



## Unhealthy gestational weight gain: Are we neglecting inadequate gestational weight gain?



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### ABSTRACT

**Objective:** To evaluate the prevalence of unhealthy gestational weight gain and analyze the role of women's knowledge about the recommendations, expectations, beliefs, counseling, and information provided by midwives as potential factors contributing to failure to meet recommendations.

**Research design/setting:** A retrospective cross-sectional study was performed in a tertiary Hospital in Seville (Spain) between March and September 2019. A sample of 500 singleton pregnant women at or over 37 weeks of gestation completed a self-administered questionnaire during a prenatal visit. Gestational weight gain was categorized as healthy/excessive/inadequate, according to the Institute of Medicine, for 409 women. Descriptive, bivariate, and multivariate analysis was performed.

**Findings:** Inadequate and excessive gestational weight gain were 33.4% and 33.9%, respectively. A multivariate model for excessive gestational weight gain showed pre-gestational body mass index was a risk factor, while exercise and believing the weight gain was healthy were protective factors. The model for inadequate gestational weight gain showed knowledge of recommendations was a protective factor while believing gestational weight was healthy was a risk factor.

**Key conclusions:** Unhealthy gestational weight gain is common. Inadequate gain from women with healthy pre-pregnancy body mass index who believed their gain was healthy, was almost as common as excessive gestational weight gain. As shown by our predictive model beliefs regarding healthy gestational weight gain may act either as a protective factor, in the excessive gain model, or as a risk factor, in the inadequate gain model, depending on women's pre-pregnancy body mass index and despite knowledge of the recommendations.

**Implications for practice:** Inadequate weight gain, and not only excessive gain, should be properly addressed during pregnancy. Healthy gestational weight gain should be approached by midwives with a combination of one-to-one and group antenatal care, where beliefs regarding healthy gestational weight gain should be addressed. Midwives should remain alert as we may be facing a new trend: increasing numbers of women presenting with inadequate gestational weight gain; with negative health implications for a healthy population. We recommend that midwives pay attention to women with a healthy pre-pregnancy Body Mass Index and who believe that their weight gain is correct because this profile frequently had an inadequate gestational weight gain

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### Introduction

Gestational weight gain (GWG) is an important prognostic factor for short and long-term health outcomes, for the mother and the new born (Grant et al., 2019; Siega-Riz et al., 2020). Pre-

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pregnancy Body Mass Index (ppBMI), and excessive and inadequate weight gain, have been associated with adverse pregnancy outcomes including: small for gestational age (SGA); large for gestational age (LGA); macrosomia; cesarian birth; gestational diabetes mellitus (GDM); preeclampsia; postpartum weight retention; and offspring obesity (Goldstein et al., 2017; Hrolfsdottir et al., 2015; Shin and Song, 2015).

Given the connection between GWG and adverse perinatal outcomes several institutions have issued recommendations on GWG which are often based on the pre-gestational BMI. This is the case of the American Institute of Medicine (IOM)'s recommendations (Rasmussen and Yanktine, 2009) which are widely adopted although not implemented in every country. To this end, the UK's National Institute for Health and Care Excellence's guideline on weight management during and after pregnancy make recommendations regarding healthy diet and physical activity without gestational weight control (NICE, 2010). However, in its 2017 surveillance review it suggest consideration should be given to whether there is evidence to support the use of the IOM's guidelines in the UK population (National Institute for Health and Care Excellence, 2017). Other countries, for instance Chile, have developed their own guidelines (Garmendia et al., 2018).

The OMS' standardised pre-gestational BMI, or versions of it adjusted for regional characteristics, is not without controversy either. Particularly, in Asian countries it has been reported better results when adhering to the regional adjusted BMI. In this regard, Jiang et al. (2019) reported Chinese women can hardly meet the IOM recommendations and advocated for the need to establish specific standards based on ethnicity. This proposition is supported by other authors (Arora and Tamber Aeri, 2019; Guo et al., 2019) and by those who suggest the need to consider the wider social context that affects GWG (Headen et al., 2012).

However, a meta-analysis including 1309,136 women (66% from the USA, 10% from western Europe and 24% from Asia) examined differences associated to ethnicity. Women from Japan and Taiwan adhered to the OMS' BMI and women from Korea and China to the OMS' regionally adjusted BMI. The study concluded the categories in the regionally adjusted BMI are more recommended for Asian women than the international categories reported by the OMS. It also showed the OMS BMI's categories are more useful for the USA and European population (Goldstein et al., 2017).

According to the European Health Information Gateway, 71% of the countries that provided information have recommendations regarding GWG. Out of these, 47% base their recommendations on the ppBMI and 41% use the cut off points provided by the WHO to establish the BMI. The previous is the case in Spain (WHO regional office for Europe, 2018). Thus, in Spain the WHO's cut-off points are used to establish the ppBMI and the IOM recommendations are implemented.

The IOM's ranges for GWG for each BMI category are as follows: underweight: 28–40 lbs. (12.5–18 Kg), normal weight: 25–35 lbs. (11.5–16 Kg), overweight: 15–25 lbs. (7–11.5 kg), and obesity: 11–20 lbs. (5–9 Kg) (Rasmussen and Yanktine, 2009).

The IOM has identified excessive GWG as one of the main factors contributing to the current obesity epidemic. A multi-ethnic study of pregnancies resulting in term live births shows excessive GWG is associated with increased maternal BMI in midlife (Hutchins et al., 2020). Thus, excessive GWG is not only a risk factor for the mother and the new-born, but also a contributing factor to one of the most prevalent public health problems of the 21st century: obesity. To this end, identifying of risk factors would help prevent excessive GWG and should be prioritized in the global fight against obesity (Chen et al., 2018; Hutchins et al., 2020).

Excessive GWG is a multifactorial problem. Although ppBMI and sedentarism are the main factors associated with excessive GWG, others such as: socio-demographic, economic, psychological, and

dietary factors, type of prenatal care, and recommendations from Health Care workers' (HCW) and midwives regarding GWG; are also at play (Samura et al., 2016; Siega-Riz et al., 2020).

Women's knowledge about GWG, expectations, beliefs, counseling, and information provided by HCW are potential factors contributing to failure to meet IOM recommendations (Krukowski et al., 2017; Ledoux et al., 2018; Shulman and Kottke, 2016). However, these factors are highly dependent on the cultural and socio economic background, which should be evaluated to design tailored educational interventions for each target population.

Although inadequate GWG has been linked to negative pregnancy outcomes (Rogozińska et al., 2019; Soltani et al., 2017; Sun et al., 2020), the factors associated to it have been scarcely studied. Underweight ppBMI and malnutrition have been linked to its occurrence (Davis-Moss and Hofferth, 2018; Suliga et al., 2018). However, little emphasis has been placed on inadequate GWG outside these two premises. This is probably due to the prevalence of excessive GWG which has attracted the interest of researchers and HCW in the last decades. Thus, inadequate GWG could also be associated with pregnant women's awareness of IOM recommendations, their beliefs, and information provided by midwives.

There is limited information regarding the prevalence of non-healthy GWG and its associated risk factors in the Spanish population. Few studies have been conducted in Spain, most focusing exclusively on GWG and health outcomes. However, an evaluation of risk factors has not been performed to date. Furthermore, these studies were mainly published in national journals which limits the dissemination of results to the international research community (De la Plata Daza, 2018; López et al., 2019).

The aim of the current study is to firstly, evaluate non-healthy weight gain during pregnancy, determining the prevalence of inadequate, healthy, and excessive GWG according to IOM recommendations. Secondly, to analyze the role of pregnant women's awareness of IOM recommendations, beliefs, and information provided by midwives, and retrieved from other sources, as potential risk factors for non-healthy GWG in the southern region of Spain.

## Methods

### Design

A retrospective cross-sectional study was performed in a tertiary Hospital in Seville (Spain) between March and September 2019.

### Sample/Participants

Our hospital cares for around 4250 pregnant women with the established selection criteria. For this population, the calculated sample was 451 pregnant women (considering 30% of reported prevalence of healthy gestational weight gain, for a precision of 4% and a confidence level of 95%) (Antonisamy et al., 2017). A convenient sample of 500 singleton pregnant women were recruited to participate in the study. The inclusion criteria were singleton pregnant women at  $\geq 37$  gestational weeks (GW), Spanish-speakers over 18 years old. The exclusion criteria were subjects with mental disorders, GDM or other conditions requiring dietary modifications.

### The questionnaire

Following a literature review, the authors prepared a self-administered questionnaire designed to gather data pertaining to the socio-demographic profile of the subjects, obstetric history, knowledge regarding GWG, information received from midwives

and retrieved from other sources, as well as expectations regarding GWG. The questionnaire was administered to a small sample ( $n = 50$ ) of pregnant women to identify potential issues, ensure readability and comprehension and determine the approximate response time which was 10–15 min. Although it was a self-administered questionnaire, help was made available to the participants who requested it.

The following questions were included in the questionnaire: “Are you aware of GWG recommendations?” and “In your opinion, your GWG has been excessive/healthy/inadequate/I don’t know”. Responses were verified according to GWG IOM recommendations and then women were classified as “aware recommendations” (yes/no).

To explore the counseling, information and recommendations received in the different prenatal visits, participants were asked whether they had received information regarding nutrition, physical activity and excessive GWG. We also sought the participants’ perception of the information received through two questions: “In your opinion, you received excessive/ inadequate/ enough information/ I do not know” and “Would you have liked health professionals to put more emphasis on these recommendations?”

Attendance to group antenatal care (ANC), offered by the Public Health System to all pregnant women, was also evaluated. Women who attended the sessions were asked whether the following topics had been addressed: relevance of nutrition and exercise during pregnancy, how to breastfeed, and breastfeeding as an effective way for postpartum weight loss.

The participants’ use of internet to search for health information during pregnancy was assessed by the following questions: “Did you search the Internet for information?” if the answer was yes, we explored the type of information searched with the questions “Did you search for information about nutrition?”, “Did you search for information regarding exercise?” and enquired about the type of website or application they used.

Furthermore, we explored the relevance women attached to receiving information about the following issues during pregnancy: exercise, nutrition, how to breastfeed and breastfeeding as an effective way for postpartum weight loss. The socio-demographic data collected included nationality, level of education, parity, civil status, type of healthcare, obesity history, and employment status of the participants and their partners, if they had one.

#### Ethical considerations

A protocol including aims, methods, and procedures for gathering and managing clinical information was designed. Human Research ethics approval was obtained from the hospital’s Ethic and Research Committee (C.P. MSA-FP-2019-01-C.I.). During a 1st Phase, midwives explained in simple terms to potential participants the dynamics, purpose, and withdrawal procedures (at any stage of the study and without penalty). Once women agreed to participate in the study, they signed an informed consent document. The consent document explained the study’s aim in a clear and concise manner. All data was anonymized, as required by current legislation. It was not necessary to take biological samples other than those carried out in routine clinical practice.

#### Data collection

Data collection took place from March to September 2019, in two phases.

**1st Phase:** Pregnant women were recruited to participate in the study during a prenatal visit at  $\geq 37$  (GW) to the hospital by midwives and completed the questionnaire during this visit.

**2nd Phase:** The digital health records of the participants were examined by the researchers to extract anthropometric data. This

information is gathered and recorded by midwives at each prenatal visit as established by the Public Primary Health Care antenatal program. pBMI was calculated by using the formula ( $\text{kg}/\text{m}^2$ ), at first pregnancy visit ( $\leq 12\text{GW}$ ) and women were classified according to cut-off points reported by WHO detailed in the introduction section. Gestational weight gain (in kilograms) was determined by subtracting pre-pregnancy weight at first pregnancy visit ( $\leq 12\text{GW}$ ) from last visit weight ( $\geq 37\text{GW}$ ) as recorded in the participants’ health records.

#### Data analysis

The questionnaires’ answers were merged and anonymized for analysis. Descriptive analyses were performed with the use of frequencies and measures of central tendency and dispersion to characterize the study sample and the results of the questionnaire. To identify factors associated with excessive GWG, bivariate analyses was performed by chi-square analysis and Fisher’s exact test for qualitative variables, where appropriate, and parametric or non-parametric test of mean comparison according to normality and homoscedasticity criteria (Antonisamy et al., 2017). A  $p$ -value  $< 0.05$  was considered statistically significant. To evaluate the potential confounder effects of the variables that reached statistical significance, multivariate linear models were performed to evaluate excessive vs healthy GWG and, inadequate vs healthy GWG women. Statistical analyses were performed using SPSS statistical software (version 23; IBM Corporation, Armonk, NY).

#### Validity and reliability/Rigor

The objective of the self-administered questionnaire was to explore women’s knowledge about GWG and identify factors affecting it. This survey did not measure a specific construct and therefore it was not necessary to determine its psychometric properties. Nevertheless, nutritional attitudes are highly influenced by psychosocial and cultural aspects of any community. Therefore, although the external validity might vary depending on the studied population, we consider the internal validity adequate.

## Results

#### Descriptive and bivariate analysis

In total 500 pregnant women completed the questionnaire, a response rate of appropriately  $> 80\%$ . The health records of 409 women contained sufficient data to categorize individual GWG as inadequate, healthy, and excessive following the IOM guidelines. Inadequate and excessive gestational weight gain rates were 33.4% and 33.9%, respectively Tables 1. and 2 present the data collected from the total sample and from the selected subjects for inference analysis.

Participants were aged 18 to 47 years. No statistically significant relationship was observed between age and GWG. The participants’ characteristics are described in Table 1. The subjects were native Spaniards, with only 8.3% of women from other nationalities (19 Hispanic-American women: 2 Ecuadorians, 3 Venezuelans, 3 Nicaraguans, 5 Bolivians, 2 Dominicans, 3 Paraguayans, 1 Cuban; 13 from Eastern Europe: 8 Romanian, 5 Ukrainian; 4 from Maghreb region (Moroccans); 2 Sub-Saharan: 1 Nigerian and 1 Malian; 2 Others: 1 Chinese and 1 Italian). Over 82% of the sample had completed either secondary or third level education and 95% were either married or in a relationship. Due to small absolute frequencies in some of these categories, we could not determine whether there is an association between these variables and GWG (labeled in tables as NA).

**Table 1**  
Socio-demographic features of women.

	Total women		n	Over GWG available (N = 409)			p-value
	n	n (%)		Inadqt n (%)	Healthy n (%)	Excessive n (%)	
<b>Age</b> (years), $\mu \pm SD$	499	33.1 $\pm$ 7.5	406	33.1 $\pm$ 7.9	33.4 $\pm$ 6.1	32.9 $\pm$ 8.9	0.292*
<b>Nationality</b>	481		390				NA
Spanish		441 (91.7)		119 (24.7)	119 (24.7)	123 (25.6)	
Hispa-American		19 (4.0)		6 (1.2)	6 (1.2)	3 (0.6)	
Eastern Europe		13 (2.7)		3 (0.6)	2 (0.4)	4 (0.8)	
Magreb region		4 (0.8)		0 (0)	1 (0.2)	0 (0)	
Sub-Saharan		2 (0.4)		0 (0)	0 (0)	2 (0.4)	
other		2 (0.4)		1 (0.2)	0 (0)	1 (0.2)	
<b>Educational Level</b>	496		405				NA
None		14 (2.8)		4 (2.9)	1 (0.8)	4 (2.9)	
Primary School		75 (15.1)		16 (11.6)	23 (17.6)	18 (13.2)	
Secondary School		214 (43.1)		53 (38.4)	59 (45)	66 (48.5)	
Higher Education		193 (38.9)		65 (47.1)	48 (36.6)	48 (35.3)	
<b>Civil Status</b>	497		404				NA
Marriage/couple		473 (95.2)		131 (95.6)	127 (96.2)	129 (95.6)	
Single		13 (2.6)		4 (2.9)	1 (0.8)	2 (1.5)	
Other		11 (2.2)		2 (1.5)	4 (3.0)	4 (3.0)	
<b>Employment, yes</b>	497	344 (69.2)	404	100 (73.5)	93 (69.9)	92 (68.1)	0.612
<b>Empl Couple, yes</b>	485	458 (94.4)	397	122 (91.7)	123 (93.2)	129 (97.7)	0.093
<b>Empl both, yes</b>	496	330 (66.5)	404	95 (69.9)	86 (64.7)	92 (68.1)	0.651
<b>Health Assistance</b>	484		395				NA
Public		357 (73.76)		93 (70.5)	103 (78.6)	98 (74.2)	
Private		3 (0.62)		3 (2.3)	0 (0)	0 (0)	
Both		124 (25.62)		36 (27.3)	28 (21.4)	34 (25.8)	
<b>Obesity Hist, yes</b>	492	65 (13.21)	401	15 (11.0)	18 (13.8)	23 (17.0)	0.361
<b>BMI (kg/m<sup>2</sup>)</b>	498		407				< 0.001
Underweight		11(2.2)		3 (2.2)	3 (2.3)	2 (1.5)	
Normal		238(47.8)		93 (67.4)	67 (50.4)	32 (23.5)	
Overweight		145(29.1)		23 (16.7)	41 (30.8)	57 (41.9)	
Obese		104(20.9)		19 (13.8)	22 (16.5)	45 (33.1)	

Inadqt: inadequate,  $\mu \pm SD$ : mean and standard deviation, Empl: employment, Hist: history, BMI: body mass index, NA: not available.

**Table 2**  
GWG categories by IOM guidelines, knowledge and Information.

	Total Women		n	Over GWG available (N = 409)			p
	n	n (%)		Inadeqt n (%)	Healthy n (%)	Excessive n (%)	
<b>Knows WG rec</b>	337	127(37.69)	286	23 (24.5)	50 (52.6)	35 (36.1)	< 0.001
<b>Thinks WG was:</b>	500		391				< 0.001
Excessive		129(25.8)		5 (3.9)	26 (19.8)	76 (57.1)	
Do not Know		35 (7)		12 (9.4)	8 (6.1)	8 (6)	
Healthy		282 (56.4)		92 (72.4)	93 (71.0)	49 (36.8)	
Inadequate		30 (6)		18 (14.2)	4 (3.1)	0 (0.0)	
No response		24 (4.8)					
<b>Info received</b>							
Nutrition	490	401 (81.84)	398	119 (89.5)	107 (81.7)	101(75.4)	0.011
PA	479	302 (63.05)	380	92 (70.2)	79 (62.7)	80 (60.2)	0.207
WG rec	471	224 (47.56)	384	56 (44.1)	64 (50.8)	64 (48.9)	0.547
<b>Consider rec</b>	485		397				0.093
Excessive		61 (12.58)		21 (15.6)	14 (11)	10 (7.4)	
Don't know		27 (5.57)		5 (3.7)	10 (7.9)	10 (7.4)	
Enough		307 (63.30)		90 (66.7)	82 (64.6)	82 (60.7)	
Inadequate		90 (18.56)		19 (14.1)	21 (16.5)	33 (24.4)	
<b>Emphasized rec</b>	475		387				0.842
Yes		82 (17.26)		17 (13.3)	20 (15.7)	26 (19.7)	
Don't Know		38 (8.0)		11 (8.6)	10 (7.9)	13 (9.8)	
Enough		293 (61.68)		83 (64.8)	80 (63)	75 (56.8)	
No		62 (13.05)		17 (13.3)	17 (13.4)	18 (13.6)	
<b>Group ANC</b>	486	234 (48.15)	396	69 (51.9)	71 (54.6)	59 (44.4)	0.226

Inadeqt: inadequate, WG: weight gain, rec: recommendations, info: information, PA: physical activity, Group ANC: group antenatal care, p: p-value.

Around 70% of women and 94% of their partners were in employment. This difference was statistically significant ( $p < 0.001$ ) with an OR (CI95%) 0.13 (0.08–0.21). In 66.5% of the cases both partners were in employment. No association was found between employment and GWG.

Most pregnant women received care in the public health system and around one quarter used both, public and private healthcare. A family history of obesity was reported in 13% of the cases.

No association was found between obesity history and GWG. A significant relationship was observed between ppBMI and GWG ( $p < 0.001$ ) due to 67% of women with GWG below IOM recommendations had a healthy ppBMI and only 23.5% had an excessive GWG. Furthermore, among women exceeding IOM recommendations, 41.9% had overweight ppBMI and 33.1% obese ppBMI while 16.7% women with inadequate GWG had overweight ppBMI and 13.8% obese ppBMI (Table 1).

**Table 3**  
Importance that pregnant women assign to knowledge/information.

Importance assigned to	Over Total Subjects (N = 500)							p-value
	n	μ (SD)	P <sub>0</sub>	P <sub>25</sub>	P <sub>50</sub>	P <sub>75</sub>	P <sub>100</sub>	
Exercise	314	4.0	1	3	4	5	5	NA
Nutrition	318	4.3	1	4	5	5	5	NA
How to breastfeed	338	4.6	1	3	5	5	5	NA
Breastfeeding to recover weight	306	3.7	1	3	4	5	5	NA

  

Importance assigned to	Over GWG available (N = 409)							p-value
	n	μ(SD)	P <sub>0</sub>	P <sub>25</sub>	P <sub>50</sub>	P <sub>75</sub>	P <sub>100</sub>	
<b>Exercise</b>								
Total	310	4 (1.1)	1	3	4	5	5	0.115
Inadequate Weight Gain	120	3.84 (1.2)	2	4	5	5	5	
Healthy Weight Gain	104	4.29 (0.9)	2	4	5	5	5	
Excessive Weight Gain	86	3.9 (1.1)	1	3	4	5	5	
<b>Nutrition</b>								
Total	314	4.3 (1.1)	1	4	5	5	5	0.032
Inadequate Weight Gain	120	4.19 (1.2)	1	4	5	5	5	
Healthy Weight Gain	109	4.47 (0.9)	1	4	5	5	5	
Excessive Weight Gain	85	4.05 (1.2)	1	3	4	5	5	
<b>How to breastfeed</b>								
Total	334	4.6 (0.8)	1	5	5	5	5	0.990
Inadequate Weight Gain	128	4.54 (0.9)	1	4	5	5	5	
Healthy Weight Gain	115	4.64 (0.8)	1	5	5	5	5	
Excessive Weight Gain	91	4.62 (0.9)	1	5	5	5	5	
<b>Breastfeeding to recover weight</b>								
Total	302	3.7 (1.2)	1	3	4	5	5	0.249
Inadequate Weight Gain	114	3.57 (1.2)	1	3	3.5	5	5	
Healthy Weight Gain	104	3.82 (1.2)	1	3	4	5	5	
Excessive Weight Gain	84	3.55 (1.3)	1	3	4	5	5	

μ (SD): mean (standard deviation), P: percentile, NA: Not Applicable.

Table 2 shows a statistically significant association between the GWG category (inadequate, healthy, or excessive) and women who declared to know the IOM recommendations ( $p < 0.001$ ), women's self-perception regarding their GWG recorded as "think her WG was" ( $p < 0.001$ ) and who declared to receive nutritional information from midwives ( $p = 0.011$ ). Women who knew about the IOM recommendations were more likely (52.6%) to have a GWG in a normal range. Most women with a GWG below recommendations (72.4%) believed that their GWG was healthy, whereas 57.1% of those with excessive GWG were aware that their GWG was above the recommendation. Additionally, 81.8% of women reported having received nutritional information. Women with excessive GWG were less likely to have received nutritional information. Overall, only 63.3% of women considered the recommendations appropriate.

Approximately half of the sample attended Group Antenatal Care (ANC), available to all women in the Public Health System. Similar results were obtained for women categorized by GWG, without statistically significant differences between inadequate, healthy, and excessive WG categories and attendance to group ANC ( $p = 0.226$ ). Women who attended group sessions ( $n = 486$ ) were asked about the topics covered during the same (nutrition, physical exercise). Only "received information about nutrition" was associated with categories of GWG as follows: inadequate GWG 89.5% vs excessive GWG 75.4% ( $p = 0.011$ , Table 2).

Table 3 shows the importance assigned (with five points Likert scales) to different topics in a descriptive (top of the table) and bivariate (bottom of the table) way. The highest mean scores in each case were for women who gained the recommended weight, although a significant difference ( $p = 0.032$ ) was found between the relevance attached to nutrition and inadequate, healthy, and excessive GWG. A worse distribution of points among women with excessive GWG was observed. Nonetheless, the non-response rate was 82%.

The use of the Internet as a source of information was also explored. Although 66% of the sample used it, the search for infor-

mation about nutrition, exercise, or type of website searched were not significantly related to GWG (not tabulated data).

#### Multivariate analysis

Two logistic regression models, that took as reference the category of women with a healthy GWG, were performed to identify factors that influenced inadequate or excessive GWG (Table 4). These models showed that the importance assigned to exercise was a protective factor (adjusted OR < 1) against excessive GWG whereas ppBMI was identified as a risk factor. Believing their GWG was healthy also had a protective effect, taking the group of participants who thought their GWG was excessive as a reference.

Awareness of IOM recommendations was a protective factor against inadequate GWG. However, taking women who thought that their GWG was excessive as a reference, believing their GWG was healthy/inadequate was identified as a risk factor for inadequate GWG.

#### Discussion

##### Study and sample profiles

The sample had a homogeneous profile it was made up of Spanish women married or in a relationship, around 33 years old and with a good education level (secondary or third level). ANC was mainly provided in the public health system, and a small proportion had a history of obesity. This profile was evenly distributed among GWG categories (inadequate, healthy, or excessive) (Table 1). Therefore, GWG groups were comparable from a socio-demographic point of view.

##### GWG outcomes

Our results show a high prevalence of excessive (33.4%) and inadequate (33.9%) GWG according to IOM recommendations, which

**Table 4**  
Logistic regression models.

Excessive weight gains predictive model			
	Estimate	p-value	Adjusted OR (CI95%)
$\beta_0$	-0.26	0.826	0.77 (0.07–7.82)
Believes WG was[healthy]	-1.90	< 0.001	0.15 (0.07–0.31)
Believes WG was [inadequate/does not Know]	-1.10	0.159	0.33 (0.07–1.60)
ppBMI	0.12	0.001	1.12 (1.05–1.21)
Importance assigned to Exercise	-0.41	0.029	0.67 (0.45–0.95)
Inadequate weight gains predictive model			
	Estimate	p-value	Adjusted OR (CI95%)
$\beta_0$	-0.79	0.139	0.46 (0.14–1.22)
Knows WG recommendations	-1.37	< 0.001	0.25 (0.12–0.50)
Believes WG was[healthy]	1.15	0.039	3.16 (1.13–10.38)
Believes WG was[inadequate]	3.58	< 0.001	35.79 (6.69–300.24)
Believes WG was [does not Know]	1.63	0.068	5.12 (0.87–31.07)

WG: weight gain, ppBMI: pre-gestational body mass index, OR: Odd Ratio, CI95%: confidence interval 95%.

are consistent with previous meta-analysis (Rogozińska et al., 2019). Women with a healthy ppBMI accounted for half of the women with adequate GWG, whereas women with overweight and obesity ppBMI mostly gained excessive weight. These findings highlight a high prevalence of unhealthy GWG (67.3%) which is consistent with a recent meta-analysis (Martínez-Hortelano et al., 2020) reporting global prevalence rates of excessive and inadequate GWG of 27.95% and 39.4%, respectively. A meta-analysis (Goldstein et al., 2017), on GWG across countries and ethnicity reported 51% excessive and 18% inadequate GWG in Europe. These results are comparable with studies in other populations (Johnson et al., 2015; Power et al., 2018). The rates of excessive (50–70%) and inadequate (10–20%) GWG reported in the literature are higher and lower, respectively, than in our sample. A recent summary on tendencies on GWG in obese women points out that the prevalence of excessive GWG has increased, although inadequate weight gain is also common (Siega-Riz et al., 2020).

#### Factors associated with GWG outcomes

Similarly to previous studies (Naftali et al., 2018; Shulman and Kottke, 2016), our study reveals a statistical association between ppBMI and GWG ( $p < 0.001$ ). Pre-pregnancy BMI in our sample was very similar to that reported in other high and middle-income countries (Chen et al., 2018; Ng et al., 2014; Park et al., 2011), with around 50% of women in the overweight and obese categories, and 47% in the healthy range (Martínez-Hortelano et al., 2020; Tebbani et al., 2019; Vivian Ukah et al., 2019). *A priori*, the biological and psychosocial factors that predispose women to have a low or high ppBMI could act as hindering factors for compliance with recommendations for a healthy pregnancy. In our study, women with pre-pregnancy overweight and obesity accounted for 75% of women who exceeded the healthy GWG range which is comparable to previous studies (Power et al., 2018; Tebbani et al., 2019).

Within the group of women who achieved a healthy GWG, 50% belonged to the healthy ppBMI category, which is consistent with other authors (Naftali et al., 2018). Also, out of the women with inadequate GWG, 67.4% had a healthy ppBMI, in line with a wide range geographic review (Rogozińska et al., 2019). These results reflect that almost half (48%) of the women with healthy ppBMI gain inadequate GWG, and only 34% achieves a healthy GWG. Other authors report a smaller percentage of women with inadequate GWG, mostly accounting for women in the underweight ppBMI category (Power et al., 2018). Multivariate analysis (taking women with underweight as a reference) revealed that ppBMI was predictive of a healthy GWG. However, the association on bivariate analysis was not confirmed by the predictive model of healthy GWG (taking women who exceeded the recommended range as a reference).

Recent studies reported the wish to have a healthy baby and delivery (while pregnant) and “wanting their body back” (after delivery) are strong predictors of behavioral change in relation to GWG (Ayyala et al., 2020; Ogawa et al., 2018). Pregnant women’s access to quality evidence-based information is essential to achieve positive pregnancy outcomes. Also, women must receive advice and assistance from midwives to engage in behavioral change. In our sample, 62.9% of women were unaware of GWG guidelines which is consistent with reports from Australia (Hill et al., 2019; McPhie et al., 2015) and America (Arinze et al., 2016; Ledoux et al., 2018). This percentage increases to 70% in low-income population, which suggests limited access to quality information is associated with poorer weight gain (Godoy-Miranda et al., 2019; McPhie et al., 2015; Nikolopoulos et al., 2017).

Our study reveals there is a significant relationship between awareness of GWG guidelines and GWG ( $p < 0.001$ ). Women with adequate information were more likely to have a GWG within a healthy range, in line with previous studies (Hill et al., 2019; Kapadia et al., 2015; Shulman and Kottke, 2016). Our predictive model shows women who were aware of IOM recommendations were less likely to have inadequate GWG, as compared to women who had a healthy GWG with OR (CI95%): 0.25 (0.12–0.50) and  $p < 0.001$ . Although this finding would seem logical, it is in contrast with reported results. For instance, low-income Afro-American women’s knowledge of GWG recommendations was inversely related to total GWG among normal and underweight women (Ledoux et al., 2018). While highly educated Japanese women wished to maintain their GWG below recommendations (Ogawa et al., 2018). Considering this, awareness of IOM guidelines could act in either direction according to racial, cultural, financial, or personal factors. However, as our results illustrate, women’s beliefs regarding “a healthy GWG” despite knowledge of recommendations can also affect GWG.

According to Kraschnewski and Chuang (2014) the failure of HCW to properly inform pregnant women about GWG recommendations contributes to perpetuate the problem. In our view, pregnant women’s lack of attendance to group ANC (less than 50% in our sample) also contributes to perpetuating the problem. To this end, few women reported receiving advice about weight gain during pregnancy (Dalhaug and Haakstad, 2019; Lindsay et al., 2017; Lopez-Cepero et al., 2018). Perhaps this is due to a focus on women presenting with obesity or excessive GWG (Weeks et al., 2020). Although in our sample, women with excessive GWG reported the lowest rates of nutritional information received. Authors believe the high rates of women exceeding the recommended GWG may indicate midwives did not focus enough on GWG during prenatal visits or group ANC (Lutsiv et al., 2012; Nikolopoulos et al., 2017). Equally so, the lack of focus on GWG may affect women

with healthy ppBMI with high rates of inadequate GWG as shown in our study.

The information that women retrieve from other sources may interfere with the educational work of midwives. Pregnant women identify the Internet, media, and HCW as the most helpful sources of information (Grimes et al., 2014; Willcox et al., 2015). Although women consider the Internet is a reliable and useful source of information (Sayakhot and Carolan-Olah, 2016), research about the accuracy of information regarding GWG on the Internet in the U.S.A revealed for-profit websites dominate the online space and for the most part, they contain incomplete, inaccurate, or not specific recommendations (Chang et al., 2016). Additionally, most women did not discuss the information they retrieved from the Internet with their midwives or other HCW (Sayakhot and Carolan-Olah, 2016). As a result, these sources could have more impact on their behavior than HCW's advice (Dalhaug and Haakstad, 2019).

### Limitations

This study is not without limitations. It is an observational study and, while it is a useful design to obtain prevalence rates and identify risk factors, may not provide the best scientific evidence. Non-randomized sampling is a possible source of confounding bias, but we believe that multivariate analysis helped overcome this limitation. Finally, there was missing weight data on the electronic health records of a considerable number of participants, which hindered GWG categorization. Still, the sample of this study is larger than most studies published to date, and this warrants a better statistical power. The low response rate regarding some aspects as the study could be related to a poor design of specific questions related to these issues. Nevertheless, we obtained interesting results for professionals of maternal and neonatal care.

### Implications for practice and /or policy

We observed that among women that gained inadequate weight a majority belonged to a healthy ppBMI. This is in contrast with previous work which reported women with inadequate GWG come mainly from underweight ppBMI (Suliga et al., 2018). In our study, women with an inadequate GWG considered their GWG was healthy despite knowledge of recommendations. However, our data suggests women with healthy ppBMI understate the importance of adhering to a healthy GWG, as well as the risks associated with insufficient GWG for instance, preterm birth or SGA (Hu et al., 2020; Melby et al., 2016). This could be partly due to the emphasis placed on the risks of excessive GWG in the last decades, which may be misleading women's beliefs regarding "healthy GWG" and steering them towards smaller GWG. Also, body image may play an important role due to the pervasive sociocultural pressures that reinforce the desirability to meet the ideal slim beauty standard (Dryer et al., 2020) which makes it difficult for women in pregnancy to maintain a positive attitude (Breda et al., 2015). Further researched should be conducted in this regard as we may be facing an emerging trend with very negative impact on health outcomes.

Our study insinuates that GWG should be a main topic in ANC. Focus should be placed on achieving a healthy GWG and the risks of both excessive and inadequate GWG should be discussed in these settings. A combination of one-to-one and group ANC should be used as it has proven to enhance education and support (Swift et al., 2020). Antenatal group care should be promoted, as it is an ideal setting for open communication about weight and body image (Watson et al., 2016), where women receive information and peer and professional support (Siega-Riz et al., 2020) in an efficient manner ("ACOG Committee Opinion No. 731: Group Prenatal Care", 2018). Midwives should verify in these sessions the quality

of the information women have as well as their beliefs and expectations regarding weight gain, to promote a healthy GWG and increase women's satisfaction.

Midwives and health policy makers should keep focusing on excessive GWG, but attention should also be paid to inadequate GWG.

### Conclusion

Although excessive GWG is a well-known health risk, this study shows that inadequate GWG among women with healthy ppBMI is also becoming common. Considering exercise important to maintain a healthy gain and ppBMI were identified as protective factors against excessive GWG. Awareness of recommendations prevents inadequate GWG, but it does not seem to be the only determining factor for achieving a healthy GWG. The quality of the information that women have and their own concerns regarding weight can lead to inadequate GWG despite their awareness of recommendations. In fact, believing that their GWG was adequate prevented excessive gain but favored inadequate gain. Based on this, we recommend the promotion of one-to-one and group ANC where these issues are addressed more thoroughly. Finally, HCW in general and midwives particularly should place more emphasis on GWG and verify the quality of the information women obtain from other sources. Attention should be shifted towards inadequate GWG.

### Ethical approval

Human research ethics approval was obtained from "Hospitales Universitarios Virgen Macarena y Virgen del Rocío Ethics and Research Committee", February 16th 2019. (C.P. MSA-FP-2019-01 - C.I.).

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### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

No conflict of interest has been declared by the authors.

### CRediT authorship contribution statement

**Socorro Arnedillo-Sánchez:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Rubén Morilla-Romero de la Osa:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Inmaculada Arnedillo-Sánchez:** Conceptualization, Methodology, Software, Data curation, Validation, Formal analysis, Writing – review & editing, Supervision.

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