CLINICAL RESEARCH STUDY

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Promotion of Cardiovascular Health in Preschool Children: 36-Month Cohort Follow-up

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ABSTRACT

BACKGROUND: Educational interventions in preschool children could improve dietary behavior and physical activity, and prevent unhealthy body weights in low- and middle-income countries. Previously, we have reported the beneficial impact of an educational intervention in preschoolers in a 6-month trial. We now report extended results after 36 months.

METHODS: Evaluating the cohort of previously intervened children, baseline measurements were made in May 2009 in 14 preschool facilities in Usaquén (Bogotá, Colombia). Follow-up measurements were performed at 18 and 36 months. The primary outcome was the mean change in children's knowledge and attitudes scores regarding healthy eating and living an active lifestyle, including habits scores related to physical activity. Secondary outcomes were the change over time of children's nutritional status and the mean change in parent's knowledge, attitudes, and habits.

RESULTS: We included 1216 children, 3-5 years of age, and 928 parents. After adjusting by sex and age of children, socioeconomic status, age of parents, and age and education level of teachers, we found a significant increase in mean knowledge, attitudes, and habits scores at 36 months, compared with baseline: 87.94 vs 76.15 ($P < .001$); 86.39 vs 57.03 ($P < .001$); and 66.29 vs 48.72 ($P < .001$), respectively. We observed a similar increase in knowledge and attitude scores in parents: 73.45 vs 70.01 ($P < .001$); and 78.08 vs 74.65 ($P < .001$). The proportion of eutrophic children increased from 62.1% at baseline to 75.0% at 36 months ($P < .0001$).

CONCLUSIONS: After 36 months, the educational intervention maintained a beneficial trend toward a healthy lifestyle in children and their parents.

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KEYWORDS: Cardiovascular disease (CVD); Global health; Health education; Noncommunicable disease (NCD); Preschool children

Worldwide, according to the Global Burden of Disease 2010,[1] noncommunicable diseases account for 65.5% of all deaths. Among all causes of death, the leading cause is ischemic heart disease (13.3%), closely followed by stroke (11.1%).[1,2] There is growing evidence that negative health behaviors initiated in childhood may persist through adulthood, leading to risk factors of cardiovascular disease and other chronic diseases.[3-5] Therefore, school and community programs that promote regular physical activity are recommended to reduce the burden of chronic diseases associated with sedentary lifestyle and obesity.[6-9]

In May 2009, we planned a long-term pedagogic and communication research program aimed at developing and evaluating effective strategies for modifying knowledge, attitudes, and habits of preschool children and other stakeholders. We conducted a cluster randomized trial in Bogotá, Colombia based on social cognitive theory and the transtheoretical model in health promotion.[10] The results

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demonstrate that a preschool-based intervention aimed at changing knowledge, attitudes, and habits related to healthy diet and active lifestyle is feasible and effective.[11]

As part of a requirement of the local institutional review board, the control group was provided a similar intervention after the initial 5-month study ended. After both interventions were completed, all children and parents were treated as a single intervened cohort, and changes were evaluated twice over a 36-month period. We also have evaluated parents' knowledge, attitudes, and habits toward healthy eating and living an active lifestyle, as well as children's change in nutritional status. We report these results here.

CLINICAL SIGNIFICANCE

- Preschool-aged children undergoing this healthy habits intervention had a significant improvement in their knowledge and attitudes toward cardiovascular health.
- Preschool-based interventions targeting both diet and physical activity have the potential to improve dietary and physical activity behaviors, and to prevent unhealthy body weights in low- and middle-income countries.
- The intervention has durability when evaluated over 36 months.

METHODS

Study Design

We designed a cohort study that included a group of preschool children and their parents who received an intervention in healthy habits in Usaquén, Bogotá.[11] This community is representative of Colombia's diverse socioeconomic levels and includes an underprivileged community with a high migration rate. Institutional review board approval was obtained from both the Icahn School of Medicine at Mount Sinai and Fundación Cardioinfantil in Bogotá.

In the initial intervention, we randomly assigned 14 preschool facilities, using a cluster design, to a 5-month playful and educational intervention or to a control group that received the usual curriculum.

Children were provided educational and interactive classroom activities throughout the 5 months (1 hour daily), which included Sesame Workshop Healthy Habits storybooks, posters, videos, games, and songs; a "Healthy Family Day" workshop (1 hour); and weekly health messages to children and their families. Parents participated in 3 workshops and weekly notes containing positive health messages about nutrition and active lifestyles to share with their children. Teachers also participated in 3 centralized training sessions, in addition to personalized working sessions with a research supervisor (2 hours, every 15 days), and received a teacher's guidebook. A total of 1216 children aged 3-5 years, 928 parents, and 120 teachers participated.

Study Measurements

We used the same questionnaires from our initial study to measure knowledge, attitudes, and habits on healthy eating and living an active lifestyle in children and their parents.[11] Baseline measurements were made in May 2009, and follow-up measurements were made at 18 and 36 months.

Children's height and weight were measured by nutritionists using standard techniques.[12] Nutritional status of children was assessed using the Centers for Disease Control and Prevention growth charts for age (in months) and sex for body mass index,[13] with children classified as malnourished if body mass index was < -2 SD, risk of malnourishment -2 SD and < -1 SD, eutrophic -1 SD and $+1$ SD, overweight $> +1$ and $+2$ SD, and obese $> +2$ SD. Socioeconomic status was measured with a tool used routinely by the Colombian government,[14] using a rating scale from 1 (lowest socioeconomic status) to 6 (highest socioeconomic status).

Outcomes

The primary outcome was the mean change in children's knowledge and attitudes scores with regard to healthy eating and living an active lifestyle, including habit scores related to physical activity. Secondary outcomes were the mean change in parent's knowledge, attitudes, and habits about healthy eating and living an active lifestyle. We also evaluated the change over time of children's nutritional status.

Statistical Analysis

Data collected were recorded in a previously designed database using ACCESS (Office 2000; Microsoft Corporation, Redmond, Wash). All statistical analyses were performed

Table 1 Baseline Characteristics of the Study Population

Characteristic	Value; n (%)
Children	
N	1216
Age	
Mean (SD), years	3.72 (0.69)
Years	
3	652 (53.62)
4	535 (44.00)
5	29 (2.38)
Sex — ratio M/F	1.13
Socioeconomic status of the neighborhood where the preschool facility is located	
1-2	711 (58.47)
3-4	505 (41.52)
Children's nutritional status by BMI (n = 1098)	
Undernourished	170 (15.48)
Eutrophic	682 (62.11)
Overweight	218 (19.85)
Obese	28 (2.55)
Parents	
n	928
Mean (SD) age — years	30.67 (7.50)
Sex — ratio M/F	0.19

BMI = body mass index.

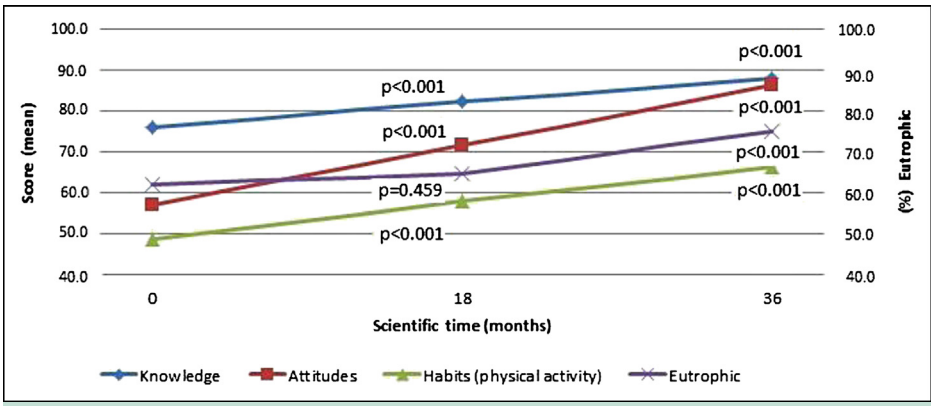

Figure 1 Mean scores for knowledge, attitudes, habits, and the percentage of eutrophic children over time.

with SAS software programs (SAS Institute, Cary, NC) and based on a predefined statistical analysis plan. For categorical outcomes, a statistical comparison between proportions for paired data was conducted with both the Stuart-Maxwell and the Cochran Q tests. For continuous outcomes in children and parents, we conducted univariate analyses between scores and scientific time, using random coefficient lineal regression modeling.

For each of these outcomes, we then fitted multivariable models where other covariates were included, to evaluate for interactions and to adjust for potential confounders. Variables included in children models were: age and sex of the child, age of the parents, early or late intervention group, and age and educational level of teachers. For the interactions, we included those between time, sex, and age of the child, socioeconomic status based on the school's location, and teacher's educational level. For parents, multivariate analysis was used to evaluate and report on interactions between time and age and sex of the parents, and socioeconomic status. To minimize problems associated with multiple variable comparisons, only interactions with P values $<.001$ are reported.

RESULTS

The total study population comprised 1216 children, 3-5 years of age, and 928 parents at baseline. The total number of children and parents evaluated was 596/435, and 598/475, at 18 and 36 months, respectively. The baseline characteristics of the study population are described in **Table 1**.

Primary Outcome

After adjusting for sex and age of children, intervention group, socioeconomic status, age of parents, and age and educational level of teachers, children showed significant changes in knowledge, attitudes, and physical activity habits (**Figure 1**, **Table 2**).

Table 2 Knowledge, Attitude, and Habit Scores in Children, Adjusted by Covariates*

	Knowledge		Attitudes		Habits†	
	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)
Baseline	758	76.15 (3.20)	800	57.03 (2.26)	827	48.72 (1.23)
18 months	374	82.25 (1.35)	379	71.53 (1.23)	381	57.80 (1.50)
36 months	379	87.94 (1.76)	382	86.39 (1.77)	382	66.29 (2.76)

*Adjusted by sex and age of children, group, socioeconomic status, age of parents, age and educational level of teachers.
†Habits in physical activity.

Table 3 Knowledge Scores* Over Time, By Age and Sex of Children, Adjusted by Covariates

Scientific Time (Months)	Age, Years†			Sex‡	
	3	4	5	Girls	Boys
Baseline	72.94 (0.59)	77.5 (0.77)	81.28 (1.52)	75.12 (0.75)	77.09 (0.79)
18 months	80.61 (0.71)	82.33 (0.51)	83.65 (0.67)	81.88 (0.50)	82.61 (0.58)
36 months	89.6 (0.69)	88.11 (0.55)	86.11 (0.70)	88.32 (0.73)	87.57 (0.48)

*Mean (SE).
†Adjusted by age of children, group, socioeconomic status, age of parents, age and educational level of teachers.
‡Adjusted by sex of children, group, socioeconomic status, age of parents, age and educational level of teachers.

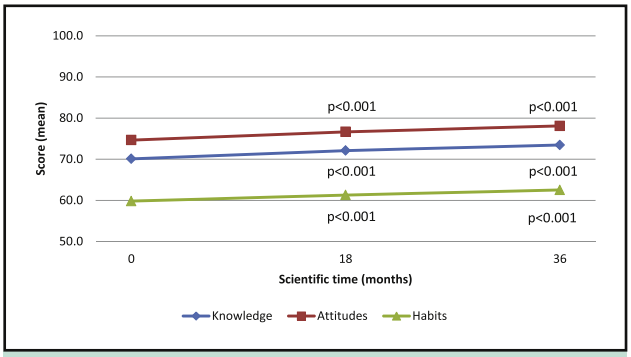

Figure 2 Knowledge, attitude, and habits scores over time in parents.* All *P* values correspond to a comparison with baseline values.

There was an interaction between age and knowledge scores, where 3-year-old children, who not surprisingly had a lower score at baseline, had a better score than older children at 36 months, $P < .001$. A similar interaction was suggested with sex, where girls showed a lower baseline score but a higher 36-month score than boys, $P = .04$ (**Table 3**).

Secondary Outcomes

After adjusting for sex and age of parents, and preschool socioeconomic status, parents showed statistically significant but minor changes in knowledge, attitudes, and habits (**Figure 2**, **Table 4**) without evidence of a worsening of the score during the follow-up.

Regarding children's nutritional status, most were eutrophic at baseline and during the 36 months of follow-up, with a decrease in the proportion of underweight children and—to a lesser extent—overweight children (**Table 5**).

Of the 540 children assessed at 36 months, 62 (11.46%) changed their nutritional status from underweight in the baseline to eutrophic, and 91 (16.82%) from overweight-obesity to eutrophic.

DISCUSSION

In this study, children of preschool age and their parents showed a positive trend up to 36 months of follow-up after receiving an intervention based on a unique program, funded and implemented by a public-private partnership, aimed at changing knowledge, attitudes, and habits related to healthy diet and active lifestyle. The results are consistent with mounting evidence that illustrates how preschool- and school-based interventions targeting both diet and physical activity, involving multiple stakeholders, integrating educational activities into the school curriculum, and using social cognitive theory in the development of the intervention, have the potential to improve dietary behavior and physical activity, and to prevent unhealthy body weights in low- and middle-income countries.[15-17]

In our study, we found that the change over time in healthy lifestyles was greater among the younger 3-year-old children. This supports our hypothesis that major lifestyle changes can be obtained with programs that begin at an early age.[18-20] Also, comparable to the proportions of the 2010 Colombian National Nutritional Survey ENSIN 2010,[21] 62.1% of the study children were eutrophic at baseline, and this percentage increased to 75.0% after 36 months of follow-up. Although the decrease in underweight children was the main contributor to the trend, after 36 months we found evidence of a decrease in overweight-obesity prevalence in these preschool children, similar to what has been reported in other studies of combined multicomponent interventions.[22-26]

Although there were changes in knowledge, attitudes, and habits toward a healthy lifestyle in parents, they were of

Table 4 Knowledge, Attitudes, and Habits Scores in Parents Adjusted by Covariates*

Scientific Time (Months)	Knowledge		Attitudes		Habits†	
	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)
Baseline	778	70.01 (2.17)	779	74.65 (1.78)	782	59.81 (2.30)
18 months	364	72.10 (2.06)	357	76.66 (1.69)	362	61.28 (1.19)
36 months	422	73.45 (2.15)	422	78.08 (1.76)	420	62.52 (0.95)

*Adjusted by sex and age of parents, socioeconomic status.
†Habits in physical activity and nutrition.

Table 5 Change in Nutritional Status in Children Over Time

Nutritional status	Baseline n (%)	18 Months		36 Months	
		n (%)	*P* Value*	n (%)	*P* Value*
Underweight	170 (15.48)	33 (12.31)	.191	18 (3.33)	<.0001
Eutrophic	682 (62.11)	173 (64.55)	.4594	405 (75.00)	<.0001
Overweight and obese	246 (22.44)	62 (23.13)	.7977	117 (21.67)	.7354

*All *P* values correspond to a comparison with baseline values.

less magnitude than those found in children, which is likely attributed to the fact that the intervention focused more on the children. This highlights the importance of involving the entire family.

At baseline, the study population was distributed throughout 14 preschool facilities within the Usaquén community, one of which was in the locality of Bogotá. However, because of the high migration rate within the country due to social and economical hardships facing many Colombians, the population transitioned to 305 schools in 12 localities of Bogotá after 36 months. In addition, we acknowledge that some of the observed beneficial changes may have been due to other circumstances aside from our intervention, such as a healthy habits program led by the local government in Bogotá that was being implemented concurrently.[26]

One limitation of the current study was the lack of information with regard to children's habits not associated with physical activity, such as dietary habits, which require further measurement validation. Additionally, retention rates of subjects between baseline and 36-month measurements can temper the overall findings. However, our retention rates were consistent with other similar trials.

In conclusion, after 36 months of follow-up, this school-based intervention maintains a positive change, mainly in children's knowledge and attitudes, and lesser effect in their parents. With respect to children's habit scores, physical activity improved after 36 months of follow-up. For children 3 years of age, the change in the knowledge score overtime was more significant. The habits score of the parents also showed a small but significant improvement.

This study contributes to a growing body of evidence that similar interventions initiated at the preschool level may represent a critical window for cardiovascular health promotion.

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