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Effects of a Standardized Curriculum on Physical Activity and Body Composition in After-School Program Participants with BMI Scores above the 90th Percentile: Assessing Theory-based Predictors

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A B S T R A C T

Childhood overweight and obesity is a continued problem. Children above the 90th percentile for BMI are particularly susceptible to cardiovascular health risks. There remains a minimal understanding of theory-based psychological predictors of physical activity and weight change in children. This research incorporated data from a subsample of after-school care enrollees above the 90th BMI percentile (M_{age}=10.1 years) who participated in either 4-day/week (n = 21) or 3-day/week (n = 24) versions of a 45 min/session, cognitive-behaviorally based physical activity/health behavior-change program over a full school year, or a control condition of usual care (n = 14). For the cognitive-behavioral groups only, significant improvements were found in self-regulation, mood, and physical activity. Their BMI increases of 0.12 and 0.11 kg/m^2, respectively, were significantly less than the 0.90 kg/m^2 rise expected through maturation. Theory-based regression models uniformly confirmed significant associations of changes in self-regulation and physical activity (R^2s = .22–.25). However, within separate analyses, entry of changes in (a) self-efficacy and mood into a multiple regression equation, (b) self-efficacy as a mediator, and (c) mood as a moderator, did not increase predictive accuracies. The significant association of changes in physical activity and BMI was stronger in the heavier children. Findings will be useful for large-scale intervention applications and refinements.

Efectos de un programa estandarizado extraescolar en la actividad física y la composición corporal de los participantes que superan el percentil 90 del índice de masa corporal: evaluación de los predictores teóricos

Palabras clave:
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R E S U M E N

El sobrepeso y la obesidad infantil suponen un problema continuo. Los niños que superan el percentil 90 de índice de masa corporal (IMC) son especialmente propensos a riesgos en la salud cardiovascular. Apenas se conocen los predictores teóricos de la actividad física y del cambio de peso en los niños. Esta investigación incorpora datos de una submuestra de niños inscritos en atención extraescolar que superan el percentil 90 en IMC (media de edad de 10.1 años), que participaron en dos modalidades de un programa cognitivo-conductual de cambio en comportamiento de la actividad física y la salud de una duración de un año escolar con sesiones de 45 minutos 4 días por semana (n = 21) o 3 días por semana (n = 24). Además, se incluía un grupo control de cuidados habituales (n = 14). Únicamente se hallaron avances significativos en los grupos cognitivo-conductuales en autorregulación, estado de ánimo y actividad física. El aumento de su IMC de 0.12 y 0.11 kg/m^2 respectivamente era menor (de modo significativo) que el aumento de 0.90 kg/m^2 que se espera en virtud de la maduración. Los modelos de regresión confirmaron de forma consistente una asociación significativa de los cambios en autorregulación y actividad física (R^2 = .22-.25). No obstante, en análisis separados, la introducción de cambios en a) autoeficacia y estado de ánimo en la ecuación de regresión múltiple, b) autoeficacia como mediador y c) el estado de ánimo como moderador no aumentaron la precisión predictiva. La asociación significativa de los cambios en la actividad física y el IMC era más estrecha en los niños con más peso. Los resultados serán de utilidad en las aplicaciones y el perfeccionamiento de la intervención a gran escala.

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Childhood overweight and obesity has risen to a combined 34.2% of 6- to 11-year-olds in the United States. Population-based data from 2000 are used to categorize overweight (i.e., age- and sex-adjusted body mass index [BMI; kg/m²] in the 85th–94.9th percentile) and obesity (i.e., BMI ≥ 95th percentile) in children (Kuczmarski et al., 2002). Although both of these BMI ranges are associated with increased risks for endocrine, cardiovascular, respiratory, psychosocial, and orthopedic problems across the lifespan (Ebbeling, Pawlak, & Ludwig, 2002), there is recent evidence that the 90th percentile is where important risks to cardiovascular health such as hypertension and atherosclerosis acutely increase (Koskinen et al., 2018; Skinner, Mayer, Flower, Perrin, & Weinberger, 2009). Lack of physical activity also independently contributes to health risks in children, including overweight and obesity (Hallal, Victora, Azevedo, & Wells, 2006; Institute of Medicine, 2007; Wong & Leatherdale, 2009). Using the objective measure of accelerometery, it was found that only 42% of 6- to 11-year-olds in the U.S. completed the recommended 300 min of moderate or greater intensity physical activity per week (Troiano et al., 2009).

Although physical activity is associated with favorable academic performance (Rasberry et al., 2011; Shephard, 1997; Sibley & Etnier, 2003), administrators often reduce physical education and other opportunities for physical activities (e.g., recess) during the school day in favor of increased academic time (Thomas, 2004; U.S. Department of Health and Human Services, 2012). Even when present, physical education had been associated with only about 12 min of moderate-to-vigorous physical activity per class (Fairclough & Stratton, 2006), or about 10% of the recommended weekly requirement (Tudor-Locke, Lee, Morgan, Beighle, & Pangrazi, 2006). While also holding a heightened concern for academic time (Vandell, Reisner, & Pierce, 2007), after-school programs present needed opportunities for increasing physical activity behaviors outside of school. They are accessed by about one-quarter of all U.S. children (Afterschool Alliance, 2014). Given that in-school physical activity is insufficient for reaching recommended minimum amounts, facilitation of out-of-school physical activity behaviors are especially salient for the promotion of child health (Society of Health and Physical Educators, 2016).

Although pediatricians are increasingly trained to identify overweight and obesity in their patients (U.S. Preventive Services Task Force, 2010), they rarely have the time or expertise to intervene in a manner that would reliably induce required behavioral changes (McCambridge et al., 2006). Some medical centers have clinics for the treatment of pediatric overweight/obesity (Hampl, Paves, Laubscher, & Eneli, 2011), but these are accessed by only a small portion of those affected. Many such programs are also limited to providing health-related information rather than the behavioral skills likely to be required to maximize success. Even considering that after-school programs are attended by children of all weights, appropriate curricula might contribute to healthy behavioral changes and an improved body composition in those with overweight and obesity without the stigmatization of being in a group limited to those with a socially disparaged condition (Puhl & Latner, 2007). Previous health-related outcomes of such programs have, however, *rarely* been favorable (Branscum & Sharma, 2012; Safron, Cislak, Gaspar, & Luszczynska, 2011; Stice, Shaw, & Marti, 2006).

Better integration of theory might be required for the least physically active and most overweight participants to not only participate fully during such programs, but also be empowered to increase their physical activities when outside of the school setting (Baranowski, Anderson, & Carmack, 1998; Baranowski, Lin, Wetter, Resnicow, & Hearn, 1997; Cook-Cottone, Casey, Feely, & Baran, 2009). This would be a practical requirement for obtaining the recommended amount of exercise (Society of Health and Physical Educators, 2016). Though understudied in children, increased physical activity in adults with a high weight has been associated with eating changes and sustaining a healthier weight, possibly through carry-over of behavioral skills internalized through the physical activity context (Annesi & Vaughn, 2017; Oaten & Cheng, 2006). Following suggestions to develop programs with a strong theoretical foundation (Baranowski et al., 1998), deliverable in an efficient, large-scale manner (Green, Sim, & Breiner, 2013), and able to be systematically evaluated and improved upon (Baranowski et al., 1997), the present investigation was designed. A new 45 min/session cognitive-behavioral program incorporating key tenets of social cognitive theory (Bandura, 1986), goal-setting theory (Locke & Latham, 2002), self-efficacy theory (Bandura, 1997), and self-regulation theory (Baumeister, Vohs, & Tice, 2007) was first developed and field-tested. It also leveraged well-supported relationships between increased physical activity and improved mood (Landers & Arent, 2007). It was then administered to after-school program groups in formats of 3 and 4 days/week over an 8-month school year using only existing after-school program staff.

It was the aim of this research to evaluate effects on enrollees who were above the 90th percentile for BMI by assessing how the treatment influenced the theory-based factors of self-regulatory skills usage, self-efficacy, and mood when contrasted with a control condition of usual care. These three factors were selected because they were consistent with the theories that formed the basis of the treatment, and had been identified as the most salient predictors of physical activity change in research with adults (Annesi & Johnson, 2015). It was thought that improved self-regulatory skills usage would help manage environmental challenges to behavioral changes; increased self-efficacy would emerge from self-regulatory skill-supported successes in dealing with barriers and thus facilitate increased effort and persistence; and improved exercise-induced mood would enable an overall positive climate that would increase self-regulatory effects (Baker & Brownell, 2000). While it could be expected that increased self-regulation would be a strong predictor of greater amounts of physical activity (Golan & Bachner-Melman, 2011), outcomes associated with its interaction with changes in the other psychological variables had been largely untested in children.

Thus, to increase understandings of how treatment-associated changes in psychological variables impact out-of-school physical activity, various explanatory models previously evaluated in adults (Annesi, 2017; Annesi & Johnson, 2015; Teixeira et al., 2015) were tested with elementary school-age children within this research. Specifically, statistical models were fit where (a) changes in self-regulation, self-efficacy, and mood simultaneously predicting out-of-school change in physical activity, (b) change in self-efficacy mediating the prediction of change in physical activity by self-regulation change, and (c) mood moderating the association of changes in physical activity and self-regulation could be contrasted.

It was hypothesized that:

- During a school year, improvements in self-regulatory skills usage, exercise barriers self-efficacy, overall negative mood, and out-of-school physical activity would be significant in only the cognitive-behavioral treatment groups, and significantly greater than in the control group. It remained a research question whether improvements would differ between the 4- and 3-day/week treatment groups.
- BMI gains in the cognitive-behavioral treatment groups, but not the control group, would be significantly less than gains expected through maturation.
- Using aggregated data, (a) changes in self-regulation, self-efficacy, and overall mood would significantly predict out-of-school physical activity change; (b) change in self-efficacy would significantly mediate the prediction of physical activity change by change in self-regulation; and (c) change in mood would significantly moderate the prediction of change in physical activity by self-regulation change. The relative strength of these three models were left as a research question.

- Change in out-of-school physical activity would be significantly (inversely) related to BMI change. It was unclear whether baseline BMI would significantly affect this relationship.

Supplementary testing of only the treatment groups sought to determine the proportion of BMI gain reduction accountable through energy expenditures associated with increased out-of-school physical activity.

It was hoped that findings would help determine the adequacy of the new cognitive-behavioral treatment for increasing physical activity and reducing weight gain; evaluate effects on psychological predictors of increased physical activity; ascertain how changes in the measured psychological variables relate to each another to predict behavioral change; and, ultimately, enable a better understanding of change processes that could refine future interventions for children with weight-related health risks.

Method

Participants

Data from participants of ages 8–11 years, with an age- and sex-adjusted BMI greater than the 90th percentile (Kuczmarski et al., 2002), were extracted from a larger study of participants of all weights still in the data collection phase. Participants were voluntary registered in an after-school program under the direction of a community-based organization in the southeast United States. Treatment conditions were randomized based on the facility enrolled (which was blinded to enrollees and staff). There was no additional cost for participation. Institutional review board approval was received. Written parental consent and verbal participant assent was required to participate, which was attained in 74% of cases. There was no significant difference between the 4 day/week treatment group (n = 21), the 3 day/week treatment group (n = 24), and the control group (n = 14) on age (overall M = 10.06 years, SD = 0.88), sex (overall 41% boys), ethnic make-up (overall 56% Black, 17% Asian, 15% Hispanic, and 12% White), and BMI (overall M = 23.91 kg/m^2, SD = 3.11).

Measures

The psychosocial and behavioral measures were adapted from adequately validated self-report surveys intended for adults and adolescents used in predictive model testing similar to this research. Suggestions for survey development in children (Saklofske, Reynolds, & Schwean, 2013), incorporating child-based focus group processes (Heary & Hennessy, 2002) and standard psychometric conventions (Kline, 2000), were used. Specifically, previous measures for self-regulation for physical activity (Annesi & Marti, 2011), exercise barriers self-efficacy (Marcus, Selby, Niaura, & Rossi, 1992), overall negative mood (McNair & Heuchert, 2009), and physical activity (Godin, 2011) were modified to accommodate the attentional and reading comprehension levels of 8- to 11-year-olds and the logistical limitations of this field-based research. Internal consistency is given as Cronbach's α. Test-retest reliability values were assessed over 1–2 weeks.

The measure of self-regulation for physical activity had five items (e.g., "I say positive things to myself about being physically active") requiring responses ranging from1 (*never*) to 4 (*often*) reflecting on the present. They were summed for a possible score range of 5-20 (higher score, more self-regulatory skills usage). Preliminary research indicated an internal consistency of α = .71, and a test-retest reliability of .76. For the present study sample, α = .68.

The measure of exercise barriers self-efficacy had five items that each started with the stem, "I am sure that I can exercise most days of the week even if". Items ended with phrases such as "I was bored by the program or activity." Responses ranged from 1 (*not at all confident*) to 5 (*definitely confident*) reflecting on the present, and were summed for a possible score range of 5–25 (higher score, more self-efficacy). Preliminary research indicated an internal consistency of α = .74, and a test-retest reliability of .75. For the present study sample, α = .75.

Overall negative mood was measured by six items (e.g., "nervous", "sad") requiring responses ranging from 0 (*not at all*) to 4 (*extremely*) reflecting on "how you see yourself over the past 2 weeks." After the response to the positively worded item of "active" was reversed, scores were summed for a possible range of 0–24 (lower score, less negative mood). Preliminary research on children of ages 10–12 years indicated strong item-response loadings of .60–.77 on only the corresponding factor of the parallel scales intended for older individuals (McNair & Heuchert, 2009; Terry & Lane, 2010). Test-retest reliability was .75.

The measure of out-of-school physical activity was the product of two items. Each required the respondent to omit "physical activities completed in phys ed or after-school care." Item 1 reflected on the past week and asked, "…how many days did you participate in physical activities that made you breathe hard (for example soccer, biking, swimming, running, dancing)?" Possible responses ranged from 0 to 7. Item 2 referred to a typical physical activity session and asked, "…approximately how many minutes were you breathing hard?" Possible responses ranged from "15 minutes" to "more than 120 minutes" (in increments of 15 min, and > 120 min coded as 135). For example, if Item 1 = 4 days, and Item 2 = 45 min, the recorded score would be 180 (4 × 45). Preliminary research indicated a strong correspondence with accelerometer scores (r = .42, p < .001), and a test-retest reliability of .75.

BMI was measured as weight in kg (measured to the nearest 0.1 kg) divided by height in m^2 (measured to the nearest 0.01 m) using a recently calibrated medical grade digital scale (Seca 876; Seca, Chino, CA) and stadiometer (Seca 213; Seca, Chino, CA). Outer-clothing such as a jacket, and footwear, was first removed. Hair on the top of the head was pushed down as much as possible for the measurement of height. The mean of two consecutive measurements was recorded.

Procedure

Requirements of the Helsinki Declaration were followed throughout all study procedures. The after-school programs were held at the same elementary school participants attended during the school day. Enrollees were provided a 30- to 45-min period designated for physical activity. However, during that period, actual participation in physical activity was largely optional, with minimal structure. Children having a poor fitness level, and those with a low physical self-concept and/or minimal interest in being physically active, were often sedentary. Within the present field design, no effort was made to intervene with such naturally occurring processes which ensued on each of the 5 weekdays for the control (i.e., typical care) condition, and on the non-treatment days in the 4-day/week and 3-day/week cognitive-behavioral treatments.

Participants in the 4-day and 3-day cognitive-behavioral treatments were administered the same 45-min protocol in place of the aforementioned unstructured approach for 4 and 3 days of the week, respectively. This occurred for 12 weeks prior to a winter holiday break and 12 weeks after. Although the format of each of the cognitive-behavioral treatment days was similar, each of the 72 and 96 sessions, respectively, incorporated different activities (i.e., no session was identical). The instructor : participant ratio was limited to 1 : 18. Each daily treatment session included, in the following order, (a) a 5 min of warm-up and stretching, (b) 10 min of vigorous cardiovascular physical activity, with body-weight resistance exercises sometimes added, (c) 10 min of either self-management skills training (e.g., goal setting/progress feedback, increasing productive self-talk, abbreviated progressing relaxation training, recruiting a social support "team" [supported by a individually completed 4-page workbook]) or nutrition topics (e.g., importance of fruit/vegetable and whole grain consumption [supported by posters]) on alternating days, (d) 10 min of moderate-to-vigorous cardiovascular physical activities designed to reinforce the content of the self-management skills training and nutrition information, and (e) 10 min of moderate cardiovascular physical activities selected by the instructor and class (from a provided list). No treatment component addressed energy restriction or weight loss. A brief letter was transferred to parents monthly that overviewed areas covered within the treatment, and offered advice on how to support their child. Treatment processes included social cognitive theory's (Bandura, 1996, 1998, 2005) emphasis on effectively dealing with environmental challenges; goal-setting theory's (Locke & Latham, 2002) focus on addressing distal goals, proximal goals, and documenting incremental progress; self-efficacy theory's (Bandura, 1997) importance of self-observed progress to reinforce feelings of ability and continued goal striving; and self-regulation theory's (Baumeister et al., 2007) focus on applying specific self-regulatory skills to overcome impediments and maximize probabilities for sustained progress. Instructors helped participants maximize their use of self-management skills via the aforementioned workbook.

All treatment components were administered by existing after-school program instructors not previously trained in health promotion or physical education methods. They were kept blind to the goals of the research. Their basic job orientation included safety training associated with participants' physical activities. For those administering the cognitive-behavioral treatments, 5 hours of in-person training was additionally provided by study staff. This was supported by a video and manual detailing each day's activities, and kept by instructors for their ongoing reference. After being trained by the principal investigator to facilitate consistent processes, a team of four study staff members performed measurements at baseline and study end (Month 8) in a private area of the school. Although they clarified items for participants when necessary, surveys were completed individually with no interactions across participants permitted. Approximately 10% of sessions had fidelity checks conducted through direct study staff observations using a list of required curricular activities. These indicated excellent protocol compliance. In the few cases where required, corrections to protocol administrations were made by the same study staff members that completed the fidelity checks.

Data Analyses

Statistical analyses were completed at the participant and group levels. The 13% of missing cases met accepted assumptions for missing at random (White, Horton, Carpenter, & Pocock, 2011). Therefore, the expectation maximization algorithm (Schafer & Graham, 2002) was applied for imputation. This enabled use of the favored intention-to-treat format. Considering the planned regression analyses with three predictors, and large effects found in similar research with 13–16 year-olds (Annesi, 2018), a minimum of 45 overall participants was required to detect a large effect of $f^2 = 0.35$ at the conservative statistical power of .90 (α = .80) (Cohen, Cohen, West, & Aiken, 2003). Because it was suggested that controlling for baseline scores introduced an additional source of bias (Glymour, Weuve, Berkman, Kawachi, & Robins, 2005), and extreme scores were not a problem in the study's data set, gain (change) scores were unadjusted. Collinearity analyses indicated acceptable tolerance values of 0.69–0.92. For analyses of within- and between-group differences, statistical significance was set at $\alpha \leq .05$, two-tailed. Because related research indicated predictable directionality in relationships among variables (Annesi, 2018), statistical significance for regression analyses was set at $\alpha \leq .05$, one-tailed. SPSS Statistics Version 22.0 (IBM, Armonk, NY), incorporating the PROCESS macro-instructional software Version 2.16 Models #1 and #4 (Hayes, 2013, 2015), was used for the statistical analyses.

Mixed-model repeated measures ANOVAs assessed overall between-group differences in changes in physical activity-related self-regulatory skills usage, exercise barriers self-efficacy, overall negative mood, out-of-school physical activity, and BMI. When significant, each was followed-up by pairwise between-group contrasts. Within-group dependent *t* tests were calculated to assess treatment effects. BMI changes were also separately contrasted with baseline BMI-, sex-, and age-adjusted normative gains (Kuczmarski et al., 2002) associated with maturation over the study time frame using one-sample *t* tests. For ANOVAs, effect sizes were expressed as partial eta-squared ($\eta^2_{partial} = SS_{effect}/[SS_{effect} + SS_{error}]$), where .01, .06, and .14 are, respectively, small, moderate, and large effects. For dependent *t* tests ($M_{baseline} - M_{month\ 8}/SD_{baseline}$) and one-sample *t* tests ($M_{group} - M_{population}/SD_{group}$), effect sizes were expressed as Cohen's *d* where values of 0.20, 0.50, and 0.80 are, respectively, small, moderate, and large effects (Cohen, 1992). A negative *t* or *d* value denote an effect in the undesirable direction.

After assessing bivariate inter-correlations in aggregated data, three regression models were fit based on previously proposed relationships between changes in self-regulation, self-efficacy, and negative mood, and physical activity change. This facilitated contrasts of the relative strengths of the three models and helped determine the most salient psychological predictor(s) of physical activity change, while also accounting for the others. Regression Model 1 simultaneously entered changes in self-regulation, self-efficacy, and negative mood as predictors of physical activity change. Regression Model 2 entered change in self-efficacy as a mediator of the prediction of physical activity change by change in self-regulation. Regression Model 3 entered change in negative mood as a moderator of the prediction of change in physical activity by self-regulation change. For each model, the overall R^2 and its significance level, and the unstandardized beta (*B*), its associated *SE*, and significance level of each predictor, mediator, and moderator, was reported. To protect against a Type I error because the family of three equations simultaneously tested the prediction of physical activity change using the same variables, the Bonferroni correction was applied in assessment of model significances (adjusted $\alpha \leq .017$ [0.05/3]).

The prediction of BMI change by change in physical activity outside of school was next assessed. In Step 2 of that regression equation, participants' baseline BMI score was entered. R^2 values, both adjusted and unadjusted for number of predictors, are given. Finally, data from the two treatment groups were aggregated to estimate the percentage of weight change differential (relative to the expected normative weight gain of 0.90 BMI points; Kuczmarski et al., 2002) accounted for by physical activity change outside of school. Additional min of physical activity from baseline (based on 24 weeks of treatment sessions and an evenly graduated increase), an assumption of 5 METs expended during physical activity time (i.e., moderate intensity; Ainsworth et al., 2000), and participants' baseline weight, were used to calculate additional treatment-induced energy expenditures (i.e., METs × kg × time = kcal; Ainsworth et al., 2000). Based on previous research (Hall, 2008), it was also assumed that 7,700 kcal = 1 kg of weight change.

Results

Data on between- and within-group changes from baseline to school-year end are given on all study variables in Table 1. There was no significant group difference at baseline. There was a significant group × time interaction on changes in self-regulation, physical

Table 1. Changes in Study Variables during the School Year, and between-Group Contrasts

	Baseline		Month 8		ΔBaseline-month 8		Within-group change					Time x group		
	M	*SD*	*M*	*SD*	*M*	*SD*	*t*	*df*	*p*	[95% CI]	*d*	*F*(2, 56)	*p*	$\eta^2_{partial}$
Self-regulation for physical activity														
4-day/week treatment	17.48	1.72	18.52	2.16	1.05	1.80	2.66	20	.015	[0.28, 1,87]	0.61			
3-day/week treatment	17.08	2.96	18.33	2.46	1.25	2.45	2.50	23	.020	[0.21, 2.29]	0.42			
Control	18.00	1.80	16.50	1.91	-1.50	2.24	-2.50	13	.027	[-2.80, -0.20]	-0.83	7.89	.001	0.22
Exercise barriers self-efficacy														
4-day/week treatment	16.90	4.71	19.00	3.91	2.10	4.98	1.93	20	.068	[-0.17, 4.36]	0.44			
3-day/week treatment	16.37	3.44	17.00	4.03	0.63	4.30	0.71	23	.484	[-1.19, 2.44]	0.18			
Control	13.79	4.28	13.07	4.57	0.71	5.77	-0.46	13	.651	[-4.05, 2.62]	-0.17	1.41	.254	0.05
Overall negative mood														
4-day/week treatment	6.52	3.41	4.43	4.62	-2.10	4.12	2.33	20	.030	[-3.97, -0.22]	0.61			
3-day/week treatment	6.25	4.67	4.08	4.00	-2.17	4.90	2.16	23	.041	[-4.24, -0.10]	0.46			
Control	5.29	2.55	5.57	3.98	3.98	2.76	-0.39	13	.705	[-1.31, 1.88]	-0.11	1.77	.181	0.06
Out-of school physical activity (min/week)														
4-day/week treatment	289.29	254.48	377.14	226.12	87.86	190.65	2.11	20	.047	[1.07, 174.64]	0.35			
3-day/week treatment	261.88	247.74	360.83	252.29	98.96	158.90	3.05	23	.006	[31.87, 166.05]	0.39			
Control	229.88	165.52	160.00	124.27	-69.29	148.28	-1.75	13	.104	[-154,90, 16.33]	-0.42	5.01	.010	0.15
BMI (kg/m²)														
4-day/week treatment	23.91	2.43	24.03	2.32	0.12	0.69	0.77	20	.448	[-0.20, 0.43]	0.05			
3-day/week treatment	25.06	3.82	25.17	3.74	0.11	0.85	0.61	23	.549	[-0.25, 0.47]	0.03			
Control	21.92	1.23	22.88	1.24	0.96	0.92	3.91	13	.002	[0.43, 1.49]	0.78	5.79	.005	0.17

Note. 4-day/week treatment group, *n* = 21; 3-day/week treatment group, *n* = 24; control group, *n* = 14. ΔBaseline–month 8 = change in score from baseline to month 8. A negative *t* and *d* value denote an effect in the undesirable direction.

activity, and BMI (Table 1). Follow-up *t* tests indicated that the 4-day and 3-day groups' improvements were greater than the control group's improvement on self-regulation and physical activity, and there was significantly less gain in BMI in the 4-day and 3-day groups than in the control group. For the 4-day and 3-day groups, within-group improvements in self-regulation, mood, and physical activity reached statistical significance with moderate, moderate, and small-moderate effect sizes, respectively. The expected 0.90 kg/m² gain in BMI associated with participants' maturation (Kuczmarski et al., 2002) was significantly greater than gains found in the 4-day/week group, $t(20) = 5.17$, $p < .001$, 95% CI [-1.10, -0.46], $d = 1.13$; and the 3-day/week group, $t(23) = 4.56$, $p < .001$, 95% CI [-1.15, -0.43], $d = 0.93$; but not in the control group, $t(13) = -0.24$, $p = .811$, 95% CI [-0.47, 0.59], $d = -0.07$ (Figure 1).

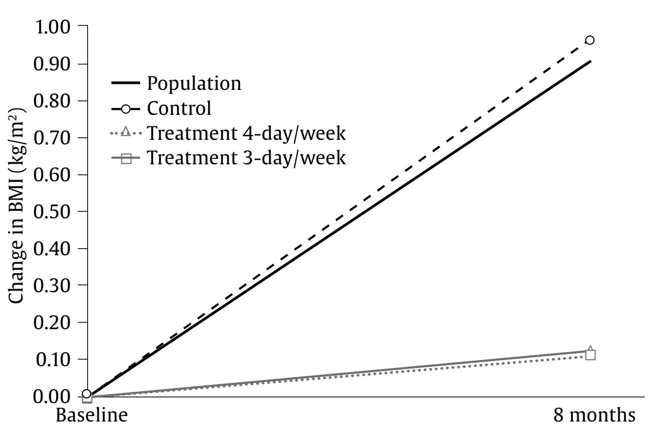

Figure 1. Expected BMI Gains Associated with Participants' Maturation, by Group.

Linear bivariate associations between changes in self-regulation, self-efficacy, and mood – and change in physical activity – were each significant (Table 2). With the exception of the relationship between changes in self-efficacy and mood ($p = .052$), associations between each of the psychological variables were significant. In Regression Model 1, physical activity change was significantly predicted, $R^2 = .23$, $p = .002$, by simultaneous entry of changes in self-regulation, $B = 27.91$, $SE = 22.47$, $p = .005$, 95% CI [10.30, 45.53], self-efficacy, $B = 3.99$, $SE = 4.48$, $p = .189$, 95% CI [-3.50, 11.47], and mood, $B = -4.03$, $SE = 5.89$, $p = .248$, 95% CI [-13.89, 5.82]. As shown above, only change in self-regulation made a significant independent contribution to the explained variance in physical activity change within that model. In Regression Model 2, physical activity change was significantly predicted, $R^2 = .22$, $p < .001$. However, change in self-efficacy was not a significant mediator, $B = 2.28$, $SE = 3.69$, $p = .227$, 95% CI [-1.03, 11.53], of a significant relationship between change in self-regulation and physical activity, $B = 31.59$, $SE = 9.01$, $p < .001$, 95% CI [16.52, 46.66]. In Regression Model 3, physical activity change was significantly predicted, $R^2 = .25$, $p < .001$. However, change in mood failed to reach statistical significance as a moderator, $B = -3.30$, $SE = 2.25$, $p = .074$, 95% CI [-7.05, 0.46] (the self-regulation change × mood change interaction term), of the significant relationship between changes in self-regulation and physical activity, $B = 27.00$, $SE = 10.38$, $p = .006$, 95% CI [9.62, 44.37].

Table 2. Inter-correlations of Changes in Physical Activity and Its Psychological Predictors (*N* = 59)

	1	2	3	4
1. Change in self-regulation	...	.26*	-.54***	.46***
2. Change in self-efficacy		...	-.21	.23*
3. Change in negative mood			...	-.32**
4. Change in physical activity				...

*$p \leq .05$ (one-tailed), **$p \leq .01$ (one-tailed), ***$p \leq .001$ (one-tailed).

There was a significant inverse relationship between changes in physical activity and BMI, R^2 = .09, $R^2_{adjusted}$ = .08, p = .019, which was significantly increased, ΔR^2 = .08, p = .030, when BMI score at baseline was entered into Step 2 of the equation, total R^2 = .17, $R^2_{adjusted}$ = .14, p = .006. Based on participants' weight and the identified mean of 1,148 min of treatment-induced physical activity outside of school (at an assumed 5 METs intensity), an additional energy expenditure of 6,208 kcal over the duration of the study was calculated (Ainsworth et al., 2000). This transposed to a mean of -0.80 kg weight change (Hall, 2008) of the mean 2.07 kg reduction in weight change associated with the treatments. Thus, an estimated 38.6% of the treatment groups' reduction in BMI gain was associated with the increased physical activity that occurred outside of school.

Discussion

Findings afforded an understanding of the efficacy of a new theory-driven cognitive-behavioral health behavior-change protocol for reducing BMI gain in enrollees of an elementary after-school care program who were above the 90th percentile for BMI. Based on usage of recommended study design elements (Baranowski, Cerin, & Baranowski, 2009), the results also clarified how treatment-associated psychosocial changes functioned to induce increased physical activity. BMI gain was significantly, and similarly, lessened in both the 3- and 4-day/week cognitive behavioral protocol groups over the 8-month duration of the study relative to changes associated with maturation. As posited, only the cognitive-behavioral treatment groups attained significant improvements in the targeted factors of self-regulatory skills usage, overall mood, and physical activity completed outside of school. Effect sizes were greater in the 4-day/week group for changes in the psychosocial factors, but not in physical activity change. Contrary to expectations, the treatment groups' increases in exercise barriers self-efficacy did not reach statistical significance. This might be associated with participants' self-comparisons with the great majority of their after-school program peers with lower weights, and suggests that the treatment's reliance on observations of self-regulatory-based successes might benefit from targeted supplementation. For example, theory suggests that self-efficacy might also be advanced through more directed verbal accolades by instructors (i.e., "verbal persuasion;" Bandura, 1997) or, possibly, by leveraging family members' social support (Anderson, Wojcik, Winett, & Williams, 2006). Providing more individualized attention to even small markers of goal progress would also be supported by theory to further increase self-efficacy (Bandura, 1997; Locke & Latham, 2002).

Each of the tested regression models significantly predicted change in out-of-school physical activity at approximately the same strength (i.e., 22%–25% of the variance explained). In each of the three theory-based configurations, the significant contribution of self-regulation change was strong, and not significantly increased by the entry of changes in either self-efficacy or mood (even though self-efficacy and mood changes each demonstrated significant bivariate relationships with physical activity change). Substantial inter-correlations among changes in the psychosocial variables could, however, have affected the regression results. The importance of self-regulation change identified here was similarly supported by both theory (Bandura, 2005) and corresponding research with adults (Annesi & Johnson, 2015; Annesi, 2017; Teixeira et al., 2015). However, even given the high importance of a self-regulatory skill focus indicated, some attention to increasing participants' self-efficacy to overcome barriers to physical activity and improving mood should remain, largely because of the considerable volume of research supporting their associations with physical activity in children (Janssen & LeBlanc, 2010; Sallis, Prochaska, & Taylor, 2000).

The significant inverse relationship between changes in physical activity and BMI was expected. The finding that this association was significantly strengthened as participants' weight increased was salient. It supported the importance of the present cognitive-behavioral methods directed at extending children's physical activity beyond school time, as well as the suitability of applying such methods to children of both normal and high weights within the same setting. Dropout from medically based pediatric weight-management programs is extremely high (Hampl et al., 2011). Given the notable weight gain reduction (i.e., approximately 85% less gain than expected through maturation) that was observed alike in the 4- and 3-day cognitive-behavioral treatment formats, the present scenario might present a more palatable option for young children in overweight and obese ranges, even with most of their program peers being at a lower weight. Additional research will be needed to better-determine if this easily replicable community-based program can serve as a behavioral alternative to more invasive medical interventions for pediatric obesity such as pharmacotherapy or, eventually, bariatric surgery.

Since about 40% of treatment participants' weight gain reduction was attributable to the increased physical activity, further investigation is required to assess if the identified psychological changes generalized to eating changes – as occurred in recent research with adults (Annesi, 2107; Annesi & Vaughn, 2017; Oaten & Cheng, 2006). Valid tracking of participants' eating behaviors will be required for this. Because so much of a child's diet emanates from adults' decisions at school and at home, research into the nutrition-based changes required to reconcile the identified weight gain reduction should occur in extensions of this research. For example, determining the extent of protocol-induced eating changes associated with the combination of the presented nutrition topics (e.g., to help set healthy eating goals), and increased self-regulatory skills instruction/practice (e.g., to manage barriers), would be important. That might have prompted healthier and more controlled eating in the high-weight children even if the school and familial meal, snack, and beverage offerings remained unchanged. It is also possible that eating changes were the result of children beginning to advocate for heathier food options from adults.

Although findings were generally promising, several limitations to this research should be acknowledged. For example, although the lowered BMI gain suggested a reduction in health risks, follow-ups through adolescence and into adulthood are required to increase confidence. Although the behavioral surveys were systematically adapted and validated for purposes of this research design, expectation effects by participants and/or social support effects by instructors might have biased responses. The likeliness of this is increased due to the novelty of the cognitive-behavioral treatment and its obvious behavior-change goals. Measurement accuracy would also benefit from a more objective assessment of physical activity, such as through accelerometry. In extensions of this research, a more active control condition and sample sizes appropriate for evaluating nesting effects associated with instructor characteristics will also be useful. Additionally, because out-of-school physical activity opportunities are affected by parents during the elementary school years, better control of that factor in the future will be valuable. Effects of warmer or colder seasons should also be considered. Accounting for response variations based on the different geographic locations of after-school sites will also be useful in replications of this research. Effects of the present treatment could benefit from parental inclusion beyond simply communication of their child's activities within the program, as occurred within the present protocol. Direct study of this is warranted. Finally, additionally accounting for ethnicity in contrasting expected BMI changes will be useful in further related research.

Even given the stated limitations, the present research advanced the development of palatable behavioral treatments for young children with overweight and obesity. Theory and related research were also progressed through decomposing effects associated with psychological changes over a full school year. Although challenging internal validity, the study's field setting advantageously facilitated generalization of findings to community-based settings capable of helping large numbers of children in need (Green et al., 2013). Based on the present findings, it is hoped that practitioners consider the importance of facilitating behavioral (i.e., self-management) skills to enable even children of high weights to feel successful at physical activity pursuits. Additionally, factors such as the mood-enhancing effects of physical activity and the value of building feelings of ability (i.e., self-efficacy) should be considered in their program development. It is hoped that continued related research is able to affect large-scale change applied to the increasing problem of high weight in children.

Conflict of Interest

The author of this article declares no conflict of interest.

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