Self-reported interoceptive deficits in eating disorders: A meta-analysis of studies using the eating disorder inventory

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ABSTRACT

Objective: An impairment of the ability to sense the physiological condition of the body – interoception – has long been proposed as central to the onset and maintenance of eating disorders. More recent attention to this topic has generally indicated the presence of interoceptive deficits in individuals with an eating disorder diagnosis; however, possible links with specific diagnosis, BMI, age, illness duration, depression, and alexithymia remain unclear from individual studies. This meta-analysis aimed to provide a necessary quantitative overview of self-reported interoceptive deficits in eating disorder populations, and the relationship between these deficits and the previously mentioned factors.

Methods: Using a random effects model, our meta-analysis assessed the magnitude of differences in interoceptive abilities as measured using the Eating Disorder Inventory in 41 samples comparing people with eating disorders (n = 4308) and healthy controls (n = 3459). Follow-up and moderator analysis was conducted, using group comparisons and meta-regressions.

Results: We report a large pooled effect size of 1.62 for eating disorders with some variation between diagnostic groups. Further moderator analysis showed that BMI, age and alexithymia were significant predictors of overall effect size.

Conclusion: This meta-analysis is the first to confirm that large interoceptive deficits occur in a variety of eating disorders and crucially, in those who have recovered. These deficits may be useful in identifying and distinguishing eating disorders. Future research needs to consider both objective and subjective measures of interoception across different types of eating disorders and may fruitfully examine interoception as a possible endophenotype and target for treatment.

1. Introduction

Eating disorders (EDs) are characterised by an ongoing disturbance of eating or eating-related behaviour, which leads to changes in the consumption or absorption of food, and significantly impaired physical health or psychosocial functioning [3]. EDs are a pervasive psychiatric consumption or absorption of food, and signiﬁcant distress, depression, suicide, substance abuse and even death [3–5,74,75]. As such, EDs represent a major clinical challenge, and priority for research to identify their aetiology, and develop effective treatments. Unfortunately, the cause of EDs remains poorly understood, with several biological, social and psychological factors identified as important in the onset and maintenance of different EDs [22].

The task of identifying the causal mechanisms underlying EDs is complicated by the fact that a different combination of factors may contribute to various subtypes of ED. The current Diagnostic and Statistical Manual (DSM-5; APA 2013) identifies three primary ED diagnoses: Anorexia Nervosa (AN; characterised by restrictive eating, severe weight loss, and an intense fear of gaining weight), Bulimia Nervosa (BN; characterised by a preoccupation with body weight and shape, normal body weight, and episodes of binge eating with compensatory behaviours such as purging), and Binge Eating Disorder (BED; characterised by frequent binge eating with feelings of loss of control, but no use of compensatory behaviours). Two further categories (Other Specified Feeding or Eating Disorder (OSFED), and Unspecified Feeding or Eating Disorder (UFED)1), also exist to classify EDs that do not more accurately fit into AN, BN, or BED, such as atypical presentations of the above or other feeding and eating disorders. Notably, early clinical descriptions of EDs highlighted “disturbances in accuracy of perception or cognitive interpretation of stimuli arising from the body” ([12], p. 189). These dual aspects have been examined under the modern-day concepts of interoception (i.e. the ability to sense...
the physiological condition of the body [19], and alexithymia (i.e. difficulty identifying and describing feelings/emotions; see [80]). Such difficulties in perceiving signals arising from the body and/or identifying and interpreting emotional states have since been established as a core psychopathological element of several ED [32,80].

Difficulties with somatic perception-awareness may contribute to EDs because individuals incorrectly interpret bodily signals referring to hunger and satiety cues [12]. A difficulty perceiving hunger cues may result in skipped meals, or the restriction of food intake until intense feelings of hunger occur. By contrast, difficulty in detecting normal levels of fullness could cause binging or overeating [32,50]. In addition, deficits in identifying emotional states may contribute to difficulties with emotional regulation; a multidimensional construct characterised by flexible modulation strategies, behavioral control, emotional awareness and distress tolerance [43,52]. ED patients may confuse their internal bodily signals with emotions, and have difficulties experiencing and differentiating different emotions, or modulating or attenuating their intensity [15,52]. Such maladaptive emotion regulation or emotional dysregulation is a key psychological problem in EDs, related to mood instability, impulsivity, recklessness, anger and self-destructiveness [52].

The majority of data concerning interoceptive deficits in EDs is based on self-reports obtained from the Eating Disorder Inventory (EDI; [42]), which primarily assesses the interpretative component of interoceptive deficits rather than somatic awareness. The EDI includes an “Interoceptive Awareness” subscale, comprising 10 questions reflecting “a lack of confidence in recognising and accurately identifying emotions and sensations of hunger or satiety” ([42], p. 18). Using the EDI and subsequent revisions (EDI-2, [40], EDI-2, [41]; EDI-VS, [58]), self-reported interoceptive deficits of this interpretative kind have been found consistently across patients with various EDs [32,52].

Importantly, although interoceptive deficits are widely reported as being a core psychopathological component of several EDs, it is not known whether the effect size is the same across the spectrum of EDs, or whether a particular diagnosis is associated with greater interoceptive deficits. In addition, several variables are known to interact and overlap

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**Fig. 1.** Flow diagram demonstrating the identification and selection process of studies for the analysis.
with interoceptive processing and EDs, such as age, disease duration, Body Mass Index (BMI), depression and alexithymia \([4,44,45,57,64,67,76]\). However, these factors have not consistently been taken into account when examining interoceptive processes in patients with ED. Taking these factors into consideration, and identifying to what extent and how deficits in the interpretation of signals arising from the body contribute to different EDs, might allow for more targeted and effective interventions to be administered. Therefore, the current study first aimed to compare the magnitude of interoceptive deficits (as measured using the EDI) across different types of ED. Secondly, we aimed to examine whether age, illness duration, BMI, depression, and alexithymia serve as moderators for any interoceptive deficits observed in ED overall, and whether these were further specific to different subtypes of ED. We did not have any a-priori predictions regarding the directionality of interoceptive deficits across different ED subtypes, or how these deficits might be moderated by the factors mentioned above, since individual studies have often not specifically examined or had statistical power to address such questions in an ED population, have used different measures to assess interoception, or have produced contradictory results in healthy and ED populations (e.g. see \[57\] for interesting work on the relationship between interoception and alexithymia); as such, our meta-analyses represent a novel, quantitative exploration into these questions.

2. Method

2.1. Identification and selection of studies

A systematic literature search was conducted in accordance with PRISMA guidelines \[63\]. The electronic databases Scopus and PubMed were selected and searched systematically for peer-reviewed papers published prior to March 2017 (inclusive) using the terms “intercept*” and “eating disorders”. A total of 328 articles were found using these terms, 124 from PubMed and 204 from Scopus. This was reduced to 253 articles when duplicates were removed.

The inclusion criteria were: (1) full text available in English, (2) a clinical sample with a prior diagnosis, or meeting a current diagnosis, of an eating disorder according to the DSM or ICD, (3) a control group with no current diagnosis of an eating disorder or any other psychiatric diagnosis, (4) reporting mean and standard deviation Interoceptive Awareness scores from the EDI (any version; see Data Extraction, below), and sample size, for both clinical and control groups. Papers not meeting these criteria were excluded from analysis (see Fig. 1).

2.2. Data extraction and meta-analysis procedure

Data extracted from each paper were: ED diagnosis (AN, BN, BED or EDNOS); mean and standard deviations for: EDI Interoceptive Awareness (IA) score, age, ED duration, BMI, depression score (as measured using the BDI; \[8\]) and alexithymia score (as measured using the TAS-20; \[7\]).

Data analysis was conducted using Comprehensive Meta-Analysis Version 2.0 for Windows \[9\]. The standardised mean difference (SMD; also known as Cohen’s \(d\)) was used as an effect size, with values of 0.2, 0.5 and 0.8 corresponding to small, medium and large effects respectively \[18\]. For ease of interpretation, these can also be stated as a Common Language Effect Size \[59\], also referred to as the probability of superiority, which expresses the probability that a randomly sampled person from one group (e.g. ED group) will have a higher observed score than a randomly sampled person from the another group (e.g. control group). The following guidelines apply: SMD: 0.2 = 56%, SMD: 0.5 = 64%, and SMD: 0.8 = 71% chance that a randomly sampled person with an eating disorder will have a greater interoceptive deficit than a person picked at random from the control group. Heterogeneity was examined using \(I^2\) \[49\]. The \(I^2\) values describe the percentage of total variation across trials that is due to heterogeneity rather than sampling error (i.e. the proportion of variation that can be attributed to the actual differences between studies rather than within-study variance). The value of \(I^2\) ranges from 0% (no inconsistency) and 100% (high heterogeneity) with values of 25%, 50%, and 75% suggested as low, moderate, and high heterogeneity. All analyses used a Random Effects model owing to the high level of heterogeneity identified (see Results). Publication bias was examined using Duval and Tweedie’s \[26\] Trim and Fill technique, which aims to estimate the number of potentially missing studies and adjusts the effect size accordingly.

The impact of ED type on effect size was examined by splitting studies according to ED diagnoses: AN, BN, BED, EDNOS, and mixed eating disorder samples (i.e. containing patients with either AN, BN, BED or EDNOS). Studies including a separate recovered ED sample were also recorded and included in our overall meta-analyses. Meta-regressions were conducted to investigate whether age, duration of illness, BMI, depression and alexithymia were significant predictors of effect size. Although there is no definitive minimum number of studies required for meta-regression, we follow the general recommendation of at least 6 to 10 studies for a continuous variable \[35,48\]; and for a (categorical) subgroup variable, a minimum of 4 studies per group \[35\].

3. Results

The analysis included 29 studies and 41 samples, providing a total sample of 4308 eating disorder participants and 3459 controls (7746 when controls are repeated in separate comparisons, see Table 1). The first, main analysis revealed significantly greater interoceptive deficits in the ED patients (SMD = 1.62: 95% CI = 1.46 to 1.77, \(p < 0.001\)) \(^{2}\) compared with healthy controls, indicating an 87% chance that a person picked at random from the ED group will have a greater interoceptive deficit than a person picked at random from the control group (probability of superiority). The studies were heterogeneous, \(Q \,(40) = 386.10, p < 0.001\) with an \(I^2\) value of 89.64. The high level of heterogeneity validated the suitability of a random-effects model and suggested the possible existence of moderating variables contributing to heterogeneity that required further investigation. Examination for publication bias Using Duval and Tweedie’s \[26\] Trim and Fill method highlighted two potentially missing studies, though it made no substantive difference to the effect size (SMD = 1.57: 95% CI = 1.41 to 1.73, \(p < 0.001\)).

3.1. Interoceptive deficits in different types of ED

Moderator analysis was undertaken to examine the impact of ED type on interoceptive deficit effect size (see Fig. 2). The initial analysis included all 29 studies and 41 samples. The samples comprised: AN (\(k = 12\)), BN (\(k = 10\)), BED (\(k = 5\)), EDNOS (\(k = 3\)), Mixed ED (\(k = 9\)) and participants recovered from AN or BN (\(k = 2\)). A significant difference in pooled effect size was found amongst the various diagnostic groups (\(Q(5) = 50.30, p < 0.001\)).

\(^{2}\)Two samples \((17\), sample 2; \[34\]) were excluded as outliers showing no overlap of 95% CI with any other studies (the former also documented worse interoception in controls) and so, were excluded.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Summary of the findings of the meta-regressions for each moderator variable.</th>
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<tbody>
<tr>
<td>Moderator variable</td>
<td>Diagnoses</td>
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<tr>
<td>Average Age (16.7 to 43.8)</td>
<td>All</td>
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<tr>
<td>BMI (15.7 to 44.82)</td>
<td>All</td>
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<tr>
<td>TAS score (54.1 to 67.05)</td>
<td>AN, BN and BED</td>
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<tr>
<td>BDZ score (12.78 to 28.70)</td>
<td>AN, BN, BED and EDNOS</td>
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<td>BMI</td>
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We subsequently compared the size of interoceptive deficits across different ED diagnoses (see Fig. 2 for individual forest plots). In accordance with the minimum study criteria for moderator analysis specified above (k ≥ 4), patients with EDNOS (k = 3) and participants recovered from AN or BN (k = 2) were not analysed as part of subsequent comparisons. In addition, as the mixed group combined several types of ED (including AN, BN and BED) it could not be meaningfully compared with the separate ED subtypes, and was not included in follow-up comparisons. The remaining comparisons between AN, BN and BED indicated that patients with BN report the greatest deficit overall, with interoceptive awareness being significantly lower in BN than BED ($Q(1) = 41.72, p < 0.001$), but not compared with AN ($Q(1) = 2.57, p = 0.11$). In addition, patients with AN showed a significantly greater interoceptive deficit compared with BED ($Q(1) = 25.27, p = 0.001$). The level of heterogeneity ($I^2$) was lower in each of these separate ED subsamples (AN = 77.91%, BN = 71.17%, BED = 38.31%) compared to when all ED types were grouped and analysed together (89.64%), as might be expected; however, the relatively high level of heterogeneity remaining in these sub-samples suggests that there may still be other unidentified sources of heterogeneity. We explored these factors in further moderator analyses below.

3.2. Further moderator analysis

The influence of age, illness duration, BMI, depression, and alexithymia on interoceptive awareness were analysed using meta-regression. As indicated above, meta-regressions were not run with subsamples fewer than six or in mixed samples. In addition, analyses were not run where the target measure was not reported or sufficiently variable for analyses to be run on the sample. Table 1 provides a summary of the meta-regressions conducted.

3.2.1. Age

Meta-regression revealed greater interoceptive deficits in younger samples when samples of all ED subtypes were included in the analyses ($k = 28$). However, sub-analysis of patients with BN ($k = 6$) and AN ($k = 9$) separately indicated that interoceptive deficits were, contrastingly, significantly larger in older groups.

3.2.2. Illness duration

There were too few samples to run regression analysis on illness duration.

3.2.3. BMI

Across 17 samples that included all types of ED diagnoses, significantly greater interoception deficits occurred in samples with lower mean BMI.

3.2.4. Depression

Depression was recorded in 8 ED samples which included the diagnoses AN, BN, EDNOS and BED. Meta-regression of these samples revealed that average depression score was not a significant predictor of effect size.

3.2.5. Alexithymia

A meta-regression of 6 samples which included the diagnoses AN, BN and BED found significantly greater interoception deficits in samples with lower mean alexithymia scores (i.e. less alexithymia/better at identifying and labelling emotions).
4. Discussion

The aim of the current meta-analysis was to investigate the extent of self-reported interoceptive deficits in EDs, and examine how various factors (i.e., ED diagnosis, age, illness duration, BMI, depression and alexithymia) may influence interoceptive deficits in ED. We identified 41 ED samples comprising 4308 people with various types of ED (including AN, BN, BED, and EDNOS), and compared these with 3459 healthy controls. A significant interoceptive deficit was found across this ED sample, with a very large effect size (SMD) of 1.62. This equates to there being approximately 87% chance that a person picked at random from the ED group will have a greater interoceptive deficit compared with a person picked at random from the control group. Furthermore, comparison across different ED subtypes revealed the novel finding that interoceptive deficits appear to exist on a continuum in EDs, with BN and AN patients experiencing significantly more pronounced interoceptive deficits compared to patients with BED. Our analyses also revealed that interoceptive deficits are greater in ED patients with a lower BMI and younger age. Separate moderator analyses of BN and AN patients, however, revealed a contrasting pattern in which interoceptive deficits are greater in older patients. Finally, we found that interoceptive deficits across several EDs were not related to levels of depression; however, individuals with lower levels of alexithymia report greater interoceptive deficits. We discuss these findings in greater detail below.

Our first, overall finding of an interoceptive deficit in patients with ED is consistent across samples and studies, and accords with the long proposed disturbance of interoception in EDs [12]. More importantly, we document for the first time that a large and significant interoceptive deficit occurs across a wide range of eating disorders. Analysis of specific EDs revealed large effect sizes in each group: AN (SMD = 1.71), BN (SMD = 1.96), BED (SMD = 0.76), EDNOS (SMD = 1.72), mixed diagnoses (SMD = 1.71) and those who had recovered from eating disorders (SMD = 0.76). We also present the hitherto unreported finding that BN and AN samples experience the greatest impairment of interoceptive abilities, whereas BED samples were found to report the smallest. Interestingly, even recovered AN and BN samples displayed a large effect size (Fig. 2F). The observation that substantial interoceptive deficits remain after recovery suggests a relative trait stability of such deficits and may have clinical implications for defining recovery from an eating disorder. For example, recovery of interoceptive abilities may not be a useful indicator for assessing ED recovery; however, the modest number of recovered samples (K = 2) means this finding should be interpreted cautiously.

Our finding that significant interoception deficits occur in all ED diagnoses lends support to a continuum or transdiagnostic approach to ED, which supposes that ED lie on a spectrum of dieting and weight concerns rather than being qualitatively distinct [23,71]. The core symptomology of EDs is the same, but can be expressed differently through the varying severity and kinds of eating behaviours displayed throughout the course of the disorder [30]. In line with this approach, we found that although interoceptive deficits are consistent across all EDs, significant inter-diagnostic differences emerge in the degree of impairment. Previous research has explored a variety of endophenotypes in EDs (for a discussion see [14,77]) and the accumulated evidence presented here points to interoception deficits as a candidate endophenotype for EDs. However, it remains unclear whether these deficits play a role in the onset and maintenance of the disorders, or are caused in some way by the disorder and its symptoms. In this context, Lilienfeld et al. [55] posit an interesting distinction regarding traits that persist after recovery from an eating disorder and in particular to whether such traits reflect either ‘...a potential vulnerability factor contributing to the development of the ED or a ‘scar’ (i.e. consequence) of the illness.” (p. 1400). Lilienfeld et al. found diminished interoceptive awareness amongst previously eating-disordered relatives of bulimic probands when compared to their never-ill relatives. They interpret this as consistent with their “scar” model, i.e. that having had an eating disorder leaves a “scar”; however, as they later note “...it is impossible to definitively determine which may be ‘scar effects’ and which may be predisposing factors at the present time” ([56], p. 313). Nonetheless, a large prospective study of junior high and high school students found that poor interoceptive awareness (from the EDI) predicted risk of eating disorders one year later [54]. Thus, a next step to further explore this line of thinking would be for future studies to assess interoception in the unaffected first degree relatives of those with EDs.

We found that mean age was a significant predictor of interoception deficit, being greater in younger samples; however separate analyses of AN and BN samples revealed contrastingly greater interoceptive deficits in older samples. The separate analysis of age and interoceptive deficit in BN patients included only a small number of samples, and this limits the conclusions that can be drawn regarding this finding. It is possible that the overall analysis may have been influenced by diagnosis, as BED samples typically had a higher average sample age and were found to have significantly smaller effect sizes, which may explain the difference in direction of the relationship found in the overall and sub-analyses. Unfortunately, there were too few samples to also analyse the effect of illness duration on interoceptive deficits, and so it is not possible to determine whether the link between age and interoceptive deficit is simply a result of the illness length, or if interoceptive deficits are a stable trait that do not change over time. In order to draw such conclusions, future studies are needed that record illness duration.

We also found that individuals with lower BMIs have significantly greater interoceptive deficits; however, the finding of a negative relationship between effect size and BMI may have again been influenced by ED subtype. Unfortunately, it was not possible to carry out further analysis of individual ED subtypes because of limitations in the recorded range of BMI and/or too few studies reporting BMI for meta-regression to be performed. Nevertheless, we note that the samples with larger BMIs were those with a BED diagnoses, which were also found in the current analyses to have significantly smaller interoceptive deficits than samples with BN or AN. Our attempts to analyse BMI and interoceptive deficits in EDs highlights potential difficulties in examining the influence of BMI across ED samples more generally. The link between interoceptive deficits, BMI and EDs may be more complex than is currently understood based on the limited evidence available, and additional research, which includes a range of BMIs and weight-recovered AN patients, is needed to examine these relationships.

Our meta-regression of alexithymia indicated that individuals with poor emotional awareness do not necessarily have poor interoception. Surprisingly, we found that greater levels of alexithymia (i.e. poorer ability to identify/label emotions/feelings) predicted fewer self-reported interoception deficits (i.e. better interoception). This finding is based on the results of only six studies and samples with relatively high levels of alexithymia overall (the mean across our samples ranged between 54.1 and 67.05, and a TAS-20 score of 61 or above indicates high levels of alexithymia; [7]), and so should be interpreted with care and/or limited to individuals with relatively high alexithymia. Nevertheless, the analysis included several types of ED, and confirms the high occurrence of alexithymia in EDs [80]. Moreover, this finding is particularly notable given similarities between the interpretative aspect of interoception (as measured by the EDI) and alexithymia (see [28]). Our result provides further insight into current debates and contrasting findings regarding the relationship between alexithymia and interoception (see [57,81]). The findings are consistent with previous research suggesting that greater levels of alexithymia are related to better
interoception (i.e. individuals with poor emotional awareness report greater somatic awareness; [27,57]). This seemingly counterintuitive relationship can be explained by the suggestion that paying attention to interoceptive sensations (i.e. high interoception) may hamper the interpretation of one’s emotional feelings (i.e. high alexithymia), and contribute to somatoform disorders via the misinterpretation of physical sensations [57].

Finally, we found that depression, as measured by the BDI [8], was not a significant predictor of interoception deficit effect size. Indeed, the association between depressive symptoms and interoceptive abilities has not always been consistent in previous research. For example, Dunn et al. [25] found a significant difference in interoception (as measured using a heartbeat perception task; see [72]) between individuals with moderate depression and controls, but no significant difference between severely depressed individuals and controls. Pollatos et al. [69] found evidence of a significant negative relationship between depression and scores on a heartbeat perception measure of interoception in healthy participants, however also found a significant interaction with anxiety, where this relationship only remained significant at high levels of anxiety. Therefore, both the severity of depressive symptoms and levels of anxiety in the samples used in this analysis may have had an influence on the relationship between depression symptoms and effect size, and may explain why no significant relationship was found. The average BDI scores of the samples analysed were also within the minimal-to-moderate range according to established BDI cut-offs. This limited variability in depression scores necessarily limits the generalisability of our findings to individuals with mild to moderate depression.

4.1. Limitations and recommendations

An important caveat of our findings is that the conclusions drawn relate only to self-reported interoceptive deficits measured by the Interoceptive Awareness subscale of the Eating Disorder Inventory (EDI). This leads to two potential limitations. Firstly, the EDI has been criticised as an assessment of interoception, as it primarily considers the interpretative, emotional aspect of interoception [28], and fails to differentiate between a confusion or lack of clarity regarding internal experiences and non-acceptance of affective arousal [60]. Moreover, it is possible that, despite self-reporting more interoceptive deficits, individuals with certain types of ED lack insight and consequently underreport the true extent of their interoceptive deficits. This would, for example, be consistent with the differing symptomology of AN and BN, where patients with AN often lack insight into or deny their illness and symptoms, whereas patients with BN are typically more motivated to recover [51]. This difference in awareness may, therefore, account to some extent for the differences found in interoceptive deficits between AN and BN patients.

Second, recent research distinguishes between different types or levels of interoceptive ability [38], with interoceptive sensibility referring to the subjective, self-evaluation of interoceptive ability; interoceptive accuracy referring to an individual’s objective accuracy in detecting and tracking internal bodily sensations; and interoceptive awareness referring to the a meta-cognitive measure of the correspondence between the objective and subjective measures (see also [16] for discussion of the origin and development of interoception as a concept). As mentioned above, Bruch [12] also distinguished between two kinds of interoceptive ability in ED (perception vs. interpretation of body signals). Importantly, the different dimensions of interoception may be distinct and dissociable [37,39]. Unfortunately, our systematic search identified only three studies that examined interoceptive ability objectively in an ED sample [33,50,68], using a heartbeat detection task [72], and so it was not possible to include these in our meta-analysis and/or conduct any meaningful comparisons. Therefore, an important aim for future ED research should be to include both objective and subjective measures of interoceptive ability, to look at awareness across different modalities (e.g. cardiovascular, gastrointestinal, pain and pleasant touch; see [20,21,46] for examples), and to see how deficits relate to body image and ownership (see [6,20,21]). Although no “gold standard” measure of interoception exists, new methods have been developed to capture the multidimensional nature of interoception (see [38,57,61,62]), and validated in a clinical eating disorder sample (e.g. [11]).

The current review also highlighted how most existing ED studies have assessed samples of AN and BN, with only three samples of EDNOS, despite this being the most common eating disorder seen in outpatient settings [29]. Our review also identified only a limited number of studies involving recovered and BED samples, again highlighting a clear gap in the current literature. Understandably, fewer studies have focused on BED in comparison to other diagnoses, since it was only recently introduced as a diagnostic category in DSM-5 [3]. A particular focus is required on future studies with recovered eating disorder samples, EDNOS and BED in order to more accurately determine the pathogenesis of these EDs, and to assess the validity of interoception as an endophenotype.

Finally, in addition to the limited number of studies looking at certain ED subtypes, our review of the literature identified that important clinical variables, such as illness duration and BMI, were not always reported by existing studies. Our meta-analysis was unable to examine the potentially important relationships between illness duration, overall disorder severity and interoceptive abilities, as the majority of studies did not report on the illness duration or severity of their samples. Overall, these issues highlight the need for future research to consistently report on key clinical variables, as well as the need for more research to examine the relationship between the variables and interoception directly using multiple measures.

5. Conclusion

We confirm the existence of a substantial, self-reported interoceptive deficit in all types of EDs examined. Impaired interoception may, therefore, be considered a transdiagnostic characteristic of EDs and a possible endophenotype. The degree of interoceptive deficit varies across ED subtypes and may provide a useful distinguishing feature of different EDs. They may also play a maintenance role in eating disorders, and consequently be an appropriate target for treatment or prevention. The extent of interoceptive deficit may be influenced by several factors, such as age, BMI, and alexithymia; however, further evidence is needed to substantiate these conclusions, with future studies reporting these factors as well as illness duration, and employing both objective and subjective measures in direct examinations of interoceptive process across all types of EDs.

Competing interest statement

The authors have no competing interests to report.

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