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Original / *Obesidad*

Pilot nutrition and physical activity intervention for preschool children attending daycare centres (JUNJI); primary and secondary outcomes

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Abstract

Introduction: **A pilot intervention was conducted to promote physical activity and nutrition in public preschool education (near half a million children in Chile), in order to prevent obesity.**

Objective: **To assess the primary (body fat) and secondary outcomes (physical activity and energy intake) of a nutrition and physical activity pilot intervention for preschool children, attending day care centres.**

Methods: **A pilot intervention in six day care centres selected at random (n = 530), in 4-5 years old preschool children, Santiago, Chile intending to: provide nutritional and physical activity education to educators and health promotion activities for the family, which in turn, will affect the primary (body fat), and secondary outcomes (physical activity pattern and energy food intake) were measured in a representative subsample of 120 intervened and 145 controls children.**

Results: **In relation to secondary outcomes monitoring, moderate-vigorous activity was duplicated in the intervention group (+5.4% and +4.7%, respectively), in both obese and eutrophic children. Energy intake decreased in 11.7% in obese and 7.5% in eutrophic children. Dietary fat intake was reduced (-11 g in obese and -8.4 g in eutrophic children). Intervened obese children reduced body fat in 1.5%, meanwhile in control obese children, b*ody fat increased 1.3% (p < 0.01).***

Conclusions: **The pilot intervention demonstrated the feasibility to influence dietary risk factors and physical activity at the day care centres and families. Therefore, the implementation of the validated intervention program will be tested in different weather conditions, to prevent unhealthy habits in preschool children and their families.**

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Key words: *Intervention. Outcomes. Preschol children. Physical activity. Nutrition.*

INTERVENCIÓN PILOTO EN NUTRICIÓN Y ACTIVIDAD FÍSICA PARA PREESCOLARES ASISTENTES A JARDINES INFANTILES (JUNJI); RESULTADOS PRIMARIOS Y SECUNDARIOS

Resumen

Introducción: **Intervención piloto en nutrición y actividad física para prevenir obesidad en la educación preescolar (cerca de medio millón de niños en Chile).**

Objetivo: **Evaluar los resultados primarios (grasa corporal) y secundarios (actividad física e ingesta energética) de una intervención piloto para niños/as asistentes a guarderías infantiles.**

Métodos: **Intervención piloto en seis guarderías seleccionadas al azar (n = 530 preescolares), 4-5 años en Santiago de Chile, con el objeto de: a) proporcionar educación en nutrición y actividad física para los educadores; b) actividades de promoción de la salud para la familia.**

El objetivo primario (grasa corporal), y los resultados secundarios (patrón de actividad física y la ingesta energética) se midieron en 265 preescolares (120 intervenidos y 145 niños controles).

Resultados: **La actividad física moderada- intensa se duplicó en los intervenidos (+5,4% y +4,7%, respectivamente), tanto en niños obesos y eutróficos. La ingesta energética se redujo en 11,7% en obesos y 7,5% en los eutróficos y la de grasa en (-11 g en obesos y -8,4 g en niños eutróficos). Los niños obesos intervenidos redujeron la grasa corporal en 1,5%, mientras que en los niños controles obesos, se incrementó 1,3% (p < 0,01).**

Conclusiones: **La intervención piloto demostró la viabilidad de influir en los factores de riesgo dietarios y de actividad física en las guarderías y en las familias. Por lo tanto, la ejecución del proyecto piloto se pondrá a prueba en diferentes condiciones climáticas, para prevenir hábitos no saludables en los preescolares y sus familias.**

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Palabras clave: *Intervención. Resultados. Preescolares. Actividad física. Nutrición.*

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Abbreviations

JUNJI: National Day Care Centres.
DCC: Day Care Centres.
BMI: Body Mass Index.
FMI: Fat-Mass Index.
FFMI: Fat-Free Mass Index.

Introduction

Obesity prevalence in Chilean children and women from low socio-economic status has increased steadily[1-3], and weight excess is over 30% in three-to-five year old preschool children[3].

Obesity prevention should be done from intrauterine life, infancy and preschool years, physiological states in which long-term regulation of energy balance may be regulated[4]. Weight excess in children and adolescents has increased in alarming proportion worldwide, reaching 20% in many European countries[5,6].

This progression from a normal nutritional status to obesity, is due to adverse environmental factors, genetic predisposition and lifestyle, all which modulate the risk of developing obesity or later on cardiovascular risk factors[7,8]. The imbalance between the energy spent by physical activity and food and on the other hand, energy intake, is in the roots of obesity[9]. The preschool age has been identified as a crucial period to prevent obesity, as it is not only the time when nutritional habits and physical activity settle down, but also a it is the period previous to the rise of the body mass index and the adiposity rebound[10,11]. Numerous studies have demonstrated that a precocious adiposity rebound is later associated to an obesity increased risk, during adolescence and adulthood[12,13].

Evidence-based interventions aimed at the prevention of preschool obesity are important. Several works have aimed to improve diet, increase physical activity, achieve behavioural change, but only a few studies have been successful, either in improving quality of diet or increasing physical activity[14].

In Chile, pre-schoolers under six years, beneficiaries of the public health system, have an overweight prevalence of 22.6% and 9.6% obesity prevalence[3]. Preschool attendants to the JUNJI have a prevalence of 29.0% of overweight and 13.0% of obesity[15].

The fast and dramatic increase of obesity prevalence in preschool children in Chile is associated to an insufficient physical activity and unhealthy energy intake. Some studies have observed an energy intake far superior to the child needs, a surplus coming especially from the consumption of food high in fat and sugar[16,17]. Obese children attending day-care centres were in energy balance during the week (6,873 ± 1,005 kJ/d) while at the weekend excess energy intake energy reached 25% (8,814 ± 1,817 kJ/d), During the eight hours permanence n the day-care centre the average consumption of fat was 22 grams while in the 4-5 when at home, the child ingested 26 grams and this consumption reached 70 grams over the he weekend[18].

Kain et. al, compared children attending day-care centres with the non assistants, measured through a daily record of activities. Sedentary activities, such as sleeping, being sat and watching reached 18.3 hours duration, independently of the nutritional state and the child's sex[19]. A more precise evaluation was done with movement sensors, being the result similar as normal and obese preschool dedicated 70-80% of daily activities to minimum activity and sedentary activity[18]. Additionally, obese boys had only 50% of the moderate/vigorous activity of their eutrophic pairs. Preschool girls had similar quantity of physical activity time in both nutritional states, thus being equally sedentary[20,21]. Being sedentary at early age, affects the appropriate and opportune motor development and physical aptitude, and contributing to the rising of cardiovascular risk factors, that increases the risk of later morbidity and mortality[22].

In a previous work conducted at the JUNJI, total body fat was evaluated by means of isotopic dilution in 250 normal children, overweight and obese. The range for this variable in normal children stretched from 12% to 34% and from 20% to 38% in obese children[23]. The excess of body fat and inactivity in preschool children urgently need the development and testing of strategies for reverting this situation. This fact, plus an altered energy balance and energy intake, led to the decision of conducting a multistage intervention in JUNJI, firstly in the Metropolitan region boroughs, which had the biggest prevalence of overweight and obesity in the metropolitan area. The main objectives in the pilot study, was to assess the primary and secondary outcomes of a designed intervention in Nutrition and Physical activity for 4 to 5 years old, aiming to increase moderate-vigorous physical activity, reduce the amount of energy-dense food and consequently their body fat content.

Materials and methods

Subjects

The study was conducted in 4-5 year old children (n = 530), attending four JUNJI DCC (two intervened and two control), located in the south-east zone of Santiago, Chile, in the largest boroughs in Santiago (La Florida, Peñalolen y Ñuñoa) where most of the low socioeconomic population lived, thus with a high obesity prevalence. Evaluation was performed on a representative sample of 85 normal nutritional status and 35 obese children. The control group (n = 145), was composed of 40 obese and 105 eutrophic children. Inclusion criteria included: none undernourished children[24], no impediments to enrol in physical activity and ethical consent of parents, to participate in the study. Exclusion criteria considered medical diagnosis of psychomotor disorder, use of drugs that could alter body composition, physical activity or biochemical parameters. This research was approved by the Ethics Committee of University of Chile.

Educational Methodology Design[25,26]

a) The educational intervention in Nutrition and Physical activity in preschool children, was built according to the theory of the "Social Cognitive Learning" and the Ecological model. The sub model of Community organization was selected, as it able to develop community capacities to contribute to the solutions of problems.
b) The project included a multidisciplinary team: nutritionists, physical education teachers, anthropologists, evaluation experts and medical doctors.
c) The control group received no intervention and continued as usual.

In the Pilot year, the *validation of the educational methodology* considered the following activities:

a) Educational material, designed to target the involved community, plus questionnaires to evidence the quality and comprehension of educative materials for educators. The material was based on the new curricula of the national Preschool Education. Educative Guidelines in Nutrition and Physical Activity were firstly designed and validated during the implementation of the project, May to September. Further counselling was carried on weekly by nutritionists and physical education teachers to clarify doubts during the intervention.
*b) After testing, f*urther design and validation of Manuals and Didactic Guide in Nutrition and Physical activity for the educators was done, in terms of materials comprehension and the process of transference of educative contents to the preschool children.
c) Specific training program for educators and parents, using designed Didactic Guides for Physical Activity and Nutrition. An anthropologist conducted perceptions and attitudes of educators and parents, relevant to changes in lifestyle and feasibility of the intervention.
d) Educational, playful *motivational strategy* for the parents and families, called "Healthy Days", conducted once/twice a month, especially at Saturday morning or Friday evenings, when parents were prone to attend. Educational leaflets containing information on growth, nutritional factors and physical activity needs, were designed and provided to parents, in order to minimise additional consumption of energy dense food to the normal pattern (breakfast, lunch, milk and bread plus dinner) and to avoid excess TV time (> one hour daily), and encouraging daily play time.
e) Educative process f*ollow-up*. Advances were registered by the educator at every play school, using and adhoc questionnaire and supervised by the intervening team.

First stage (pilot) measurements

Primary outcome in boy intervened and control DCC. *Total body fat*; with the validated equation, derived from the measurement of total body water. Body fat measurements, obtained[27]:

$$\text{Body fat (kg)} = [-1{,}524 + (0.371 * \text{weight, kg}) + 0.114 * (\text{triceps} + \text{subscapular, mm}) - (0.238 * \text{age, years}) + (0.378 * \text{sex}) - (0.105 * \text{calf circumference, cm})]$$

(Sex: 1 Boys, 2 Girls)

Secondary outcomes (intervened children)

- *Energy Intake in the* day *care-centre*, food intake measured during the eight hours of stay in DCC (twice a week), on non-consecutive days. Food intake was weighed before each meal, and data was obtained by subtracting the weight of the food leftover on the tray. The food components of each preparation were known in advance and its chemical composition was provided by the food suppliers. All children ate the same menu; hence, there were no differences in the type of foods served, but only in the amount eaten by each child. The children were discretely supervised during the mealtime.
- *Week days food intake measurement at home:* the same day of the measurement at the day care centre, home food intake was measured by providing the mother a questionnaire, on which to record all week foods eaten by the child from 16:30 until bedtime and the next day breakfast. The following day, the mother came to the centre, to review the information regarding the types of preparations, amount or portions consumed, and name brand foods eaten by the child. A trained nutritionist, who also weighed the food intake at the day care centre, checked with the mother, the information on home intake in the immediate next day of the measurement. Dietary information on energy and macronutrient composition during the week was obtained via an ad-hoc computational program based on the Chilean Food Composition table[28].
- *Weekend food intake*. Mothers were provided with a 24 h recall questionnaire to record all food intakes at home on one weekend day. The mother was interviewed the following Monday in order to review with her the portion sizes, food types, in-

gredients of food preparations and name brand foods. This information was utilised to quantify energy intake during the week and weekend. The measurement of energy intake as described above had a 7.3% difference, compared to doubly-labelled water (sent to publication).

– *Physical Activity*. A triaxial movement sensor was used (TRITRAC-R3D RESEARCH ERGOMETER, Professional Products, Division of Reining International, Madison, Wisconsin, USA). This sensor collected information on three-dimensional movement (lateral, vertical and horizontal) every minute and this information is stored as a Vector of Magnitude, which is the square root of the sum of each vector in directions X, Y, Z elevated to the square power. The information was collected during three days (two during the week and one day at weekend). Results were downloaded to a computer where it could be analyzed as needed.

Preschool children require setting distinct activity cut-off points for this group. Children's activities were categorized into four ranges after direct observation of 20 children of normal nutritional status (table I). The cut-off counts for moderate and moderate-vigorous activity in our group is similar to three Mets activities (around 1,000 counts) as found in Rowland et al[29]. The Tritrac motion monitors were used during three full days (two weekdays and one weekend day). The monitor was placed immediately after waking up and disconnected once asleep; the mother or caretaker was asked to register those times, as well as any other moment of disconnection of the equipment (i.e., shower, swimming) in an ad-hoc questionnaire.

The movement sensor was firmly attached to the child's chest within a stitched pocket. This fact ensured the monitor's tight positioning, avoiding the possibility of shifting, to reflect the child's real activity but allowing freedom of movement**.** Positioning the monitor at the hip was either not accepted by the children, due to their stature or had the risk of being easily manipulated. The position in the chest was used as a proxy, (8-10 centimetres away from the hip in 4-5 year old children).

Table I
Cut-off points used to classify physical activity levels based on Tritrac measurements

Activities	*Activity counts (Vector of Magnitude)*
Resting and minimal movements	< 188
Sedentary activities in the classroom	188-349
Light effort activities in the playground	350-1,074
Moderate and intense activities in the playground	> 1,074

Data analysis

Descriptive statistics were performed on the data, including minimums, maximums, and frequency tables. Below we provide a description of the variables utilised. For continuous variables the Shapiro Wilk goodness of fit and the homogeneity of variance tests were used. Descriptive statistics was performed according to the nature of the variables. For those that complied with the assumption of normality, the population mean and standard deviation were used; for those that did not, the median and interquartile range were preferred. A Student or Wilcoxon test was used to assess statistical significant differences according to data distribution. Statistical significance was set at $p < 0.05$. Data was analysed using the STATA program version 12.0 (StataCorp. 2011 Stata Statistical Software: Release 12. College Station, TX: StataCorp LP).

Results

Table II shows the baseline anthropometrical data for obese and eutrophic children. The expected differences are presented for weight, Z Weight for Age, Z Height for Age and Z Weight for Height ($p < 0.05$), as well as arm circumferences, calf circumferences, triceps, subscapular, suprailiac and then, the two, four and five sum of skinfold thickness, body fat, FMI and FFMI.

Table III, shows the changes produced by the Pilot intervention in energy intake (kcal), physical activity pattern and body fat (k), for intervened (obese and eutrophic), preschool children. The intervention produced a significant reduction in the energy intake of both obese and eutrophic children (-745 kJ and -447 kJ respectively). A significant reduction in fat intake -23.9% (-11 g) for obese and eutrophic children -18,5% (-8,4 g) was observed.

Physical activity, significantly decreased in minimal activity (12.5% in obese children (57.6 minutes) and 12,1% in normal nutritional status children (58.1 minutes). The intervention produced an increase in moderate-vigorous activity, in obese preschool children with 5.4% (25.9 minutes) and 4,7% (22.6 minutes), in eutrophic preschool children ($p < 0.01$). A reduction in the energy intake in -11.8% (-712 kJ, $p < 0.05$) and -6.3% (-372 kJ) in obese and eutrophic children, respectively. Fat intake decreased in -20.3% (-9.2 g, $p < 0.05$) in obese and -16.9% (-7.5 g, $p < 0.01$) in eutrophic children. Minimal physical activity decreased 20.8% in obese (99.8 minutes) and -18.2% (92.2 minutes in eutrophic preschool children). Moderate-vigorous activity, increased significantly in obese preschool children, from 1.7% to 7.5% (31.7 minutes increase) and 5.8% in sedentary eutrophic (19.7 minutes).

According to the positive results in food and physical activity, a reduction was observed in the sum of skinfold thickness, of 8.2 mm and 2.8 mm, in obese and eutrophic children, respectively ($p < 0.01$). Table IV,

Table II
Anthropometrical baseline data for intervened obese and eutrophic children

Variable	*Obese Group (n = 13 M, 22 F)*	*Eutrophic Group (n = 52 M, 33 F)*
Age (years)	4.4 ± 0.4	4.4 ± 0.4
Weight (kg)	22.3 ± 2.5*	17.2 ± 1.7*
Height (cm)	107.2 ± 4.5	104.7 ± 4.7
Weight for Age Z-score	2.2 ± 1.0*	-0.1 ± 0.7*
Height for Age Z-score	0.3 ± 0.8*	-0.3 ± 0.9*
Weight for Height Z-score	2.7 ± 0.8*	0.1 ± 0.5*
Circumferences (cm)		
Arm	19.6 ± 1.3*	16.7 ± 0.8*
Calf	25.1 ± 1.5	21.7 ± 2.7*
Skinfold thickness (mm)		
Triceps (T)	14.6 ± 3.1*	9.6 ± 2.3*
Biceps (B)	8.9 ± 2.5	8.3 ± 2.9
Subscapular (SB)	10.9 ± 4.6*	6.6 ± 1.6*
Suprailiac (SP)	14.6 ± 6.1*	7.5 ± 3.3*
Calf (C)	16.4 ± 4.4*	12.9 ± 3.3*
T + SB	25.5 ± 7.1*	16.1 ± 3.3*
Σ 4 (T+B+SB+SP)	49.1 ± 14.0*	32.1 ± 6.9*
Σ 5 (T+B+SB+SP+C)	65.5 ± 17.3*	45.0 ± 9.3*
Body Fat (%)	29.4 ± 3.7*	21.7 ± 3.1*
FMI (kg/m^2)	5.7 ± 1.0*	2.4 ± 0.5*
FFMI (kg/m^2)	15.7 ± 1.6*	13.4 ± 1.3*

Mean ± SD FMI; Fat-Mass Index. FFMI; Fat-free Mass Index. *p < 0.05.

Table III
Changes of intake (kJ), physical activity (%) and body fat in obese (O) and eutrophic (E) in intervened preschool children

Variable	*Group*	*Baseline*	*Follow-up*	*Change*
Energy intake (kJ)	O	6,347 ± 1,086	5,602 ± 904	-745.0*
	E	5,991 ± 820	5,544 ± 946	-447.0*
Fat intake (g)	O	46.1 ± 9.2	35.1 ± 7.8	-11.0*
	E	45.4 ± 11.9	37.0 ± 10.3	-8.4*
Minimal Activity (%)	O	60.5 ± 13.6	48.0 ± 9.4	-12.5*
	E	58.3 ± 10.5	46.2 ± 10.7	-12.1*
Vigorous Activity (%)	O	2.8 ± 3.2	8.2 ± 4.5	+5.4*
	E	3.8 ± 3.5	8.5 ± 5.1	+4.7*
Σ 4 (T+B+SB+SP) (mm)	O	48.5 ± 14.0	40.3 ± 11.5	-8.2*
	E	26.4 ± 5.4	23.6 ± 4.2	-2.8*
Body fat (%)	O	30.7 ± 5.7	29.7 ± 6.6	-1.0
	E	20.4 ± 6.2	19.4 ± 5.0	-1.0

Mean ± SD. *p < 0,01.

describes the effect of the intervention, on sedentary obese and eutrophic preschool children (who had a minimal weekly physical activity > 50%, at baseline level). The intervention program was more efficacious in this *sedentary* group (obese and eutrophic children), producing a higher reduction of the skinfold thickness sum (-6.1 mm ± 14.3, $p < 0.05$) and greater reduction in body fat in obese children (-3.1% ± 4.4).

Results in the primary outcome. In the control group, two skinfolds sum increased in 3.3 mm, four skinfolds (+7.0 mm) or five skinfold thickness (+7.8 mm). In respect to body fat (%) a small reduction was observed in obese preschool children (from 30.7 ± 5.7 to 29.7 ± 6.6), and also in eutrophic preschool children (20.4 ± 6.2 to 19.4 ± 5.0).

Thus, the intervention pilot project was able to produce favourable changes in preschool children, to-

Table IV
Changes of intake and fat intake, physical activity and body fat in the baseline inactive obese (O) and eutrophic (E) children

Variable	*Group*	*Baseline*	*Follow-up*	*Change*
Energy intake (kJ)	O	6,021 ± 858	5,309 ± 797	-712*
	E	5,899 ± 907	5,527 ± 1051	-372
Fat intake (g)	O	45.3 ± 12.1	36.1 ± 8.0	-9.2*
	E	44.3 ± 13.5	36.8 ± 10.5	-7.5**
Minimal activity (%)	O	68.0 ± 8.0	47.2 ± 9.2	-20.8**
	E	66.1 ± 5.8	47.9 ± 10.3	-18.2**
Vigorous activity (%)	O	0.9 ± 0.9	8.4 ± 5.8	+7.5**
	E	1.7 ± 1.9	7.5 ± 4.0	+5.8**
Σ 4 (T+B+SB+SP) (mm)	O	49.9 ± 15.0	43.8 ± 13.5	-6.1*
	E	26.6 ± 5.5	24.1 ± 4.4	-2.5**
Body fat (%)	O	31.7 ± 4.7	28.6 ± 4.1	-3.1*
	E	20.6 ± 6.2	20.0 ± 5.3	-0.6

Mean ± SD. T: triceps. B; Biceps. SB, subscapular. SP: Suprailiac. *$p < 0.05$. **$p < 0.01$.

Table V
Intervention and control group comparison in change of anthropometrial data in obese and eutrophic children

	Obese children			*Europhic children*		
Variable	*Intervention group*	*Control group*	*p*	*Intervention group*	*Control group*	*p*
Weight (kg)	+1.4 ± 1.0	+0.9 ± 2.3	0.18	+1.1 ± 0.6	+0.9 ± 1.5	0.31
Height (cm)	+3.6 ± 1.5	+2.8 ± 4.7	0.21	+3.3 ± 1.5	+3.4 ± 4.4	0.88
Weight for Age Z-score	- 0.03 ± 0.4	-0.2 ± 1.0	0.43	-0.00 ± 0.4	0.08 ± 1.0	0.45
Height for Age Z-score	+0.1 ± 0.6	-0.09 ± 1.0	0.22	-0.07 ± 0.5	+0.04 ± 0.9	0.31
Weight for Height Z-score	-0.1 ± 0.5	-0.1 ± 0.7	0.64	-0.02 ± 0.4	-0.05 ± 0.4	0.56
T + SB	-3.2 ± 2.1	+ 3.3 ± 3.5	< 0.01	1.0 ± 2.3	+2.0 ± 2.8	< 0.01
Σ 4 (T+B+SB+SP)	-8.2 ± 5.1	+7.0 ± 4.9	< 0.01	-2.8 ± 4.8	+3.8 ± 3.8	< 0.01
Σ 5 (T+B+SB+SP+C)	-10.9 ± 7.6	+7.8 ± 5.1	< 0.01	-5.0 ± 7.3	+4.8 ± 4.3	< 0.01
Body fat (%)	-1.5 ± 1.8	+1.3 ± 2.0	< 0.01	-0.7± 2.2	+1.0 ± 2.1	< 0.01
FMI (kg/m^2)	-0.3 ± 0.4	+0.2 ± 0.5	< 0.01	-0.1 ± 0.3	+0.1 ± 0.3	< 0.01
FFMI (kg/m^2)	+1.4 ± 0.7	+0.3 ± 1.5	< 0.01	+ 1.0 ± 0.5	+0.5 ± 1.0	< 0.01

Mean ± SD. T: Triceps. B: Biceps. SB: Subscapular. SP: Suprailiac.

wards a healthier nutritional status and physical activity. Additionally, the intervention was able to affect positively the most inactive children found at baseline. As Chile is 4,000 km long, in the following stage, the validated guides and educational methodology for educators and parents, will be applied to preschool children living different weather conditions (dry, Mediterranean and cold).

Discussion

An intervention in California which lasted for six months, produced a statistically significant reduction in BMI (intervention versus control change: 18.38 to 18.67 kg/m^2 *versus* 18.10 to 18.81 kg/m^2, respectively; adjusted difference -0.45 kg/m^2 [95% confidence interval, -0.73 to -0.17]; p = 0.002)[30]. Another intervention for two years in Massachusetts reduced watching television in children and found that each hour of reduction in television viewing, predicted reduced obesity prevalence (odds ratio, 0.85; 95% confidence interval, 0.75-0.97; p = 0.02)[31]. These results are similar to the ones obtained in an investigation in 66 obese Austrian children, participating in a similar intervention, aimed for the reduction of weight and improvement of metabolic own factors of risk of obesity[32].

Other studies in preschool children and teenagers in Thailand and Greece, also showed significant reduction of skinfold thickness, due to the intervention[33,34]. Previous studies in Chilean children have shown a high consumption of energetic food, with a contribution higher than their requirements, excess coming from ingestion of rich food in saturated fats, cholesterol, sucrose and sodium, which added to intake of sweet, salt, tipsy delicacies and juices, contribute to the excess of calories[18,21].

In the present intervention, obese girls, achieved a significant decrease in the energy intake, of proteins, fat and carbohydrates ($p < 0.05$), although in boys, only a significant decrease in the ingestion of carbohydrates was obtained ($p = 0.01$). In the eutrophic girls and boys, the intervention also produced a significant reduction in fat and carbohydrates intake ($p < 0.05$). During weekend, obese boys and girls, reduced the energy intake ($p = 0.04$), as carbohydrates in girls ($p = 0.02$) and lipids in boys ($p = 0.03$). The intervention generated at home, the reduction of energy intake and fat; this reduction is very important, as home contributes with a higher energy and fat intake in children, mainly during the weekend, as seen in another study, whereas obese children were at energy balance during the week, due to the attendance to play schools.

Parents and caregivers are important role models and their food choices influence those made by their children. In Chile, day care centres are centrally regulated in respect to the quality and quantity of food delivered to the children covering 65% of their needs. Additionally no kiosks are allowed within the play centre, although vendors outside, may pose a problem, as well as additional food the child may bring into the day care centre[15].

Energy intake at home together with the sedentary time at the day-care centre, were the main risk factor for obesity[18,21]. Another positive change, product of the intervention, was the significant increase of fruits and vegetables intake (of 124.1 g to 190,4 g; $p < 0.05$) and the ingestion of sweet and salty snacks (of 63.1 g to 36.8 g; $p < 0.05$).

In the main outcome, we verified an absolute difference of 2.5% in body fat intervened obese compared to control preschool children (1.5% decrease in the intervened children and 1% increase in body fat in control group).

An intervention in North American students, increased in the consumption of fruits, vegetables and a reduction in the energetic ingestion of fat during 7, 9 and 24 months[35,36]. It is important to emphasize the efficiency of an early intervention, so that changes in diet take place, which are often difficult to obtain at greater ages.

Physical activity interventions are attractive to attempt in preschool children, as children are prone to play at this age, and thus easier to incorporate in the daily routine of educators. This study was able to reduce minimum physical activity, and encourage its moderate-vigorous counterpart, which is cleared in the most inactive children at baseline.

The role of parents has been visualised in a recent paper, with successful results in the promotion of vigorous physical activity[37], an aspect which was strongly considered in our intervention. Physical activity is also a key component of the energy balance in children, being also one of the factors promoting an ideal growth and development, as well as a healthier life[38]. Diverse authors highlight the fact that passive education, the availability of computers, video games, plus other cultural aspects and environmental ones, combine to reduce active physical activity and therefore, the energy expenditure, constituting a risk for childhood obesity[39,40].

The information gathered with movement sensors suggested that obese and eutrophic children (boys and girls), initially had characteristics of a sedentary population, during most of the day. During the week, the intervention was able to decrease minimal activity ($p = 0.04$) and increased, especially moderate to moderate-vigorous activity ($p = 0.01$) in obese preschool children. At weekend, this increase occurred only in moderate-vigorous activity ($p = 0.04$), which reflects in children having more time to run, jump or playing active games.

Over the week and weekend, minimal activity decreased ($p < 0.00001$) and moderate-vigorous activity ($p < 0.0001$), increased in eutrophic boys, a result that shows that intervention was able to counteract the environmental leaning to sedentary habits. On the week days, a similar trend is observed in obese girls: reduction in the minimal activity ($p = 0.04$) and an increase of moderate-vigorous activity one ($p = 0.02$). At the weekend, minimal activity also diminished the ($p = 0.01$) and the moderate-vigorous category was increased ($p = 0.03$).

In eutrophic girls, similar results were observed during the week and weekend, adding the reduction of sedentary activity ($p = 0.02$). The intervention produced a significant increase in the physical activities of a major energy demand, both in the week and the weekend. In the eight hours period, that preschool children attended JUNJI day care centres, the majority of the time was dedicated to the fulfilment of educative aspects (children sat most of the time)[16].

Studies have demonstrated the viability of increasing physical activity in the educational environment[41,42], as involves the educational system, rather than producing changes in dietary intake, which involves mainly family habits. The quantity of time spent in sedentary activities (watching television, play computer games, sat or lying down), suggests that the consistent reduction in time for sedentary activities, can be as important than increasing short periods of vigorous activity, to support daily energy balance. Other studies which have explored the effect of watching television, although to produce an obesity prevalence reduction, there is a need of a multistage intervention, given the difficulty to produce significant and sustainable changes in a short time.

The association between the time spent on sedentary activity and the obesity was firstly investigated by Dietz and Gortmaker in the 1980s[30], and later confirmed[31,43]. In our study, minimum activity was reduced in 20.2% during the eight hours of permanence (equivalent to 96 minutes) and vigorous physical activity increased 5.4% (26 minutes), a goal achieved in five months of intervention. Our investigation has also been effective in decreasing energy dense intake and body fat in intervened children. The main outcome demonstrated a significant reduction in subcutaneous and total body fat, compared to the control group. In Scottish day care centres, Reilly et al increased 30 minutes of vigorous physical activity, significantly higher performance in movement skills tests than control children at six month follow-up ($p < 0.0027$), but no change was obtained in BMI, which could be due to a higher energy intake[44]. In our experience, physical activity and exercise are more easily incorporated in the preschool and school settings, but should be accompanied by nutrition workshops for parents and educators, and if needed, changes made in the food received at canteens. Additionally, it may be not possible to reduce obesity prevalence in one year intervention, so a multistage intervention should be considered since start, to assure sustainable changes in a school or day-care centre settings.

The results of this work have shown that the intervention was effective in controlling excess fat intake, energy intake and inactivity. These results are similar to interventions including diet and physical exercise, conducted in children from Europe and Asia[32-34]. The contribution of the child's home is reflected in the diet and physical activity changes, which supports that parents can positively influence healthy habits in children at this age, as socialization of many behaviors occurs within the family, related to parents' beliefs, attitudes, and behaviors substantially affecting children's health[45,46].

Results in the more inactive group of preschool children, reinforce that this intervention was able to significantly increase moderate-vigorous physical activity, reduce consumption of fat and sugar, all resulting in a higher reduction of body fat compared to the whole group. Thus, interventions should be addressed to all day care centres children, instead of only choosing overweight ones.

Lastly and quite important has been the role of public planning officers (Ministries of Health, Education and Sports), as the DCC's Nutrition officer, that have been part of the planning and implementation of the intervention, facilitating the process, financial issues and eventually, sustainability.

Several stages of the intervention will be implemented during the next three years, in different geographical settings in Chile (north, centre and south), in order to propose an effective educational intervention methodology, able to reduce cardiovascular risk factors in preschool children living in different weather conditions.

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Conflict of interest

The authors declare no conflict of interest.

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