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Body image dissatisfaction and interoceptive sensibility significantly predict postpartum depressive symptoms

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| Corresponding Author: | Caterina Grano Sapienza University of Rome: Universita degli Studi di Roma La Sapienza ITALY |
| First Author: | Claudio Singh Solorzano |
| Order of Authors: | Claudio Singh Solorzano Giuseppina Porciello Cristiano Violani Caterina Grano |
| Abstract: | <p>Background During pregnancy women experience rapid and unique changes in body weight, shape and size over a relatively short time period. While research focused on the role of external bodily modifications during pregnancy, research on internal bodily variations is missing.</p> <p>Methods In a longitudinal study, we recruited healthy pregnant women and measured whether and how depressive symptoms, body image dissatisfaction and the subjective tendency to focus on one's own internal bodily sensations, i.e., interoceptive sensibility, changed during pregnancy and postpartum. Pregnant women filled online self-report questionnaires during pregnancy (i.e. second and third trimester) and after (i.e. six weeks) the delivery, including the Body Areas Satisfaction Scale, the Multidimensional Assessment of Interoceptive Awareness, and the Edinburgh Postnatal Depression Scale.</p> <p>Results While depressive symptoms remained stable in the peripartum, body image dissatisfaction increased in the postpartum compared to the pregnancy period, and interoceptive sensibility increased over pregnancy. Findings showed that the increase of body dissatisfaction through the peripartum and the levels of interoceptive sensibility in the early phase of pregnancy predicted depressive symptoms in the postpartum.</p> <p>Limitations Interoception was evaluated as a subjective measure (i.e., interoceptive sensibility). Future studies may include objective measures of interoceptive accuracy and interoceptive awareness.</p> <p>Conclusions The current study supports the importance of body image dissatisfaction and interoceptive sensibility in the development of postpartum depressive symptoms. Future studies need to investigate if interventions aimed to increase interoceptive sensibility might be useful in preventing depressive symptoms and identify the mechanisms that can lead to these changes.</p> |
| Suggested Reviewers: | Jane Aspell jane.aspell@aru.ac.uk Pertinent field of interest: Interoceptive and exteroceptive body representation and peripersonal space in non-pregnant and pregnant women. Amanda Nerini nerini@psico.unifi.it Pertinent field of interest: body image in female population. Lara Maister |

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|---------------------------|--|
| | <p>I.maister@bangor.ac.uk Pertinent field of interest: Interoceptive and exteroceptive bodily self-representation and self-awareness.</p> <p>Helen Skouteris helen.skouteris@monash.edu Pertinent field of interest: Association between postpartum depression and body image (dis)satisfaction.</p> |
| Opposed Reviewers: | |

Highlights

- After the delivery, women are maximally unsatisfied about their body
- Sensibility to inner body signals (IS) increases over pregnancy
- Women with low IS report high level of depressive symptoms in the postpartum
- Postpartum depressive symptoms are predicted by body image dissatisfaction changes

Title

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Authors' names

Claudio Singh Solorzano^a, Giuseppina Porciello^{a,b}, Cristiano Violani^a, Caterina Grano^a

Affiliations

^aDepartment of Psychology, Sapienza University, Rome, Italy

^bIRCCS Santa Lucia Foundation, Rome, Italy

Corresponding Author Details

Caterina Grano (caterina.grano@uniroma1.it)

Department of Psychology, Sapienza University, Via dei Marsi 78, 00185, Roma, Tel. +39 06 4991 7627.

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1. Introduction

Depressive symptoms in pregnant women are common both during pregnancy and after the delivery (Gelaye et al., 2016). The fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* considers postpartum depression (PPD) as a subtype of major depressive disorder “*with peripartum onset, if the onset of mood symptoms occurs during pregnancy or within 4 weeks following the delivery*” (American Psychiatric Association, 2013). PPD generally has the same symptoms as non-childbearing depressive disorders, but it is characterized by a greater comorbid anxiety amplified by physiological and physical rapid changes affecting the body during pregnancy, the stress of childbirth, and the awareness of the increased responsibility that motherhood brings (Brummelte and Galea, 2016). The prevalence of women suffering from depression during gestation is 11.9% (Woody et al., 2017), whereas in the postpartum period, the rate increases even up to 19% (O’Hara and McCabe, 2013). Besides resulting in maternal suffering (Stewart and Vigod, 2016), PPD is also associated with reduced new-born care activities (O’Hara and McCabe, 2013). For instance, it was found that mother’s PPD had a negative influence on infant feeding outcomes, including reduced breastfeeding duration and breastfeeding self-efficacy (Dennis and McQueen, 2007; Gagliardi et al., 2012), which in turn are related to negative health outcomes for the child (Figueiredo et al., 2014). Some studies reported that children of depressed mothers are more likely to develop cognitive, behavioural, and health-related problems which may persist into later childhood and adolescence (O’Hara and McCabe, 2013). Therefore, identifying risk factors for developing PPD is of vital importance both for the prevention and early treatment of depression in pregnant women, and for promoting new-born’s wellbeing. Between the risk factors of PPD, it seems that a crucial role is played by body image (Chan et al., 2020; Elise et al., 2019).

Indeed during pregnancy, women experience rapid and unique changes in body weight, shape and size over a relatively short time period (Skouteris et al., 2005). Some studies indicate that although women tend to adapt to the new body condition, when this adaptation does not occur, body image dissatisfaction might arise (Skouteris et al., 2005). If body image dissatisfaction rests stable over pregnancy or varies, and in which phase of the pregnancy is maximum, it is still debated in the literature (Clark et al., 2009; Duncombe et al., 2008; Goodwin et al., 2000; Silveira et al., 2015; Skouteris et al., 2005). Considering the postpartum period, studies indicate that women show higher levels of body image dissatisfaction compared to pregnancy period (Baker et al., 1999; Clark et al., 2009; Rallis et al., 2007). It has been suggested that this might be associated with concerns about meeting pre-pregnancy body standards and with the inappropriate comparison by postpartum women with women who have not recently given birth (Rallis et al., 2007). Interestingly, recent longitudinal studies show that body dissatisfaction is an important risk factor for detecting PPD

(Chan et al., 2020; Elise et al., 2019). Accordingly, prospective studies found higher incidents of PPD in women with higher levels of body image dissatisfaction during pregnancy, although they lack consistency in terms of timing of assessment and instruments used (see Silveira et al., 2015 for a review).

Besides changes affecting body satisfaction, pregnancy is also associated with important internal changes involving multiple internal districts (Soma-Pillay et al., 2016), however these aspects received little attention from scientific research. The sense of the physiological condition of the internal body is known as interoception (Craig, 2002); it is at the basis of self-consciousness (e.g., Aspell et al., 2013; Monti et al., 2020; Suzuki et al., 2013, see also Herbert & Pollatos, 2012 for a review), varies extremely between individuals and results to be impaired in different mental health conditions, including mood disorders (see Khalsa et al., 2018 and Monti et al., 2021 for a recent review). Garfinkel and colleagues (2015) conceptualized interoception into three distinct dimensions, namely: interoceptive sensibility, accuracy, and awareness. Interoceptive sensibility is the subjective tendency to focus one's own attention towards internal bodily sensations and it is assessed by self-report questionnaires, differently from the interoceptive accuracy which is participants' ability to objectively detect inner bodily signals assessed via behavioural tasks, and awareness which is participants' metacognitive awareness of their own interoceptive accuracy, e.g. confidence-accuracy correspondence (Arnold et al., 2019; Garfinkel et al., 2015). Recent studies highlighted the role of interoceptive sensibility in depressive symptoms and overall in psychological wellbeing in general populations (Harshaw, 2015). In particular, reduced interoceptive sensibility predicted suicide ideation (Forkmann et al., 2019) and alexithymia (Paulus and Stein, 2010; Zamariola et al., 2018) which are typical features of the onset and maintaining of depressive disorders. Furthermore, different domains of interoceptive sensibility were positively associated with psychological wellbeing (Hanley et al., 2017).

If interoceptive sensibility increases during pregnancy due to an increase in the attention toward signals coming from within the body, such as the baby's movements (Kirk and Preston, 2019) and if this may help mothers to positively deal with pregnancy body changes (Clark et al., 2009) and protect them from the development of depressive symptoms after the delivery, are open issues. To the best of our knowledge indeed, despite its role in the onset of emotional and psychological problems in non-pregnant populations (Critchley and Garfinkel, 2017; Khalsa et al., 2018), no studies analysed the trend of interoception during pregnancy as well as its possible impact on PPD. We performed a longitudinal study on a sample of healthy pregnant women with the aim of exploring changes in: i) depressive symptoms, ii) body image dissatisfaction, and iii) interoceptive sensibility during early and late phases of pregnancy (i.e. during the second and third trimester) and

in the peripartum period (i.e. six weeks after the delivery). Importantly, the study also aimed to establish the role of the above mentioned variables as risk factors for developing postpartum depressive symptoms.

We expected to find higher levels of depressive symptoms and body image dissatisfaction in the peripartum period and an increase of interoceptive sensibility over pregnancy. We also expect that depressive symptoms characterizing the peripartum period depended on the strength of: i) depressive symptoms measured at the beginning of the pregnancy; ii) body image dissatisfaction iii) and crucially, interoceptive sensibility.

2. Methods

2.1. Participants

Two-hundred and twenty-nine healthy pregnant women volunteered to participate in a three-phase longitudinal study after providing their written informed consent. Women were administered questionnaires when they were at the second semester of pregnancy (T1); three months later, i.e., when they were at the third semester (T2); and in the postpartum, at around six weeks from the delivery (T3).

Data from women who withdrew from the study in the second or third phase were omitted from the final analyses. Therefore, the final sample was composed of 134 women, with an age range between 20 and 42 years ($M= 31.93$ years, $SD= 4.84$). Further demographic characteristics of the sample are shown in Table 1.

Table 1 Sociodemographic and anthropometric description of the final sample of pregnant women (N = 134)

| Variable | N (%) or Mean \pm SD |
|--------------------|------------------------|
| Age | 31.93 \pm 4.84 |
| Nationality | |
| Italian | 132 (98.5) |
| Other Countries | 2 (1.5) |
| Education | |
| Middle School | 8 (6) |
| High School | 51 (38) |

| | |
|---|--------------|
| Bachelor | 22 (16.4) |
| Master's degree | 37 (27.6) |
| Post-lauream specialization courses | 6 (4.5) |
| PhD | 10 (7.5) |
| Marital status | |
| Married | 60 (44.8) |
| Committed relationship, but not married | 68 (50.7) |
| Single/casually dating | 6 (4.5) |
| Month of pregnancy (T1) | |
| 4th | 60 (44.8) |
| 5th | 58 (43.3) |
| 6th | 16 (11.9) |
| Parity status | |
| Primiparous | 78 (58.2) |
| Multiparous | 56 (41.8) |
| BMI | |
| T1 | 25.23 ± 4.38 |
| T2 | 27.17 ± 4.06 |
| T3 | 25.32 ± 4.23 |

2.2. Procedures

Women were directly and opportunistically recruited through a variety of means, including private maternity centers, schools, family associations, and diagnostic centers in the center of Italy. To be included in the study, women had to be in the second trimester of pregnancy (the fourth, fifth or sixth month) and be fluent in Italian. All participants took part on a voluntary basis and were not remunerated. Each woman received an information sheet explaining the general procedure of the study and was asked to sign in an informed consent form. Participants were required to provide an email address and a phone number for further contact. In a second phase, and within a week from the first contact, an email with more complete information about the study and the link to an online questionnaire was sent to them. At the same time, a personal code was sent to their mobile phone number. Only through this code women could have access to the online questionnaire. The study was approved by the Institutional Review Board of the Psychology Department, Sapienza University of Rome (Prot. n. 0000102 of 24/01/2018). Questionnaires were built and run through

the online survey editor SurveyMonkey. Demographic variables were assessed at T1. Height, weight, depressive symptoms, body dissatisfaction and interoceptive sensibility were measured at each phase of the study (i.e., T1, T2 and T3).

2.3. Measures

Women were asked to complete the following measures: age, weight, height, months of gestation, parity status (number of children), education, marital status, and nationality. In addition to these variables, pregnancy women were asked to fill in a list of standardized self-report questionnaires.

The Italian version of Edinburgh Postnatal Depression Scale (EDPS) (Benvenuti et al., 1999) was used to assess the levels of depressive symptoms in the previous week. It is a 10-item self-report scale and responses to each statement are scored on a 4-point Likert scale ranging from 0 to 3, with higher scores indicating greater frequency of depressive symptoms. It has been shown to be a reliable instrument for screening depressive symptoms both during pregnancy and in the postnatal period (Bergink et al., 2011; Sit and Wisner, 2009). In the current sample, Cronbach's alphas were $\alpha = 0.80$ (T1), $\alpha = 0.83$ (T2) and $\alpha = 0.85$ (T3).

The Body Areas Satisfaction Scale (BASS) is a 9-item self-report subscale of the Italian version of the Multidimensional Body-Self Relations Questionnaire (MBSRQ) (Cash, 2000). The permission to use the questionnaire was obtained by the authors. Participants rated the degree of satisfaction with specified body parts and attributes. Responses are scored on a 5-point Likert scale ranging from 1 (*very dissatisfied*) to 5 (*very satisfied*), with lower scores indicating greater body dissatisfaction. The BASS subscale was used in previous studies on pregnant women, showing good internal consistency and reliability (Downs and Hausenblas, 2003; Rauff and Downs, 2011). In the current sample Cronbach's alphas were $\alpha = 0.75$ (T1); $\alpha = 0.81$ (T2) and $\alpha = 0.79$ (T3). Changes in body image (dis)satisfaction (BASS at postpartum (T3) – BASS at early pregnancy (T1)) was also calculated. Negative scores indicate an increase in body image dissatisfaction over time.

The Italian version of the Multidimensional Assessment of Interoceptive Awareness (MAIA) (Cali et al., 2015) is a 32-item self-report questionnaire that assesses 8 dimensions of interoceptive sensibility, namely: the tendency to notice or become aware of body sensations (4 questions: *Noticing*); the tendency to not distract from sensations of pain or discomfort (3 questions: *Not-distracting*), the tendency to not worry about or experience emotional distress in response to sensations of pain or discomfort (3 questions: *Not-worrying*); the ability to sustain and control attention to body sensations (7 questions: *Attention regulation*); the awareness of the link between

emotion and body sensations (5 questions: *Emotion awareness*); the ability to regulate negative emotion by focusing attention on body sensations (4 questions: *Self-regulation*); the tendency to listen to body sensations for insight into emotion and guide behaviour (3 questions: *Body listening*); and the tendency to experience the body as safe and trustworthy (3 questions: *Trusting*). Responses to each statement are scored on a 6-point Likert scale ranging from 0 (“*This never applies to me on a daily basis*”) to 5 (“*This always applies to me on a daily basis*”), with higher scores indicating higher interoceptive sensibility. In the current sample, Cronbach’s alphas ranged from 0.69 to 0.90 at T1, with only Not-distracting whose α was poor (i.e., 0.37); from 0.64 to 0.89 at T2, with only Not-distracting whose α was poor (i.e., 0.38), and from 0.57 to 0.92 at T3.

2.4. Statistical analyses

2.4.1. Preliminary Analyses

In order to examine whether participants recruited in the first assessment differed or not from those who completed the study, separate t-tests on depressive symptomatology and body image (dis)satisfaction scores and a 2 (Group) x 8 (Maia subscale) analysis of variance (ANOVA) on interoceptive sensibility were performed. The Greenhouse-Geisser correction for non-sphericity was applied when appropriate (Keselman and Rogan, 1980)

2.4.2. Depressive symptoms changes

After computing total scores of the EDPS in each testing phase (T1, T2 and T3), and after verifying the normality distributions of the data (z-scores of kurtosis and skewness were all below 2.58), EDPS scores underwent a repeated measures analysis of variance (ANOVA) with Time as the within-subjects factor. The Greenhouse-Geisser correction for non-sphericity was applied when appropriate (Keselman and Rogan, 1980). The aim of the ANOVA was to test if depressive symptomatology changed over pregnancy and in the postpartum.

2.4.3. Body image (dis)satisfaction changes

After computing total scores of the BASS in each testing phase (T1, T2 and T3), and after verifying the normality distributions of the data (z-scores of kurtosis and skewness were all below 2.58), BASS scores underwent a repeated measure ANOVA with Time as the within-subjects factor. The Greenhouse-Geisser correction for non-sphericity was applied when appropriate (Keselman and Rogan, 1980). The aim of the ANOVA was to test if body image (dis)satisfaction changed during pregnancy or in the postpartum.

2.4.4. Interoceptive sensibility changes

After computing scores of the eight subscales for each individual and in each testing phase (T1, T2 and T3), and after verifying the normality distributions of the data (z-scores of kurtosis and skewness were all below 2.58), MAIA scores underwent a repeated measures 3 x 8 ANOVA with Time and Subscale as the within-subjects factors. The Greenhouse-Geisser correction for non-sphericity was applied when appropriate (Keselman and Rogan, 1980). The aim of these analyses was to test if the dimensions of interoceptive sensibility changed over pregnancy and in the postpartum.

2.4.5. Predictors of postpartum depressive symptoms

In order to test which were the significant predictors of postpartum depressive symptoms, we first ran a series of explorative correlations and then selected only the variables that significantly correlated with postpartum depressive symptoms. We built a hierarchical regression model in which we tested the specific contribution of the change in body (dis)satisfaction during the peripartum and the initial levels of interoceptive sensibility during pregnancy over postpartum depressive symptoms, after taking into account depressive symptomatology measured at the beginning of pregnancy.

3. Results

Table 1 shows descriptive statistics (Means, standard deviations, and percentages) of the sample.

3.1. Preliminary Analyses

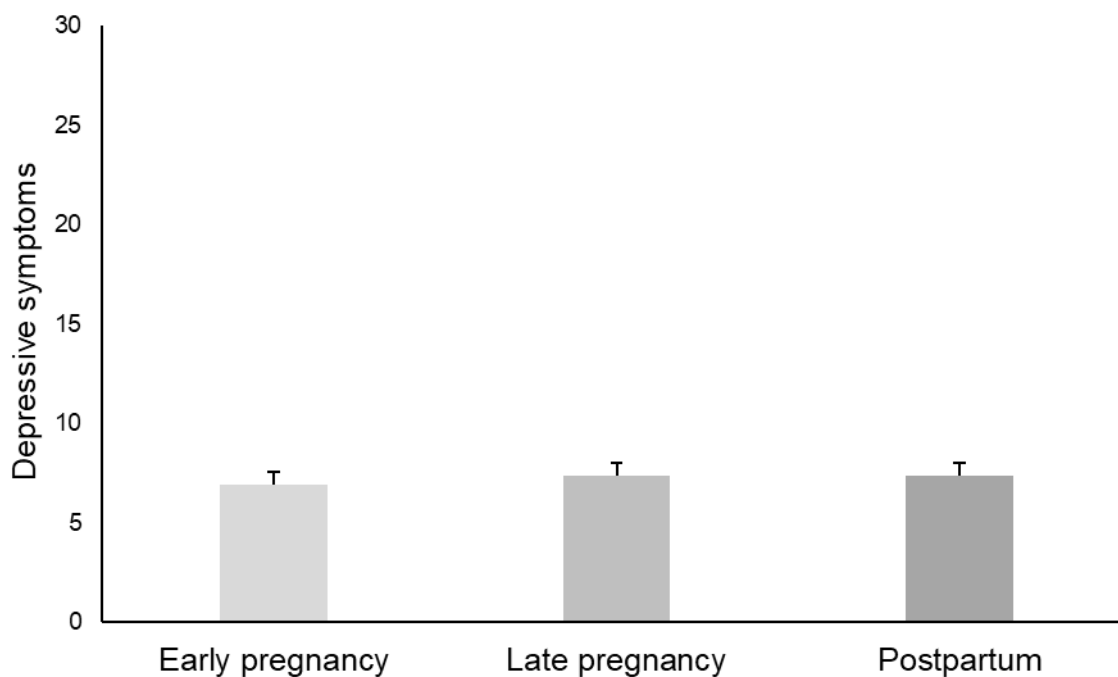
Of the initial sample of 229 pregnant women who were recruited for the first assessment interview (T1), 95 did not participate at the second assessment three months later (T2) or at the postpartum assessment (T3), which left a final sample of 134 resulting in a 58.5% participation rate in the entire study. Due to high dropout, we performed preliminary analyses to test if there were significant differences in the amount of depressive symptoms, body (dis)satisfaction and interoceptive sensibility between pregnant women who participated only in the first assessment and those who completed the three waves of the study. The statistical analyses revealed no significant differences between the two groups. Specifically, t-tests performed on the EDPS and BASS scores showed that the two groups of pregnant women did not differ for the amount of depressive symptoms ($t(226)=1.550$; $p=0.123$) and for the amount of body (dis)satisfaction ($t(221)=1.098$; $p=0.273$) respectively. The two groups did not differ either for the amount of interoceptive sensibility, i.e., the interaction Group x MAIA subscale was not significant ($F(5.00, 1005.53)=0.610$, $p=0.693$). The two samples were comparable also considering demographic variables, namely age ($t(149)=1.296$;

$p= 0.197$), education ($t(226)= -0.502$; $p= 0.616$), marital status ($\chi^2(3)= 2.894$, $p= 0.408$), month of pregnancy ($\chi^2(2)= 0.344$, $p= 0.842$), parity status ($\chi^2(1)= 0.043$, $p= 0.837$), and BMI ($t(223)= -0.590$; $p= 0.556$).

3.2. Depressive symptoms changes

The repeated measures ANOVA with a Greenhouse-Geisser correction showed no significant effect of the factor Time $F(1.76, 233.84)= 0.587$, $p= 0.536$, $\eta^2= 0.04$. Therefore, our data did not show changes in depressive symptoms over pregnancy and in the postpartum. Results are represented in Figure 1.

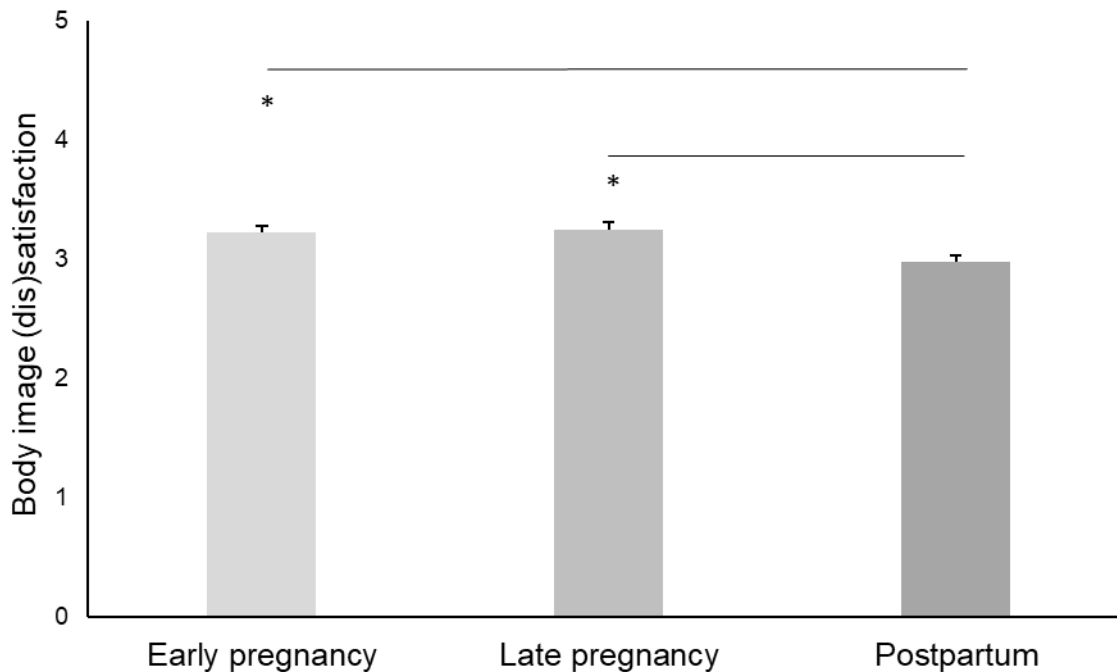
Figure 1 Depressive symptoms during pregnancy and in the postpartum. No significant changes of depressive symptoms over the peripartum emerged from the ANOVA.



3.3. Body image (dis)satisfaction changes

The repeated measures ANOVA with a Greenhouse-Geisser correction showed a significant effect of the factor Time $F(1.89, 251.54)= 18.59$, $p< 0.001$, $\eta^2= 0.123$. Post hoc tests using the Bonferroni correction showed that during the postpartum women's body dissatisfaction significantly increased compared to the early and late phases of pregnancy ($ps< 0.001$). Results are represented in Figure 2.

Figure 2 Body image (dis)satisfaction measured across pregnancy and in the postpartum. Results from the ANOVA show that women were significantly less satisfied of their bodies during the postpartum than during pregnancy. * $p < 0.001$.

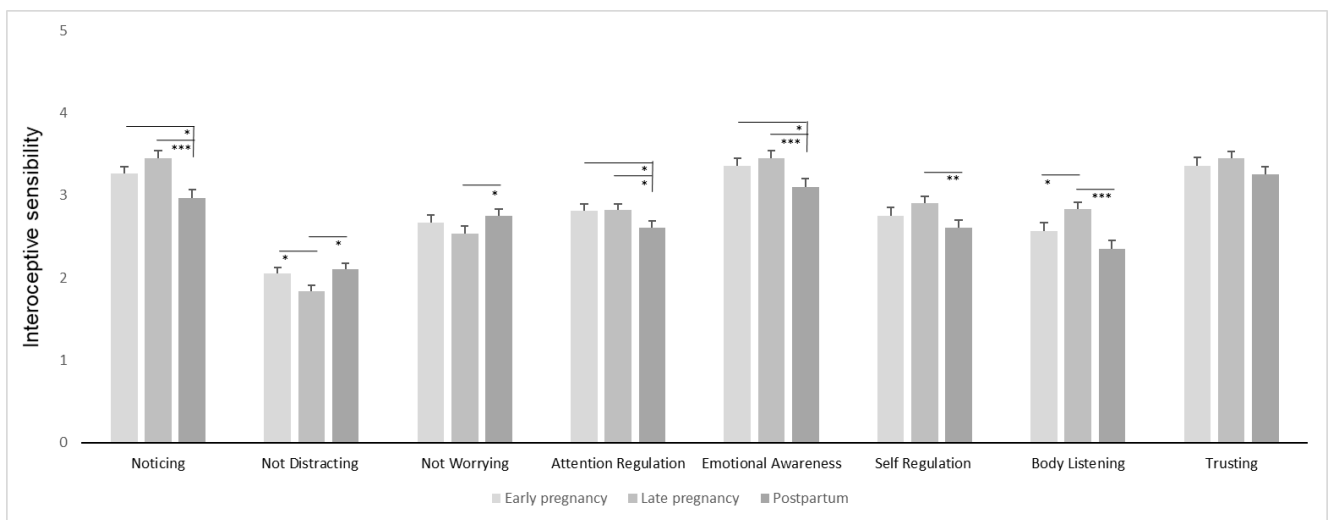


3.4. Interoceptive sensibility changes

The repeated measures ANOVA with a Greenhouse-Geisser correction showed a significant effect of the factor Time $F(1.88, 250.97) = 9.65, p < 0.001, \eta^2 = 0.068$ and a significant effect of the factor Subscale $F(4.74, 630.28) = 53.39, p < 0.001; \eta^2 = 0.286$. The main effects were further defined by a significant Time x Subscale interaction $F(9.94, 1321.45) = 6.09, p = 0.001; \eta^2 = 0.044$. Post hoc tests using the Bonferroni correction showed that women were more able to notice or become aware of internal body sensations (*Noticing*) in both early and late phases of pregnancy compared to the postpartum (MT1= 3.26 vs MT3= 2.97, $p = 0.022$; MT2= 3.45 vs MT3= 2.97, $p < 0.001$); ignore less sensations of pain or discomfort (*Not-distracting*) during the last period of their pregnancy compared to the early phase and the postpartum (MT1= 2.05 vs MT2= 1.84, $p = 0.023$; MT2= 1.84 vs MT3= 2.10, $p = 0.019$); were more worried about or experienced more emotional distress in response to sensations of pain or discomfort (*Not-worrying*) in the last phase of pregnancy compared to the postpartum (MT2= 2.54 vs MT3= 2.75, $p = 0.021$); were more able to sustain and control the attention to body sensations (*Attention Regulation*) during pregnancy compared to the postpartum (MT1= 2.81 vs MT3= 2.61, $p = 0.031$; MT2= 2.82 vs MT3= 2.61, $p = 0.039$); were more aware of the link between emotions and body sensations (*Emotional Awareness*) during pregnancy

compared to the postpartum (MT1= 3.37 vs MT3= 3.10, $p= 0.021$; MT2= 3.45 vs MT3= 3.10, $p< 0.001$); were more able to regulate negative emotions by focusing attention on body sensations (*Self-regulation*) during the last period of their pregnancy compared to the postpartum (MT2= 2.91 vs MT3= 2.62, $p= 0.004$); were more able to listen to their body sensations (*Body Listening*) in the late phase of pregnancy compared to the early phase and to the postpartum (MT1= 2.57 vs MT2= 2.83, $p= 0.021$; MT2= 2.83 vs MT3= 2.35, $p< 0.001$). Results are represented in Figure 3.

Figure 3 Interoceptive sensibility during pregnancy and in the postpartum. * $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$



3.5. Predictors of postpartum depressive symptoms

We correlated postpartum depressive symptomatology with changes in body image (dis)satisfaction and with the eight dimensions of interoceptive sensibility measured during pregnancy (T1 and T2) by means of the MAIA questionnaire. Correlations among the variables considered are reported in Table 1 of Supplemental Materials. The not worrying subscale of the MAIA questionnaire measured at the initial phase of the pregnancy and the changes in body image (dis)satisfaction (BASS at T3 – BASS at T1) were significantly correlated with postpartum depressive symptoms, therefore were included in the ensuing regression analysis performed to predict postpartum depressive symptoms

In order to test if and to what extent body image (dis)satisfaction and interoceptive sensibility significantly predicted postpartum depressive symptoms, once depressive symptoms measured in the initial phase of pregnancy were taken into account, a hierarchical regression analysis was run. Depressive symptoms measured at the beginning of pregnancy were inserted at step one of the

regression model. At step two, changes in body image (dis)satisfaction (BASS at T3 – BASS at T1) and interoceptive ability (i.e., the Not Worrying subscale of the MAIA) measured at the beginning of the pregnancy were entered.

Results indicated that, at step one, depressive symptoms measured at the beginning of pregnancy significantly predicted postpartum depressive symptoms ($\beta= 0.231, p= 0.007$). This step accounted for 4% of the variance in the level of postpartum depressive symptoms. At step two, changes in body (dis)satisfaction and interoceptive sensibility measured in the first phase of pregnancy were added. Taken together, the three predictors accounted for 13% of the variance in the level of depressive symptoms in the postpartum. Thus, being less satisfied with one's own body during pregnancy ($\beta= -0.266, p= 0.002$) and being more worried and experiencing more emotional distress in the initial phase of pregnancy ($\beta= -0.222, p= 0.008$), predicted higher levels of depressive symptoms in the postpartum. Results of the regression analysis are reported in Table 2.

Table 2 Hierarchical multiple regression model and results. Results show that once depressive symptoms in the first phase of pregnancy are taken into account both changes in body satisfaction and interoceptive sensibility measured in the first phase of pregnancy significantly predict postpartum depressive symptomatology. * $p < 0.01$.

| Variable | Total R² | ΔR^2 | ΔF | β | t | p-value |
|---|----------------------------|--------------------------------|------------------------------|---------------------------|----------|----------------|
| <i>Step 1</i> | 0.053 | 0.053* | 7.435* | | | |
| Early pregnancy depressive symptoms | | | | 0.231 | 2,727 | 0.007 |
| <i>Step 2</i> | 0.153 | 0.099* | 7.626 | | | |
| Early pregnancy depressive symptoms | | | | 0.215 | 2.617 | 0.010 |
| Change in body (dis)satisfaction | | | | -0.266 | -3.237 | 0.002 |
| Early pregnancy interoceptive sensibility | | | | -0.222 | -2.673 | 0.008 |

4. Discussion

The present study aimed to explore changes in depressive symptoms, body (dis)satisfaction, and interoceptive sensibility during the peripartum period and establish their impact on the onset of postpartum depression symptoms. To test our hypotheses, we performed a longitudinal study in which we administered a series of standardized questionnaires to a sample of healthy pregnant women in three specific moments of their pregnancy, i.e. when they were at the second trimester of pregnancy (T1), three months later in the last trimester (T2) and in the postpartum period (T3).

Our findings indicated that depressive symptoms remained stable along the peripartum period with no difference between pregnancy and postpartum evaluations. This stability is consistent with previous studies which used repeated measures of depression both before and after the delivery (Heron et al., 2004; Skouteris et al., 2009), however are in contrast with some other studies reporting higher depressive symptoms in the postpartum period (Chan et al., 2020; Sidebottom et al., 2012).

Differently from depressive symptoms, and consistently with our hypotheses and previous studies (Baker et al., 1999; Clark et al., 2009; Rallis et al., 2007), our findings show that pregnant women were most likely to experience higher levels of body dissatisfaction in the postpartum compared to the early and late phases of pregnancy. This is in line with the idea that, while during pregnancy women are prepared and accept body changes as part of a normal transition to a mother role and recognised the functionality of the pregnant body (Watson et al., 2016), after the delivery they may lose the justification of their pregnant status and may no longer feel protected from the cultural pressure to achieve an ideal body shape or size (Davies and Wardle, 1994; Loth et al., 2011).

Moreover, higher levels of dissatisfaction toward the body in the postpartum period may also be due to women's desire to return to pre-pregnancy body size and standards (Rallis et al., 2007; Silveira et al., 2015).

Concerning interoceptive sensibility, in line with our hypotheses, our findings indicated that, during both early and late phases of pregnancy, compared to the postpartum, women were more aware of the sensations coming from inside the body, also they were more aware of the connection between these sensations and their emotional states, and reported higher abilities to sustain and control attention to their body sensations. Moreover and interestingly, pregnant women reported to listen more actively to their inner body signals and to ignore less sensations of pain or discomfort over their pregnancy (i.e. from the early to late phases) compared to the postpartum. They also showed to be more worried about or experience more emotional distress in response to sensations of pain or discomfort in the late phase of pregnancy compared to the postpartum. Finally, they reported to be less able to regulate distress by focusing on body sensations during the postpartum compared to the late phases of pregnancy. This is in line with evidence that shows that the postpartum period may be a very stressful moment that poses great biological and psychosocial changes the life of a women (Obrochta et al., 2020) due for example to frequent awakening during the night (Clout and Brown, 2015; Hunter et al., 2009) or perceptions of not being able to care properly for the child (Law et al., 2019).

To the best of our knowledge, this is the first study that tests how interoceptive sensibility varies in the peripartum period. Indeed, only one recent study (Kirk and Preston, 2019) measured

interoception in the pregnant population, but it did not tested its changes. We think that the greater attention to internal bodily signals found in the late phase of pregnancy could constitute an adaptive behaviour aimed at safeguarding the health and the life of the foetus. We speculate that increased awareness and attention to body sensations and the tendency to listen to the body from the inside actively, could be due to tangible physiological and hormonal changes (Murphy et al., 2019). Indeed during pregnancy, women report an heightened cardiac output and oxygen consumption as well as few gastrointestinal changes that could result in nausea and vomiting (Hill and Pickinpaugh, 2008; Murphy et al., 2019). These changes occur progressively as the fetus develops and physical movements increase (Schmied and Lupton, 2001). Future studies need to evaluate if increased sensibility toward body signals is a function of the hormonal or physiological changes characterizing pregnancy status and, if this increased attention toward body sensations extends to the other dimensions of interoception, i.e. interoceptive accuracy and awareness.

The final aim of the present study was to identify possible risk factors for developing depressive symptoms in the postpartum period. Results from the hierarchical regression analysis show that increased body image dissatisfaction experienced over time and lower levels of interoceptive sensibility (specifically the increased tendency to experience emotional distress when uncomfortable painful sensations coming from within the body are experienced) measured in the first phase of pregnancy, predicted the strength of depressive symptoms measured after the delivery. The predictive power of these variables did not disappear when we controlled for participants' initial levels of depressive symptoms. These results are in line with previous evidence showing that initial levels of depressive symptoms strongly predict the strength of postpartum depression (e.g. O' Hara, Rehm & Campbell, 1982) and highlight the role of both body image dissatisfaction and, for the first time, of interoceptive sensibility in the postpartum depressive symptoms. Specifically, our results confirm previous evidence supporting the idea that body image dissatisfaction may be considered an independent risk factor for postpartum depressive symptoms (Chan et al., 2020; Elise et al., 2019; Kirk and Preston, 2019) even if other studies suggest that a reverse association between the two variables is also possible (Silveira et al., 2015). Moreover, and importantly, our results shed new light on an until-now neglected possible risk factor of postpartum depression, namely interoception and specifically, sensibility and preoccupation towards uncomfortable body sensations. Even if interoceptive awareness intuitively characterizes pregnancy and may be related to concepts related to the emotions of fear and sadness (Connell et al., 2018), no studies measured its role until now. Interoception dysregulation has been linked to greater depressive symptoms (Harshaw, 2015; Khalsa et al., 2018; Paulus and Stein, 2010) in non-pregnant samples, and women generally reported heightened attention to internal sensations and more somatic complaints

compared to males (Grabauskaitė et al., 2017; Murphy et al., 2019). Furthermore, our results are in line with the idea that worry and emotional distress in response to uncomfortable or painful sensations are generally associated with several features of emotion dysregulation and with a worst management of negative body sensations (Mehling et al., 2012). Consistently, findings from the present study evidenced that the tendency to worry about the internal signals of the body at the beginning of pregnancy predicts postpartum depressive symptoms.

Many studies reported the efficacy of intervention based on mind and body interconnection, relaxation, exploration of internal experience and self-management in the pregnant population, supporting the crucial role of interoception in the onset of postpartum depressive symptoms (Duncan et al., 2017; Pan et al., 2019; Satyapriya et al., 2013). Future studies need to investigate if interventions aimed to increase interoceptive sensibility might be useful in preventing depressive symptoms.

5. Limitations

Some limits of the study need to be acknowledged. First, we used a convenience sample which limits the representativeness and generalization of the results. Second, we asked women to answer a self-reported measure of depressive symptoms. Although the instrument we used is well-validated and broadly used, an interview with a clinician would be preferable as well as it would be worthwhile to evaluate how dissatisfaction and interoception interact with depressive symptoms over a clinical population of depressed women. Third, in this study, we measured a single dimension of interoception, i.e., interoceptive sensibility, by using a self-report questionnaire. Future studies may confirm current results by also measuring interoceptive accuracy and interoceptive awareness through more objectively tasks. Finally, it would be fundamental to unveil the bio-behavioural mechanisms at the basis of the increase of the interoception over pregnancy by focusing on the physiological changes related to the pregnancy status.

6. Conclusions

Overall, this longitudinal study suggests that while body image dissatisfaction and interoceptive sensibility vary over the peripartum period, depressive symptoms remain stable. Specifically, body image dissatisfaction increased in the postpartum with respect to the pre-pregnancy and the pregnancy period. From what concerns interoceptive sensibility, our results show that pregnancy (especially the late phase) is associated with an increase of interoceptive sensibility in women. Moreover, the change in body (dis)satisfaction through pregnancy and lower levels of interoceptive

sensibility measured in the early phase of pregnancy were predictors for the onset of depressive symptoms after the delivery. Future studies should investigate if and how pregnancy affects the multidimensional nature of interoception and identify the mechanisms that can lead to these changes. Moreover, additional studies are needed to identify the physiological mechanisms that lead to postpartum depression. This is fundamental to find novel interventions to support and help women during this crucial transition period.

Declaration of interest: none.

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Figure 1 Depressive symptoms during pregnancy and in the postpartum. No significant changes of depressive symptoms over the peripartum emerged from the ANOVA.

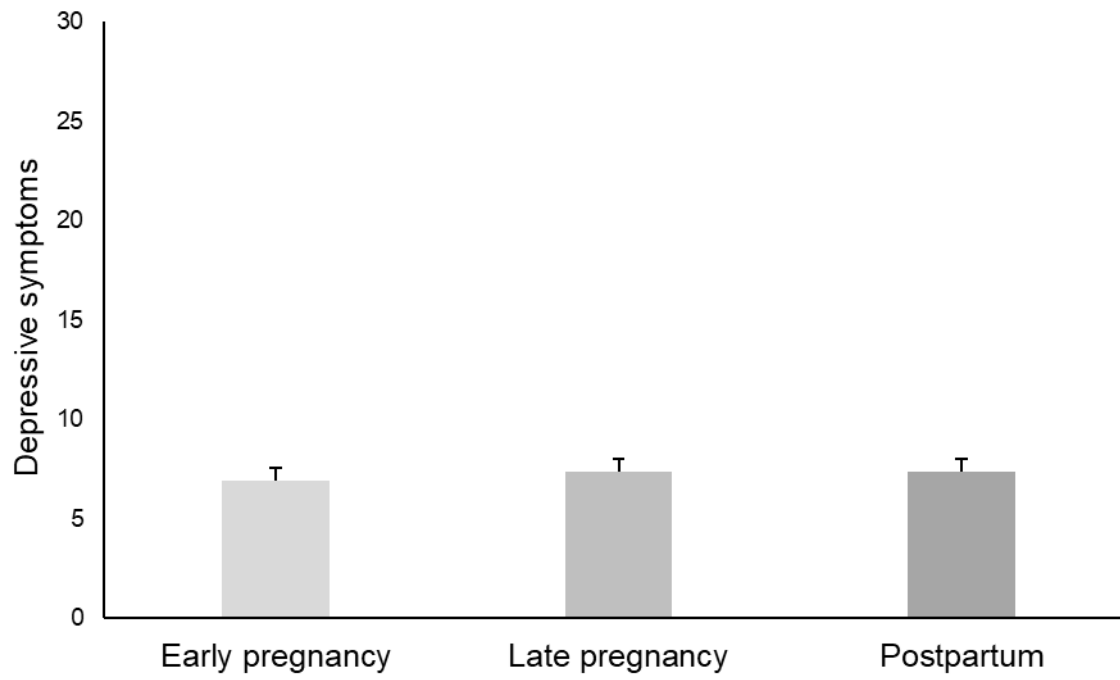


Figure 2 Body image (dis)satisfaction measured across pregnancy and in the postpartum. Results from the ANOVA show that women were significantly less satisfied of their bodies during the postpartum than during pregnancy. * $p < 0.001$.

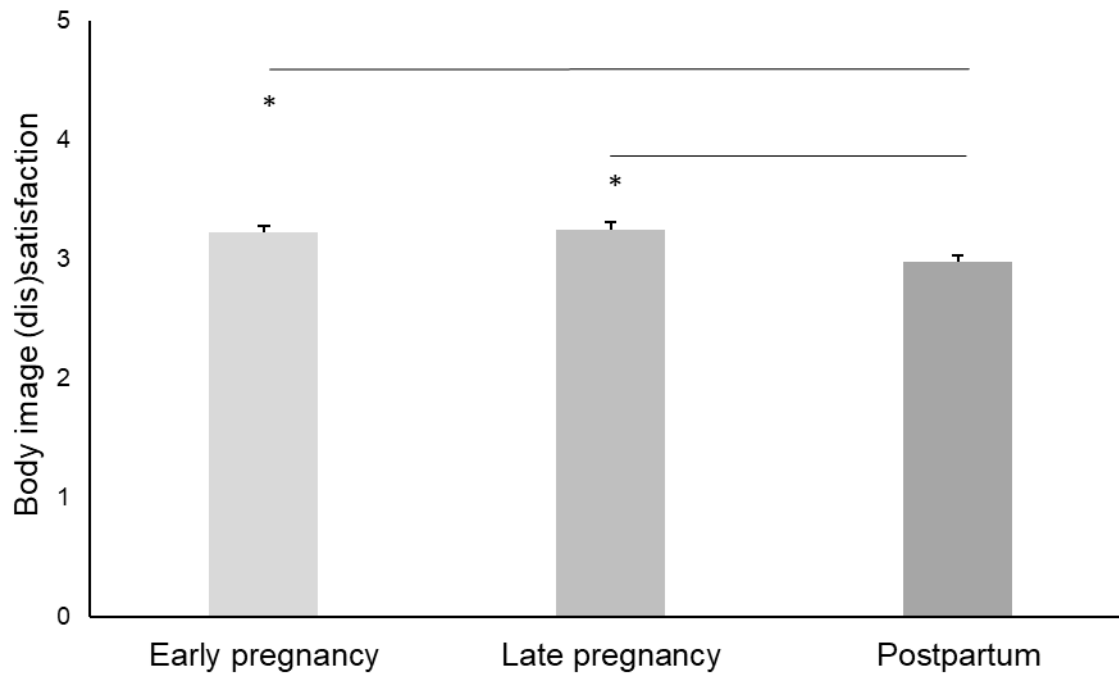


Figure 3 Interoceptive sensibility during pregnancy and in the postpartum. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

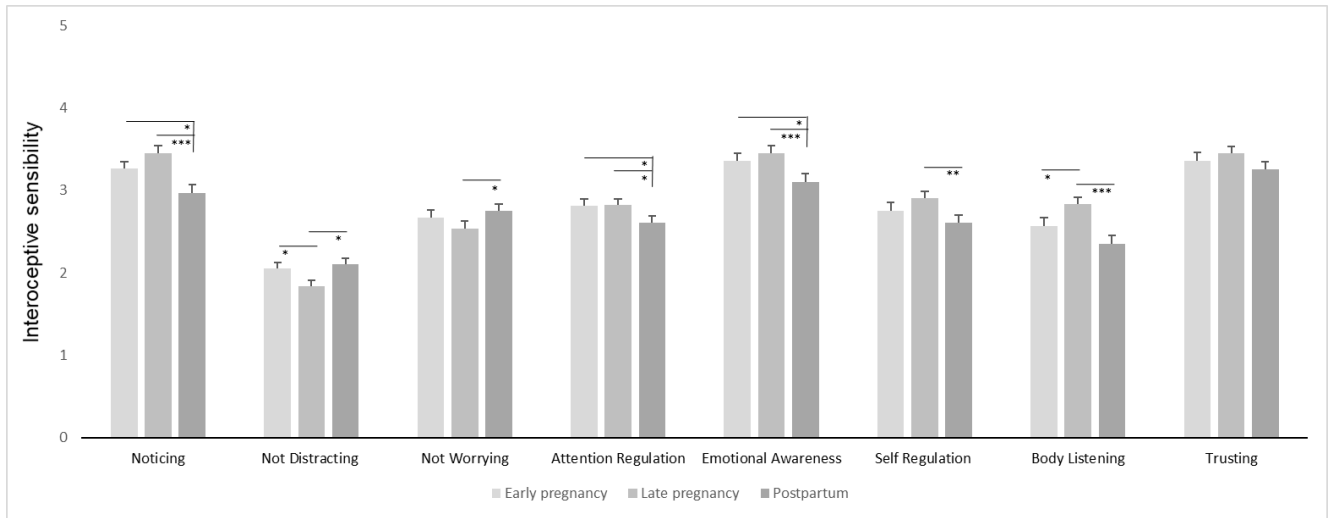


Table 1 Sociodemographic and anthropometric description of the final sample of pregnant women (N = 134)

| Variable | N (%) or Mean \pm SD |
|---|--|
| Age | 31.93 \pm 4.84 |
| Nationality | |
| Italian | 132 (98.5) |
| Other Countries | 2 (1.5) |
| Education | |
| Middle School | 8 (6) |
| High School | 51 (38) |
| Bachelor | 22 (16.4) |
| Master's degree | 37 (27.6) |
| Post-lauream specialization courses | 6 (4.5) |
| PhD | 10 (7.5) |
| Marital status | |
| Married | 60 (44.8) |
| Committed relationship, but not married | 68 (50.7) |
| Single/casually dating | 6 (4.5) |
| Month of pregnancy (T1) | |
| 4th | 60 (44.8) |
| 5th | 58 (43.3) |
| 6th | 16 (11.9) |
| Parity status | |
| Primiparous | 78 (58.2) |
| Multiparous | 56 (41.8) |
| BMI | |
| T1 | 25.23 \pm 4.38 |
| T2 | 27.17 \pm 4.06 |
| T3 | 25.32 \pm 4.23 |

Table 2 Hierarchical multiple regression model and results. Results show that once depressive symptoms in the first phase of pregnancy are taken into account both changes in body satisfaction and interoceptive sensibility measured in the first phase of pregnancy significantly predict postpartum depressive symptomatology. * $p < 0.01$.

| Variable | Total R² | ΔR² | ΔF | β | t | p-value |
|---|----------------------------|-----------------------|-----------|----------|----------|----------------|
| <i>Step 1</i> | 0.053 | 0.053* | 7.435* | | | |
| Early pregnancy depressive symptoms | | | | 0.231 | 2,727 | 0.007 |
| <i>Step 2</i> | 0.153 | 0.099* | 7.626 | | | |
| Early pregnancy depressive symptoms | | | | 0.215 | 2.617 | 0.010 |
| Change in body (dis)satisfaction | | | | -0.266 | -3.237 | 0.002 |
| Early pregnancy interoceptive sensibility | | | | -0.222 | -2.673 | 0.008 |

Declarations of interest: none.

Author statement

Author contributions

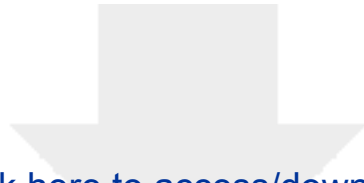
C.G. and G.P. conceived the study, C.S.S, G.P. and C.G., analyzed data, C.S.S., G.P. and C.G., wrote the original draft and CG revised the manuscript. C.V. help in the revision of the manuscript. All authors read and agreed to the published version of the manuscript.

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Supplementary Material

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