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# Association between high prepregnancy body mass index, excess gestational weight gain, and poor breastfeeding with overweight in Chilean children 3 to 4 y of age

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ABSTRACT

*Objective:* The aim of this study was to determine the association between prepregnancy body mass, gestational weight gain, and inadequate breastfeeding (BF) with overweight in Chilean children ages 3 to 4 y.
*Methods:* This was an analytical and cross-sectional study with 560 participants. Age, residence, BF, and weight gain information were collected from child care records. The children's nutritional status (NS) was determined according to the weight-for-height *z*-score for sex. Bivariate relationships were evaluated by the $\chi^2$ test, and a multivariate logistic regression model was applied with the Stata version 15 software at $\alpha < 0.05$.
*Results:* Prepregnancy NS values were 37% normal and 63% overweight. Excess weight gain occurred in 75% of the mothers. The children's NS was related to the duration of BF ($P = 0.002$), prepregnancy NS ($P = 0.002$), and weight gain ($P = 0.004$). When adjusting the logistic regression model for sex and maternal age, the overweight prepregnancy NS increased up to twice the risk for OW in children (odds ratio [OR], 2; 95% confidence interval [CI], 1.3–4.1), as well as excess weight gain (OR, 2.3; 95% CI, 1.5–5.9), and non-exclusive BF (OR, 2.4; 95% CI, 1.3–4.4).
*Conclusion:* Children showing risk factors such as non-exclusive BF, prepregnancy NS with overweight, and excess gestational weight gain faced between 2 and 2.4 times more risk for overweight than children without these factors.



## Introduction

The current global epidemiologic profile identifies obesity as a risk factor for various diseases and disabilities [1]. Several studies have associated overweight (OW) with diseases and pathologic conditions, demonstrating how excess weight increases the risk for diabetes mellitus, cardiometabolic alterations, osteoarticular problems, psychological disorders, and physical performance [2–4]. All age groups have been affected by obesity; however, world statistics in the last decades show children as one of the most at-risk groups [5]. The 2017 Chilean National Health Survey provided alarming numbers for OW in children <15 y of age [6]. OW is a condition with a multifactorial origin involving environmental and genetic determinants; the genetic factor includes metabolic, hormonal, and psychological alterations [1,7,8]. Likewise, there is evidence that the gestational environment and maternal–fetal alterations could affect the offspring's health status [9,10].

It has been reported that the prepregnancy nutritional status (NS) and weight gain during pregnancy are related to the NS of the offspring, such as birth weight, NS, and development of metabolic pathologies [11–13]. Fetal exposure to metabolic alterations in OW mothers undergoing cesarean delivery could have several consequences such as altered microbiota, inadequate nutrient supply, epigenetic involvement, and DNA methylation [9].

On the other hand, it has been demonstrated that adequate breastfeeding (BF) during the first years of life is a determinant of NS in childhood and adulthood [14,15]. Although the mechanism of action is not clear, some studies indicate that it acts by self-regulating energy intake, which allows directly breastfed children to identify internal satiety cues [16].

LSG and MAGS were responsible for the conceptualization and study methodology. GPD was responsible for data collection and resources. ARF was responsible for the formal analysis and writing of the original draft. JPF was responsible for the study methodology and writing of the original draft, as well as manuscript modification and responding to the reviewers. EMS was responsible for the formal analysis; writing, review, and editing; visualization; and supervision; as well as manuscript modification and responding to the reviewers.

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Therefore, we designed a study aimed at determining the association between prepregnancy body mass, gestational weight gain, and inadequate BF with overweight in Chilean children 3 to 4 y of age.

## Methods

### *Study design and participants*

The was an analytical and cross-sectional study. The stratified probabilistic sample consisted of 560 mothers and children (280 of each). Children of both sexes were included in the sample; their ages ranged from 3 to 4 y 11 mo 30 d. The participants came from rural and urban areas, and were registered in the public health system's child care program, Primary Health Care in Southern Chile. The following inclusion criteria were met: term birth (37–40 wk gestational age) and no associated pathologies. The study was reviewed and approved by the Bioethics Committee of the Hospital Clínico Herminda Martín (Chillán, Chile). The anonymity of the institution and participants was safeguarded.

### *Data collection*

The following maternal information was accessed from the public system's child care program; each variable included two groups for maternal age (<35 and ≥35 y), education (<12 and ≥12 y), residence (rural/urban), exclusive BF (<6 and ≥6 mo), prepregnancy NS (normal/overweight), and weight gain (normal/excess). Prepregnancy NS was considered normal when the body mass index (BMI) was 18.5 to 24.9 kg/m$^2$ and OW (including obesity) when BMI >24.9 kg/m$^2$. The Chilean Ministry of Health perinatal guidelines establish the following criteria for adequate weight gain according to the NS of the pregnant woman: underweight (12.7–18.2 kg), normal weight (11.4–15.9 kg), OW (6.8–11.4 kg), and obesity (5–9.1 kg) [17]. Excess weight gain was defined as that which exceeded the maximum range for the NS of the pregnant woman.

Children's NS was determined based on weight (kg) and height (cm), which were measured by standardized procedures [18]. Following the World Health Organization's guideline, both normal (≥ −1 and ≤ +1 SD) and overweight (≥ +1 SD) NS were established based on the weight-for-height z-score according to sex [19].

### *Statistical analysis*

Qualitative variables were described with absolute frequency and percentage and quantitative variables with central tendency and dispersion measurements. Bivariate relationships were evaluated by the $\chi^2$ test. A multivariate logistic regression model adjusted for maternal age was applied to evaluate the children's risk for OW using odds ratio (OR) and 95% confidence interval (CI). Data were processed with the Stata version 15 (StataCorp, College Station, TX, USA) software at a significance level of $\alpha < 0.05$.

## Results

The sample included 138 (49%) boys and 142 (51%) girls, which reflects the population distribution in the country. The majority of the children (n = 189; 67%) lived in urban areas. Mean weight and height were 18.1 ± 7 kg and 101.9 ± 6.2 cm, respectively. There was 56% exclusive BF and the NS was normal for 40% of the children and 60% OW (26% obesity). Maternal data showed a mean age of 26.6 ± 6.9 y. Of the mothers, 84% were <35 y of age, and 62% had >12 y of education. Prepregnancy NS was 37% normal and 63% OW and excess weight gain occurred in 75% of mothers.

No statistically significant differences were found between the children's NS according to sex, maternal age, maternal education, and residence ($P > 0.05$). However, there was a relationship with the duration of BF ($P = 0.002$), prepregnancy NS ($P = 0.002$), and weight gain ($P = 0.004$; Table 1).

The logistic regression model showed that when sex and maternal age were adjusted, prepregnancy OW increased the children's risk for OW up to twofold (OR, 2; 95% CI, 1.3–4.1), as did excess weight gain (OR, 2.3; 95% CI, 1.5–5.9), and non-exclusive BF (OR, 2.4; 95% CI, 1.3–4.4l Table 2).

**Table 1**
Bivariate analysis of the nutritional status of children according to sex and maternal characteristics

| Variables | Normal n (%) | Overweight n (%) | *P* value |
|---|---|---|---|
| Sex | | | |
| Girls | 103 (72.5) | 39 (27.5) | 0.497 |
| Boys | 105 (76.1) | 33 (23.9) | |
| Maternal age (y) | | | |
| <35 | 176 (74.6) | 60 (25.4) | 0.797 |
| ≥35 | 32 (72.7) | 12 (21.3) | |
| Education (y) | | | |
| <12 | 133 (76.9) | 40 (23.1) | 0.207 |
| ≥12 | 75 (70.1) | 32 (29.9) | |
| Residence | | | |
| Urban | 141 (74.6) | 48 (25.4) | 0.861 |
| Rural | 67 (73.6) | 24 (26.4) | |
| Breastfeeding (mo) | | | |
| <6 | 80 (65) | 43(35) | 0.002 |
| ≥6 | 128 (81.5) | 29(18.5) | |
| Prepregnancy nutritional status | | | |
| Normal | 89 (84.8) | 16 (15.2) | 0.002 |
| Overweight | 119 (68) | 56 (32) | |
| Weight gain | | | |
| Normal | 57 (82.6) | 12 (17.4) | 0.004 |
| Excess | 151 (71.6) | 60 (28.4) | |

$\chi^2$ test: $\alpha < 0.05$

**Table 2**
Multiple logistic regression model to associate overweight in Chilean children ages 3 to 4 y

| Variable | $OR_{gross}$ (95% CI) | $OR_{adjusted}$ (95% CI)* |
|---|---|---|
| Overweight Prepregnancy | 2.6 (1.4–4.8) | 2.0 (1.3–4.1) |
| Excess weight gain | 3.3 (1.5–7.3) | 2.3 (1.5–5.9) |
| Breastfeeding (<6 mo) | 2.4 (1.4–4.1) | 2.4 (1.3–4.4) |

*Adjusted for sex and maternal age.

## Discussion

Given the multifactorial origin of OW, several studies have been conducted to establish risk factor associations during gestation with OW or obesity in childhood. Among these, we highlighted prepregnancy maternal BMI, excess maternal gestational weight gain, prenatal exposure to tobacco, high birth weight, BF, and food insecurity with different results and some contradictions [14,20].

In the present study, the prevalence of OW was 34% and 26% obesity in children. These values are similar to the national prevalence and much higher than those reported in the United States with 26% and 16%, respectively [21]. Prepregnancy NS was 37% normal and 63% OW, and these values are similar to national statistics [3].

When analyzing the BF variable, children who breastfed <6 mo were 2.4 times more likely to be OW than those who exclusively breastfed for longer (OR, 2.4; 95% CI, 1.3–4.4). We highlighted the positive effect of BF duration as a protective risk factor for childhood obesity during the first years of life, which has been indicated in other international studies [22–24].

Another important aspect to consider was excess weight gain during pregnancy, which was positively associated with OW in the children (OR 2.3; 95% CI, 1.5–5.9). Prepregnancy NS is a strong predictor of growth and development in the first years of life and is related to the presence of noncommunicable diseases in adulthood [25]. Therefore, the present findings concur with the results of other authors who have indicated the importance of controlling weight gain during gestation as a risk factor for childhood OW; also there is a need to evaluate the effect of weight variation in each gestational trimester as a preventive factor of childhood OW problems [14,26–28].

On the other hand, prepregnancy maternal OW is an independent risk factor for OW and obesity [29]. In the present study, 3- and 4-y-old children of mothers with OW had double the risk (OR, 2; 95% CI, 1.3–4.1) for obesity than children whose mothers had

normal NS. This risk relationship for OW in preschool children is higher than in a recent study conducted in our country [30]. OW also has been observed in adolescents. It was reported that prenatal exposure to maternal OW was positively associated with higher risk for OW (OR, 2.56), emphasizing the need for further study of these risk factors [31].

## Conclusion

Preschool children ages 3 and 4 who experienced risk factors such as non-exclusive BF, maternal prepregnancy OW, and excess gestational weight gain were between 2 and 2.4 times more likely to be OW than children without these factors. We emphasize that there are few studies that have jointly analyzed these risk factors for this age group, and we suggest that these risk factors should be studied in depth.

## CRediT authorship contribution statement

**Lorena Salazar-Gutiérrez:** Methodology, Conceptualization. **María Angélica González-Stager:** Conceptualization, Methodology. **Gustavo Pastén-Dué:** Data collection, Resources. **Alejandra Rodríguez-Fernández:** Formal analysis, Writing - original draft. **Julio Parra-Flores:** Methodology, Writing - original draft. **Eduard Maury-Sintjago:** Formal analysis, Writing - review & editing, Visualization, Supervision.

## Declaration of interests

None.

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