activity levels can be improved, as indicated by the significant positive increases in physical activity levels in the treatment group of the project, as compared to the control group. Twenty-one of 23 physical activity goals (91%) from the 13 NAP SACC improvement plans designed by the treatment group facility managers were met. In addition, the treatment facilities' staff found the workshops informative, and the parents of the subjects gave positive feedback on the literature regarding home physical activity and nutrition suggestions that were provided to them. Though the subjects did not attain the IOM or USHHS physical activity recommendations, the outcome results were positive and moved toward achieving physical activity guidelines (Table 3).[2,3,34] Although the

NAP SACC advisors suggested outcome goal recommendations, the daycare facility managers in the treatment group determined how quickly to implement the goals for their individual daycare facilities based upon their available resources. With the completion of the NAP SACC program in the current study, the treatment facilities have the training and ability to sustain and improve healthful behavior on a continuing basis and achieve either or both of the IOM and USHHS physical activity recommendations.[2,3]

Although the aim of the current study was to objectively measure the physical activity component of the NAP SACC program, turn-key interventions must be able to address both physical activity and nutrition concerns to successfully achieve outcomes that reduce obesity and improve short- and long-term health benefits. The NAP SACC program has the flexibility to achieve both physical activity and nutrition recommendations within the unique circumstances of any daycare center.

NAP SACC implementation also improved the healthful environment of the treatment child care centers. Trost and colleagues concluded that access to programs such as NAP SACC is an environmental variable that positively influences physical activity in daycare facilities.[33]

The current study used the van Cauwenberghe protocol, which was widely cited in physical activity studies of preschool children.[10,35–37] Subsequently, a 2013 study conducted by Janssen and colleagues investigated the predictive validity of Actigraph energy expenditure equations and cutpoints in young children 4–6 years of age for six different protocols.[38] It indicated that the van Cauwenberghe protocol overestimated sedentary behavior and underestimated vigorous physical activity. If these findings are correct, then the high sedentary behavior found in both treatment and control groups of this study should be scrutinized; however, the protocol provided an objective standard by which a comparison of physical activity differences between the treatment and control groups could be made. The treatment group still demonstrated significant increases in moderate and vigorous physical activity, as compared to the control group, even if the protocol underestimated vigorous physical activity.

Another limitation of the study was its limited time constraints resulting from budget considerations. Increasing the accelerometer measurement frequency from 2 days to a best practice of 3–4 days would have been preferred. The concern was whether 2 days of 9 hours of clean data were sufficient to make a valid comparison instead of 3 (13.5 hours) or 4 (18 hours) days of clean data. Preceding the main study, a pilot test consisting of 99 subjects in three different daycare facilities in New Orleans was conducted. Four days of 6.5-hour sessions of accelerometer measurements were collected. An analysis of variance was run comparing the data results of days 1 and 2, days 1, 2, and 3, and days 1, 2, 3, and 4. The test indicated that the group variances were homogeneous and there were no significant differences among the three groups ($p > 0.05$). Based upon the results of the pilot study measurements, the conclusion was that the 2-day results, though not equal to the 3- to 4-day best practices results, would provide sufficient information to determine whether the intervention was successful. In addition, the pilot study tested instruments and field procedures, trialed implementation of the NAP SACC program, and developed coordination and administration procedures. Based upon the results of the pilot study, a plan, a time table, and a schedule of the main study were prepared.

Furthermore, a longer intervention of 9–12 months would have been preferred to show intervention effects of anthropometric variables. Despite the limitations, the current study demonstrated that the NAP SACC program is a viable instrument for increasing physical activity in daycare facilities.

Conclusion

Continuation of the NAP SACC program is recommended to investigate further improvements in physical activity and better nutrition choices and determine whether these positive changes equate to a corresponding decrease in obesity levels of its students. Turn-key programs such as NAP SACC are beneficial to many daycare facilities that do not have the resources to design, identify, and implement the types of improvements that are necessary to address childhood obesity problems.[8] A periodic review of the consistent application of the program may reveal the extent of positive change in its students and the facilities.

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Author Disclosure Statement

No competing financial interests exist.

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