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Original Research

The role of interoceptive sensibility on central sensitization to pain in vulvodynia

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Abstract

Background: Interoception may be linked to central sensitization in chronic pain.
Aim: We aimed to provide evidence about the role of interoceptive sensibility on central sensitization in vulvodynia.
Methods: In this cross-sectional study, a sample of females who received a diagnosis of vulvodynia filled out validated questionnaires relative to the individual level of interoceptive sensibility and the symptoms of central sensitization.
Outcomes: Interoceptive sensibility and symptoms of central sensitization were measured with the Multidimensional Assessment of Interoceptive Awareness and the Central Sensitization Inventory, respectively.
Results: A lower level of trust and a higher level of emotional awareness predicted a higher number of central sensitization symptoms in our sample.
Clinical Implications: Our evidence may increase the researchers' and physicians' attention toward the involvement of the central nervous system in pain phenomenology in vulvodynia.
Strengths and Limitations: No ad-hoc control sample was collected. No behavioral assessments about interoception were performed.
Conclusion: As registered in other chronic pain conditions, interoceptive sensibility may play a crucial role in the expressions of symptoms of central sensitization in vulvodynia.

Keywords: vulvodynia; chronic pain; interoception; interoceptive sensibility; central sensitization.

Introduction

The individual's level of confidence about bodily perceptions, together with the ability to decodebodily signals, is crucial to forming an efficient body representation[1,2]: it is called *interoceptive sensibility*.[3] This ability, which is traditionally assessed through self-report questionnaires, along with *accuracy* (the objective level of accuracy in detecting changing bodily signals measured through behavioral tasks) and *metacognitive awareness* (the relationship between self-perceived accuracy and actual accuracy), form *interoception* (i.e., the sense that allows to perceive internal bodily state[1,3,4]). Interoceptive sensibility may be conceived as a trait-like feature.[5] Thus, people with high expressions of this trait may be more efficient in detecting and regulating symptom-related distress by paying attention toward sensory sensations, and reducing the tendency to worry about uncomfortable symptoms, with a positive impact on symptom management.[6-9] Notably, some studies underlined the pivotal role of interoception in sexual functioning[10-12]: sexual difficulties may be linked to lower levels of interoceptive awareness.

In the past few decades, we have fostered a growing interest about interoception in chronic pain. In this context, pain is considered a bodily signal, "*a feeling from the body*",[13] generated by specialized circuits in the central nervous system, including the insular cortex. Very recently, Locatelli and colleagues[9] reviewed the existing literature to understand how interoception may shape the subjective experience of symptoms in individuals suffering of a chronic disease (including chronic pain conditions). All the interoceptive subdimensions (i.e., sensibility, accuracy, and awareness) seemed to influence the perception of pain-related symptoms. Crucially, the higher the interoceptive sensibility, the less pain is perceived as excessive and unmanageable. However, this evidence contrasted with the results reported in another study by Di Lernia and colleagues[14]: they reported inconclusive evidence about this relationship in primary or secondary chronic pain.

The present study aimed to provide evidence about interoceptive sensibility in vulvodynia. This clinical condition was not included in the previous reviews[9,14] because of no available data in the literature. Vulvodynia is a chronic pain condition, with a severe impact of pain-related symptoms on bodily experience and quality of life. Vulvodynia is a "*vulvar discomfort, most often described as burning pain without relevant visible findings or a specific, clinically identifiable, neurologic disorder*".[15] It is characterized by high inter-individual variability in terms of symptoms: some women report sensation like burning or itching, others report stinging or irritation. Pain may be localized to one area or generalized to the entire

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vulva. Direct (ie, inserting a tampon or sexual intercourse) as indirect (ie, walking) situations may trigger pain; in some cases, pain emerges even without a clear provocation. The origin of vulvodynia is uncertain and still a matter of debate. It is a diagnosis of exclusion, but there is an overall consensus in considering its origin as multifactorial.[16] As observed for other chronic pain conditions,[17-19] in vulvodynia the development and maintenance of pain-related symptoms may be due to alterations in both peripheral and central mechanisms.[20-23] Levesque and colleagues[24] suggested the pain-related experience in vulvodynia as an effect of *central sensitization*. This definition refers to a hypersensitivity (signaled by increased brain activity) of those cerebral areas (ie, insula, anterior cingulate cortex, and prefrontal cortex) involved in acute pain processing, and in other cerebral regions (various brain stem nuclei, dorsolateral frontal cortex, and parietal associated cortex).[25] Moreover, central hypersensitivity may cause injury or inflammation in the (peripheral) body areas.[25] This condition emerges when the central nervous system change, distort or amplify the pain-related sensation, increasing its degree, duration, and spatial extent (such as reduction in threshold, exaggerated response to a noxious stimulus, pain after the end of a stimulus, and a spread of sensitivity to normal tissue).[26] According to Pukall and Cahill,[27] vulvodynia may be characterized by central sensitization, since the recognition of other (not-vulva related) symptoms, including allodynia, lowered pain thresholds, spontaneous pain, and hyperalgesia, as in other chronic pain conditions.

In this research, we aimed to verify if interoceptive sensibility[3,4] may play a role in the expression of symptoms of central sensitization, measured through the Central Sensitization Inventory (CSI,[28]), in a sample of females who had received a diagnosis of vulvodynia. The link between interoception and central sensitization is far away to being fully understood.[18,29] However, the hypothesis is that a maladaptive interoception, which mirrors the individual tendency to avoid, ignore, or suppress perceptions of bodily sensations, may enhance hypersensitivity in central pain processing.[18,29] Colgan and colleagues[29] reported seminal evidence about this hypothesis in a sample of individuals with chronic pain. The authors used the traditional Multidimensional Assessment of Interoceptive Awareness questionnaire,[30] which measures individual beliefs about own ability to perceive and interpret bodily perceptions. The authors observed some components of interoception sensibility (not-distracting, not-worrying, body trusting, and emotional awareness) as associated with the manifestation of symptoms of central sensitization. Would lower levels of interoceptive sensibility predict a higher number of central sensitization symptoms in the context of the vulvodynia?

Methods

This study was approved by the Bioethics Commission of the University of Turin (Prot. n. 0271630) and it was performed accordingly to the Declaration of Helsinki's principles. Individuals gave their written consent to participate before any procedure. They were volunteers and they were free to withdraw at any point during the study. They were not remunerated for their participation.

Data were collected in Italy from September 1, 2022 and February 28, 2023. Participants were enrolled if they spoke a fluent Italian language, since the use of self-report questionnaires. Only females (sex assigned at birth) were included in the study. Recruitment and diagnostic assessment were performed by one of the authors, who is a gynecologist with expertise in the field of vulvodynia. To include participants in this study, we referred to the "2015 classification" proposed by the International Society for the Study of Vulvovaginal Disease, the International Society for the Study of Women's Sexual Health, and the International Pelvic Pain Society. This classification describes vulvodynia as an idiopathic vulvar pain of at least 3 months' duration, without a clear, identifiable cause.[31] Since it is a diagnosis of exclusion, other causes were excluded, such as: infections, inflammation, neoplastic disorders, neurologic disorders, vulva trauma, leading to pain, estrogen deficiencies, iatrogenic causes. Moreover, participants were included in this study if they reported pain at the cotton swab test, and dyspareunia.

For each participant, we collected demographic and clinical information, as shown in Table 1. We asked participants to rate the subjective level of vulvar pain on a scale from 0 to 10 during sexual activities in the genital area in the last month, or the previous experience if the participant was not sexually active at the time of the survey.

All participants filled out the Italian version of the DASS-21,[32] which assesses an individual's emotional conditions related to depression, anxiety, and stress, through 21 items with a Likert scale ranging from 0 (no applicability) to 3 (high applicability). Since the individual expression of depression and anxiety symptoms negatively impacts on affected individual's quality of life,[33-35] we computed the score relative to the anxiety and depression subscales. Each subscale has a score range of 0 to 42, where higher scores in each subscale indicate greater levels of depression or anxiety, respectively. According to the seminal article, the reliability coefficients of Cronbach's alpha were 0.81 for the depression scale and 0.89 for the anxiety scale.

Our participants completed the Female Sexual Function Index (FSFI)[36] in its Italian validation[37] to assess sexual function among our participants. Comprising 19 items, this questionnaire covers six domains of sexual function: desire, arousal, lubrication, orgasm, satisfaction, and pain. Each item is scored on a scale (eg, 1 to 5), and domain scores are derived by summing relevant item scores. The total FSFI score, ranging from 2 to 36, provides insights into the participant's overall sexual function with higher scores representing lower levels of sexual dysfunction. A FSFI total score of 26 has been identified as the optimum cutoff for the presence of sexual dysfunction. According to the seminal article, Cronbach's alpha coefficients for total and domain scores were sufficiently high, ranging from 0.92 to 0.97.

Interoceptive sensibility

The Italian version[38] of Multidimensional Assessment of Interoceptive Awareness (MAIA,[30]) was used. It consists of 32 items on a six-point Likert scale, in which the participant has to rate "how often each statement applies to you generally in daily life," with ordinal responses coded from 0 ("never") to 5 ("always"). The interoceptive sensibility is measured multidimensionally on eight scales: (1) *noticing*, meaning the level of individual awareness about bodily sensations (4 items); (2) *not-distracting*, suggesting that an individual tend to not ignore or suppress bodily sensations of pain or discomfort (3 items); (3) *not-worrying*, meaning that people do not report emotional distress or worry about bodily sensations of pain

Table 1. Demographical and clinical information is reported for the included sample of participants ($n = 104$).

	Descriptive results	
Age in years	M = 32.5; SD = 10.23; range = 17–70	
Education in years	M = 15.66; SD = 2.4; range = 8–18	
Marital status	Married	*n* = 25 (24.03 %)
	Common-law wife	*n* = 31 (29.8 %)
	Divorced	*n* = 2 (1.92 %)
	Unmarried	*n* = 46 (44.23 %)
Children	No	*n* = 85 (81.73 %)
	Yes	*n* = 19 (18.26) about which: One child *n* = 10 (5.63 %) Two children *n* = 8 (4.1 %) Three children *n* = 1 (5.26 %)
Clinical characteristics		
Time from diagnosis	More than 24 months	*n* = 18 (17.3%)
	In the previous 24 months	*n* = 10 (9.61%)
	In the previous 12 months	*n* = 22 (21.15 %)
	In the previous 6 months	*n* = 15 (14.42 %)
	In the previous 3 months	*n* = 19 (18.26 %)
Time from symptoms onset (ie, pain duration)	Around 6 months	*n* = 7 (6.73 %)
	Around 12 months	*n* = 4 (3.84 %)
	More than 12 months, but less than 3 years	*n* = 32 (30.76 %)
	More than 3 years, but less than 5 years	*n* = 18 (17.3 %)
	More than 5 years	*n* = 43 (41.34 %)
Type of pain	Localized	*n* = 69 (66.34 %)
	Generalized	*n* = 35 (33.65 %)
Trigger of pain	Provoked	*n* = 50 (48.07 %)
	Spontaneous	*n* = 6 (5.76 %)
	Mixed	*n* = 48 (46.15 %)
Timing	Primary (the pain is present since its first manifestation)	*n* = 77 (74.03 %)
	Secondary (the pain occurs after 6 months of no pain symptoms)	*n* = 27 (25.96 %)
Presence of other pain-related diseases	*n* = 22 (21.25 %)	
Drugs	Local	*n* = 69 (66.34 %)
	Oral	*n* = 80 (76.92 %)
	Pelvis therapy	*n* = 50 (48.07 %)
Gynecological surgery	*n* = 14 (13.46 %)	
Level of subjective pain (0–10)	Overall sample	M = 7.01; SD = 2.29; range = 0–10
	Current sexual activity	*n* = 68; M = 6.44; SD = 2.37; range = 0–10
	Previous experience (no current sexual activity)	*n* = 36; M = 8.11; SD = 1.66; range = 3–10
Anxiety Symptoms—from DASS-21 (0–42)		M = 14.60; SD = 8.67; range = 0–38
Depressive symptoms—from DASS-21 (0–42)		M = 18.85; SD = 9.31); range = 0–36
Sexual functioning—from Female Sexual Function Index (0–36)		M = 8.91; SD = 3.36; range = 2.16–15.74

or discomfort (3 items); (4) *attention regulation*, indicating the individual ability to manage the level of attention to body sensations (7 items); (5) *emotional awareness*, suggesting how an individual takes into account the relationship between bodily sensations and emotions (5 items); (6) *self-regulation*, indicating the individual ability in managing the level of psychological distress controlling the attention toward body sensations (4 items); (7) *body listening*, which is the tendency to pay attention to body for insight (3 items); and finally (8) *trusting*, which refers how an individual rates own body as safe and trustworthy (3 items). The score for each scale is computed by averaging the scores of its items (range from 0 to 5), with higher scores suggesting higher expressions of the interoceptive components investigated by the questionnaire. According to the seminal article, the Cronbach's alpha values varied between 0.53 and 0.80.

Central sensitization symptoms

We used the Italian version[39] of the CSI[28] to detect somatic (ie, sleep difficulties, level of physical energy, muscle tension; headaches, pain in the pelvic area) and emotional (ie, anxiety attacks, how stress makes physical symptoms get worse, level of sadness or depression) symptoms common to central sensitization. Specifically, we consider part A of the inventory: it includes 25 items, scored on a five-point Likert scale from 0 to 4. Higher total scores suggest higher symptomatology. A score of 40 is used as a significant threshold for the presence of central sensitization.[39] According to the seminal article, the Cronbach's alpha was equal to 0.87.

Data analyses

All the questionnaires were scored according to the seminal articles. Continuous factors will be reported as mean and standard deviation; categorical factors will be reported as frequency and percentage.

To verify possible alteration in interoceptive sensitivity, the sample's mean scores at the MAIA questionnaire[30] were compared with the Italian normative data (321 participants, aged between 19 and 27 years; mean age in years of 20.53,

SD = 0.88; the majority of the sample, $n = 293$, representing approximately 91 % of the total sample, were female (mean age = 20.49 years, SD = 0.85) provided by Calì and colleagues,[38] through an independent sample *t*-test computed using the two groups' mean, standard deviation, and sample size.

To verify if interoception sensibility may predict the level of central sensitization, we performed a stepwise regression analysis. Thus, the correlation and directionality of the data were investigated in a preliminary analysis to formulate the statistical model, using Pearson's correlation coefficient (Pearson's r). The scores relative to the subcomponents of MAIA that were significantly associated (P value $\leq .05$) with the main outcome (score at the CSI) were further investigated with a linear regression model. In this model, *age*, *pain duration* (ie, time from symptoms onset), and *pain intensity* were entered at the first step; the subscores relative to MAIA were entered at the second step. Goodness-of-fit was reported as R^2 and the significance of the model was evaluated by F-value and p-value. Finally, the relative contribution of the factors included in the statistical model with the dependent variable (score relative to the CSI) was verified. The variance inflation factor (VIF), as a measure of multicollinearity, was reported for each factor included in the model.

Results

Participants

Overall 190 agreed to participate, but only 104 participants completed the survey: they were included in the final sample. All the collected demographical and clinical information is reported in Table 1.

As reported in Table 1, 21.25 % ($N = 22$) of our participants declared to suffer of other pain-related conditions, that are migraine ($N = 4$), adenomyosis ($N = 3$), irritable bowel syndrome ($N = 3$), fibromyalgia ($N = 2$), endometriosis ($N = 2$), pudendal neuropathy ($N = 1$), and skeletal muscle pain ($N = 6$). 65.8 % of the sample reported to have sexual activity at the time of the survey, while 34.61 % reported to be not sexually active at the moment of the survey. According to the non-parametric Mann–Whitney test, the level of experienced pain was higher for those participants who were not sexually active at the time of the data collection in comparison with those who were active ($U = 694$; $P < 0.001$).

Interoceptive sensibility

In Table 2, we reported the scores at all the subscales of MAIA by our sample of participants.

When we compared the scores of our sample with the Italian normative data,[38] we observed significantly lower scores, suggesting a lower level of awareness, in the components of attention regulation, self-regulation, and trusting. Instead, higher scores (suggesting a higher level of awareness) were observed in the components of noticing and not-worrying. Finally, no difference was observed in the scores relative to the components of not-distracting, emotional awareness, and body listening.

In Table 3, we reported the correlational matrix relative to the different categories measured by MAIA questionnaire.

CSI

Our participants with vulvodynia reported a mean score of 45.62 (SD = 16.9; range = 11–88). Within our sample, 64 (61.53 %) participants reported a score higher than the threshold of 40, which indicates the presence of central sensitization.[39]

Bivariate correlations and regression model

The results relative to the analyses investigated the relationship between the scores from MAIA and the total score from the CSI are reported in Table 4.

A significant positive relationship emerged between the scores regarding the components of noticing, not worrying, and emotional awareness from MAIA with the total score from CSI. Instead, in the case of the score relative to trusting from MAIA, we observed a significant negative relationship.

Then, the regression model was performed. In step one, *age*, *pain duration*, and *pain intensity* were entered into the model; in step two, the scores relative to the components of *noticing*, *not worrying*, *emotional awareness*, and *trusting* as possible predictive factors of CSI *total score*. The model was significant [$R^2 = 0.36$; $F(4,99) = 14.4$; $P < .001$]. *Age* [b = -0.08; $t = -0.09$; $P = .92$; VIF = 1.044], *pain duration* [b = 0.01; $t = 0.13$; $P = .89$; VIF = 1.027], and *pain intensity* [b = 0.11; $t = 1.32$; $P = .17$; VIF = 1.018] were not significant. About the MAIA components, the score relative to *trusting* [b = -6.64; $t = -6.23$; $P < .001$; VIF = 1.224] and *emotional awareness* [b = 5.12; $t = 3.8$; $P < .001$; VIF = 1.581] significantly predicted the CSI score. No significant results emerged about *noticing* [b = 1.91; $t = 0.99$; $P = .32$; VIF = 1.359] and *not worrying* [b = 2.41; $t = 1.27$; $P = .2$; VIF = 1.078] scores. Overall, a lower level of trust and a higher level of emotional awareness predicted a higher number of central sensitization symptoms in our sample.

Discussion

Interoceptive sensibility, which is part of the larger concept of interoception, contributes significantly in modeling bodily experience,[2,5] especially in chronic pain disorders.[9,14] Moreover, some evidence—even though in its infancy—links interoception to central sensitization in chronic pain.[18] Because of these considerations, we verified if interoceptive sensibility was linked to symptoms of central sensitization in vulvodynia. The present results suggested the predictive role of some components of interoceptive sensibility on the number of symptoms of central sensitization, as reported in other chronic (including chronic pain) conditions.[9] In detail, in our sample, a higher number of central sensitization symptoms were linked to two components of interoceptive sensibility[30]: trusting and emotional awareness. A higher tendency to experience body as unsafe and untrustworthy (trusting) and a higher emotional awareness (meaning the tendency to focus attention on the connection between body and emotion) predicted a higher number of central sensitization symptoms. Overall, our results seemed in agreement with the evidence provided by Locatelli and colleagues[9] and Colgan and colleagues[29] about chronic pain: the subjective experience of body as unsafe and untrustworthy (trusting) and higher awareness about body sensations (noticing) are linked to emotional states (emotional awareness), whereas lower emotional and attentional responses to bodily sensations (not-distracting and not-worrying) seem to be related to a higher number of symptoms of central sensitization. If our results would be confirmed by future research, they would point out toward the role of interoceptive sensibility in shaping pain-related experience in vulvodynia. Notably,

Table 2. The mean (M), standard deviation (SD), and range for each component of the MAIA questionnaire are reported for the sample of participants of vulvodynia. We also report the comparison with the normative data. Significant differences are shown in bold.

	Noticing	Not distracting	Not worrying	Attention regulation	Emotional awareness	Self-regulation	Body listening	Trusting
Participants with vulvodynia ($n = 104$)								
M	3.48	2.76	2.79	2.44	3.37	2.04	2.39	2.48
SD	0.82	0.79	0.73	1.1	1.26	1.17	1.28	1.4
Range	1.75-5	0.67–4.67	0.33–5	0–5	0–5	0–5	0–5	0–5
Normative data (Calì and colleagues, 2015; $n = 321$)								
M	2.84	2.77	2.51	2.69	3.37	2.63	2.32	3.01
SD	0.97	1.06	1.01	0.77	0.85	0.9	0.94	1.09
Statistical difference (df = 423)								
t	6.06	0.0885	2.61	2.57	< 0.001	5.37	0.6	4.044
P value	**0.0001**	0.92	**0.009**	**0.01**	1	**0.0001**	0.54	**0.0001**
d'	0.71	0.01	0.31	0.26	0	0.56	0.06	0.42

Table 3. Pairwise correlation matrix among the scores reported at MAIA questionnaire. In bold, significant results [$P \leq 0.05$].

	Noticing	Not distracting	Not worrying	Attention regulation	Emotional awareness	Self regulation	Body listening	Trusting
Noticing	-	0.083	0.178	**0.247**	**0.497**	**0.277**	**0.310**	0.096
Not distracting	0.083	-	**-0.210**	0.152	0.073	**0.276**	0.169	**0.213**
Not worrying	0.178	**-0.210**	-	-0.053	0.148	0.004	-0.067	-0.132
Attention regulation	**0.247**	0.152	-0.053	-	**0.366**	**0.524**	**0.535**	**0.331**
Emotional awareness	**0.497**	0.073	0.148	**0.366**	-	**0.492**	**0.475**	**0.375**
Self regulation	**0.277**	**0.276**	0.004	**0.524**	**0.492**	-	**0.682**	**0.430**
Body listening	**0.310**	0.169	-0.067	**0.535**	**0.475**	**0.682**	-	**0.471**
Trusting	0.096	**0.213**	-0.132	**0.331**	**0.375**	**0.430**	**0.471**	-

N = 104

Table 4. Statistical results (Pearson's r and *P* value) relative to the relationship between the components of MAIA and the total score at the CSI. Significant results are shown in bold.

	CSI—total score	
	Pearson's r	*P* value
MAIA—noticing	**0.24**	(**0.01**)
MAIA—not distracting	0.002	(0.98)
MAIA—not worrying	**0.25**	(**0.01**)
MAIA—attention regulation	-0.14	(0.14)
MAIA—emotional awareness	**0.23**	(**0.01**)
MAIA—self-regulation	-0.076	(0.44)
MAIA—body listening	-0.049	(0.62)
MAIA—trusting	**-0.41**	(**<0.001**)

$n = 104$.

not all the same interoceptive components may be implicated in the expression of the symptoms across the different pain chronic conditions, since they can differ in terms of etiology and phenomenology of symptoms.

In this manuscript, we furnish some pivotal evidence about the possible alteration of interoceptive sensibility in vulvodynia. We observed significant differences in the scores reported by our sample in MAIA questionnaire[30] when compared with the Italian normative data.[38] This evidence is only partial, since we did not collect data about an ad hoc sample of women free from pain symptoms. However, since the lack of the evidence in field, we discuss these preliminary results to spot a light on this topic and increase the chance of future research with between-subjects methodological approaches. According to our results, our participants reported lower scores in the components of attention regulation, self-regulation, and trusting. On the other hand, higher scores were reported in terms of noticing and not-worrying. In different words, women with vulvodynia may experience difficulties in controlling the level of attention toward bodily sensations (attention regulation), about which they seemed to be very aware (noticing). Even though they describe a lower emotional distress in relation to their pain (not-worrying), they could have some difficulties in regulating the levels of psychological distress through mechanisms related to bodily sensation (self-regulation). This pattern may recall the coping strategy of suppression of negative emotions[40] with the aim to attune the emotional distress. This strategy is conceived as opposite to the acceptance, when the individual accepts and experiences the emotion, with no control-based or avoidance-based strategies.[40,41] Overall, women with vulvodynia may experience their own body as unsafe and untrustworthy (trusting), with a possible side-negative effect on their level of engagement in physical as well as social activities, enhancing the subjective perception of isolation.[35,42] Very interestingly, the subjective level of awareness about bodily sensation (noticing) and the tendency

to not ignore or distract themselves from the sensation of pain (not-distracting) may suggest that females with vulvodynia are very connected with their experienced pain. As a coping strategy, they may tend to not avoid pain; instead, they may psychologically integrate pain into their somatic experience. In other words, it is an *embodied pain*. With this definition, we refer to the concept of embodiment, which is the human sensation of having a body,[43] of being inside our body, and intentionally moving our body, interacting with the environment.[44] This sensation derives from the complex interaction between bottom–up peripherical input and top-down cognitive components.[45] In this framework, the sensory bottom-up (nociception) and top–down (cognitive beliefs and expectations) components of pain are part of this process, and thus individuals act taking into account (rather than denying) their painful (somatic) experience and their cognitions, beliefs, and emotions. In chronic pain conditions, an increased interoceptive sensibility may result in hypervigilance about pain[2,47-49]; as coping, affected people tend to act taking into account (rather than to avoid) the perceived pain. This mechanism mirrors the altered behavior observed in neuropsychological tasks investigating the body when involved in actions, such as the Hand Laterality Task[50] and the Mental Motor Chronometry Task[51] in different pain-related conditions[52-56]: all these studies agree in suggesting that chronic pain affects bodily actions. Further research may explore this concept also in the context of vulvodynia, taking advantage of a neuropsychological approach.

We underlined some limitations of this study. As previously stated, the absence of an ad-hoc control sample limited the data interpretation of the levels of MAIA score within the sample. Moreover, it should be noted that our sample was characterized by a wide age variability (range from 17 to 70; standard deviation of 10.23). The regression analysis did not show a predictive effect of age on the relationship between interoception and central sensitization. However, we cannot exclude the role played by age-related neurobiological aspects in the subjective experience of vulvar pain. Moreover, some of the collected information were not included in the statistical analyses because of the lack of data variability. However, it should be considered that about most of these factors (such as sexuality, type of pain, and trigger of pain), we had no a-priori hypothesis. As reported by Pukall,[57] although different pathophysiologic processes may be involved in the development and maintenance of vestibulodynia and general vulvodynia, the data in the literature were mixed. Larger samples are necessary to avoid the lack of data variability and to disentangle the role of inter-individual differences on the main outcome, larger samples are necessary.

We offer a final consideration about the tools used to assessed interoceptive sensitivity and symptoms of central sensitization. We used previously validated measurements; however, no behavioral assessments were performed. About interoception,[4] in this research we focused on its subjective dimension (ie, how well a person thinks he/she perceives interoceptive signals) which is generally measured through self-reported questionnaires, as MAIA.[30] Nevertheless, there is a more objective dimension of interoception, which is assessed through behavioral tasks. There is also the metacognitive interoceptive awareness, which refers to the correspondence between actual objective performance and subjective sense of interoceptive ability. These different dimensions of interoception are dissociable from each other.[4] Thus, our results pointing out toward a possible alteration of the subjective dimension of interoception (interoceptive sensibility) in vulvodynia would be not replicated in the other interoceptive dimensions. Similarly, we used a self-report questionnaire to measure symptoms of central sensitization. As underlined by Woolf,[26] pain-related sensory inflow cannot be directly measured, since it grounds mainly on individual report about pain perceptions. In the context of central sensitization, it should be also considered that peripheral changes can contribute to sensory amplification as well as peripheral input commonly is the trigger of central sensitization. Thus, to verify central sensitization, Woolf[26] signaled the need for detailed phenotyping of different patient cohorts to capture differences in pain sensitivity, combined with objective measures of central activity in the presence of nociceptive stimuli, such as fMRI or evoked-potentials. Some studies[22,58] used quantitative sensory testings (measuring pain sensibility with graded forceps or pressure stimulators for pressure pain sensibility,[59]), reporting an enhancement of local pain perception[60] and systemic pain perception[58] in vulvar vestibulitis syndrome. Here, we did not present any data about quantitative sensory testing. They are generally time-consuming. Moreover, they may enhance emotional distress in participants affected by chronic pain. Thus, the use of questionnaires, as the CSI,[28] which are designed to assess key somatic and emotional complaints with central sensitization[28] in the absence of any behavioral assessment, seems more recommendable, even the limitations intrinsically related to its self-report nature. The two methods investigate central sensitization differently: the CSI measures self-reported symptoms thought to be related to central sensitization, while quantitative sensory testing aims to measure psychophysical signs of central sensitization (generalized hyperalgesia). Thus, different results between the two methods could be observed.[61] Finally, Adams and colleagues[62] suggested the score at the CSI may more closely reflect psychological hypervigilance than increased responsiveness of nociceptive cerebral areas. Because of this evidence, one would suggest that here we measured psychological hypervigilance about bodily pain rather than symptoms of central sensitization per se.

Our results may have crucial consequences in the way vulvodynia is commonly conceived. First, the evidence predicting that affected females would experience a high number of central sensitization symptoms—if confirmed by future studies—may increase the researchers' and physicians' attention toward the role of the central nervous system in pain phenomenology in vulvodynia. Moreover, the recognition of an organic origin may help females with vulvodynia to overcome the psychological distress, the social stigma, and the perception of injustice deriving from seeing their own subjective painful experience invalidated by others.[35,42] This study may be crucial for sexual health. Indeed, in the current literature, there is no direct evidence concerning the role of interoceptive awareness on sexual dysfunction in vulvodynia. However, some preliminary evidence relative to healthy women (not clinical samples) seemed to point toward a significant role of lower interoceptive awareness on sexual distress.[10,12] In the future, this relationship should be explored in the context of vulvodynia. In this research, we focused on interoceptive sensibility, which is part of interoception.[3,4] As previously noted, interoceptive sensibility measures how an individual rates their own level of efficiency in decoding internal bodily changes. Thus, it is not a measure of accuracy in judging

the subjective interoceptive sensibility. This may be crucial when we intend to measure this construct in conditions, such as vulvodynia, in which females may experience lower levels of trust about own bodies. Thus, it may be necessary to investigate interoception in vulvodynia in comparison with samples of women affected by other chronic pain conditions as well as women free from any kind of pain, combining a measure of interoceptive accuracy (different types of tasks are available in the literature, about which the Heartbeat Perception Tasks[63,64] is the most common) with a measure of interoceptive sensibility: this procedure may underlie a possible dissociation between the more subjective (self-report) and the more objective (behavior) components of interoception.

Author contributions

F.S.: Conceptualization-Equal, Data curation-Equal, Formal analysis-Lead, Investigation-Equal, Methodology-Equal, Writing—original draft-Lead. M.N.: Data curation-Equal, Investigation-Equal, Writing—review & editing-Equal. G.V.: Conceptualization-Equal, Methodology-Equal, Writing—review & editing-Equal. R.B.: Conceptualization-Equal, Investigation-Equal, Writing—review & editing-Equal.

Supplementary material

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Conflicts of interest

None declared.

Data availability

The data that support the findings of this study are available in Zenodo at https://doi.org/10.5281/zenodo.10512666.

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