


An examination of the mechanisms and personality traits underlying food addiction among individuals with severe obesity awaiting bariatric surgery

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Abstract

Purpose The aetiology underlying addiction has often been investigated to shed more light on the factors contributing to the development and maintenance of various disorders. In the field of addictive eating behaviours, data on the aetiological factors related to food addiction (FA) in the bariatric context remain scarce. The present study aimed to explore mechanisms and variables underlying FA among individuals suffering from severe obesity and awaiting bariatric surgery. **Methods** Participants ($N = 146$) were recruited at the Quebec Heart and Lung Institute during their pre-operative visit and were invited to complete questionnaires. Participants with and without FA were compared on reward sensitivity, impulsivity, emotion dysregulation, and personality traits. **Results** Findings showed that bariatric candidates with FA (16%) presented more emotion dysregulation, more harm avoidance, and less self-directedness. Further exploration showed that the association between harm avoidance and the number of FA criteria endorsed was mediated by emotion dysregulation, while the association between

self-directedness and the number of FA criteria endorsed was mediated by reward sensitivity.

Conclusions These results indicate that an inability to regulate affect by strategies other than eating highly palatable food, in a context where negative affect and long-term goals can hardly be sustained, underlies a diagnostic of FA among bariatric candidates. From a clinical standpoint, the presence of a double vulnerability leading to FA symptomatology could help design better-targeted interventions to maximise weight loss maintenance in the bariatric context.

Level of evidence Level V, descriptive study.

Keywords Food addiction · Bariatric surgery · Emotion regulation · Personality traits

Introduction

The aetiology of addiction has often been investigated to better identify risk factors, highlighting the role of various mechanisms and personality traits. Indeed, both impulsivity and reward sensitivity have been associated with addictive

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disorders [1]. For instance, they were found to be positively correlated with severity of cocaine and alcohol use as well as with severity of gambling problems among the general population and treatment-seeking individuals [1–5]. Emotion regulation has also been associated with addictive disorders, as difficulties in recognizing, understanding, and managing emotions have been found among individuals suffering from cocaine and alcohol dependence as well as among individuals presenting pathological gambling [6–8]. In terms of personality traits, the use of the temperament and character inventory (TCI) [9] has revealed that individuals presenting various addictive disorders exhibited higher novelty seeking, higher harm avoidance, and lower persistence (temperament) as well as lower self-directedness, lower cooperativeness, and higher self-transcendence (character) when compared to control individuals [10–12].

The aforementioned risk factors have also been investigated in relation to eating disorders and obesity. Studies have shown that impulsivity and reward sensitivity were associated with problematic eating behaviours that can lead to a higher body mass index (BMI), such as binge eating and food cravings [13–15]. Emotion dysregulation has also been identified as an important predictor of the presence of binge eating [16, 17]. Studies exploring personality profiles have revealed that individuals with obesity and individuals suffering from binge eating disorder differed from control individuals on various traits of the TCI, namely novelty seeking, harm avoidance, and persistence (temperament) as well as self-directedness and cooperativeness (character) [18, 19].

Partly based on these findings, parallels have been drawn between addictive disorders and compulsive overeating [20, 21], leading to the development of the concept of food addiction (FA). Subsequently, Gearhardt et al. [23] operationalized the concept by adapting the DSM-IV-TR diagnostic criteria for substance dependence to food and eating and developing the Yale food addiction scale (YFAS) [22, 23]. With regards to underlying mechanisms, studies using the YFAS have shown that FA was positively correlated with facets of impulsivity, reward sensitivity, and emotion dysregulation [24–26]. With regards to personality traits, fewer studies have been conducted in the context of FA. It was nonetheless reported that individuals with FA showed less self-directedness than their counterparts without FA [27, 28].

Although bariatric candidates constitute a group of individuals suffering from severe obesity, which is frequently accompanied by serious physical and psychological comorbidities, knowledge of the mechanisms and personality traits underlying FA remains scarce in this clinical sample. To date, studies have shown prevalence rates for presurgical FA ranging from 14 [29] to 54% [30], indicating that this set of problematic eating behaviours is undoubtedly present among bariatric candidates. Moreover, studies have shown that

bariatric candidates fulfilling a FA diagnosis showed a more severe eating profile (for instance, more food cravings, more binge eating, lower eating self-efficacy) as well as a more severe psychological profile (for instance, more depression and anxiety symptoms, lower quality of life, more impulsivity) [29, 31–34]. Reward sensitivity, emotion dysregulation, and personality traits have, however, never been investigated in relation to FA among bariatric candidates.

The present study proposed to explore mechanisms and personality traits underlying FA among individuals suffering from severe obesity and awaiting bariatric surgery. Differences between bariatric candidates with FA (FA group) and without FA (noFA group) in terms of reward sensitivity, impulsivity, emotion dysregulation, and personality traits were examined. The associations between personality traits and FA were also more closely investigated. Based on the previously cited literature, it was hypothesized that individuals from the FA group would show higher levels of impulsivity, heightened reward sensitivity, and greater emotion dysregulation when compared to individuals from the noFA group. It was also hypothesized that the former group would be characterized by higher novelty seeking, higher harm avoidance, and lower persistence (temperament) as well as lower self-directedness and cooperativeness (character) when compared to their counterparts.

Method

Participants and procedure

Participants were recruited at the Quebec Heart and Lung Institute, at the time of their pre-operative visit. They were invited to complete a booklet of questionnaires. Weight and height information were obtained from their medical files. The final sample comprised 146 individuals (112 women and 34 men), who presented a mean age of 39.8 years ($SD=7.1$) and a mean BMI of 48.29 kg/m^2 ($SD=6.24$). The vast majority of participants was White/Caucasian (94%), although information regarding ethnicity was not available for five participants. Regarding education and employment, most of them had completed a post-secondary degree (60%) and reported working full time (79%).

Measures

FA

The YFAS [23] is a self-reported instrument designed to examine FA over the last 12 months. It comprises 25 items, among which 20 are based on the seven DSM-IV-TR diagnostic criteria for substance dependence [22]. Two more items are included to assess the presence of significant

distress/functional impairment and three more items provide clarification for subsequent items (primer items). Items contained in the YFAS are either answered on a five-point Likert scale or on a yes–no basis. When scoring the instrument, an already-established chart is used to determine whether an item is endorsed or not by the respondent and a criterion is considered fulfilled when the respondent endorses at least one item pertaining to the criterion. Data obtained from the YFAS can either reflect the severity of FA symptomatology through the number of criteria endorsed (0–7) or the presence of a FA diagnosis, when three criteria are endorsed and significant distress/functional impairment is reported. A previous validation study of the French YFAS by our research team showed that a 16-item version was best suitable for the present bariatric sample (manuscript submitted). Internal consistency for this version was excellent ($\alpha = 0.92$).

Reward sensitivity

The sensitivity to punishment and sensitivity to reward questionnaire (SPSRQ) [35] is a self-reported questionnaire based on Gray's model of personality [36]. The reward sensitivity subscale was developed to reflect a motivational system, namely the behavioural activation system that is responsible for responses to incentives. Its shorter version includes 17 items, each presenting situations that involve various rewards and rated on a four-point Likert scale [37, 38]. Internal consistency for the reward sensitivity subscale was good in the present sample ($\alpha = 0.78$).

Impulsivity

The Barratt impulsiveness scale-brief (BIS-brief) [39] is a self-reported questionnaire used to assess impulsivity. The BIS-brief is a short and unidimensional version of the Barratt impulsiveness scale [40] and, as such, comprises eight of the original items. Respondents are instructed to answer on a four-point Likert scale, depending on the frequency of occurrence of the different behaviours presented. The internal consistency of the BIS-brief was satisfying in the present sample ($\alpha = 0.70$).

Difficulties in emotion regulation

The difficulties in emotion regulation scale (DERS) [41] was used to assess emotion dysregulation. This self-reported instrument comprises 36 items, aiming to measure the occurrence of various situations related to emotion regulation and rated on a five-point Likert scale. In the present study, only the DERS total score was used considering that statistically significant correlations were observed between the DERS subscales (r ranging from 0.21 to 0.78; $p < 0.05$)

and that the internal consistency for the 36 items was excellent ($\alpha = 0.95$).

Personality traits

The short version of the TCI, which comprises 125 self-reported items, was used to evaluate seven personality dimensions according to the psychobiological model described in Cloninger et al. [9]. Four dimensions are related to temperament and are thought to have underlying biological determinants [novelty seeking ($\alpha = 0.64$), harm avoidance ($\alpha = 0.87$), reward dependence ($\alpha = 0.63$), and persistence ($\alpha = 0.49$)], while three dimensions are related to character and are thought to have underlying social determinants [self-directedness ($\alpha = 0.80$), cooperativeness ($\alpha = 0.62$), and self-transcendence ($\alpha = 0.67$)]. Each item is evaluated on a true or false basis.

Data analytic plan

All analyses were conducted using statistical package for social sciences (SPSS). Descriptive and correlational analyses were first conducted to draw up a general portrait of the sample and variables under investigation. Following the YFAS guidelines, participants were classified in the FA group if they endorsed three FA criteria in addition to the significant distress/functional impairment criterion. Otherwise, they were classified in the noFA group. To examine sociodemographic differences, Chi-square tests and t tests were performed when appropriate. To examine group differences in terms of mechanisms and personality traits, correlated variables were entered in a multivariate analysis of variance (MANOVA), while the other variables were entered in a series of univariate analysis of variance (ANOVA).

To further examine the associations between personality traits and FA, multiple mediation analyses were conducted using the fourth model of Hayes' PROCESS macro for SPSS [42], which tests the significance of the overall model (mediators as a group) as well as the significance of the indirect effects via each mediator and provides information on the effect of the independent variable on the dependent variable in the absence of mediators (total effect) as well as when controlling for the mediators (direct effect). Only the personality traits that were correlated with the number of FA criteria endorsed were investigated and only the mechanisms correlated with both those personality traits and the number of FA criteria endorsed were entered as possible mediators. Bias-corrected bootstrap confidence intervals ($n = 10,000$; 95% confidence intervals) were considered when assessing the indirect effects, which were reported to be significant when zero was not contained within the confidence interval limits. This nonparametric procedure was advantageous to use in the present study, as it estimates common and unique

variance separately, thus accounting for the association between mediators when testing each specific indirect effect [43].

Results

According to the YFAS, an average of 2.16 (SD = 1.78) FA criteria were endorsed and 16% (N = 24) of the sample presented a FA diagnosis. Chi-square tests revealed no statistically significant differences between the FA and the noFA groups in terms of sex (p = 0.756), ethnicity (p = 0.728), education (p = 0.689), and employment (p = 0.408). Results

from the t tests showed that the groups did not differ in terms of BMI (p = 0.968) or in terms of age (p = 0.077).

As presented in Table 1, results from the correlational analyses showed that scores on the SPSRQ, the BIS-brief, the DERS, and the novelty seeking, harm avoidance, and self-directedness subscales of the TCI were significantly correlated with one another. These variables were thus entered in a MANOVA, which revealed a significant effect [F(6, 123) = 2.450, p = 0.028]. The subsequent ANOVAs revealed that individuals from the FA group reported more emotion dysregulation, more harm avoidance, and less self-directedness than the noFA group (p < 0.01) (Table 2). Results from the correlational analyses showed that scores on the reward dependence, persistence, cooperativeness,

Table 1 Associations between mechanisms and personality traits related to food addiction

	1	2	3	4	5	6	7	8	9	10	11
1. SPSRQ_R	–	–	–	–	–	–	–	–	–	–	–
2. BIS-brief	0.13	–	–	–	–	–	–	–	–	–	–
3. DERS	0.22**	0.43***	–	–	–	–	–	–	–	–	–
4. TCI_NS	0.31***	0.47***	0.10	–	–	–	–	–	–	–	–
5. TCI_HA	0.01	0.24**	0.47***	–0.19*	–	–	–	–	–	–	–
6. TCI_RD	–0.02	–0.14	–0.04	–0.04	0.08	–	–	–	–	–	–
7. TCI_P	–0.11	0.20*	0.01	–0.07	0.15	–0.06	–	–	–	–	–
8. TCI_SD	–0.26**	–0.42***	–0.65***	–0.14	–0.53***	0.11	–0.03	–	–	–	–
9. TCI_C	–0.15	–0.24**	–0.35***	–0.09	–0.09	0.33***	–0.08	0.38***	–	–	–
10. TCI_ST	0.08	0.05	0.03	0.17	–0.11	0.02	–0.07	–0.02	0.23**	–	–
11. FA criteria	0.26**	0.24**	0.36***	0.11	0.24**	–0.00	0.09	–0.42***	–0.10	0.11	–

SPSRQ_R “reward” subscale of the sensitivity to punishment and sensitivity to reward questionnaire, BIS-brief Barratt impulsiveness scale-brief, DERS difficulties in emotion regulation scale, TCI temperament and character inventory, NS novelty seeking, HA harm avoidance, RD reward dependence, P persistence, SD self-directedness, C cooperativeness, ST self-transcendence, FA food addiction

*p < 0.05 ; **p < 0.01 ; ***p < 0.001

Table 2 Descriptive statistics and comparisons between the noFA and the FA groups

	noFA group		FA group		F	df	p
	M (N)	SD	M (N)	SD			
SPSRQ_R	37.06 (108)	6.98	39.18 (22)	6.10	1.748	1	0.188
BIS-brief	13.90 (108)	3.56	15.27 (22)	3.31	2.783	1	0.098
DERS_TOTAL	78.15 (108)	21.63	96.27 (22)	25.74	12.011	1	0.001
TCI_NS	43.38 (108)	17.09	43.18 (22)	15.16	0.003	1	0.960
TCI_HA	51.39 (108)	23.17	67.50 (22)	25.62	8.525	1	0.004
TCI_RD	67.12 (117)	18.46	71.39 (24)	13.55	1.152	1	0.285
TCI_P	48.85 (122)	25.98	45.83 (24)	27.96	0.264	1	0.608
TCI_SD	72.41 (108)	17.21	60.00 (22)	22.29	8.546	1	0.004
TCI_C	80.31 (116)	11.38	77.33 (24)	13.12	1.291	1	0.258
TCI_ST	35.13 (119)	18.53	38.84 (23)	16.65	0.799	1	0.373

FA food addiction, SPSRQ_R “reward” subscale of the sensitivity to punishment and sensitivity to reward questionnaire, BIS-brief Barratt impulsiveness scale-brief, DERS difficulties in emotion regulation scale, TCI temperament and character inventory, NS novelty seeking, HA harm avoidance, RD reward dependence, P persistence, SD self-directedness, C cooperativeness, ST self-transcendence

and self-transcendence subscales of the TCI were not significantly correlated with other variables (Table 1). These TCI subscales were thus entered in a series of ANOVA, which revealed no significant group differences ($p > 0.05$) (Table 2).

Results from the correlational analyses also showed a significant positive correlation between the score on the harm avoidance subscale of the TCI and the number of FA criteria endorsed, which were both significantly and positively correlated with the DERS total score and the BIS-brief total score (Table 1). The first multiple mediation model was tested to explore the relationship between harm avoidance and FA symptomatology as mediated by emotion dysregulation and impulsivity (parallel mediators). Results revealed that the overall model was statistically significant (95% CI 0.0063–0.0254) and accounted for over 16% of the explained variance in FA symptomatology. When considering each indirect effect, results showed that emotion dysregulation was the only statistically significant mediator (95% CI 0.0034–0.0210). Figure 1 shows that there was a non-significant direct effect of harm avoidance on FA symptomatology (path c'), but a significant indirect effect of harm avoidance on FA symptomatology through emotion dysregulation (path $a_2 \times b_2$) (complete mediation).

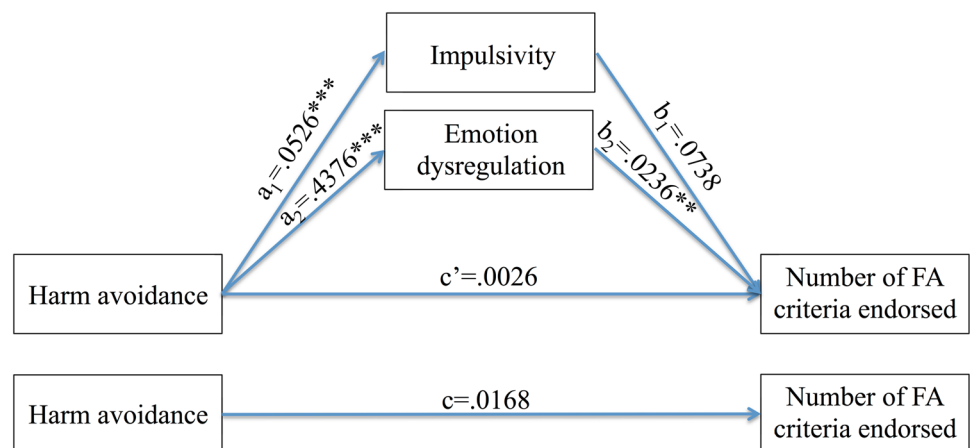
Lastly, results from the correlational analyses showed a significant negative correlation between the score on the self-directedness subscale of the TCI and the number of FA criteria endorsed, which were both significantly correlated with the reward sensitivity subscale of the SPSRQ, the DERS total score, and the BIS-Brief total score; while the correlations for the self-directedness subscale of the TCI were negative, the correlations for the number of FA criteria

endorsed were positive (Table 1). The second multiple mediation model was tested to explore the relationship between self-directedness and FA symptomatology as mediated by reward sensitivity, emotion dysregulation, and impulsivity. Findings revealed that the overall mediation model was statistically significant [95% CI (–0.0324) to (–0.0017)] and accounted for over 22% of the explained variance in FA symptomatology. When considering each specific indirect effect, reward sensitivity was identified as the only statistically significant mediator [95% CI (–0.0105) to (–0.005)]. Figure 2 shows that there was a significant direct effect of self-directedness on FA symptomatology (path c') as well as a significant indirect effect of self-directedness on FA symptomatology through reward sensitivity (path $a_1 \times b_1$) (partial mediation).

Discussion

The present study aimed to examine the mechanisms and personality traits underlying FA among individuals suffering from severe obesity and awaiting bariatric surgery. Findings showed that bariatric candidates with FA exhibited more emotion dysregulation, greater harm avoidance, and less self-directedness. These findings correspond to what was hypothesized. However, participants with FA did not show more impulsivity, more reward sensitivity, more novelty seeking, less persistence, or less cooperativeness than their counterparts without FA, as was expected based on the addiction literature. Therefore, it appears that a different kind of profile may be evidenced when it comes to FA in the bariatric context. Considering that the combination

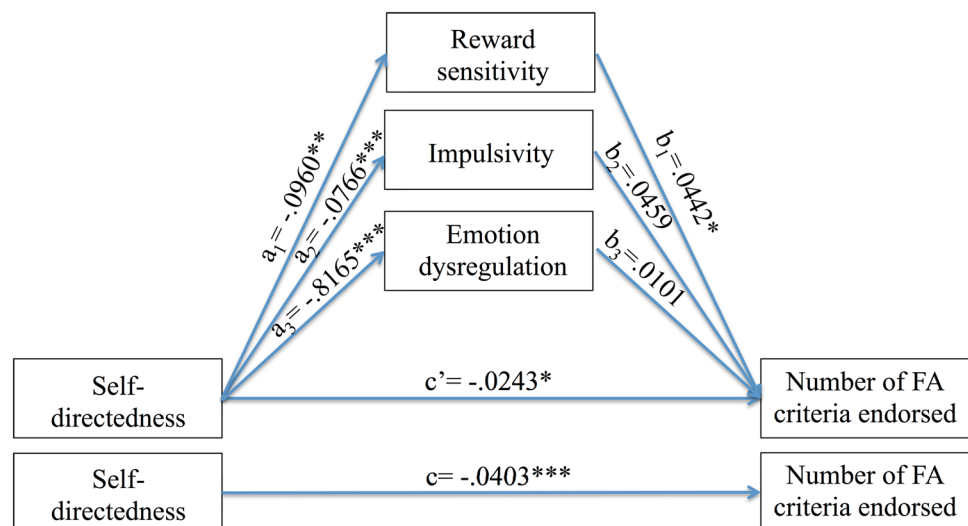
Fig. 1 Multiple mediation model of the effects of harm avoidance on the number of FA criteria endorsed through impulsivity and emotion dysregulation



Note. All values are unstandardized regression coefficients; a_1 a_2 =effect of harm avoidance on impulsivity and emotion dysregulation, respectively; b_1 b_2 =effect of impulsivity and emotion dysregulation on the number of FA criteria endorsed, respectively; c =total effect of harm avoidance on the number of FA criteria endorsed; c' =direct effect of harm avoidance on the number of FA criteria endorsed.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Fig. 2 Multiple mediation model of the effects of self-directedness on the number of FA criteria endorsed through reward sensitivity, impulsivity, and emotion dysregulation



Note. All values are unstandardized regression coefficients; a_1 a_2 a_3 =effect of self-directedness on reward sensitivity, impulsivity, and emotion dysregulation, respectively; b_1 b_2 b_3 =effect of reward sensitivity, impulsivity, and emotion dysregulation on the number of FA criteria endorsed, respectively; c =total effect of self-directedness on the number of FA criteria endorsed; c' =direct effect of self-directedness on the number of FA criteria endorsed.

* $p < .05$; ** $p < .01$; *** $p < .001$.

of emotion dysregulation, harm avoidance, and self-directedness overruled, in the present sample, other mechanisms and personality dimensions identified in previous addiction studies, it is possible to think that an inability to properly regulate affect by other strategies than eating highly palatable food, in a context where negative affect (for example, anger) cannot be tolerated and long-term goals (for example, losing weight) cannot be sustained, could underlie a diagnosis of FA in the bariatric context.

Findings from the first mediation model further evidenced a vulnerability related to negative affect, as it was found that individuals who deploy greater efforts to avoid experiencing any forms of discomfort would have greater difficulties regulating their emotions and would thus endorse a higher number of FA criteria. The idea of such vulnerability when considering FA symptomatology is consistent with the literature. It was previously found that low distress tolerance, namely an inability to tolerate negative affect, was negatively associated with the number of FA criteria endorsed and FA-related eating behaviours (emotional eating, external eating, and disinhibition towards food), supporting the idea that avoidance of negative affect could underlie FA symptomatology [44]. In the same line of thoughts, it was found that experiential avoidance, namely the unwillingness to feel internal events such as emotions, mediated the relationship between negative emotions and emotional eating and thus helped explain why some individuals tend to overeat when experiencing negative affect [45].

Findings from the second mediation model supported the idea of another vulnerability, revealing that individuals

who show low self-directedness would be more sensitive to various rewarding experiences and would thus endorse a higher number of FA criteria. Previous studies showed that self-directedness is a key risk factor when it comes to problematic eating behaviours, as individuals suffering from FA as well as from binge eating disorder presented significantly less self-directedness than individuals who were free of these disorders [19, 27]. As previously put forward by Bégin et al. [27], individuals suffering from FA symptomatology may present great difficulties in setting, focusing, and directing efforts on long-term goals, especially when short-term rewards are present [27]. Furthermore, a recently proposed comprehensive model showed that a lack of self-directedness, high negative urgency, and emotion dysregulation acted in an interrelated way to explain FA symptomatology among individuals suffering from binge eating disorder [46]. Taken together, these results may point to a double vulnerability, considering that eating underlying FA symptomatology could not only be driven by avoidance behaviour (i.e., more emotion dysregulation in the context of high harm avoidance), but also by approach behaviour (i.e., heightened reward sensitivity in the context of low self-directedness).

Replication among other samples remains important to see if these mechanisms and personality traits are indicative of FA as experienced by any individuals or FA as specifically experienced by individuals with severe weight problems. A limitation of this study is that participants were recruited approximately 3 months prior to the bariatric surgery; at time of participation, some may have already taken actions on the factors maintaining their problematic eating

behaviours with the help of a dietician. Another limitation is that participants may have answered in a socially desirable manner, even though they were informed that answers to the questionnaires would remain confidential and would not jeopardize their eligibility for the surgery. Further research would benefit from testing bariatric candidates earlier in their surgical process and evaluating social desirability at time of testing to acknowledge its influence when analysing data and reporting results.

Conclusion

From a clinical standpoint, the possible existence of vulnerable profiles related to FA highlights the importance of adequately screening for the presence of FA as well as for the presence of specific mechanisms and addictive personality traits. Especially in the bariatric context, candidates with FA could benefit from better-targeted interventions to maximise weight loss maintenance, such as various emotion regulation and distress tolerance strategies as well as strategies to better approach negative affect in their life and to better focus on long-term goals.

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Compliance with ethical standards

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest Dr. Tchernof as well as Dr. Biertho report grants from Johnson & Johnson Medical Companies, outside the submitted work. The other authors declare no conflict of interest.

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