ABSTRACT

Objective: To determine the influence of pre-pregnancy maternal BMI and increases in maternal weight during pregnancy on perinatal and child outcomes at birth and at 5 years.

Research design/setting: A prospective cohort study was conducted between November 2016 and December 2021. The participants were a total of 115 women-child dyads, selected from among pregnant women receiving routine prenatal care in different health centres belonging to 2 health districts. Follow-ups were conducted with the women during pregnancy and with their children during the 10 days after birth and at 5 years.

Findings: The total weight gain during pregnancy is influenced by an inadequate pre-pregnancy BMI (0.03; 95% CI, 0.004 – 0.25; *P*=.001) and a greater increase in maternal BMI during the first and second term of pregnancy. A greater increase in BMI during pregnancy was associated with higher breastfeeding rates both in the short term (1.21; 95% CI, 1.01–1.44; *P* =.04) and the long term (12 months: 1.30; 95% CI, 1.02 – 1.67; *P* =.04; 24 months: 1.30; 95% CI, 1.02 – 1.69; *P* =.04). No links were found between gains in maternal weight and the weight of the newborn, nor between maternal weight and/or pre-pregnancy BMI with the nutritional status of the child.

Key conclusions: After studying these results, it was concluded that promoting and implementing health and education policies focused on enhancing maternal nutritional status is essential to improve the nutritional status of children.

Implications for practice: Healthy gestational weight gain (GWG) is an important issue to be addressed by the midwife in primary care, both in the preconception period and throughout pregnancy.

As a result, it is important that the midwife is trained and has the appropriate resources and tools to work with pregnant women individually and collectively. In addition to paying attention to overweight and obese pregnant women, the midwife should also pay attention to women with a normal BMI, as they seem to have greater difficulty in maintaining a healthy weight gain.

Another line of intervention to be addressed is breastfeeding (BF), where the midwife should be the main point of reference from the beginning of this process, taking into account the relationship between BMI and BF.

KEYWORDS

Body Mass Index; pregnancy; childbirth; infant; nutritional state; breastfeeding

Introduction

Obesity is a major social issue today, affecting both adults and children, with the prevalence of overweight and obesity among European children aged 2-7 years estimated at 17.9%. It is forecast that by 2025 both issues will affect 70 million children of various ages (Usheva et al., 2021). However, interventions to prevent and/or treat childhood obesity seem ineffectual, and prevention needs improving, including during the prenatal period (Waits et al., 2021).

Among the most effective early interventions to prevent childhood obesity is exclusive breastfeeding (EBF) – recommended for the first six months and at least until the age of two years through prolonged breastfeeding (PBF) (Ma et al., 2020) – which is associated with other short- and long-term health benefits, particularly the prevention of childhood diabetes (Hermann et al.,2010; Horta and de Lima, 2019) and colorectal cancer (Murphy et al., 2021). The World Health Organization (WHO) recommends EBF as the best diet for newborns (NB) in the first six months and PBF with complementary foods up to two years (Nuzzi et al., 2021; Usheva et al., 2021).

Obesity is a problem among children and women, increasing the risk of adverse effects during pregnancy, birth and postpartum (and also affecting the NB). Other health problems may appear later in life, aggravated by factors such as excessive gestational weight gain (EGWG) (Dodd et al., 2022). It is documented that EGWG further increases risk of complications in both singleton and multiple pregnancies (Choi et al., 2022; Langley-Evans et al., 2022; Lipworth et al., 2021). One common complication of EGWG is foetal macrosomia (Stang and Huffman, 2016), which is considered an early stage of neonatal malnutrition, with important repercussions on the later nutritional status of the NB, increasing chances of childhood obesity (Waits et al., 2021).

Furthermore, the presence of nutritional problems – EGWG in the women or the NB during pregnancy – may affect the onset and duration of EBF. Nonetheless, recent studies suggest no link between increased gestational weight and EBF, at least in women with Class 3 obesity (Darling et al., 2022), nor between macrosomia and EBF (Davie et al., 2021).

However, when addressing obesity prevention, the health system must consider both exogenous factors (health interventions) and endogenous factors (those of the women and the NB) (Santana et al., 2020).

Regarding interventions to reduce and control GWG, midwives are focusing antepartum midwifery care on nutritional advice and promoting self-guided or supervised exercise programmes (Sartorelli et al., 2022; Shum et al., 2022; Teede et al., 2022).

Major endogenous factors are pre-pregnancy body mass index (BMI) and parity (Vila-Candel et al., 2021). Recent findings suggest that high pre-pregnancy BMI is associated with greater risk of EGWG and foetal macrosomia (Aji et al., 2022). Nevertheless, weight gain during different pregnancy trimesters also affects the final outcome distinctly (Uchinuma et al., 2021). In terms of parity, it has been well established that NB weight usually increases with the number of deliveries (Garces et al., 2020).

Given the relevance of these factors, the goal of this study was to determine the influence of pre-pregnancy BMI and GWG on perinatal and offspring outcomes at birth and at 5 years.

Methods

Design

A prospective cohort study was conducted between November 2016 and December 2021.

Sample/Participants

Participants were selected from among pregnant women receiving routine perinatal care in various health centres (HC) in 2 health districts. All women attending prenatal classes were informed by their midwives of the possibility of participating in the study if they met inclusion criteria: (1) registration in prenatal programme, (2) written consent to participate, (3) singleton pregnancy, (4) low-risk pregnancy, (5) pre-pregnancy BMI $\geq$ 18.5 kg/m^2, and (6) age over 18. Women not attending prenatal appointments, with difficulties in speaking or understanding Spanish, and those declining to participate, were excluded.

Follow-ups were conducted with the women during pregnancy and their children during the 10 days after birth and at 5 years.

After excluding women declining to participate and children for whom no information was available at age 5, a total of 115 women-child dyads were followed up.

Ethical considerations

The study was developed respecting the fundamental principles of the Declaration of Helsinki (1964), the Council of Europe Convention on Human Rights and Biomedicine (1997) and the UNESCO Universal Declaration on the Human Genome and Human Rights (1997). Requirements established in Spanish legislation in the field of biomedical research, personal data protection, and bioethics – updated through Organic Law 3/2018 of 5 December – were met. The approval of the Health Service Bioethics Committee was obtained (PI 021/14 of 21/08/2014). Data was collected from only those who signed the informed consent form and their descendants.

Data collection

Data were collected during the pregnancy, the first 10 days postpartum and at 5 years.

Users of the Spanish public health system have digital health records and women during the period of pregnancy also have a pregnancy healthcare document. Both sources of information were used to extract socio-demographic data (maternal age and education), maternal anthropometric data (height, pre-pregnancy weight, last recorded weight before delivery, gestational age, gestational history and type of delivery) and offspring data at birth and at 5 years (weight and height). Data on feeding at birth and during infancy were collected through structured telephone interviews conducted by trained interviewers. The weight of the NB obtained at ten days postpartum was used as the birth weight. This data was contrasted through the information the mother gave in the postpartum interview and the information collected in the clinical history regarding the birth.

Pre-pregnancy BMI and maternal GWG

Based on pre-pregnancy weight (kg) and maternal height (m), pre-pregnancy BMI (weight [kg]/height [m^2]) was calculated. The women were classified in accordance with WHO guidelines in 3 categories based on BMI: normal weight (BMI ≥ 18.5 and ≤ 24.9 kg/m^2); overweight (BMI ≥ 25 and ≤ 29.9 kg/m^2) and obese (BMI ≥ 30 kg/m^2) (WHO Consultation on Obesity, 2000).

Regarding pregnancy weight gain, total GWG was calculated as the difference between maternal pre-pregnancy and delivery weight. The classification was based on the Institute of Medicine (IOM) Guidelines for singleton pregnancies: normal, overweight and obese (Rasmussen et al., 2009). Appropriate weight gain was considered to be 11.5 – 16 kg in pregnant women with previously normal BMI, 7 – 11.5 kg for overweight women and 5 – 9 kg for obese women (Vila-Candel et al., 2021). Recommended weight gain was defined as normal GWG, while gains below or above the IOM guidelines were defined as inadequate or excessive GWG.

Perinatal and child outcomes

The pregnancy period was categorised per trimester: first (< 14 weeks), second (≥ 14 – < 28 weeks) and third (≥ 28 weeks).

The weight for gestational age classification was based on the standards of the INTERGROWTH-21st study group (Villar et al., 2014), defined according to gestational age and sex, as follows: small for gestational age (SGA), NB below the 10th percentile; appropriate (AGA), 10th – 90th percentile; large (LGA), above the 90th percentile.

BMI was calculated as weight (kg) divided by the square of length (m^2), and the BMI z-score was generated from the BMI reference specified by age and sex, based on Carrascosa and Mesa growth patterns (Carrascosa and Mesa, 2018). Several categories were based on BMI-z at 5 years: low weight (BMI-z < -2); normal weight (-2 ≤ BMI-z ≥ 1); and overweight/obese (BMI-z > 1).

Study covariates

Study covariates included maternal age (< 35 years; ≥ 35 years), educational level (basic/secondary and higher education), smoking during pregnancy (yes/no), parity (number of live births) and gender of NB (male/female).

Data analysis

Quantitative variables are presented as mean and standard deviation, and qualitative variables as absolute frequencies and percentages.

The Kolmogorov-Smirnov test with the Lilliefors correction was used for the goodness of fit to a normal distribution of the data from quantitative variables. For bivariate hypothesis testing, Student's t-test for 2 means was used, while for qualitative variables, Chi-square and Fisher's exact test were used when necessary. Correlation between quantitative variables was tested using Pearson's correlation coefficient (r). Finally, if the normality or homoscedasticity criterion was not met, non-parametric versions of the above tests were performed.

For pregnant women, binary logistic regression models were calculated to study the effect of each variable measured in GWG. For the NB, multinomial regression models were calculated to assess the effect of each measured variable on nutritional status according to weight for gestational age at birth. Additionally, in these same children at 5 years, binary logistic regression models were estimated to see the effect of each variable measured on nutritional status according to the BMI-z. The raw and adjusted Odds Ratios (OR) were determined with confidence interval at 95%. The goodness of fit tests (–2 log likelihood, goodness of fit statistic, Cox and Snell R^2, Nagelkerke R^2 and Hosmer–Lemeshow tests) were calculated to assess the global fit of the models.

For all the statistical analyses, a probability of alpha error of less than 5% ($p < 0.05$) was accepted and the confidence interval was calculated with 95% confidence. All statistical analysis was run by the computer program IBM SPSS Statistics v.27 (SPSS, IBM, Chicago, IL, USA).

Results

The 235 pregnant women attended maternal education sessions in their HC. After volunteering in the study and applying the eligibility criteria, 102 participants were excluded (58 not meeting the inclusion criteria and 44 declining), with a final selection of 133 pregnant woman-newborn dyads.

During the 5-year follow-up, 15 drop-outs were recorded resulting from inability to contact women or access children's data, and 3 drop-outs from declining to participate in the follow-up. The final participant group consisted of 115 women-child dyads. Figure 1 shows the flow diagram.

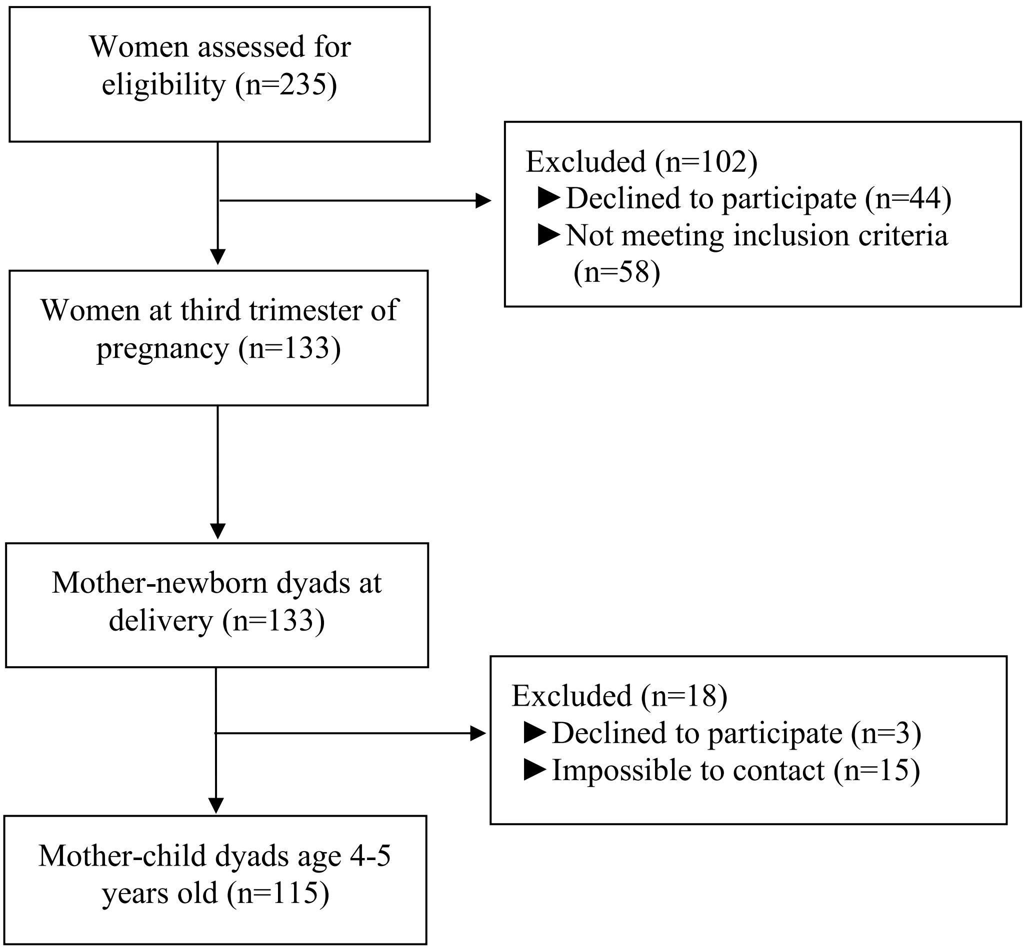

Figure 1. The flow diagram of the participants through each stage of the study.

Characteristics and nutritional status of pregnant women

At the beginning of the study, the 115 participants had an average age of 32.8 (±4.3) years. Most had primary or secondary education (66.1%) and a low/moderate physical-activity lifestyle (90.4%), were non-smokers (94.8%), with an average pre-pregnancy BMI of 24.5 (±4.1) kg/m2, indicating a normal weight but bordering slightly on overweight.

Regarding attendance at the maternal-education programme sessions (Appendix 1), it was higher in primiparous pregnant women than in multiparous pregnant women [86 (74.8%) and 29 (25.2%), respectively]. In addition, 66 primiparous women (76.7%) attended more than four sessions compared with 19 multiparous women (65.5%).

Regarding weight gain in the first trimester, 69.6% started at normal weight, while 30.4% were overweight. Women with a normal pre-pregnancy weight had a higher mean GWG than overweight or obese women (10.1±5.8 vs. 7.7±6.1). Significant differences between the two groups were found for the different categories of GWG ($p<.001$) and for weight gain in the third trimester ($p=.04$) (Table 1).

Association between pre-gestational BMI and GWG

After analysing the influence of BMI during pregnancy, results showed that EGWG risk was lower in women with an initial inadequate weight according to pre-pregnancy BMI (0.03 [0.004 – 0.25; $p=.001$]), and EGWG risk was higher in women with a greater increase in BMI during the first and second trimesters (5.49 [2.31 – 13.09; $p<.001$]; 5.35 [2.05 – 13.96; $p<.001$]), (Table 2).

Perinatal outcomes and predictor variables

Most of the NB (57.4%) were male. Delivery occurred in the majority of cases (79.1%) at 37 – 40 weeks' gestation and 69.5% of deliveries were vaginal. Regarding distribution by weight, over 80% of NB had sufficient weight at birth, regardless of gestation weeks, and over 90% were EBF while in hospital. No differences in length at birth were found according to sex, but there were the expected weight differences (Appendix 2).

After analysing the different birth-weight categories according to gestational age (Table 3), primiparous women were more likely than multiparous women have a NB with LGA (4.30 [1.25-14.80]; $p=.02$), in relation to the NB group with AGA.

Offspring BMI at 5 years and predictor variables

The average age of the children when assessing nutritional status at 5 years was 5.2 (±0.3). Average weight was slightly higher in males than females, and 29.6% of children had inadequate nutritional status (26% overweight/obese). The prevalence of BF after birth was above 80%, dropping to just over 50% at 6 months. No significant differences were found for any variable between sexes (Appendix 3).

Maternal pre-pregnancy weight, GWG and Child BMI-z

The influence of parity on the child's nutritional status over the years was observed. Children of multiparous women showed 3.13 times (CI95% 1.22–8.02; *p*=.02) more risk of inadequate nutritional status compared to the offspring of primiparous women. No statistically significant differences were found between pre-pregnancy weight, GWG and the child's nutritional status in the first 5 years (Table 4).

Maternal BMI, birth weight and exclusive and prolonged breastfeeding

The average duration of BF was 13.1 (±14.0) months, with 57.4% of women EBF for more than 6 months. Furthermore, BF was prolonged until 12 months in 36.5% and to 24 in 27.8% (Appendix 3).

Regarding EBF, women who breastfed for at least 6 months were older on average than those who did not. Increased BMI during pregnancy was found to favour the likelihood of EBF during the first 6 months (1.21 [CI95% 1.01–1.44]; *p*=.04). It was also observed that having a high birth weight for gestational age was a protective factor for EBF during the first 6 months, compared to having an appropriate weight (0.20 [CI 95% 0.04 – 0.99]; *p*=.05) (Table 5).

Comparing women-child dyads that breastfed for 12 months or longer with those that did not (Table 6), it was observed that the increase in BMI during the first trimester of pregnancy increased the likelihood of prolonged breastfeeding (PBF) (1.30 [CI95% 1.02 – 1.67], p=.04; 1.30 [CI95% 1.02 – 1.69], p=.04]). Regarding the influence of GWG and the duration of EBF or PBF, no statistically significant differences were found in the statistical analyses.

Discussion

Obesity and sedentary lifestyle negatively affect pregnancy outcomes (Barakat and Refoyo, 2022; Chen et al., 2020; Fayed et al., 2022), and low physical activity is associated with being overweight and obesity (Kolovos et al., 2021). Therefore, this study aims to analyse the adverse effects of EGWG on the NB and at 5 years.

Pre-pregnancy BMI and maternal GWG

Results obtained include, firstly, the high level of physical inactivity (45.2%), consistent with previous studies indicating that physical activity decreases as gestation progresses (Merkx et al., 2015), and contrasting with recent studies that indicate a lower extent of pre-pregnancy sedentary lifestyle (Román-Gálvez et al., 2021). Secondly, they highlight that the pre-pregnancy BMI of the sample is close to overweight (24.5±4.1). These results reflect the latest European report on perinatal health, showing that over 30% of women start their pregnancies with a higher-than-recommended BMI (Euro Peristat and Macfarlane, 2018). Our study presents similar outcomes, with a prevalence of excess weight and obesity of 30.4%, which is somewhat higher than seen in other studies in Mediterranean countries (Spain and Italy) (Benvenuti et al., 2021; González-Plaza et al., 2022). However, the level is also lower than that provided by other studies, which estimate a much higher prevalence of excess weight and obesity (40%-60%) (Melchor et al., 2019; Ramón-Arbués, 2017).

Analysing pre-pregnancy BMI, this study showed that women who began their pregnancies with a BMI ≥ 25 kg/m^2 had less probability of EGWG. Although studies contradicting these results have been found (Aung et al., 2022; Benvenuti et al., 2021; Sun et al., 2020), this may be linked to the current trend in clinical practice to encourage reduced GWG in overweight or obese pregnant women (Lima et al., 2021) by their healthcare providers and primarily, by the midwife (Aung et al., 2022) through the implementation of nutritional interventions (Krebs et al., 2022). This hypothesis is supported by studies showing that obese pregnant women regularly monitored by their midwives had lower GWG (Aung et al., 2022). On the other hand, focusing on pregnancy follow-ups in Spain, clinical-practice guidelines on perinatal care promote the identification of women who require follow-up of GWG and those with BMI ≥ 25 kg/m^2, making the appropriate nutritional recommendations at each control visit on an individual basis (Committee opinion no. 650, 2015; Beltrán-Calvo et al., 2014; Dapcich et al., 2004;). Specifically in Andalusia, according to the Integrated Care Process for pregnancy, childbirth and puerperium, a pre-pregnancy BMI > 30 kg/m^2 means a high-risk pregnancy, requiring GWG assessment at each consultation and intensive promotion of dietary and physical-exercise habits to keep GWG within IOM recommendations (Aceituno et al., 2014; Rasmussen et al., 2009), a practice that favours gestational weight control (Bye et al., 2016). This care and monitoring includes routine weighing during gestation, which further enhances gestational weight control in overweight/obese women, decreasing the likelihood of EGWG (Allen-Walker et al., 2017). Such attention and care increase knowledge of healthy GWG recommendations and awareness of the need to improve nutrition during pregnancy in women with higher pre-pregnancy BMI, thus reducing gestational weight gain in this population group, as has been indicated by other studies (Arnedillo-Sanchez et al.,2022; Willcox et al., 2017).

As for the possible explanation for the results obtained in relation to higher GWG in women with normal pregestational BMI, we found studies with disparate outcomes, including those showing greater GWG in thin women and those with normal pre-pregnancy weight (Carrilho et al., 2022) and others suggesting that thin women usually have a preventive attitude to GWG and thus gain less weight during pregnancy (Andrews et al., 2018). On the other hand, there are also studies that indicate that erroneous beliefs about healthy GWG (Arnedillo-Sanchez et al., 2022) or lack of motivation and poor family support to follow a healthy diet (Fuller-Tyszkiewicz et al., 2016) are also risk factors for EGWG in this group of pregnant women, which could explain the results obtained.

It has also been found that a greater increase in BMI during the first and second trimester is associated with higher EGWG, though no link was found in third trimester, as has also be concluded by other studies (Carrilho et al., 2022). Other studies have already explained this phenomenon, suggesting that the ability of pregnant women to control GWG begins as a function of the weight gained during the first trimester (Uchinuma et al., 2021).

In relation to smoking, the low prevalence of tobacco use (97.4% non-smokers) stands out, figures similar to those found in other studies (Azenkot et al., 2023; Havard et al., 2022) and which show compliance with the recommendations that are part of the maternity training offered by the midwives who participated in the study (Aceituno et al., 2014).

Regarding the percentage of women who required induction of labour (79.6%), it should be noted that this is inconsistent with other studies (Haavaldsen et al., 2023; Marconi, 2019). In any case, this variable does not appear to be related to breastfeeding duration of more than 6 months, a fact that has not been reported in previous studies that have assessed variables related to breastfeeding (Chen et al., 2019; Shipton et al., 2023).

In relation to other widely studied associations, the absence of links between pre-pregnancy BMI and GWG (Gottfreðsdóttir and Nieuwenhuijze, 2018), or between GWG and other variables – such as parity (Liu et al., 2019), type of birth (caesarean) (Fayed et al., 2022; Feng and Huang, 2021; Harvey et al., 2018) and BF (Huang et al., 2019) –

found in the cited studies, should be noted. We believe that this may be partly because of the smaller sample size of our research compared to the abovementioned studies. Furthermore, this may also be related to differences in the healthcare these women receive through their health systems (Whitaker et al., 2021).

Parity, birth weight and child nutritional status at 5 years of age

The outcomes of this study on the relationship between parity and neonatal weight link primiparity with an increased likelihood of NB LGA, contradicting the findings of other studies reporting that the higher the number of births, the greater the probability of LGA (Ali et al., 2020; Chauhan et al., 2020). A link has also been found between pre-pregnancy BMI and a lower probability of having an NB SGA, though not with the likelihood of having an NB LGA. These results contradict other studies showing how pre-pregnancy BMI and inadequate GWG are associated with foetal macrosomia (Bazalar-Salas and Loo-Valverde, 2019) and maternal overweight/obesity, and how inadequate/excessive GWG increased risk of overweight and obesity in offspring from birth (Chang et al., 2022).

The results also suggest that a higher number of births increases the likelihood that the NB will have inadequate nutritional status (according to BMI-z) at 5 years, results matching those from studies reporting links between multiparity and higher birth weight, as well as a slower weight gain in the child, which may explain this inadequacy of nutritional status in childhood (Sha et al., 2019).

Regarding the influence of pre-pregnancy BMI and/or GWG on the child's nutritional status, no link has been observed, which is in line with other studies that have reported the lack of influence of both variables on weight development during early childhood (Sha et al., 2019), and in contrast to (more numerous) studies showing how pre-pregnancy BMI and GWG are independently and positively associated with obesity in children (Adane et a al., 2019; Hunt et al., 2022; Liu et al., 2018; Morgen et al., 2018).

Likewise, no link has been found between the NB birth weight and the nutritional status of the child at 5 years, as established in other studies suggesting that LGA status is a strong predictor of excess weight in childhood (Czarnobay et al., 2021).

Regarding this subject, family influence should be highlighted as the main source of the teaching-learning of childhood dietary habits, since – as some studies point out – this fact is closely linked to nutritional status during this period and can condition development from birth through to adulthood (Anaya-Garcia and Alvarez-Gallego, 2018).

Maternal BMI and breastfeeding

Regarding the outcomes of this study concerning the start-up rates of BF during hospital stays, the figures are somewhat lower (80%) than those described by other Spanish studies, which put the rates at between 88% and 90.4% (Santiago et al., 2019). Moreover, regarding EBF figures, the results from our study are striking, as the prevalence at 6 months is 57.4%, slightly higher than the figures recommended by the WHO (50%) (Sarki et al., 2019) and much higher than those described in other articles referring to the Spanish population, which places them below 30% (Santiago et al., 2019; Sarki et al., 2019). The same occurs with EBF figures at 24 months, which are much higher (27.8%) than those from other studies (7.7%) (Ramiro-González et al., 2018; Villar et al., 2018).

Also noteworthy are the findings on BMI gain as a factor that favours EBF and PBF, with the latter observed at both 12 and 24 months.

Concerning other outcomes, we can highlight the link between older maternal age with higher rates of EBF at 6 months with other studies reporting similar findings (Ramiro-González et al., 2018), and the protective effect found in LGA against EBF, a result also shown by other studies that found that NB LGA are more likely to be exclusively breastfed (Davie et al., 2021).

Regarding PBF, a directly proportional relationship was found with increased BMI during the first trimester of pregnancy, similar results to those obtained by other studies (Flores et al., 2022).

Reference should be made to the lack of evidence found in this study on the relationship between BF and the nutritional status of the child. While this on the one hand coincides with one study (Usheva et al., 2021), it contradicts the majority of studies, which show a relationship between BF in the first 6 months and a reduced risk of excess weight (Mantzorou et al., 2022; Ramiro-González et al., 2018; Rivaldo et al., 2020) and BF to 12 months as a beneficial effect on nutrition, eating behaviours and dietary intake in childhood (Borkhoff et al., 2018).

Finally, it is clear that the role of the healthcare providers acquires prominence in the care of the pregnant woman and her offspring, as the midwife is the key professional for pregnancy monitoring in primary care and in developing maternal education sessions, empowering and strengthening the ability of the pregnant woman to manage her own care (de Jersey et al., 2018; Liu et al., 2021; Soriano-Vidal et al., 2018). Therefore, taking into account studies indicating that pregnant women – and particularly those with lower educational backgrounds – currently do not meet dietary recommendations, (Lee et al., 2018), and in light of the results obtained in this study, interventions to be enhanced during prenatal follow-up and a preconception consultation should be considered (Dapcich et al., 2004; Wallace et all., 2022). This consultation should focus on promoting optimal pre-pregnancy nutritional status and increasing women's knowledge of the importance of proper GWG to reduce risk factors during gestation and for their offspring (Hill et al., 2019; Swift et al., 2017), always taking into account the social and cultural context of the pregnant woman (Whitaker et al., 2016).

Another line of action should be aimed at improving the health of multiparous pregnant women, which our study, like others (Monari et al., 2021), highlights as a risk factor for inadequate nutritional status at birth, increasing the likelihood of LGA, and throughout childhood, enhancing the risk of inadequate nutritional status. This seems to be related to the fact that a high percentage of multiparous women start their pregnancies at a higher weight than in previous pregnancies (Ziauddeen et al. 2019), which in turn is associated with a higher maternal BMI and poorer nutritional status of their offspring (Lewandowska, 2021). The aspects to work on should include increasing attendance at maternal classes, as this has been shown to be lower than in the case of primiparous women (Balasoiu et al., 2021; Tichelman et al., 2019), as our study indicates.

Ultimately, during the postnatal period, the goal should be promoting BF and the correct feeding of both women and children throughout life, through breastfeeding-support consultations with the midwife or other groups (Baño-Piñero et al., 2018). Furthermore, health education in terms of healthy eating habits aimed at improving the quality of maternal – and therefore future child – nutrition is also relevant, as BF rates do not meet WHO guidelines, and there is evidence that overweight and obese women are less compliant and need additional help to prolong BF (Achike and Akpinar-Elci, 2021).

Finally, there is a need to train midwives in communication skills to foster motivation for behaviour change (Christenson et al., 2018). Pregnancy monitoring should be adapted to the changing times by supporting the interventions described above with ICTs (e.g., through mobile apps). All this, with the aim of encouraging interaction between midwives and pregnant women, as it has been shown that these strategies can be effective in maintaining adequate weight control by promoting healthy eating habits and physical exercise routines (González-Plaza et al., 2022; Lee et al., 2023; Sandborg et al., 2021).

Limitations

Taking into account contradictory findings from previous studies, further research is needed, with larger sample sizes and a more exhaustive control of other variables on nutritional habits of families – especially children over 2 years of age – to explain these inconsistencies, as well as an increased number of assessments throughout offspring follow-up.

Also worth researching through intervention studies are the effectiveness and outcomes of pregnancy follow-up visits and maternal-education sessions on BMI gains during pregnancy and GWG, and their influence on BF, both for improved perinatal outcomes and throughout childhood.

Despite the limitations described above, the importance of the results of this study for general knowledge related to perinatal health should be highlighted.

Implications for practice and/or policy

It is evident that the control of healthy GWG should be addressed in primary healthcare, mainly by the midwife, both in the preconception period and throughout pregnancy.

To this end, the midwife must be trained and have the appropriate resources and tools to work with pregnant woman individually and collectively, paying special attention to those women who start with a normal BMI, as they seem to show greater difficulty in maintaining a healthy weight gain.

Another line of intervention would be BF, where the midwife should be the main point of reference at the beginning of this process, taking into account the relationship between BMI and BF.

Conclusion

The presence of inadequate pregestational BMI and higher weight gain during the first and second trimester of gestation have been shown to be risk factors for total GWG and NB weight. On the other hand, it is also observed that increased gestational BMI acts as a protective factor in EBF and PBF. In addition, it is observed that parity conditions the birth of NB with LGA in primiparous women and in children with inadequate nutritional status in multiparous women. These results highlight the importance of actions focusing on promoting and implementing health and education policies based on improving the nutritional status of the women before, during and after pregnancy, as they are essential to promote the nutritional status of children.

Therefore, although continuing progress in research on the long-term effects of maternal nutrition on perinatal and offspring outcomes is necessary, healthcare providers should consider implementing new strategies to teach future pregnant women about the importance of their own nutritional status before and during pregnancy, fostering and encouraging adequate GWG.

Ethical approval

Human research ethics approval was obtained from "Health Service Bioethics Committee". (PI 021/14 of 21/08/2014).

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Table 1

Demographic characteristics of participants during pregnancy according to pre-pregnancy BMI

Variable	Total (n = 115)	Normal weight (n=80)	Excessive weight (n=35)	*P*
	Mean or n (SD or %)	Mean or n (SD or %)	Mean or n (SD or %)	
Maternal age (years)	32.8 (4.3)	32.4 (4.3)	33.7 (4.2)	.81
<35	73 (63.5)	52 (65.0)	21 (60.0)	.61
≥35	42 (36.5)	28 (35.0)	14 (40.0)	
Physical Activity				
Low	52 (45.2)	35 (43.8)	17 (48.6)	
Moderate	52 (45.2)	39 (48.8)	13 (37.1)	.36
Intense	11 (9.6)	6 (7.5)	5 (14.3)	
Educational level				
High school or below	76 (66.1)	54 (67.5)	22 (62.9)	.63
College or above	39 (33.9)	26 (32.5)	13 (37.1)	
Parity				
Primiparity	86 (74.8)	64 (80.0)	22 (62.9)	.05
Multiparity	29 (25.2)	16 (20.0)	13 (37.1)	
Previous Caesarean				
No	112 (97.4)	79 (98.8)	33 (94.3)	.22
Yes	3 (2.6)	1 (1.3)	2 (5.7)	
Weeks of Gestation	28.0 (3.6)	28.0 (3.8)	28.0 (3.2)	.97
SBP (mm Hg)	111.6 (12.0)	111.8 (11.8)	111.2 (12.7)	.81
DBP (mm Hg)	67.5 (8.7)	67.3 (8.5)	68.0 (9.2)	.67
Tobacco exposure				
No	109 (94.8)	77 (96.3)	32 (91.4)	.26
Yes	6 (5.2)	3 (3.8)	3 (8.6)	
GWG (kg)	9.4 (6.0)	10.1 (5.8)	7.7 (6.1)	.05
Weight gain recommendations[a]				
Low	58 (50.4)	50 (62.5)	8 (22.9)	
Normal	41 (35.7)	24 (30.0)	17 (48.6)	<.001
High	16 (13.9)	6 (7.5)	10 (28.6)	
GWG by trimester (kg)[b]				
First trimester	4.9 (4.3)	5.2 (4.0)	4.4 (4.9)	.40
Second trimester	2.6 (2.7)	2.8 (2.8)	2.2 (2.5)	.31
Third trimester	1.8 (2.9)	2.2 (3.1)	1.1 (2.1)	.04

BMI: Body Mass Index, SBP: Sistolic blood pressure, DBP: Diastolic blood pressure, GWG: gestational weight gain, IOM: Institute of Medicine, SD: Standard deviation, *P: p-value*.

[a] According to IOM recommendations in pregnancy.

[b] First trimester: <12 gestational weeks; Second trimester: 13-26 gestational weeks; Third trimester: > 26 gestational weeks.

Table 2

Characteristics of the sample by excessive or non-excessive gestational weight gain and logistic regression

Variable	Non-EGWG (n=99)	EGWG (n=16)	Crude estimate			Adjusted estimate		
	Mean or n (SD or %)	Mean or n (SD or %)	OR	CI 95%	*P*	OR	CI 95%	*P*
Age (years)	32.9 (4.5)	32.0 (3.1)	0.95	0.84 – 1.07	.42			
Pre-pregnancy BMI								
Normal	74 (74.7)	6 (37.5)	1 (Rf.)	1 (Rf.)	.005	1 (Rf.)	1 (Rf.)	.001
Excessive	25 (25.3)	10 (62.5)	0.20	0.07 – 0.61		0.03	0.004 – 0.25	
BMI gain (kg/m²)								
BMI gain 1st trimester[a]	1.6 (1.6)	3.6 (1.1)	2.24	1.49 – 3.36	<.001	5.49	2.31 – 13.09	<.001
BMI gain 2sd trimester[b]	0.8 (0.9)	1.6 (1.3)	2.04	1.22 – 3.39	.006	5.35	2.05 – 13.96	<.001
BMI gain 3rd trimester[c]	0.5 (1.3)	0.5 (2.1)	1.02	0.70 – 1.50	.91			
Physical Activity								
Low- Moderate	91 (91.9)	13 (81.3)	1 (Rf.)	1 (Rf.)	.19			
Intense	8 (8.1)	3 (18.8)	2.62	0.62 – 11.17				
Education level								
Primary–Secondary	68 (68.7)	8 (50.0)	1 (Ref.)	1 (Ref.)	.15			
Superior–Further	31 (31.3)	8 (50.0)	2.19	0.75 – 6.38				
Parity								
Primiparity	75 (75.8)	11 (68.8)	1 (Rf.)	1 (Rf.)	.55			
Multiparity	24 (24.2)	5 (31.3)	1.42	0.50 – 4.50				

EGWG: Excessive Gestational Weight Gain, BMI: Body Mass Index, IC: confidence interval, OR: odds ratio, *P*: *p-value*, Ref.: reference

[a] Difference between BMI pre-pregnancy- BMI 1st trimester, [b] Difference between BMI 1st– BMI 2sd trimester, [c] Difference between BMI 2sd– BMI 3rd trimester.

*Log-2 likelihood:*41.113; *R2 Cox–Snell:*0.362; *R2 Nagelkerke:* 0.654; *Hosmer–Lemeshow*: 7.107, 8 gl (*P* =.525)

Table 3

Factors influencing newborn weight according to SGA, AGA or LGA

Variable	SGA (n=9)	AGA (n=93)	LGA (n=13)	Crude estimation				Adjusted estimate			
				SGA		*LGA*		*SGA*		*LGA*	
	Mean/ n (SD or %)	Mean/ n (SD or %)	Mean/ n (SD or %)	OR (CI 95%)	*P*	OR (CI 95%)	*P*	OR (CI 95%)	*P*	OR (CI 95%)	*P*
Maternal age (years)	34.4 (3.5)	32.5 (4.3)	33.6 (4.8)	1.12 (0.94 – 1.32)	.20	1.06 (0.92 – 1.22)	.39				
Pre-pregnancy BMI (Kg/m²)											
Normal (18.5-23.9)	7 (77.8)	63 (67.7)	10 (76.9)	1.67 (0.33 – 8.51)	.54	1.59 (0.41 – 6.19)	.51				
Overweight/ obese (≥24.0)	2 (22.2)	30 (32.3)	3 (23.1)	1 (Rf.)		1 (Rf.)					
Total Gestational BMI gain[a] (Kg/m²)	1.9 (2.6)	3.5 (2.1)	3.2 (2.9)	0.73 (0.54 – 0.99)	.04	0.93 (0.72 – 1.21)	.59	0.69 (0.48 – 0.99)	.04	0.91 (0.71 – 1.16)	.43
GWG 1tr[b] (kg)	3.2 (4.7)	5.2 (4.3)	4.0 (3.9)	0.89 (0.76 – 1.05)	.18	0.93 (0.81 -1.07)	.33				
GWG 2 tr[c] (kg)	2.4 (3.6)	2.6 (2.6)	2.2 (2.9)	0.97 (0.75 – 1.26)	.82	0.94 (0.75 – 1.18)	.59				
GWG 3 tr[d] (kg)	1.3 (1.9)	1.8 (2.9)	2.1 (3.4)	0.93 (0.71 – 1.22)	.60	1.04 (0.85 – 1.26)	.72				
Total GWG[e] (kg)	7 (8.5)	3.5 (2.1)	3.2 (2.9)	0.93 (0.83 – 1.04)	.19	0.96 (0.87 – 1.06)	.44				
Parity											
Primiparity	7 (77.8)	73 (78.5)	6 (46.2)	1.04 (0.20 – 5.42)	.96	4.26 (1.29 – 14.10)	.02	0.67 (0.11 – 4.14)	.67	4.30 (1.25 – 14.80)	.02
Multiparity	2 (22.2)	20 (21.5)	7 (53.8)	1 (Rf.)		1 (Rf.)		1 (Rf.)		1 (Rf.)	
Newborn sex											
Male	5 (55.6)	51 (54.8)	10 (76.9)	1.03 (0.26 – 4.08)	.97	2.74 (0.71 – 10.62)	.14				

Female	4 (44.4)	42 (45.2)	3 (23.1)	1 (Rf.)		1 (Rf.)					
Newborn length (cm)	48.4 (1.7)	49.8 (1.3)	50.7 (2.1)	0.50 (0.28 – 0.85)	.01	1.48 (0.98 – 2.22)	.06	0.49 (0.28 – 0.86)	.01	1.53 (0.98 – 2.36)	.06

SGA: small gestational age, AGA: adequate gestational age, LGA: large gestational age, BMI: Body Mass Index, IC: confidence interval, OR: odds ratio, *P*: *p-value*, Rf: reference.

[a] BMI pre-gestational – BMI 3rd trimester, [b] Weight between pre-pregnancy – 12 weeks, [c] Weight between 12 – 27 weeks, [d] Weight between 28 weeks – delivery, [e] Weight between pre-pregnancy – delivery.

Table 4

Sample characteristics of participating women and children by child nutritional status (BMI-z) at 5 years and logistic regression

Variable	Adequate BMI-z (n=81)	Non-adequate BMI-z (n=34)	Crude estimate			Adjusted estimate		
	Mean/ n (SD or %)	Mean/ n (SD or %)	OR	CI 95%	*P*	OR	CI 95%	*P*
Maternal age (years)	32.7 (4.5)	33.1 (4.0)	1.02	0.93 – 1.21	.67			
Maternal educational level								
Primary–Secondary	53 (6.4)	23 (67.6)	1 (Rf.)	1 (Rf.)	-			
Superior–Further	28 (34.6)	11 (32.4)	0.90	0.39 – 2.12	.82			
Weeks of gestation at birth	39.3 (1.4)	39.2 (1.2)	0.94	0.70 – 1.26	.67			
Parity								
Primiparity	65 (80.2)	21 (61.8)	1 (Rf.)	1 (Rf.)	-	1 (Rf.)	1 (Rf.)	.02
Multiparity	16 (19.8)	13 (38.2)	2.51	1.04 – 6.07	.04	3.13	1.22 – 8.02	
Delivery type								
Vaginal	55 (67.9)	25 (73.5)	1 (Rf.)	1 (Rf.)	-			
Caesarean section	26 (32.1)	9 (26.5)	0.76	0.31 – 1.86	.55			
Pre-pregnancy BMI (Kg/m^2)								
Normal (18.5-23.9)	53 (65.4)	27 (79.4)	1 (Rf.)	1 (Rf.)	.14			
Overweight/obese (≥24.0)	28 (34.6)	7 (20.6)	0.49	0.19 – 1.27				
BMI gestational gain[a] (Kg/m^2)	3.2 (2.2)	3.6 (2.4)	1.08	0.90 – 1.29	.41			
Gestational weight gain (kg)[b]								
Insufficient	40 (49.4)	18 (52.9)	0.87	0.39 – 1.93	.73			
Appropriate	28 (34.6)	13 (38.2)	1 (Rf.)	1 (Rf.)	-			
Excessive	13 (16.0)	3 (8.8)	1.97	0.52 – 7.43	.31			
Infant sex								

Male	48 (59.3)	18 (52.9)	1 (Rf.)	1 (Rf.)	.53
Female	33 (40.7)	16 (47.1)	1.29	0.58 – 2.89	
Birth weight (g)					
SGA	8 (9.9)	1 (2.9)	0.28	0.03 – 2.30	.23
AGA	66 (81.5)	27 (79.4)	1 (Rf.)	1 (Rf.)	-
LGA	7 (8.6)	6 (17.6)	2.26	0.70 – 7.33	.17
Feeding mode at birth					
Exclusive breastfeeding	69 (85.2)	29 (85.3)	1 (Rf.)	1 (Rf.)	.99
Formula feeding	12 (14.8)	5 (14.7)	0.99	0.32 – 3.07	
Feeding mode at 6 months					
Exclusive breastfeeding	41 (50.6)	19 (55.9)	1 (Rf.)	1 (Rf.)	-
Mixed feeding	5 (6.2)	1 (2.9)	0.46	0.05 – 4.10	.49
Formula feeding	35 (43.2)	14 (41.2)	0.92	041 – 2.07	.84

BMI: Body Mass Index, IC: confidence interval, OR: odds ratio, *P: p-value*, Rf.: reference.

[a] BMI 3rd trimester – BMI pre-pregnancy, [b] Weight 3rd trimester – weight pre-pregnancy.

*Log-2 likelihood:*131.575; *R2 Cox–Snell*: 0.068; *R2 Nagelkerke*: 0.096; *Hosmer–Lemeshow*: 0.022, 2 gl (*P*=.989)

Table 5

Characteristics of the sample (women and children) by duration of breastfeeding longer than 6 months and logistic regression

Variable	Yes (n=66)	No (n=49)	Crude estimate			Adjusted estimate		
	Mean or n (SD or %)	Mean or n (SD or %)	OR	CI 95%	*P*	OR	CI 95%	*P*
Maternal age (years)	33.1 (3.9)	32.4 (4.8)	0.96	0.88 – 1.05	.38			
Pre-pregnancy BMI (Kg/m^2)	24.3 (3.7)	24.7 (4.6)	1.02	0.93 – 1.12	.67			
BMI first trimester gain (Kg/m^2)	1.7 (1.7)	2.2 (1.6)	1.19	0.95 – 1.49	.13			
BMI gestational gain (Kg/m^2)[a]	2.9 (2.5)	3.9 (1.8)	1.21	1.01 – 1.45	.03	1.21	1.01 – 1.44	.04
Gestational weight gain (kg)[b]								
Normal	22 (44.9)	19 (28.8)	1 (Rf.)	1 (Rf.)	-			
Low	19 (38.8)	39 (59.1)	0.44	0.2 – 0.93	.03			
Excessive	8 (12.1)	8 (12.1)	1.41	0.49 – 4.08	.52			
Educational level								
Primary–Secondary	32 (65.3)	44 (66.7)	1 (Rf.)	1 (Rf.)	.88			
Superior–Further	17 (34.7)	22 (33.3)	1.06	0.49 – 2.32				
Parity								
Primiparity	38 (77.6)	48 (72.7)	1 (Rf.)	1 (Rf.)	.56			
Multiparity	11 (22.4)	18 (27.3)	0.77	0.33 – 1.83				
Induction of labour								
No	39 (79.6)	54 (81.8)	1 (Rf.)	1 (Rf.)	.76			
Yes	10 (20.4)	12 (18.2)	1.15	0.45 – 2.94				
Type of birth								
Unassisted vaginal	22 (44.9)	30 (45.5)	1 (Rf.)	1 (Rf.)	-			
Assisted vaginal	12 (24.5)	16 (24.2)	1.01	0.43 – 2.40	.98			
Caesarean section	15 (30.6)	20 (30.3)	1.01	0.45 – 2.65	.97			
Nutritional status by gestational age								
SGA	3 (6.1)	6 (9.1)	0.65	0.15 – 2.75	.56	0.73	0.16 – 3.28	.69
AGA	44 (89.8)	49 (74.2)				1 (Rf.)	1 (Rf.)	-
LGA	2 (4.1)	11 (16.7)	0.21	0.04 - .01	.05	0.20	0.04 – 0.99	.05

BMI: Body Mass Index, SGA: small gestational age, AGA: adequate gestational age, LGA: large gestational age, IC: confidence interval, OR: odds ratio, *P: p-value*, Rf.: reference.

[a] BMI 3rd trimester – BMI pre-pregnancy, [b] Weight pre-pregnancy – weight 3rd trimester.

*Log-2 likelihood:*146.886; *R2 Cox–Snell*:0.083; *R2 Nagelkerke*:0.112; *Hosmer–Lemeshow:* 2.927, 8 gl (*P* = .939)

Table 6

Characteristics of the sample of participating pregnant women and children by duration of breastfeeding and logistic regression.

	> 12 months							
Variable	**Yes (n=42)**	**No (n=73)**	**Crude estimate**			**Adjusted estimate**		
	Mean/n (SD or %)	**Mean/n (SD or %)**	**OR**	**CI 95%**	***P***	**OR**	**CI 95%**	***P***
Maternal age (years)	33.6 (3.8)	32.4 (4.5)	0.93	0.85 – 1.02	.15			
Pre-pregnancy BMI (Kg/m²)	24.1 (2.2)	24.7 (4.8)	1.04	0.94 – 1.61	.41			
BMI first trimester gain	1.4 (1.7)	2.2 (1.6)	1.33	1.04 – 1.70	.02	1.30	1.02 – 1.67	.04
BMI gestational gain (Kg/m²)[a]	2.8 (2.8)	3.7 (1.8)	1.20	1.00 – 1.43	.05			
Gestational weight gain (kg)[b]								
Low	34 (46.6)	24 (57.1)	0.65	0.30 - 1.40	.28			
Normal	29 (39.7)	12 (28.6)	1 (Rf.)	1 (Rf.)	-			
Excessive	10 (13.7)	6 (14.3)	0.95	0.32 – 1.84	.93			
Educational level								
Primary–Secondary	48 (65.8)	28 (66.7)	1 (Rf.)	1 (Rf.)	.92			
Superior–Further	25 (34.2)	14 (33.3)	1.04	0.47- 2.33				
Parity								
Primipara	57 (78.1)	29 (69.0)	1 (Rf.)	1 (Rf.)	.28			
Multipara	16 (21.9)	13 (31.0)	0.63	0.27 – 1.48				
Induction of labour								
No	59 (80.8)	34 (81.0)	1 (Rf.)	1 (Rf.)	.99			
Yes	14 (19.2)	8 (19.0)	1.01	0.38 – 2.65				
Type of birth								
Unassisted vaginal	33 (45.2)	19 (45.2)	1 (Rf.)	1 (Rf.)	-			

Assisted vaginal	19 (26.0)	9 (21.4)	1.29	0.52 – 3.18	.58			
Caesarean section	21 (28.8)	14 (33.3)	0.81	0.36 – 1.83	.61			
Nutritional status by gestational age								
SGA	5 (6.8)	4 (9.5)	0.70	0.18 – 2.76	.61			
AGA	63 (86.3)	30 (71.4)	1 (Rf.)	1 (Rf.)	-			
LGA	5 (6.8)	8 (19.0)	0.31	0.09 – 1.03	.06			
				> 24 months				
Maternal age (years)	33.7 (4.0)	32.4 (4.4)	0.93	0.84 – 1.03	.16			
Pre-pregnancy BMI (Kg/m^2)	24.2 (2.3)	24.6 (4.6)	1.03	0.92 – 1.14	.64			
BMI first trimester gain	1.4 (1.6)	2.1 (1.7)	1.30	1.002 – 1.69	.048	1.30	1.02 – 1.69	0.04
BMI gestational gain (Kg/m^2)[a]	2.9 (2.8)	3.5 (2.1)	1.12	0.94 – 1.35	.21			
Low	19 (59.4)	39 (47.0)	0.61	0.26 – 1.39	.24			
Normal	8 (25.0)	33 (39.8)	1 (Rf.)	1 (Rf.)				
Excessive	5 (15.6)	11 (13.3)	0.82	0.26 – 2.59	.74			
Educational level								
Primary–Secondary	20 (62.5)	56 (67.5)	1 (Rf.)	1 (Rf.)	.61			
Superior–Further	12 (37.5)	27 (3.5)	0.80	034 – 1.88				
Parity								
Primipara	22 (68.8)	64 (77.1)	1 (Rf.)	1 (Rf.)	.36			
Multipara	10 (31.3)	19 (22.9)	0.65	0.26 – 1.62				
Induction of labour								
No	25 (78.1)	68 (81.9)	1 (Rf.)	1 (Rf.)	.64			
Yes	7 (21.9)	15 (18.1)	0.79	0.29 – 2.16				
Type of birth								
Unassisted vaginal	17 (53.1)	35 (42.2)	1 (Rf.)	1 (Rf.)				

Assisted vaginal	5 (15.6)	23 (27.7)	2.07	0.71 – 6.03	.18
Caesarean section	10 (31.3)	25 (30.1)	0.95	0.39 – 2.92	.91
Nutritional status by gestational age					
SGA	4 (12.5)	5 (6.0)	0.45	0.11 – 1.79	.26
AGA	22 (68.8)	71 (85.5)	1 (Rf.)	1 (Rf.)	
LGA	6 (18.8)	7 (8.4)	0.40	0.12 – 1.30	.13

BMI: Body Mass Index, SGA: small gestational age, AGA: adequate gestational age, LGA: large gestational age, IC: confidence interval, OR: odds ratio, *P: p*-value, Rf.: reference.

[a] BMI 3rd trimester – BMI pre-pregnancy, [b] Weight pre-pregnancy – weight 3rd trimester.

(>12 months) *Log-2 likelihood*:141.979; *R2 Cox–Snell*:0.075; *R2 Nagelkerke:*0.103; *Hosmer–Lemeshow*: 5.586, 8 gl (P = .693), (>24 months) *Log-2 likelihood*:131.806; *R2 Cox–Snell*:0.036; *R2 Nagelkerke*:0.052; *Hosmer–Lemeshow*: 9.593; 7 gl (P = .213)

Appendix 1

Schedule for the sessions of the Birth Preparation and Parenting Programme attended by the pregnant women

Session number	Topic of the session
Session 1	Physiological changes during pregnancy
Session 2	The birth
Session 3	Caring for the newborn
Session 4	The time after birth
Session 5	Breastfeeding

Appendix 2

Demographic characteristics of newborn participants according to sex

Variable	Total (n = 115)	Male (n=66)	Female (n=49)	*P*
	Mean or n (SD or %)	Mean or n (SD or %)	Mean or n (SD or %)	
Length (cm)	49.8 (1.5)	49.9 (1.6)	49.7 (1.5)	.33
Weight (g)				
<2500	8 (7.0)	3 (4.5)	5 (10.2)	
2500-4000	101 (87.8)	57 (86.4)	44 (89.8)	.05
>4000	6 (5.2)	6 (9.1)	0 (0.0)	
Weight according to gestational age				
SGA	9 (7.8)	5 (7.6)	4 (8.2)	
AGA	93 (80.9)	51 (77.3)	42 (85.7)	.32
LGA	13 (11.3)	10 (15.2)	3 (6.1)	
Weeks of Gestation[a]	39.3 (1.3)	39.3 (1.4)	39.2 (1.3)	.66
<37	6 (5.2)	4 (6.1)	2 (4.1)	
37-40	91 (79.1)	47 (71.2)	44 (89.8)	.04
≥41	18 (15.7)	15 (22.7)	3 (6.1)	
Type of birth				
Unassisted vaginal	52 (45.2)	26 (39.4)	26 (53.1)	
Assisted vaginal	28 (24.3)	18 (27.3)	10 (20.4)	.34
Caesarean section	35 (30.4)	22 (33.3)	13 (26.5)	
Feeding mode at birth[b]				
Exclusive breastfeeding	98 (85.2)	55 (83.3)	43 (87.8)	.51
Formula feeding	17 (14.8)	11 (16.7)	6 (12.2)	

SD: standard deviation, SGA: small gestational age, AGA: adequate gestational age, LGA: large gestational age, *P: p-value*

[a] At delivery, [b] During hospital state.

Appendix 3

Demographic characteristics of participants by sex at 5 years of age

Variable	Total (n = 115) Mean or n (SD or %)	Male (n=66) Mean or n (SD or %)	Female (n=49) Mean or n (SD or %)	*P*
Child age (years)	5.2 (0.3)	5.2 (0.2)	5.2 (0.3)	.66
Hight (cm)	112.0 (7.1)	112.5 (7.2)	111.3 (7.0)	.37
Weight (kg)	19.8 (3.4)	20.1 (3.4)	19.5 (3.4)	.37
Nutritional status according to BMI-z				
Low weight (<–2)	8 (7.0)	5 (7.6)	3 (6.1)	
Normal weight (≤–2; ≥2)	81 (70.4)	48 (72.7)	33 (67.3)	.68
Overweight/obese (>2)	26 (22.6)	13 (19.7)	13 (26.5)	
Breastfeeding duration (months)	13.1 (14.0)	12.9 (14.6)	13.4 (13.4)	.83
Feeding mode at birth[a]				
Formula feeding	17 (14.8)	11 (16.7)	6 (12.2)	.51
Exclusive breastfeeding	98 (85.2)	55 (83.3)	43 (87.8)	
Feeding mode at 6 months				
Exclusive breastfeeding	60 (52.2)	36 (54.5)	24 (49.0)	
Mixed feeding	6 (5.2)	2 (3.0)	4 (8.2)	.45
Formula feeding	49 (42.6)	28 (42.4)	21 (42.9)	
Feeding mode at 12 months				
Exclusive breastfeeding	42 (36.5)	22 (33.3)	20 (40.8)	.41
Formula feeding	73 (63.5)	44 (66.7)	29 (59.2)	
Feeding mode at 24 months				
Exclusive breastfeeding	32 (27.8)	16 (24.2)	16 (32.7)	.32
Formula feeding	83 (72.2)	50 (75.8)	33 (67.3)	

SD: standard deviation, *P: p-value*.

[a] During hospital state.