REVISTA CHILENA DE PEDIATRÍA
www.revistachilenadepediatria.cl
www.scielo.cl
Rev Chil Pediatr. 2018;89(2):173-181
DOI: 10.4067/S0370-41062018000200173
ORIGINAL ARTICLE

Breastfeeding, obesity and metabolic syndrome in school-age

Lactancia materna, obesidad y síndrome metabólico en la edad escolar

María Fernanda Oyarzún[a], Salesa Barja[b], María Angélica Domínguez[c], Luis Villarroel[c], Pilar Arnaiz[d], Francisco Mardones[c]

[a]MD. Student of the MSC Nutrition Program, Pontificia Universidad Católica de Chile
[b]MD, MSC in Pediatric Nutrition, Department of Pediatric Gastroenterology and Nutrition. School of Medicine. Pontificia Universidad Católica de Chile
[c]Statistics. Department of Public Health. School of Medicine. Pontificia Universidad Católica de Chile
[d]MD, Pediatric Cardiologist. Division of Pediatrics. School of Medicine. Pontificia Universidad Católica de Chile

Received: 13-07-2017; Accepted: 04-11-2017

Abstract

Introduction: Breastfeeding (BF) can be a protective factor against obesity and its associated metabolic complications. **Objective:** To determine the association between breastfeeding history and present obesity, metabolic syndrome (MS) and insulin resistance (IR). **Patients and Methods:** Cross-sectional study in 20 public schools in Santiago, Chile. Anthropometry and blood pressure were assessed. Blood lipids, glucose, insulin and HOMA index were measured in a fast blood sample. Parents answered a survey on BF. MS was defined according to Cook´s criteria and IR as HOMA > 90th percentile. Parents answered a survey about the antecedent of breastfeeding. Chi2 and Fischer tests were used (SSPS). **Results:** 3,278 surveys were valid. Average age: 11.4 ± 1 years, 52.3% were female. Most of them (98.2%) were breasted, with a 15.9% prevalence of obesity versus 18.6% in the group that was not breastfed (p = 0.039). There was a non-significant trend of higher prevalence in MS and its components (except IR) in the non-breastfed group. The group breastfed from three to six months had a lower prevalence of obesity and MS components than the 0 to 3 months group ; the effect was the opposite when BF lsted longer than nine months. **Conclusions:** The prevalence of obesity was higher in children that did not received breastfeeding. A longer breastfeeding time during the first semester of life was associated with lower prevalence of obesity and metabolic complications.

Keywords:
Breastfeeding;
cardiovascular risk;
obesity;
insulin resistance;
metabolic syndrome;
pediatric

Correspondence:
Dra. Salesa Barja
sbarja@uc.cl

Introduction

Chile is experiencing an accelerated epidemiological transition, characterized by an epidemic of chronic non-communicable diseases, present in most of the world. The majority begins in childhood and favors early atherosclerosis[1-5]. Therefore, it is essential to promote preventive strategies, among which breastfeeding (BF) emerges as a protective factor[6-7].

BF is optimal for the newborn and infant, a situation that has led the World Health Organization to recommend it as the exclusive food during the first six months of life and up to two years or more, supplemented with a healthy diet. Due to its composition in nutrients, trophic and immunomodulatory factors, it could also protect against obesity, chronic diseases[8-10] and Metabolic Syndrome (MS). The latter is associated with a high cardiovascular risk and has been defined as the coincidence of at least three out of five components: abdominal obesity, systolic or diastolic hypertension, hypertriglyceridemia, low cholesterol linked to high-density lipoprotein (HDL-C) and fasting hyperglycemia[11]. According to these criteria adapted to pediatric age, the prevalence of MS in Chilean schoolchildren aged 10 to 14 years is 7.3%[12]. It main etiopathogenic factor is insulin resistance (IR), mediated by signals from adipocytes and with a greater impact on genetically susceptible individuals[13].

In 2015, obesity reached a prevalence of 24.2% in children starting the first year of primary education[14]. Its treatment requires permanent lifestyle changes at the individual, family and social level and although the child has physiological advantages for a better response than the adult, the performance of the therapy has been deficient, especially associated with low adherence[15-16].

In this scenario, prevention is the best approach and BF can be an excellent cost-effective strategy. A Chilean study previously showed that predominant BF at the first six months of life is a protective factor against obesity in a retrospective cohort of preschoolers[12]. However, in our country, there is a lack of studies with a possible projection to the general population that considers the metabolic complications associated with obesity. The objective of this study was to study in a population sample of schoolchildren the association between the antecedent and the duration of BF and the nutritional status, the MS, its components and the IR.

Patients and Methods

The present corresponds to a secondary analysis of a cross-sectional study that investigated the early origins of MS[13]. Participants were recruited between 2009 and 2011 in 20 public schools in the commune of Puente Alto, Santiago, Chile. Children who were in 5th and 6th grade were included and those with health conditions that affected the results were excluded during the previous 15 days.

A nurse and a nutritionist visited each school to make measurements and samples taking. Weight and height were determined using a Seca® scale with stadiometer. Children were measured barefoot and dressed in light clothing, subtracted later. Each measurement was made twice, averaging the obtained values. The body mass index (BMI = weight in k/height in meters^2) was calculated to determine the nutritional status, with reference NCHS-CDC 2000, expressed in percentiles (p) Normal: p5 to p84; overweight: p85 to p94; Obesity: ≥ p95; and low weight: <p5. The waist circumference (WC) was measured standing, with an inextensible tape measure around the waist, on the iliac crest and at the end of a normal expiration. Three measurements were averaged, and it was considered abnormal if ≥ p90[19]. Blood pressure was measured with the Critikon ® Dinamap Pro100 pressure monitor, with three averaged measures. It was considered abnormal if ≥ p90 of the reference[20].

Each child was asked for a private self-report of the pubertal state, with photographs of breast development in women, genital development in males and pubic hair in both.

Samples of venous blood were extracted with 12 hours of fasting to measure glycemia (GLY) (Glucoquant method, Glucose/Hexokinase, Roche Diagnostics GmbH, Manheim) and insulinemia (direct chemoluminometric immunoassay, ADVIA Centaur® XP. Bayer HealthCare LLC, Kyowa Medex Co, Japan). The HOMA (Homeostasis Model Assessment) index was calculated and IR was defined as> p90 of a Chilean reference[21]. Triglycerides (TG), HDL cholesterol (HDL-C) and total cholesterol (TC) were obtained by an enzymatic-colorimetric method (Modular P-800, Roche Diagnostics GmbH, Mannheim, Germany). LDL cholesterol (LDL-C) was calculated with Friedewald's formula. SM was defined according to modified Cook criteria[12], such as the presence of three or more of five components: Waist circumference (WC) ≥ p90, systolic blood pressure (SBP) or diastolic blood pressure (DBP) ≥ p90, HDL-C ≤ 40 mg/dL, TG ≥ 110 mg/dL (22) and GLY ≥ 100 mg/dL[23].

The parents and/or guardians answered a survey on breastfeeding (self-administered) that included the following questions: 1. Was your child breastfed? (Answer Yes/No); 2. How long did you receive only breast milk, without formula and without food? (Response in number of months); 3. How much time did you receive in total? (Alternatives: a) Less than three months, b) Between three and six months, c) Between six and nine months and e) More than nine months).

The socioeconomic level (SEL) was estimated through the maternal educational level, an indicator that has been associated with the SEL of the family and access to health services in Chilean and foreign studies[24-26].

The statistical analysis was carried out with the SPSS 17 software. The distribution of the variables was evaluated through Shapiro-Wilk test, averages and standard deviation (SD) were used for description. To evaluate the association between BF and obesity, SM, its components, IR or others, Student's T-test (averages) or Chi-square test (proportions) were used. Any p value <0.05 was considered significant.

The parents or guardians signed an informed consent and the children an informed assent. The study was approved by the Research Ethics Committee of the Faculty of Medicine of the Pontifical Catholic University of Chile and the National Fund for Scientific and Technological Development (FONDECYT # 1090594), Chile.

Results

The total number of students in 5th and 6th grade in the 20 primary schools was 5,614 children, 2,616 (46.6%) women and 2,998 men (53.4%). 3,523 accepted to participate and 2,289 refused to participate (38.5% women and 61.5% men, p <0.0001), with no difference in age or maternal education between both groups. 3,521 families answered the survey, with a 99.9% return rate, 243 (4.3%) surveys were excluded because they were incomplete and finally 3,278 were included. Out of these, 31.5% were girls and 68.5% boys (p < 0.0001).

Table I shows the general characteristics, anthropometry and main measurements for the total group and according to the antecedent of having received (or not) BF.

The girls presented higher H/Az: 0.041 ± 0.9 vs. -0.43 ± 0.9 (p = 0.01); WC: 73.7 ± 10.2 vs. 72.9 ± 10.7 cm (p = 0.044); TG: 99.5 ± 61.3 vs. 85.4 ± 57 mg/dl (p = 0.000); insulinemia: 16.5 ± 9.9 vs 12.7 ± 9.3 uU/mL (p = 0.000), HOMA: 3.6 ± 2.2 vs. 2.8 ± 2.2 (p = 0.000) and proportion of MS: 8.6% vs. 5.7% (p =, 0001) than men. Conversely, girls had lower HDL-C: 50.7 ± 11.9 mg/dl vs. 53.4 ± 12.2 mg/dl (p = 0.000), glycemia: 88.8 ± 6.5 mg/dl vs 91 ± 6.5 mg/dl (p = 0.000) and prepubertal proportion: 11.1% vs 31.8% (p = 0.000). There was no difference in BMIz, W/Az, SBP, DBP, Total C or LDL-C according to gender.

Prevalence and duration of breastfeeding

It was observed that in the total sample (n = 3,278), 98.2% (n = 3,219) received BF at some time and 1.8% (n = 59) was never breastfed, without difference according to gender or maternal education. Regarding the duration of BF, 14.5% received BF between one day and 2.9 months, 20.9% between 3 and 5.9 months, 29.7% between 6 and 8.9 months and 34.7% for ≥9 months.

Table 1. General characteristics, anthropometry and cardiovascular risk factors# according to breastfeeding, in 3278 school-age children of Puente Alto County. Santiago, Chile (2009-2012)

Measurements	Total (n = 3278)	BF (n = 3219)	Non-BF (n = 59)
Girls (%)	52.30	52.50	44.00
Age in years	11.43 ± 1	11.35 ± 1	11.50 ± 1
Pre-pubertal (Tanner I) (%)	21.00	20.90	23.70
Weight/Age z-score	0.40 ± 1	0.40 ± 1	0.29 ± 1
Height/Age z-score	0.00 ± 0.9	0.00 ± 0.9	0.06 ± 0.5
BMI z-score	0.58 ± 1	1.07 ± 1.06	0.35 ± 1.2
Waist Circumference (cm)	73.34 ± 10.5	73.30 ± 10.5	71.20 ± 9.7
Systolic Blood Pressure (mmHg)	110.30 ± 7.7	110.30 ± 7.7	110.80 ± 8.5
Diastolic Blood Pressure (mmHg)	57.59 ± 7	57.50 ± 7*	59.00 ± 6*
HDL Cholesterol (mg/dL)	52.03 ± 59.7	52.06 ± 12	50.05 ± 11.1
Triglycerides (mg/dL)	92.82 ± 28.2	93.00 ± 60	87.60 ± 47.8
Glycemia (mg/dL)	89.91 ± 6.6	90.00 ± 6.6	90.20 ± 8.4
HOMA index	3.29 ± 2.2	3.28 ± 2.2	3.37 ± 3.5
Metabolic Syndrome (%)	7.20	7.20	8.50

#Average ± ED or percentage. *p < 0.05 (Pearson Chi-squared test). Differences between children that were breastfed (BF) and non-breastfed (non-BF).

Regarding the question about EBF, 83.5% answered having received it at some time, with a duration of 6.6 ± 7.5 months (Range 1 day to 72 months). These responses are discordant with the usual feeding practices of the infant since the indication to initiate the complementary feeding is between the 5th and 6th month and its compliance exceptionally exceeds seven months. For this reason, in subsequent analyzes, this question was excluded.

Prevalence of malnutrition by excess according to the history of BF

Table II describes the prevalence of obesity and overweight for the total sample and by gender. There is a lower prevalence of obesity and higher overweight in the group that was breastfed. Boys (breastfed or not) had higher obesity than girls, but in the overweight group, it only occurred in non-breastfed.

Cardiovascular risk factors according to the history of BF

Table I shows the averages of the cardiovascular risk factor (CVRF) measurements, according to the antecedent of having received or not BF; the breastfed only had lower SBP, with limited significance. However, as shown in Figure 1, a non-significant trend was observed with a higher prevalence of all CVRF in non-breastfed (except IR). The prevalence of MS was 8.5% in the non-breastfed versus 7.3% in those who received BF (p = 0.71). There was no difference by gender.

Table 2. Obesity and overweight prevalences according to sex and breastfeeding antecedent in 3278 school-age children of Puente Alto County. Santiago, Chile (2009-2012)

	All	BF	Non-BF	p*
Overweight (IMC p85-94)				
Total (%)	22.4	22.5	16.9	0.039
Girls (%)	24.4	24.6	11.5	0.122
Boys (%)	20.1	20.1	21.2	0.862
Obesity (IMC ≥ p95)				
Total (%)	15.9	15.9	18.6	0.039
Girls (%)	13.1	13.0	15.4	0.724
Boys (%)	19.1	19.0	21.2	0.751

*p < 0.05 (Pearson Chi-squared test). Differences between children that were breastfed (BF) and non-breastfed (non-BF).

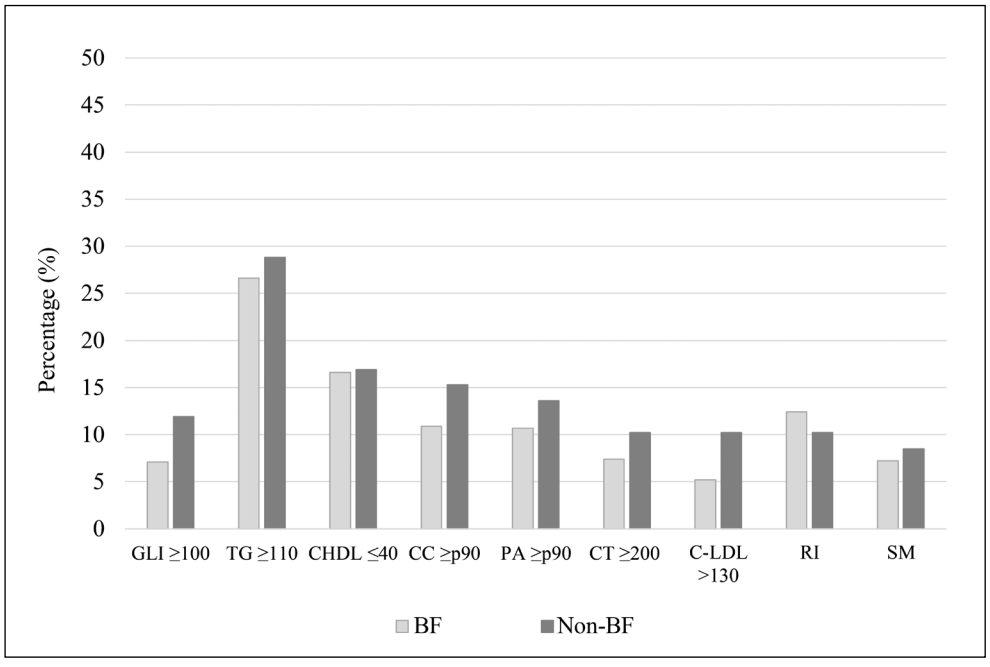

Figure 1. Prevalences of cardiovascular risk factors and Metabolic Syndrome, according to the breastfeeding (BF) antecedent. GLI: Glycemia ≥ 100 mg/dL; TG: Triglycerides ≥ 110 mg/dL; HDL: Cholesterol HDL ≤ 40 (mg/dL); WC: Waist circumference ≥ percentile 90; BP: Blood pressure (systolic or diastolic) ≥ 90th percentile; CT: Total cholesterol ≥ 200 mg/dL; LDL-C: LDL cholesterol > 130 mg/dL; IR: insulin resistance ≥ 90th percentile; MS: Metabolic Syndrome. Sin differences significative entre ambos groups. Pearson Chi squared test (P > 0.05).

Malnutrition by excess and its association with the duration of the BF:

Figure 2 shows a lower prevalence of obesity in the group that received BF for three to 5.9 months versus those breastfed for less than three months and lower than those breastfed for more than nine months (p = 0.046). Finally, the joint prevalence of overweight and obesity was higher in the latter group than in the rest (p> 0.05).

Association between duration of BF and cardiovascular risk factors:

Table III shows the prevalence of CVRF and MS, according to the duration of the BF, finding a trend to

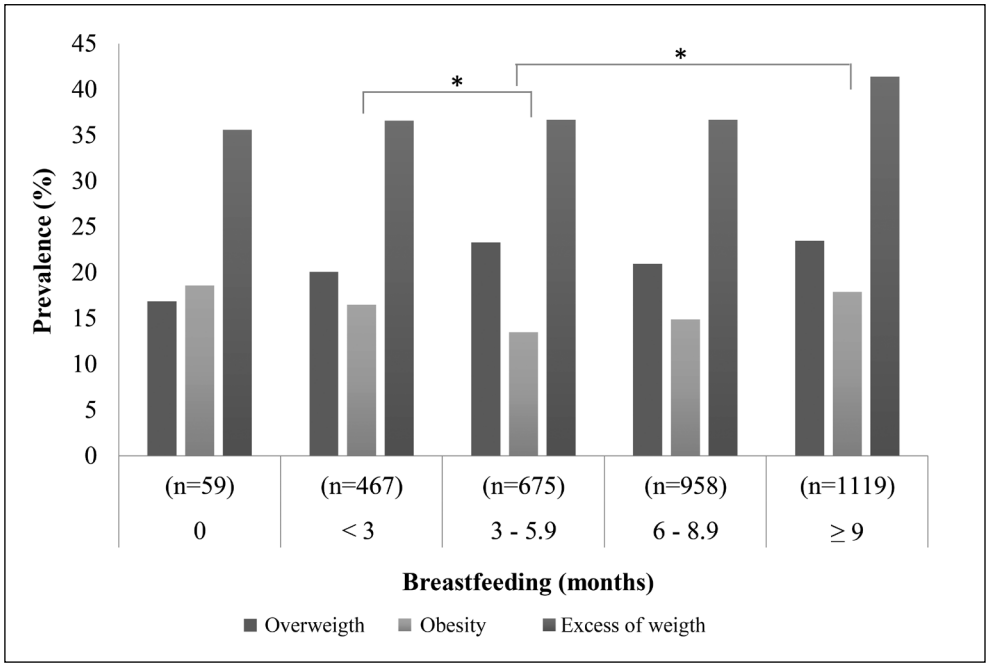

Figure 2. Prevalence of obesity and overweigth according to breastfeeding length in months. Overweigth: BMI p85 to 94th percentile. Obesity: BMI ≥ 95v percentile. Weigth excess: ≥ 85th percentile (NCHS-CDC 2000). *p= 0.046. Pearson Chi squared test.

Table 3. Prevalences of cardiovascular risk factors and Metabolic Syndrome, according to breastfeeding (BF) length, in 3278 school-age children of Puente Alto County. Santiago, Chile (2009-2012)

Variables	BF length (months)					P value*
	0	< 3	3-5.9	6-8.9	≥ 9	
N	59	467	675	958	1119	
BMI p85-94	16.9	20.1	23.5	21.8	23.3	0.046
BMI ≥ p95	18.6	15.7	13.5	14.9	17.9	0.046
BMI ≥ p85	35.6	36.6	36.7	36.7	41.4	0.037
WC ≥ p90 (%)	15.3	22.5	19.6	18*	24.4*	0.001
SBP o DBP ≥ p90 (%)	13.6	10.5	9.6	14.9	8	0
TC ≥ 200 mg/dL	10.2	6.2	7.6	8.9	6.4	ns
HDL-C ≤ 40 mg/dL (%)	16.9	14.6	15.4	18	17	ns
LDL-C ≥ 130 mg/dL	10.2	3.4	4.6	7.3*	4.5*	0.033
TG ≥ 110 mg/dL (%)	28.8	35.9	25.3	27.1	27.1	ns
GLI ≥ 100 mg/dL (%)	11.9	7.7	5.5*	9.8*	5.6	0.001
Insulinemia uUI/dL (%)	11.9	15.8	12.4	12.9	13.2	ns
HOMA ≥ p90 (%)	10.2	13.7	12.1	12.2	12.2	ns
MS (%)	8.5	8.4	6.1	7.6	7.1	ns

BMI: body mass index, WC: waist circumference, SBP systolic blood pressure, DBP: diastolic blood pressure, TC: total cholesterol, TG: triglycerides, GLI: glycemia, MS: Metabolic Syndrome. Test de Chi cuadrado de Pearson, *p < 0.05.

lower prevalence of WC, TG, BP, GLY, MS and high insulinemia, as well as IR and obesity in the group who received BF between three and six months, compared to those who received BF for less time. This difference was significant for high WC, GLY, and LDLC. Children breastfed for more than six months had a higher prevalence of most CVRF.

Discussion

This study demonstrates an association between the history of having received BF and lower prevalence of obesity, as well as a tendency to lower prevalence of MS, its components, and other CVRF. To our knowledge, this is the first work that studies this interaction in a population sample of Chilean schoolchildren.

The BF rate (98.2%) found was higher than expected; according to data from the Ministry of Health, the percentage of EBF at the sixth month is 46% nationally and 28.5% in the commune of Puente Alto, where the sample comes from[27-28]. This high rate of BF could be influenced by the predominance of low or middle-low socioeconomic level, a segment in which breastfeeding is higher (29-30). Historically, the duration of the EBF was very low in Chile between the 30's and 80's. Since the 90's, thanks to the promotion and the Innocenti Declaration which promotes, protects and supports the BF, it was observed an increase in the duration of the EBF as indicated by national surveys from 1993 to 2005. This has been supported by maternal postnatal leave, a protective factor whose duration has increased from 1.5 months in 1925 to three months in the 1950s and up to six months since 2011.

The protective effect of the BF against future obesity found is consistent with other international epidemiological studies[8,11,31,32]. This was addressed in a systematic review in 2010 that included more than 69,000 subjects and demonstrated a reduction in the risk of obesity[33]. Finally, in 2015 another extensive review that included 20 meta-analyses demonstrated a consistent role of BF in the prevention of childhood obesity[34]. Unlike our study, these studies were carried out mostly in English-speaking countries, where the size of the groups that received BF were comparable to the non-breastfed, which favored demonstrating differences.

Other studies have not been able to demonstrate this protective effect of the BF on obesity or CVRF and report risk factors such as maternal age, birth weight, obesity in parents, maternal smoking, increased weight gain and/or gestational diabetes[35-37]. The confusing effect of other protective factors should be considered since mothers who breastfeed would also have a greater awareness of health and promotion of healthy habits. Moreover, the importance that the mother gives to breastfeeding and the duration of breastfeeding modulate the effect of maternal weight, constituting key points for policies that favor the BF and the lesser use of artificial feeding in the child[38].

Regarding the protection of the BF for CVRF, a systematic review of the year 2013 showed a moderate protective effect for SBP and DBP. For high cholesterol, no effect was found and in type II diabetes, a protective effect was observed in adolescents[7]. In our sample, the tendency of the protective effect of BF existed for almost all the CVRF, but it did not reach significance, possibly due to the low proportion of children who were not breastfed.

Regarding the duration of breastfeeding, we found a protective effect of the BF against obesity for the period between 3-6 months, in relation to the one of shorter duration. However, the effect was the opposite for those breastfed for longer; we think that this paradoxical effect could be explained because after the introduction of complementary feeding at six months, other obesity risk factors can be added, such as: the start of hypercaloric milk formulas, higher protein, sodium, sugary drinks and/or juices intake, as well as the incorporation to less healthy family habits. In the literature, the evidence regarding the effect of duration is discordant: although a greater benefit of BF has been found, which lasts beyond six months and up to two years[39-40], it has also been raised that the BF, even for a short time, is effective in preventing obesity[41]. Others report a protective effect with EBF of 4-6 months or BF for more than 12 months[42] and recently, two systematic reviews showed that BF reduces by 15% the risk of overweight in children who have ever received it in comparison with children not breastfed, with a protective effect if they received it for more than seven months[43].

The analysis of the long-term effect of the BF presents other difficulties that could explain the disparity in the results; there is no unanimity in defining the duration or exclusivity of the BF and most consider the duration of the total BF or EBF for six months, moreover, the study of the EBF is often reduced to four months, to reduce confusing.

Together with the factors analyzed above, like ours, most of the population studies are cross-sectional and with the antecedent of retrospective BF, therefore, they show an association and not causality. They also present possible failures in the collection of information, along with the important memory bias that generates difficulties not always considered. Prospective studies overcome these limitations, such as the recently published cohort in Chile, but are based on smaller samples that are difficult to project to the general population[16].

The mechanisms by which the BF can protect from obesity and CVRF are not entirely clear. There are

several hypotheses and probably its effect on appetite and satiety through a modulation in the release of ghrelin and leptin are the main[44]. This is how children with EBF at free demand self-regulate their intake better, which is difficult to achieve in those with artificial formula. Also, the EBF has been related to a lower rate of weight gain of the child, which may be associated with the lower protein content of the BF, since the higher consumption of proteins through artificial formulas may increase the risk of future obesity.

The main strengths of this study are the sample size, the homogeneity of the measurements in the field, the conditions of taking the blood samples and their reliable processing. However, we have noted the limitations discussed above, particularly in the responses of the parents on the EBF, a question ruled out by the inconsistency of the answers with the usual practices. The self-application and insufficient validation of the questions should be considered, as well as the important memory bias of a retrospective study. Finally, the overrepresentation of the middle and lower-middle SEL population limits, although it does not exclude, its extrapolation to the national reality.

In conclusion, most of this population sample of schoolchildren received EBF, who had a lower prevalence of obesity than those who did not receive it, as well as a trend towards a lower prevalence of cardiometabolic complications. As for the duration of the BF, there is a protective effect during the first semester if it is received for more than three months. This information is useful for studies after the extension in Chile of postnatal maternity leave from three to six months. Our results contribute to the national epidemiological knowledge to promote the BF, which plays a critical role in the regulation of appetite and metabolic programming in the short and medium term. Strengthening the EBF is a strategy that, among other favorable effects, contributes to preventing obesity and the chronic diseases associated with it.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Financial Disclosure

FONDECYT Project (#1090594, years 2009-2013): Intrauterine origin of the Metabolic Syndrome in school-age Chilean children.

Conflicts of Interest:

Authors declare no conflict of interest regarding the present study.

References

1. Arnaiz P, Villarroel L, Barja S, et al. La presión arterial es un importante marcador de ateroesclerosis subclínica en niños. Rev Med Chile. 2012;140:1268-75.
2. Arnaiz P, Barja S, Villarroel L, et al. Ateroesclerosis subclínica y síndrome metabólico en niños. Nutr Hosp. 2013;28:1587-93.
3. Barja S, Barrios X, Arnaiz P, et al. Niveles de lípidos sanguíneos en escolares chilenos de 10 a 14 años de edad. Nutr Hosp. 2013;28:719-20.
4. Freedman DS, Khan LK, Dietz WH, Srinivasan SR, Berenson GS. Relationship of childhood obesity to coronary heart disease risk factors in adulthood: the Bogalusa Heart Study. Pediatrics. 2001;108:712-8.
5. Burrows R, Bugueño M, Leiva L, et al. Perfil metabólico de riesgo cardiovascular en niños y adolescentes obesos con menor sensibilidad insulínica. Rev Med Chile. 2005;133:795-804.
6. Grummer-Strawn LM, Mei Z. Centers for Disease Control and Prevention: Pediatric Nutrition Surveillance System. Does breastfeeding protect against pediatric overweight? Analysis of longitudinal data from the Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System. Pediatrics. 2004;113:81-6.
7. Horta BL, Bahl R, Martines JC, Victora CG. V. Results and Discussion. En: Evidence on the long-term effects of breastfeeding: systematic reviews and meta-analysis, Geneva: WHO, 2007: 11-39. Última visita: 11-10-2017. Disponible en: http://www.who.int/maternal_child_adolescent/documents/9241595230/en/
8. Owen CG, Martin RM. Effect of infant feeding on the risk of obesity across the life course: a quantitative review of published evidence. Pediatrics. 2005;115:1367-77.
9. Burke V, Beilin LJ, Simmer K, et al. Breastfeeding and overweight: longitudinal analysis in an Australian birth cohort. J Pediatr. 2005;147:56-61.
10. Armstrong J, Reilly JJ, Child Health Information Team. Breastfeeding and lowering the risk of childhood obesity. Lancet. 2002;359:2003-4.
11. Cook S, Weitzman M, Auinguer P, Nguyen M, Dietz W. Prevalence of a metabolic syndrome phenotype in adolescents: findings from the third National Health and Nutrition Examination Survey1988-1994. Arch Pediatr Adolesc Med. 2003;157:821-7.

12. Mardones F, Arnaiz P, Barja S, et al. Estado nutricional, síndrome metabólico y resistencia a la insulina en niños de Santiago, Chile. Nutr Hosp. 2013;28:1999-2005.
13. Barja S, Arteaga A, Acosta A, Hodgson M. Resistencia insulínica y otras expresiones del síndrome metabólico en niños obesos chilenos. Rev Med Chile. 2003;131:259-68.
14. Informe mapa nutricional JUNAEB 2015. Situación nutricional de los preescolares y escolares de establecimientos municipalizados y particulares subvencionados del país. Última visita: 11-10-2017. Disponible en: https://www.junaeb.cl/wp-content/uploads/2017/03/Informe-Mapa-Nutricional-2015.pdf.
15. Barja S, Núñez E, Velandia S, Urrejola P, Hodgson M. Adherencia y efectividad a mediano plazo del tratamiento de la obesidad infantil. Rev Chil Pediatr. 2005;76:151-8.
16. Jarpa C, Cerda J, Terrazas C, Cano C. Lactancia materna como factor protector de sobrepeso y obesidad en preescolares. Rev Chil Pediatr. 2015;86:32-7.
17. Unidad de Nutrición del Ministerio de Salud, Consejo Asesor en Nutrición, Grupo de Expertos. Norma técnica de evaluación nutricional del niño de 6 a 18 años, 2003. Rev Chil Nutr. 2004;31:128-37.
18. Centers for Disease Control and Prevention. CDC Clinical Growth Charts. Última visita: 11-10-2017. Disponible en: https://www.cdc.gov/growthcharts/clinical_charts.htm
19. Fernández J, Redden D, Pietrobelli A, Allison D. Waist circumference percentiles in nationally representative samples of African-American, European-American and Mexican- American children and adolescents. J Pediatr. 2004;145:439-44.
20. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents. Pediatrics. 2004;114:555-76.
21. Barja S, Arnaiz P, Domínguez A, et al. Normal plasma insulin and HOMA values among Chilean children and adolescents. Rev Med Chile. 2011;139:1444-52.
22. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents: Summary Report. Pediatrics. 2009;128:213-56.
23. The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diagnosis and Classification of Diabetes Mellitus. Diabetes Care. 2003;26:3160-7.
24. Villarroel L, Karzulovic L, Manzi J, Eriksson JG, Mardones F. Association of perinatal factors and school performance in primary school Chilean children. J Dev Orig Health Dis. 2013;4:232-8.
25. Cleland JG, van Gineken JK. Maternal education and child survival in developing countries: the search for pathways of influence. Soc Sc Med. 1988;27:1357-68.
26. Esteban-Cornejo I, Tejero-González CM, Martínez-Gómez D, et al. Independent and combined influence of the components of physical fitness on academic performance in youth. J Pediatr. 2014;165:306-12.
27. Vigilancia del estado nutricional de la población bajo control y de la lactancia materna en el sistema público de salud de Chile. Diciembre de 2016. Última visita: 11-10-2017. Disponible en: http://www.bibliotecaminsal.cl/vigilancia-del-estado-nutricional-de-la-poblacion-bajo-control-y-de-la-lactancia-materna-en-el-sistema-publico-de-salud-de-chile/
28. Tasa de lactancia materna exclusiva en niños de 6º mes de vida por comuna región metropolitana. Última visita: 11-10-2017. Disponible en: http://www.asrm.cl/archivoContenidos/lactancia-materna-exclusiva-1-3-6-mes-2012.pdf
29. Cabezuelo G, Vidal S, Abeledo A, Frontera P. Factores relacionados con el abandono precoz de la lactancia materna. Rev Esp Pediatr. 2006;62:212-8.
30. Niño M Rosa, Silva E Gioconda, Atalah S Eduardo. Factores asociados a la lactancia materna exclusiva. Rev Chil Pediatr. 2012;83:161-9.
31. Harder T, Bergmann R, Kallischnigg G, Plagemann A. Duration of breastfeeding and risk of overweight: a meta-analysis. Am J Epidemiol. 2005;162:397-403.
32. D, Kendall GE, Newnham JP, Landau LI, Stanley FJ. Breastfeeding and overweight: longitudinal analysis in an Australian birth cohort. J Pediatr. 2005;147:56-61.
33. Arenz S, Rückerl R, Koletzko B, von Kries R. Breastfeeding and childhood obesity. A systematic review. Int J Obes Relat Metab Disord. 2004;28:1247-56.
34. Sánchez López AM, Expósito Ruiz M, Hermoso Rodríguez E, Mur Villar N, Aguilar Cordero MJ, Madrid Baños N. Lactancia materna como prevención del sobrepeso y la obesidad en el niño y el adolescente; revisión sistemática. Nutr Hosp. 2015;31:606-20.
35. Casazza K, Fontaine KR, Astrup A, et al. Myths, presumptions and facts about obesity. N Engl J Med. 2013;368:446-54.
36. Carling SJ, Demment MM, Kjolhede CL, Olson CM. Breastfeeding Duration and Weight Gain Trajectory in Infancy. Pediatrics. 2015;135:111-9.
37. Kwok MK, Schooling CM, Lam TH, Leung GM. Does breastfeeding protect against childhood overweight? Hong Kong's 'Children of 1997' birth cohort. Int J Epidemiol. 2010;39:297-305.
38. Bartok CJ, Schaefer EW, Beiler JS, Paul IM. Role of body mass index and gestational weight gain in breastfeeding outcomes. Breastfeed Med. 2012;7:448-56.
39. Imai CM, Gunnarsdottir I, Thorisdottir B, Halldorsson TI, Thorsdottir I. Associations between infant feeding practice prior to six months and body mass index at six years of age. Nutrients. 2014;6:1608-17.
40. González-Jiménez E, Montero-Alonso MA, Schmidt-RioValle J, García-García CJ, Padez C. Metabolic syndrome in Spanish adolescents and its association with birth weight, breastfeeding duration, maternal smoking, and maternal obesity: a cross-sectional study. Eur J Nutr. 2014;4:589-97.
41. Jwa SC, Fujiwara T, Kondo N. Latent protective effects of breastfeeding on late childhood overweight and obesity: a nationwide prospective study. Obesity. 2014;22:1527-37.
42. Verstraete SG, Heyman MB, Wojcicki JM. Breastfeeding offers protection against obesity in children of recently immigrated latina women. J Community Health. 2014;39:480-6.
43. Yan J, Liu L, Zhu Y, Huang G, Wang PP. The association between breastfeeding and childhood obesity: a meta-analysis. BMC Public Health. 2014;14:1267.
44. Miralles O, Sánchez J, Palou A, Pico C. A physiological role of breast milk leptin in body weight control in developing infants. Obesity. 2006;14:1371-7.