Infant Processed Food Consumption and their Interaction to Breastfeeding and Growth in Children up to Six Months Old

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Abstract

Background

Evidences suggest that early processed food consumption may cause harms to infant health. During the first six months of life, it is not known whether timing and quantity of this food group can impact in breastfeeding and growth. The aim was to analyze the interaction between infant processed food consumption and their relation to breastfeeding and infant growth up to six months old.

Methods

Longitudinal study with a sample of newborns in Porto Alegre, Brazil. Data were collected in six interviews, from birth to six months, in a sample of infants with adverse intrauterine environments. Processed food consumption was calculated by gravity score food (GSF) in relation to feeding supply quality and time. For the analysis, the scores were divided into tertiles, making scores severities: Null, Mild, Moderate and Severe. It was tested its interaction with breastfeeding (exclusive and nonexclusive) and growth (analyzed in Z-scores, by weight for height and body mass index for age).

Results

A total of 236 infants were included in the study. Greater GSF were associated with better rates of breastfeeding practices and higher growth indicators scores in the sixth month of infants. The adjusted analyzes for family income, maternal age and pre-gestational body mass index confirmed these findings.

Conclusion

The harms of eating processed foods are more evident the greater and earlier they are consumed, in relation to breastfeeding and infant growth. Future studies should explore interventions to reduce consumption of these foods to prevent adverse health outcomes in later life.

Background

Adequate feeding in early childhood is critical for satisfactory growth and development of the child [1]. Inadequate nutrition, especially in childhood, can cause important repercussions individuals health of throughout the course of life and is intrinsically linked to cognitive and social development [2]. It was evidenced that the best feeding practice for infants during their first months of life is breast milk [3], since it provides several benefits to the infant, like protecting against allergic and respiratory diseases [4] and preventing development of type 2 diabetes mellitus (DM) and obesity at short- and long-term [5].

It is known that, after the sixth month of life, complementary feeding (CF) are necessary for both nutritional and developmental factors, and they are an important transition from milk supply to family feeding [6]. There are large changes in diet during this period, with exposure to new foods, tastes, textures and feeding experiences [6–8]. Inappropriate infant feeding practices, such as early interruption of breastfeeding (BF), unsuitable introduction of CF and excessive consumption of industrialized products rich in sugar, fat and sodium, can lead to feeding inadequacies throughout childhood [9].

Food processing contributes to food security, by ensuring that sufficient food is available for the population, and to nutrition security, by ensuring that its quality meets human nutrient needs. However, its excessive consumption contributes to the diet in a negative way, offering an unrestricted amount of energy, saturated fat, sugar and sodium [10]. Among processed foods most consumed by children under six months of age, gelatin and juice from cartons, followed by filled biscuits and salty snacks at the subsequent months of age [11].

Exposure to different intrauterine environments, such as DM [5, 12, 13], hypertensive disorders (HD) [14], intrauterine growth restriction (IUGR) [15] and smoking [16] may affect BF practices, other milks, introduction of CF and child growth, by influencing birth weight and infant weight gain over the months.

It is not well known whether, depending on timing and quantity of processed foods (PF) offered, they may act differently in health or breastfeed practices, being more or less harmful to children in early childhood. Therefore, the aim of this study is to analyze the interaction between infant processed food consumption and their relation to breastfeeding and infant growth up to six months old.

Methods

Participants:

This is a longitudinal observational study performed with a convenience sample of neonates, from September 2011 to December 2016. The study is part of a larger prospective controlled project entitled Impact of Perinatal Environment Variations on the Health of the Newborn in the First Six Months of Life (IVAPSA), whose objective was to understand the long-term effects of perinatal environmental variations on growth, nutrition, behavior, metabolism and neurodevelopmental of the individual, as well as to identify the vulnerability to deleterious effects of these variations. Further details about IVAPSA study [17], as well as some baseline results [18] were previously published.

According to the IVAPSA study, the final sample size estimated was 521 children, being 87 for each group and 174 pairs for the control group. The sample size calculation is described in details elsewhere [17]. Newborns were recruited at three hospitals in the city of Porto Alegre: Hospital de Clínicas de Porto Alegre (HCPA), Hospital Fêmina and Hospital Nossa Senhora da Conceição, both belonging to Grupo Hospitalar Conceição (GHC) (figure 1). These hospitals are public, provide assistance to pregnant women with similar socioeconomic characteristics and are a reference for prenatal care at risk.

The selection of infants, made in a random way, was done by analysis of medical records, in the hospitals. Six data collections were performed: between 24 and 48 hours after delivery at hospital, and after: at seven and 15 days, at one, three and six months, at home or at Clinical Research Center of HCPA. The researchers were periodically trained in order to standardize the interviews, the collection techniques and the anthropometric measures. Inclusion criteria consisted of pairs attended in the hospitals and belonging to the area covered by Porto Alegre city, Rio Grande do Sul. Mothers with HIV (Human Immunodeficiency Virus) positive test, newborn twins or who had congenital diseases at birth or gestational age less than 37 weeks, or those who required hospital admission, or those with birth weight below 500 grams, and pairs who did not attend the six-month interview were excluded of the study.

The sample consisted of newborns who had different backgrounds of adverse intrauterine environments, such as tobacco (affirmative answer for smoking during pregnancy, regardless the amount of cigarettes used per day), DM (gestational diabetes, type 1 or 2 diagnosis), HD (hypertensive disorders during pregnancy, whether it was classified as preeclampsia and eclampsia, preeclampsia superimposed on chronic hypertension, chronic hypertension), control (mothers who did not have hypertension or DM, as well as those who were non-smokers), IUGR (mothers with term infants small for gestational age who were below the percentile 5, according to Alexander curve parameters [19], whose causes were not smoking, HD or DM). The questionnaires used in this study were extracted from the IVAPSA original ones, which were specially developed for que research, and are available as supplementary material (Supplementary File 1-4).

Covariates:

Covariates were collected at first and sixth interviews, using structured questionnaires about maternal issues, socioeconomic, pregnancy, childbirth and the infant. Maternal data were number of past pregnancies (prior live births), education (years of study), total family income (in Reais – Brazilian currency) and age (in years). Gestational data consisted of pre-gestational body mass index (BMI) (expressed in kilogram by stature squared, Kg/m^2) and group of gestational clinical conditions (DM, HD, tobacco, IUGR and control). Infant data were use of pacifier and bottle feeding at six months, introduction of cow's or formula milk (in days).

Feeding practices:

For infant feeding practices analysis, data were collected from second to sixth interviews, referring to infant feeding at hospital discharge; time in minutes of initiation of BF at postpartum, questions related to BF, weaning and introduction of CF.

The recommendations of infant nutrition analyzed were those proposed by "Feeding Guide for Brazilian Children Under Two Years" [20] and "Dietary Guidelines for the Brazilian Population" [21], both publications of the Ministry of Health of Brazil.

The BF variables were elaborated according to World Health Organization (WHO) [22]: exclusive breastfeeding (EBF), when the child received just BF, without any other liquid or solid, except for supplements and medicine and nonexclusive (non EBF), when the child was breastfeeding, independent of other liquids or feeding offered and. Then, an analysis about time of EBF and non EBF was made, in days.

Foods consumed in R24h were transposed in Excel® and categorized according to the degree of food processing (NOVA classification), proposed by “Dietary Guidelines for the Brazilian Population”, according to Monteiro and collaborators [23]:

- In natura or minimally processed foods: foods obtained directly from plants or animals, and may or may not be subjected to minimum changes, such as drying, grinding, polishing, among others, such as grains, fruits, vegetables, meats and milk;

- Culinary ingredients: products extracted from foods in natura or directly from nature and used for seasoning, cooking and create culinary preparations, such as oil, fat, sugar and salt;

- Processed foods: products made essentially from addition of salt or sugar to an in natura or minimally processed food, such as preserved vegetables, fruit in syrup, cheese and bread;

- Ultra-processed foods: products whose manufacturing involves various stages and processing techniques and various ingredients, many of them exclusively for industrial use, such as soft drinks, biscuits, snacks and instant noodles.

The last three categories of processing (culinary ingredients, processed and ultra-processed foods) were grouped as “processed foods” for analyzes. After the compilation of the three groups of PF, a weighting was carried out by the numbers of items consumed, scoring more severity the earlier the consumption.

The gravity score food (GSF) calculation occurred as follows: infants who did not consume any type of PF during the first six months of life, obtained null weighting. To the others, the score was assigned according to feeding consumption for each data collection: 10 points for each food consumed at 15 days of life; 7 points, at 30 days of life, 5 points, at 90 days of life and 3 points at 180 days. That is, the same food, if it was offered in more than one data collection, would be scored every time it was mentioned. These scores were divided into tertiles, generating groups of mild severity (1-12 points), moderate (13-30 points) and severe (more than 30 points).

Child growth:

Measurements of weight (in kilograms) and height (in centimeters) were investigated in all interviews. Child growth was assessed by WHO *Anthro*® software. The growth parameters were evaluated according to the anthropometric indices weight for height (WHZ) and body mass index for age (BAZ), proposed by WHO [24]. The cut-off points for nutritional diagnosis of z scores followed the criteria adopted by Ministry of Health, in 2011 [25].

Statistical analysis:

Data were processed and analyzed by the statistical program SPSS®, version 18.0 (PASW Inc., Chicago, IL, EUA). Qualitative variables were expressed by absolute number and percentage, and Pearson's chi-square test was used to detect differences between proportions. The Shapiro-Wilk test was used to identify the normality of quantitative variables. Quantitative variables were expressed by median [interquartile range], and analyzed by Kruskal-Wallis test, with Dunn Post Hoc test.

To compare the averages of growth variables between the different GSF, it was performed an analysis of variance test (ANOVA), with Tukey Post Hoc test. For asymmetric variables, distribution of BF time (exclusive and prolonged) was compared using Kruskal-Wallis test; when significant, it was compared by Dunn Post Hoc test.

To perform the adjusted comparison for variables age, maternal pre-gestational BMI and income, the BF time variables (exclusive and prolonged) were transformed into logarithms, correcting the values asymmetry. The comparison of growth variables and BF time logs were performed using ANCOVA test. Results were presented by geometric mean and 95% confidence interval. For all analyzes, a significance level of 5% were considered.

Ethical aspects

The mothers signed, in duplicate, the Free and Clarified Consent Term, at the time that preceded the first interview in the first 48 hours after delivery. An identification number was defined for each child, maintaining anonymity of the participants. The study was approved by the Research Ethics Committee of HCPA and GHC, under protocol numbers 11-0097 and 11-027, respectively.

Results

A total of 236 infants were included in the study. Infants included in sample had significantly higher percentage of living with their mother's partner ($p = 0.047$), higher maternal education ($p = 0.006$), maternal age ($p = 0.001$) and number of prenatal consultations ($p = 0.004$), compared to infants from recruitment, due to loss of follow-up and missing data (data not shown in tables).

The associations between descriptive sample data and GSF are shown in table 1. Of the 236 infants, 28 (11.86%) were in Null severity score, 74 (31.36%) in Mild severity score, 66 (27.97%) in Moderate severity score and 68 (28.81%) were in the Severe group. Monthly family income of Null group was significantly higher than Moderate and Severe groups, as well as Mild group in relation to Severe group ($p < 0.001$). In the same way, Null and Mild groups was differentiated by higher maternal education, when compared to the other two scores groups ($p < 0.001$). Women of Severe group were younger than Null and Mild groups ($p = 0.003$). Moderate group presented significantly higher pre-gestational BMI than Null group ($p = 0.010$). Regarding the different backgrounds of adverse intrauterine environments, controls showed higher percentage in Mild scores, when compared to tobacco and DM groups. In contrast, in Severe group

controls presented lower percentage of participants compared to tobacco. In Moderate severity, DM obtained a higher proportion in relation to HD ($p = 0.013$). Number of past pregnancies, same as children related variables, presented no significant differences between GSF.

In the crude analysis of growth and BF variables and their relationship with GSF (table 2 and Fig. 2), it was perceived that Moderate group obtained higher WHZ and BAZ, compared to Null severity ($p = 0.040$ and $p = 0.041$, respectively). Likewise, Null and Mild scores demonstrated better rates at BF variables. Time of EBF was higher in Null group in contrast to Severe, and in Mild group compared to Moderate and Severe ($p < 0.001$). Both Null and Mild scores presented greater general non EBF rates, in relation to the others ($p < 0.001$). Adjusted analysis for total family income, maternal age and maternal pre-gestational BMI confirmed the crude findings. Relative to growth, Null severity had lower WHZ and BAZ than Moderate severity ($p = 0.025$ and $p = 0.030$, respectively). Findings of non EBF also confirmed crude analysis, in which Null and Mild scores statistically differed from Severe, and Mild from Moderate, in EBF duration ($p < 0.001$); while Null and Mild severities demonstrated better rates of non EBF, compared to Moderate and Severe groups ($p < 0.001$).

Discussion

The present study found that higher infant PF consumption analyzing by GSF was associated with higher WHZ and BAZ, even as lower EBF and non EBF time in the sixth month of infants. It should be emphasized that there was a meticulous division of feeding introduction with regard to degree of food processing, due to the fact that literature shows that consumption of ultra-processed foods, as well as sweetened beverages, has its start early, in a frequent way even before the age of six months [26].

In this survey sample, there were a large number of infants in Null, Moderate and Severe scores, demonstrating the current food situation. As in other studies [27, 28], the early childhood eating practices confirmed to be inadequate, compared to the recommendations for this age group [20], when replacing foods considered natural and healthy for the processed ones. This high consumption by infants reflects on a nutritionally poor diet with high amounts of carbohydrates sugar, sodium, total and saturated fats and energy density, and low amounts of proteins, fibers, vitamins and minerals [29].

The factors most strongly associated with this early and large consumption of infants were maternal education and age, family income, number of past pregnancies, BF in the first month of life and the main caregiver, not being the mother [27, 28]. In the present study, the sample descriptive characteristics corroborated with the literature, on what Null score had higher family income in comparison to Moderate and Severe scores, as well as did Mild score in relation to Severe. Maternal education and age was also higher in lower severity score groups. In contrast, women in Moderate score presented higher pre-gestational BMI than Null ones. In EDEN cohort, it was found that mothers who offer ultra-processed foods tend to be younger, with higher educational level and more likely to be obese [30].

Referring to adverse intrauterine environments, infants from control group revealed greater number on Mild severity, compared to tobacco and DM. In Moderate score, the infants from diabetic group were in a

higher proportion in relation to HD; and in Severe, the tobacco group predominated above control ones. In fact, these adverse intrauterine environments caused by different gestational clinical conditions has already been related to BF, by reducing volume of milk produced and child response to breast milk in smoking [31, 32], leading to less BF time in smoking, gestational DM [33] and HD [34], even as early introduction of CF, before four months of life [16]. However, relative to PF supply, studies are still scarce. Recent study observed that in children exposed to gestational DM, BF only maintain its protection against childhood obesity if processed foods, like sugar-sweetened beverages intake is also low [35].

On this research, child growth z scores were higher in Moderate severity. However, these values did not exceed the normal range of eutrophic, and these data may not have great clinical relevance. A possible explanation would be that the period of child growth monitoring was considered short, being necessary more time so that greater differences could be noticed. These ideas corroborates with a systematic review, that found a positive association between consumption of ultra-processed foods and body fat, during childhood and adolescence [36].

In addition, a study carried out in Nicaragua by Contreras and collaborators pointed out that children receive a low-quality CF, with high consumption of ultra-processed foods and sweetened drinks frequently, starting at around six months of age [26]; and its consumption in pre-school age is a predictor of increased waist circumference in school age [37].

Moreover, the consumption of PF, together with early introduction of wheat, cow's or formula milk and shorter duration of BF interfere on diet quality, which may affect nutritional status at two years of age [38]. In the present study, Null and Mild severity scores demonstrated better rates of general and EBF and non EBF time, evidencing possible mutual protective effect.

Other studies have shown likely results: EBF for less than four months is associated with lower consumption of fruits and vegetables and higher consumption of ultra-processed foods [39]. It can be seen that feeding introduction at the right time, in a non-early stage, is associated with EBF in the first month of life [40]. In Denmark, longer duration of EBF, between four and five months, was related to higher daily consumption of vegetables [41].

Breast milk reduces the chances of consuming non-recommended foods, like cookies and crackers for children under six months old, industrialized yogurt between six and twelve months old, and soft drinks between twelve and twenty-four months of age [42]. Although researches indicate the adverse effects of processed foods on daily basis, and government agencies strongly recommend not consuming them, it is known that, with globalization, it could be increasingly difficult to completely extinguish processed foods. On the other hand, while total exclusion is difficult to achieve, reducing consumption, with it not being part of the routine, can be a viable alternative for population.

Furthermore, the study of impact of ultra-processed foods on human health is essential, since they could impact in the prevalence of autoimmune diseases, by inducing gut dysbiosis and promoting a pro-inflammatory response [43].

Among the strengths of the study, can be highlighted the data collection in six interviews, in an important period of life, the first six months; making it possible to identify potential crucial periods for interventions. The analysis of feeding practices was performed meticulously and managed to encompass all aspects of infant feeding, by counting on a variety of collection instruments, increasing reliability of data and reducing information bias given by the interviewees. Finally, the severity scores allowed an accurate analysis of PF consumption, providing different scores according to the moment and number of times offered. And also, a pioneering research on infant feeding in the first six months considering, besides breastfeeding, the classification by type of food processing.

Instead, this study has shown limitations. The longitudinal character study generated a 41% loss of follow-up, decreasing the sample. This may have occurred due to the great housing mobility, characteristic of the most vulnerable social classes in Brazil; although, the analysis showed sufficient sample power. Because the sample has specific adverse intrauterine environments resulting from gestational clinical conditions, these results may not be generalized for the general population. Despite this, since this research used a sample of varied intrauterine environments with high prevalence, it is possible that the relations observed here may be interesting for the population of children of Brazil.

Conclusion

The high and/or early consumption of processed foods by infants demonstrated a strong relationship with shorter breastfeeding time and higher growth scores at their six months of life. Less supply from this food group, or its postponement, can be capable of reducing food processing harms. It is of great value, for a better understanding of the subject, that further studies be carried out with a longer period of follow-up.

Abbreviations

BAZ
Body Mass Index for Age Z Score
BF
Breastfeeding
BMI
Body Mass Index
CF
Complementary Feeding
DM
Diabetes Mellitus
EBF
Exclusive Breastfeeding
GHC
Grupo Hospitalar Conceição

GSF
Gravity Score Food
HCPA
Hospital de Clínicas de Porto Alegre
HD
Hypertensive Disorders
IUGR
Intrauterine Growth Restriction

Declarations

Ethics approval and consent to participate

The study was approved by the Research Ethics Committee of Hospital de Clínicas de Porto Alegre and Grupo Hospitalar Conceição, under protocol numbers 11–0097 and 11–027, respectively. All participants assigned the Informed Consent Form.

Consent for publication

All authors revised and approved the publication of this manuscript.

Availability of data and material

The questionnaires used for the research are available as Supplemental File. Data can be requested from the responsible researcher, by email renataoliveiraneves@gmail.com.

Competing interests

None of the authors have any potential financial relationship or conflict of interest related to this study to disclose.

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Figures

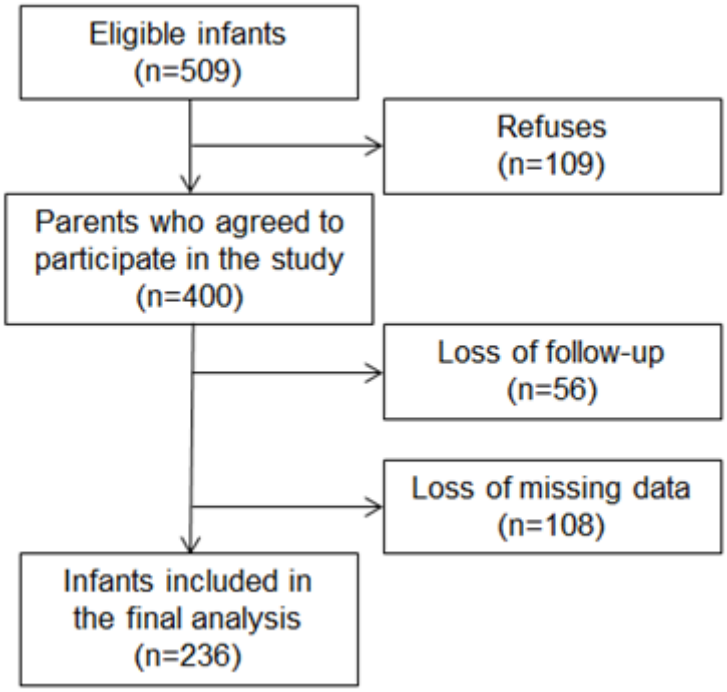

Figure 1

Infant selection flowchart, IVAPSA.

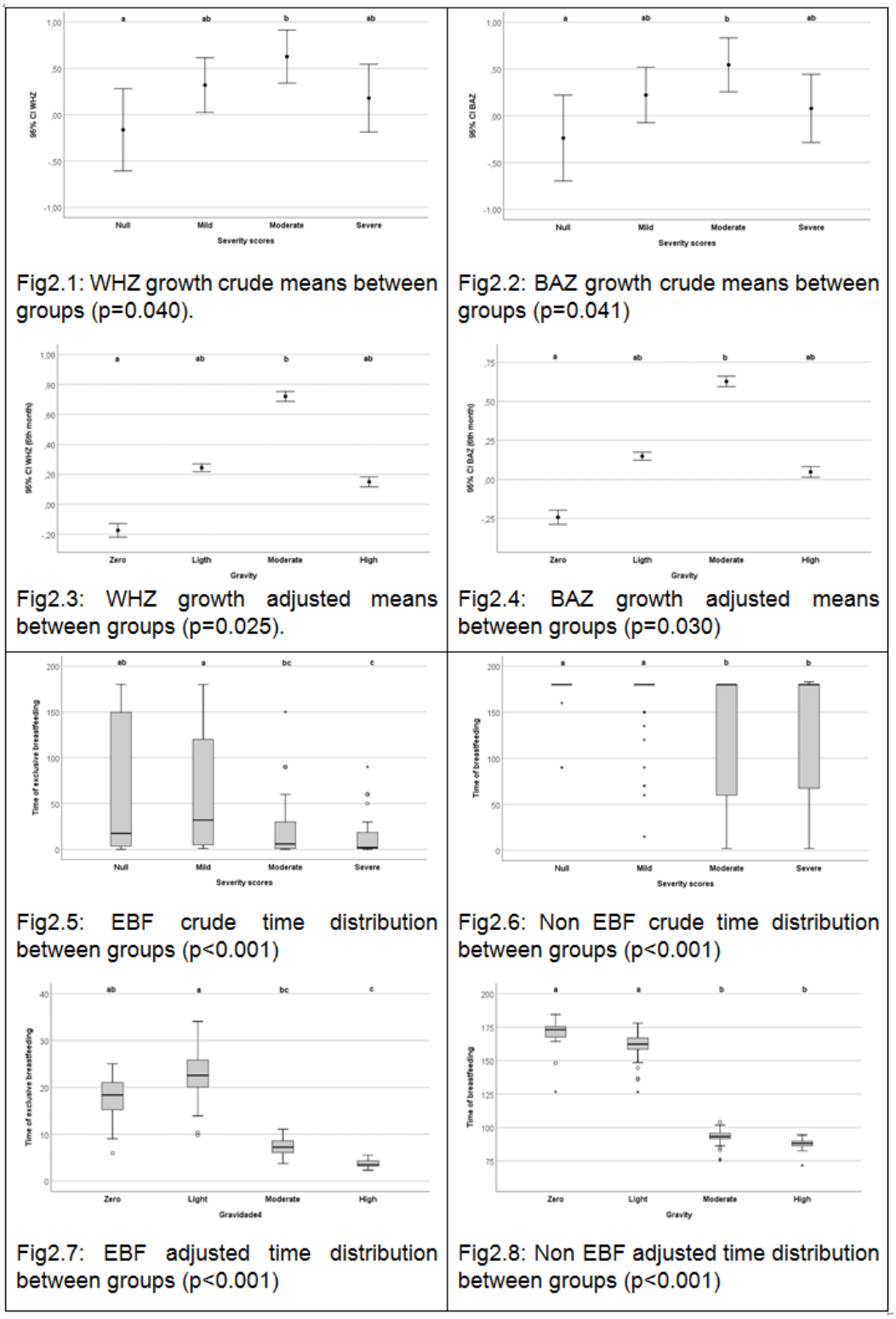

Fig2.1: WHZ growth crude means between groups (p=0.040).

Fig2.2: BAZ growth crude means between groups (p=0.041)

Fig2.3: WHZ growth adjusted means between groups (p=0.025).

Fig2.4: BAZ growth adjusted means between groups (p=0.030)

Fig2.5: EBF crude time distribution between groups (p<0.001)

Fig2.6: Non EBF crude time distribution between groups (p<0.001)

Fig2.7: EBF adjusted time distribution between groups (p<0.001)

Fig2.8: Non EBF adjusted time distribution between groups (p<0.001)

Figure 2

Crude and adjusted means distributions of growth and duration of breastfeeding variables, between different processed feeding severity scores, of IVAPSA sample included in the analysis, Porto Alegre.

Supplementary Files

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