A Participatory Physical Activity Intervention in Preschools

A Cluster Randomized Controlled Trial

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Background: Previous studies on physical activity interventions in preschools have reported limited effectiveness. Participatory community-based approaches hold promise for increasing intervention effectiveness and involving parents as key stakeholders in a sustainable way.

Purpose: To assess whether a participatory parent-focused approach using parents as agents of behavioral change enhances the efficacy of a preschool physical activity (PA) intervention.

Design: Two-armed, cluster-RCT with preschool as unit of randomization and children as unit of analysis.

Setting/participants: 39 South German preschools applying for an existing state-sponsored PA program with 826 children (52% boys, aged 5.0±0.2 years), with 441 allocated to the intervention arm.

Intervention: Control preschools received a state-sponsored program consisting of twice-weekly gym classes over 6 months. In intervention preschools, this program was augmented by motivating parents to develop and implement their own project ideas for promoting children's PA.

Main outcome measures: Primary outcomes included mean accelerometry counts and time spent in moderate- to vigorous-intensity PA or sedentary behavior. Secondary outcomes were BMI, percentage body fat, quality of life, sleep quality, and general health. Outcomes were measured at baseline and at 6 and 12 months in both study arms (time period: 2008–2010). Using an intention-to-treat-analysis, linear multilevel regression models assessed change over time and across study arms, adjusted for age, gender, season, and preschool location. Analysis was conducted in 2011.

Results: In 15 intervention preschools, parents implemented 25 PA projects. Compared with controls, intervention arm children were 11 minutes less sedentary per day (95% CI=5.39, 17.01, p=0.014); had significantly more mean accelerometry counts (1.4 counts/15 seconds [95% CI=0.22, 2.54], p=0.019); and showed benefits in perceived general health and quality of life. All other outcomes showed no difference between study arms.

Conclusions: A participatory preschool intervention focusing on parents as agents of behavioral change may be able to promote PA and reduce sedentary behavior in preschoolers. These benefits may go beyond the effects of existing nonparticipatory interventions.

Trial registration: This study is registered at clinicaltrials.gov NCT00987532.
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Background

Childhood obesity rates in most western countries continue to rise rapidly.[1–4] As treatment of manifest obesity in children is mostly ineffective,[5,6] efforts at the community level to prevent obesity in children are urgently needed. Preventive efforts [7,8] should focus on key determinants of obesity in specific communities involving children, such as preschools and schools. Along with changing diet,[9] increasing physical activity (PA)[10] and reducing sedentary behavior have been recognized as crucial elements in addressing the childhood obesity epidemic.[7,8]

In children, early interventions might be more sustainable[11–13] as behavioral patterns are shaped in the first years of life.[8] Given high preschool attendance rates in most industrialized countries, [14–16] preschools offer an ideal setting to increase PA and decrease sedentary behavior. Despite this potential, few studies have tested PA interventions specifically targeted to preschool communities.

In contrast to older children, young children's natural PA is "play." [17] Interaction with caregivers such as parents and teachers is important for organizing play activities.[18–20] Involving caregivers therefore seems essential to ensure the effectiveness and sustainability of interventions aimed at increasing everyday PA of preschool-aged children both at home and in school settings.[21–23] Such involvement is in keeping with the core assumptions of social learning, according to which children establish patterns of normative behavior through role models encountered in their everyday interactions. Given the limited effectiveness and sustainability[23–25] of most preschool PA interventions to date, approaches that successfully involve parents and other members of the preschool community deserve more attention.

Participatory strategies have been shown to hold promise for building capacity and empowering communities.[26] Central components of participatory interventions include choices, acknowledgment of preferences, codetermination, and participant-driven intervention implementation.[27] A goal of the current study was to test whether adding a participatory parent-focused intervention to an existing nonparticipatory expert-driven PA program leads to changes in preschoolers' objectively measured PA and sedentary behavior, both at home and in school, and in other outcomes as compared to the existing program alone. Data on intervention implementation were used to interpret the results.

Methods

Setting and Participants

The study was set in preschools from three distinct regions of Baden-Württemberg, a federal state of 11 million inhabitants in southwest Germany with >90% preschool attendance rates.[28] Children who enrolled at one of the preschools participating in an existing, state-sponsored PA program and were aged 4–6 years were eligible. Preschools in the state-sponsored program[29] were representative of the German preschool system (mostly community- and church-run, half-day attendance). Informed written consent was obtained from the parents of all participating children. Ethical approval was granted by the Ethics Committee of the Medical Faculty, Mannheim, Heidelberg University.

Design and Randomization

In brief, a cluster RCT was conducted with preschools as the unit of randomization and children as the unit of analysis. Preschools were randomized (1:1) to either the intervention or control arm after stratification for aggregate SES[29] and geographic location[29] (urban versus rural) using sealed opaque envelopes. Outcome assessors were blinded to group allocation as suggested for prospective randomized open trials with blinded evaluation.[30] To account for seasonal differences in PA,[31,32] the study was implemented at two time points during the year (spring and autumn). Further details of the study protocol have been published elsewhere.[29]

The control arm was made up of 19 preschools receiving the nonparticipatory, state-sponsored PA program (Figure 1). This consisted of a highly standardized twice-weekly 1-hour gym class delivered by external gym trainers over 6 months plus one parent–gym trainer meeting. The intervention arm consisted of 18 preschools receiving the additional participatory intervention as described below in addition to the state-sponsored PA program. Results are reported here using an extension of the CONSORT Statement for cluster RCTs.[33]

Participatory Intervention

The participatory intervention is best described as a complex intervention[34] in which specific components may vary across sites, even though each component serves the common function of promoting routine daily PA in preschool children. The conceptual framework and details of intervention design can be found elsewhere.[29,35] The participatory intervention was designed to engage parents, preschool teachers, and other members of the preschool community in a sustainable way that builds local capacity. Participatory interventions have been shown to result in significant changes of various behavioral and clinical outcomes and to have a higher likelihood of sustained effects once the formal intervention period has ended.[36] Process evaluation played a key role in the evaluation of the current intervention, as the participatory process resulted in considerable variation across sites in the scope and quality of the resulting intervention projects.

Resources offered to parents and preschool communities were as follows: an intervention-specific website (www.ene-mene-fit.de); an introductory video; and a printed book with 15 project ideas.[29] The external gym trainers in intervention schools received additional training and served as intervention facilitators helping to coordinate parent activities (e.g., by proposing timelines); encouraging participation; and documenting the intervention implementation. For each site, all children in the preschool could take part in participatory PA projects established by parents and teachers and scheduled by posted lists.

In line with the participatory approach, the majority of realized project ideas were designed de novo by the preschool community. The ensuing new ideas were usually connected to the children's

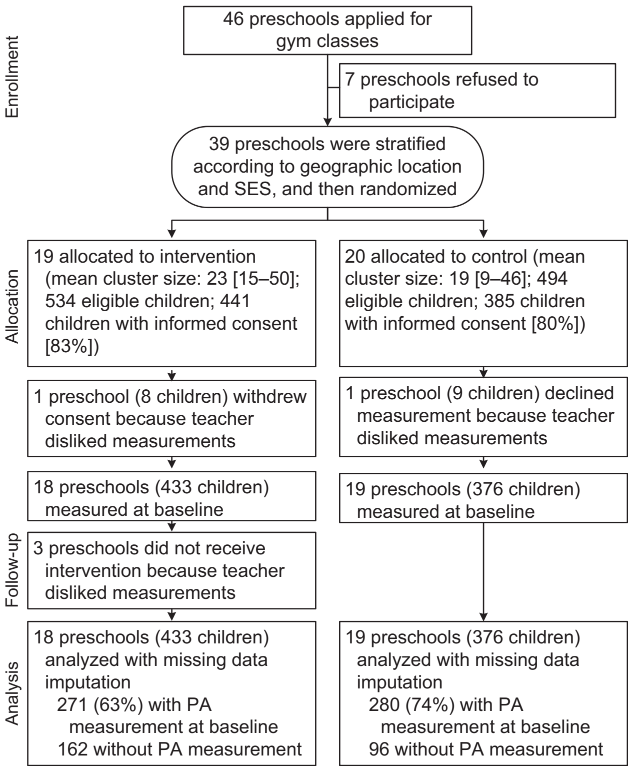

Figure 1. Flow of clusters and individual participants through each study stage.

Note: Measurement: accelerometry and heart rate measurement over 6 days. Numbers in parentheses after mean cluster size are minimum and maximum numbers of children per preschool.

PA, physical activity

everyday life or outdoor play, and were inexpensive and relatively simple to implement and sustain (Appendix A, available online at www.ajpmonline.org). The intervention ran concurrently with the existing state-sponsored, expert-driven PA program over the first 6 months, but continued for a total of up to 9 months. The availability of intervention facilitators over this extended period was deemed appropriate given the complexity of the participatory processes to be fostered, which included steps such as the selection of up to four projects per preschool in an initial workshop, team-building, implementation of projects as regular activities, and a final transfer of implemented projects to the new school year.

Outcomes and Measurements

Repeated outcome measurements were performed at 0 (baseline); 6 (shortly before the end of intervention); and 12 months (approximately 6 months after end of intervention) in children of both study arms (Figure 2) between 2008 and 2010. The primary outcome was mean accelerometry counts, as determined by the Actiheart device; time spent in sedentary behavior and moderate- to vigorous-intensity physical activity (MVPA) per day were derived from the device.[37] Results expressed as time spent in MVPA and sedentary behavior allow for comparison to other studies using different accelerometers. Secondary outcomes included children's BMI, percentage body fat, perceived quality of life, general health, and sleep quality.

Objective physical activity. Children who were present on the first day of the measurement week wore Actiheart devices with an epoch setting of 15 seconds for up to 6 consecutive days each at baseline, 6 months, and 12 months with continuous 24-hour recording per child. For the present analysis, only waking time periods between 7AM and 9PM (defined as "waking day") and children with at least 1 weekend and 1 weekday recorded (97%) were included. Outcome values were averaged over all measurement days of the specific observation period. Mean monitoring time was 5.8±1.4 days with 9.9±4.8 hours.

Anthropometry and body composition measures. Measurements followed a standardized protocol for anthropometric assessment at multiple sites.[29] Overweight was defined according to BMI cut-offs of the International Obesity Task Force (IOTF).[38] Body fat was calculated from triceps and subscapular skinfold values using Slaughter equations.[39]

Subjective well-being via parent questionnaire. Use of a participatory approach to affect behavior change may strengthen ties and cooperation among parents, children, and teachers as social players in the preschool community,[40] thereby exerting a positive effect on children's psychosocial health and well-being.[41] To this end, the current study made use of three of the six dimensions of the KINDL-R quality of life measure[42]: physical well-being (two items); psychological well-being (four items); and self-esteem (three items). Item scores were averaged for each child as an overall quality of life score. General subjective health status as adapted from Raat et al.,[43] and sleep quality using an adaptation of the Pittsburgh Sleep Quality Index,[44] were measured on a 5-point ordinal scale ranging from *very poor* to *very good*.

Covariates. Covariates included gender, age, and rural versus urban community of preschools and season.

Process evaluation of participatory intervention. To estimate the public health impact of the intervention, elements[45] of the RE-AIM (reach, effectiveness, adoption, implementation, and maintenance) framework were used. "Reach" was expressed as the proportion of participating children and parents compared to the total number of targeted, eligible, and recruited children and parents; "adoption" by the proportion of eligible preschools adopting at least the first workshop of the intervention (cancercontrol.cancer.gov/IS/reaim/). Implementation rate was defined as the proportion of preschools having implemented projects at least to some degree; the degree of implementation was rated as on a scale of 0%–100%. Sustainability was estimated by the proportion of project ideas that were designed and developed by the parents de novo (i.e., not taken from the menu of 15 project ideas offered as a general intervention resource). "Maintenance" was measured through the proportion of participatory projects that were transferred to the new school year. The external intervention facilitators were able to follow the intervention activities closely and document the process data using a standardized protocol.

Data Analysis

Sample size calculations[29] assumed a conservatively estimated intraclass correlation coefficient of 0.1[25] (design effect=3) and

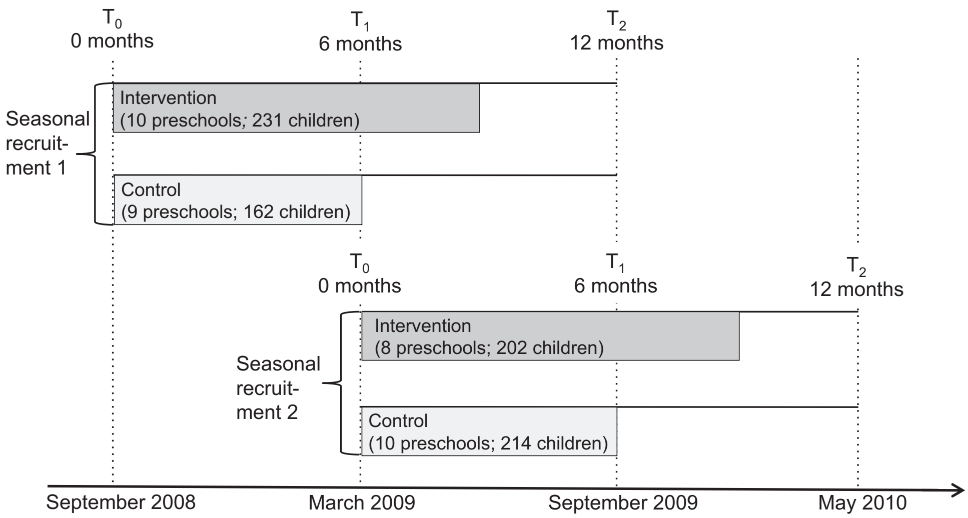

Figure 2. Study design: cluster RCT with three measurements (T_0–T_2) per arm

Note: Implementation was seasonally staggered after initial randomization of all study preschools in August 2008. The duration of the participatory intervention was not equal in all preschools. The minimum duration was 6 months, but intervention facilitators were available over 9 months in all preschools. Depending on the preschool communities and their commitment, activities were planned for an intervention period of up to 9 months.

resulted in a total sample size of 504 children in 24 schools, to be able to show a difference of 0.5 SDs (=19.05 counts/15 seconds[29]) activity counts with a power of 90% and a type I error probability of <5%. Recruitment goals were increased to 560 children (280 per arm) to account for a 10% loss-to-follow-up rate.

Analyses were performed on an intention-to-treat basis. The core model assumed a linear change of the outcomes with time and included two normally distributed random effects (one at the preschool level and one at the child level) to adjust for clustering in the data due to the hierarchic sampling scheme. Further, all models included the variables age, gender, rural versus urban community of preschools, and season as covariates to adjust for a potential confounding effect of these variables. Individual covariates equally distributed in both study arms (immigrant background, maternal education) were not introduced into the model.

For hypothesis testing, fixed effects terms were included to (1) quantify the linear change of outcomes with time (i.e., the slope,); (2) test whether the average measures over all time points differed between study arms; and (3) an interaction term testing differences in slopes between study arms. The effect estimates describe the difference between the mean change in the control versus the intervention groups. In all models, missing data of the outcomes were imputed by a cross-sectional regression imputation approach (age, gender, and measurement time as predictors; 14.6% of anthropometry and 31% of PA data imputed). All statistical analyses were conducted in 2011 using Stata, version 12.

Results

Participants

Of the 46 eligible preschools, 39 (86%) preschools with a total of 1028 eligible children were recruited (Figure 1). In each study arm, one preschool left after randomization, leaving 433 children in 18 intervention preschools, and 376 children in 19 control preschools for analysis. In larger preschool groups (>20 children), accelerometers were distributed alphabetically among the children present on pre-planned measurement days. Overall, more than 75% of children in both study arms provided PA data at each measurement point (Table 1).

Baseline Data

Of the 809 children (mean age 5.05 years, 52% boys, 5.4% overweight), the status of maternal education was low for 25%, middle for 55%, and high for 20%; 37% had an immigrant background. Except for larger group sizes in the intervention arm (mean cluster size 23 [15–50] vs 19 [9–46]), there were no differences in baseline characteristics between the study arms (Appendix B, available online at www.ajpmonline.org). On average, children had 32±9 accelerometer counts per 15 seconds at baseline, spent 37±12 minutes in MVPA, and had 631±53 minutes in sedentary behavior per waking day. Additional raw and unadjusted objective primary and secondary outcome values at baseline, 6-month, and 12-month follow-up are provided in Table 1 for both study arms.

If children were not present on the first measurement day in the preschool (mostly due to sickness or vacation with parents), no data were obtained. The resulting pattern of missing data in children without PA monitoring did not differ between the two arms (Appendix C versus Appendix D, available online at www.ajpmonline.org). Missing data did not differ between children with or without PA monitoring, either, with the exception of immigrant background.

Process Evaluation

On average, 7.3 parents/grandparents were involved in each preschool in participatory activities, and 11.2

Table 1. Raw primary and secondary outcome values without imputation/adjustment (all measurement times and both study arms)

		T_0=baseline		T_1=6 months		T_2=12 months	
	ICCs	Intervention	Control	Intervention	Control	Intervention	Control
Preschools, *n*		18	19	18	19	18	18
Recruited children, *n*		433	376	433	376	433	370
Children with raw data on PA outcomes, *n* (%)[a]		271 (63)	280 (74)	285 (66)	302 (80)	248 (57)	219 (59)
Mean accelerometry, counts/15 seconds/day (SD)[b,c]	0.048	31.4 (8.1)	31.8 (9.7)	32.2 (8.7)	31.8 (9.4)	32.95 (10.78	32.6 (11.6)
MVPA, minutes/day (SD)[b,c]	0.022	37.31 (15.21)	36.42 (14.83)	38.11 (15.98)	37.51 (16.73)	40.32 (20.61)	38.56 (16.1)
Sedentary behavior, minutes/day (SD)[b,c]	0.036	631.3 (68.3)	631.4 (63.2)	629.9 (62.6)	633.3 (63.5)	623.9 (66.8)	628.1 (67.1)
Children present for BMI measurement, *n* (%)[a]		363 (83)	328 (87)	329 (76)	331 (88)	310 (72)	262 (70)
BMI, M (SD)	0.043	15.1 (1.46)	15.3 (1.65)	15.11 (1.55)	15.2 (1.75)	15.2 (1.66)	15.38 (1.85)
Quality of life (SD)[d]		4.28 (0.38)	4.32 (0.37)	4.32 (0.37)	4.29 (0.4)	4.33 (0.36)	4.30 (0.39)
General perceived health (SD)[d]		4.6 (0.59)	4.61 (0.59)	4.61 (0.69)	4.61 (0.62)	4.68 (0.52)	4.57 (0.66)
Sleep quality (SD)[d]		4.4 (0.78)	4.34 (0.82)	4.51 (0.76)	4.37 (0.84)	4.47 (0.79)	4.44 (0.82)

[a]Percentages of all children recruited for the evaluation study with informed consent.
[b]Averaged over maximally 6 days measurement, at least 1 weekend plus 1 weekday
[c]All physical activity values are given as minutes per waking day between 7AM and 9PM.
[d]As rated by the parents on a 5-point ordinal scale ranging from *very poor*=1 to *very good*=5
ICC, intraclass correlation coefficient; MVPA, moderate- to vigorous-intensity physical activity; SB, sedentary behavior; T, time point

children participated regularly in PA projects organized by their parents and teachers (Appendix A, available online at www.ajpmonline.org). In all, 33% of the eligible children and 46% of the parents were reached. Three of 18 recruited preschools refrained from organizing planning workshops (83% adoption rate), with two of the remaining 15 not choosing project activities in the initial workshop. Overall, 36 project ideas (mean per preschool: 2.4) were chosen in workshops, with 25 (69%; mean per preschool: 1.7) project activities actually implemented in 12 of 15 preschools (implementation rate: 80%). Table 2 and Appendix A (available online at www.ajpmonline.org) show varying degrees of implementation and frequencies for implemented project activities. The majority of projects (65%) were developed by the parents de novo, and many (44%) were transferred to the new school year.

Effectiveness Evaluation

Multilevel linear regression models adjusted for gender, age, preschool location, and season demonstrated significant improvements in primary outcomes, based on the interaction term testing for differences in slopes between study arms. At 12 months, children in the parent-focused participatory intervention group were 11 minutes less sedentary per waking day (95% CI=5.39, 17.01, p=0.014) and showed an increase of 1.38 mean counts per 15-second interval (95% CI=0.22, 2.54, p=0.019), or a 4% increase in PA averaged over all measurement days, as compared to children in the control group (Figure 3). Time in MVPA was not different in children in the intervention group (0.97 minutes per waking day [95% CI= −1.13, +3.09], $p>0.1$) at 12 months. In contrast to changes in PA measures, no differences were observed in mean change of BMI or body fat between the study arms (0.064 mg/m^2 [95% CI= −0.08, 0.21, p=0.41] and 0.21% [95% CI=−0.2, 0.63, p=0.32], respectively).

In addition, positive effects were observed in other secondary outcomes (Figure 4). Perceived general health and quality of life of children in the intervention group increased compared to the control group:

Table 2. More-detailed description of content, frequency, and other features of intervention activities across all preschools

Intervention projects implemented	More-detailed description of projects	No. of preschools	Frequency	Transferred to next school year	Outdoor project	During preschool hours	Other locations than preschool
Mini driving/ biking school	Children bring bikes and other vehicles, parents build/paint traffic signs	2	Once and twice monthly		x	x	
Barefoot parcours	Newly built by parents, sensory stimulation on bare feet	2	—	x	x	x	
Swim day	Visit of indoor swimming pool	1	Twice monthly	x		(x)	x
Campfire[a]	Campfire place newly built by parents, connected with outdoor experience	3	Twice/year to monthly	x	x		
Child disco[a]	In the evening	2	Every second month				
Excursions to local farm	Walking outdoors, getting to know animals	1	—		x	x	x
Active reading night	Reading ghost stories with physical activity	1	Regularly	x			
Active games with grandparents[a]	In the afternoon	1	Once				x
Adventure hike	e.g., Hiking in costumes	2	Once	x	x	x	x
Monthly excursion	Walking with children to various places	1	More than twice		x	x	x
Seasonal activities	Harvesting apples and other fruits, collecting chestnuts	1	—	x	x	x	
Music and dancing	Course given by one mother	2	Once a week during preschool semester	x		x	
Preschool gardening[a]	Beds, climbing slopes Newly built by parent initiative on preschool estate	2	Several times	x	x	x	
Active games/ soccer event[a]	In the afternoon	2	Several times			x	
Outdoor day	Organized activities like kite-flying, open air swimming pool, traffic sign course	1	Once monthly	x	x		x
Biking course	Summer program with biking on country lanes	1	1 whole week over summer break		x		x

(continued on next page)

Table 2. More-detailed description of content, frequency, and other features of intervention activities across all preschools *(continued)*

Intervention projects implemented	More-detailed description of projects	No. of preschools	Frequency	Transferred to next school year	Outdoor project	During preschool hours	Other locations than preschool
Building a tree house	Newly built by parent initiative, together with children	1	Several times	x	x	x	x
Playground imitating construction site	Site newly built by parent initiative on community estate	1	—	x	x	(x)	x

Note: x=yes; (x)=*partly*
[a]Project ideas chosen by preschool community from the menu offered to the parents as general intervention resource (printed book or website). All other projects were developed de novo by the preschool community.

0.15 (95% CI= 0.06, 0.23, $p<0.001$) and 0.07 points on a 5-point ordinal scale (95% CI=0.02, 0.2, p=0.007), respectively. There was also a trend toward improved subjective sleep quality in the intervention group (0.113 [95% CI=−0.003, 0.23], p=0.056).

Sensitivity analyses were used to assess the effects of missing data on the current findings. Without the imputed data, the direction of effects remained consistent for all outcome measures. However, only the reduction in sedentary behavior and the increase in general perceived health remained significant at $p<0.05$.

Discussion

Main Findings

This cluster RCT examined the effect of a participatory parent-focused intervention over and above a standard, expert-driven program for increasing PA in preschool children. Children who received a combination of the participatory intervention and the expert-driven nonparticipatory program were significantly less sedentary and more physically active after 12 months, compared to children enrolled in the standard, expert-driven program alone. Half a year after terminating the intervention, children in the participatory arm had 4% more accelerometry counts and spent 11 (−1.7%) fewer minutes in sedentary behavior during wake time. Moreover, parents of children in the intervention arm rated their children's general health and quality of life higher than did those in the control arm.

The participatory intervention was well adopted by the parents and had a moderate reach into the parent population, leading to a sustained "pro physical activity (PA)" culture after 12 months in many preschools. As most participatory projects were not implemented prior

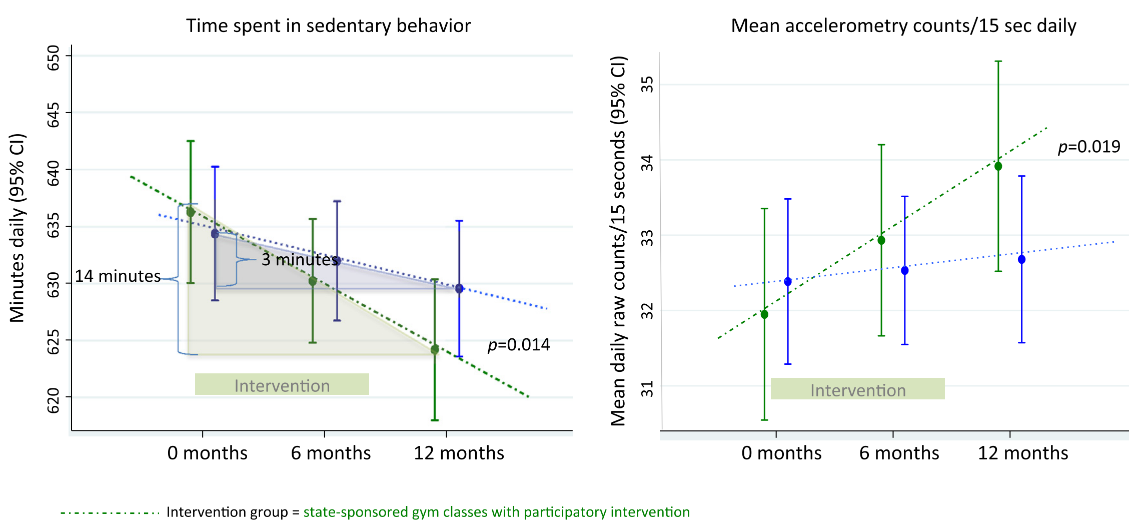

Figure 3. Intervention effects on primary outcomes
Note: Primary outcomes are time spent in sedentary behavior per waking day; and raw accelerometry counts/15 seconds, at baseline, and at 6-month and 12-month follow-up. *p*-values are for the difference in slopes between study arms.

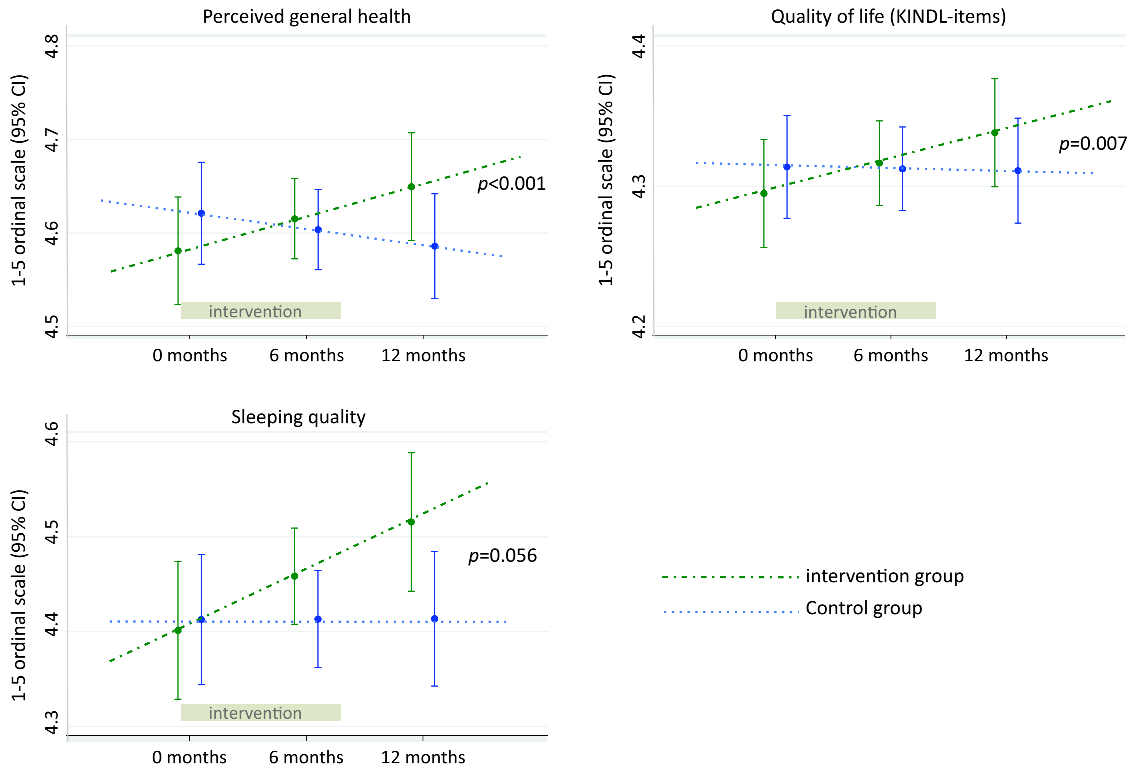

Figure 4. Results of the secondary analysis
Note: Shows intervention effects on subjective measures of child well-being at baseline, 6-month, and 12-month follow-up; *p*-values are for the difference in slopes between study arms.

to 3 months after process initiation, the intervention duration (a maximum of 9 months) was roughly equivalent to the 6 months of intervention exposure in the nonparticipatory program.

Comparison with Other Studies

How do these results compare to those of other published studies? The majority of preschool studies found no changes in objectively measured PA and sedentary behavior following PA interventions.[23,25,46] The few exceptions are two combined dietary–PA preschool programs: one in African-American children reported an increase of 7 minutes per day spent in MVPA[47] after hip-hop activities; the other found an increase in steps counts through exercise training.[48] Two more PA intervention studies in preschools reported significant changes: a pilot-sized study (N=5) increased preschoolers' MVPA by 10-week teacher-implemented activities[49]; and a family-focused active play intervention decreased sedentary behavior by 1.7%,[50] compared with control groups. In all studies mentioned, the effects were measured post-intervention, which hampers direct comparisons with the current results, which were measured at 6-month follow-up.

Also, between-group differences in the current study might be affected by the fact that the control group received an active program. One study in older children (aged 5–12 years)[51] reported the largest longer-term effects to date (after 1 year). In that intervention, designed to promote PA through a community activity coordinator (employed continuously for 2 years) and to target dietary behaviors, results were a 9% decrease in time spent in sedentary behavior, a 10% increase in MVPA, and a 28% increase in accelerometry counts.[51]

Clinical Relevance

In the current study, an increase in PA was observed, but not in BMI. The increased PA was mostly due to an increase in light PA, as evidenced by the fact that accelerometry counts went up whereas MVPA remained unchanged. This finding might be explained by the fact that most of the participatory PA projects implemented (Table 2) do not focus on high-intensity PA but rather on light-intensity activities such as walking and gardening.

As long-term health effects were not measured, the ultimate benefit of the current intervention remains unproven. However, prospective studies suggest that a decrease in sedentary behavior is associated with a more favorable metabolic and cardiovascular profile[52,53] and better fitness[54] in later childhood independent of changes in BMI. The observed effect size is comparable to gender-related differences in sedentary behavior for this age group.[49,55] Although the changes in accelerometry counts seem small, the reduction in sedentary behavior observed may suffice to weaken the known natural developmental trend of declining PA from preschool to mid-childhood.[56]

The children exposed to the participatory intervention were reported by their parents to experience better health and quality of life. In the absence of objective measurements, this might reflect social desirability. However, the children in the control group also received an intense intervention without a concomitant increase in perceived quality of health; thus, the reported effects may indeed be a by-product of the strengthening of social networks associated with the participatory approach. These "social" effects have been implicated in strengthening general health.[41]

Possible Mechanisms

The current intervention was geared to preschool children, who differ from schoolchildren in key aspects of development and motor coordination.[57] Thus, the intervention focused on promoting PA in everyday activities through nonathletic forms of activity (e.g., outdoor play, dancing[47], theater) rather than by expert-driven exercise. Indeed, more than 80% of the participatory intervention projects developed de novo by the preschool communities included playing outdoors (Appendix A, available online at www.ajpmonline.org), which has repeatedly been associated with higher levels of PA in young children[58,59] and improved well-being.[18,60,61] The character of the intervention as "fun" and "childlike" rather than "good for health" may explain why parents in the participatory intervention successfully transferred 44% of the PA projects to the new (i.e., post-intervention) school year.

The participatory approach allowed for network-building among parents. These networks developed the majority (65%) of projects in the intervention de novo, which also explains the variability in the intervention-related activities across preschools (Table 2). This tailoring to local necessities (context-level adaptation) seems to be typical of complex interventions[34] and key in fostering the sustainability of behavioral and social change.[62,63]

Strengths and Limitations

One strength of the study is its design as a cluster RCT, building on objective measurements and a follow-up period of 6 months. A parallel process evaluation[29] documented the role of the various community members involved. Several caveats and limitations must be considered. First, children were sampled from preschools voluntarily applying for a new state-sponsored PA program. Although the percentage of overweight in the current sample was lower (5.5 vs 9.6%),[64] all other sociodemographic indicators were comparable to southern-German reference values,[28] supporting possible generalizability.

Second, absence of children on measurement days may have introduced a postrandomization selection bias. The possible oversampling of a low-risk population (without immigrant background) would rather lead to an underestimation of intervention effect size,[65] and is very unlikely to lead to a change in the direction of the effect.[66,67] Third, the high level of context-level adaptation observed in the current study complicates a clear understanding of which specific intervention components explain the effects. This is indeed a problem in interventions building on ideas from the community. In the current study, an attempt was made to strengthen intervention integrity across sites by standardizing at least core elements of the intervention (e.g., parent workshops) as mechanisms to engage parents.[34]

Fourth, a full control group without any PA program might have been desirable. There was however the opportunity to compare the participatory intervention group outcomes at 6 months with those of children at the end of a 6-month waiting list, who received no intervention. The results revealed a 10% (4-minute) increase in MVPA during wake time in the children in the participatory intervention group (p=0.043, data not shown). Fifth, intervention facilitators were involved in the process evaluation, which might have affected the process documentation.

Practical Lessons

The implementation of the participatory intervention worked better in some preschools than in others (Table 2). Factors identified as obstacles mostly affected the communication level: in some preschools the staff felt overwhelmed by additional parent activities, especially if many other extracurricular activities existed. In others, staff feared extra work and time commitment. Also, busy parent schedules sometimes did not allow for additional volunteer work. In preschools with well-functioning, pre-existing communication routines among parents and teachers, implementation was more successful. Generally, if a project was implemented regularly it also tended to be transferred to the next school year.

Conclusion

Preschool-based approaches that decrease sedentary behavior and increase PA may aid in combating the epidemic of juvenile obesity. The moderate to high rates of adoption, implementation, and maintenance observed in the current study suggest that the intervention might be of public health relevance. In many developed countries, regular PA lessons are the favored approach for preventive PA programs. As shown, participatory modules might be able to increase the effectiveness of such exercise programs and possibly benefit the psychosocial health of children. The current study also adds practical details to one of the central questions in promoting PA in young children— how to best engage parents in an effective and sustainable way.

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Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.amepre.2013.03.001.