

Is physical activity associated with lower borderline personality disorder severity, accounting for insomnia disorder?

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Abstract

Background:

Borderline personality disorder is associated with severe suffering and insomnia. Physical activity has been related to improvements in borderline personality disorder and sleep disorders. However, no study has yet analyzed the relationship between physical activity and borderline personality disorder, accounting for insomnia disorder. This study aimed to fill this gap in the literature.

Method:

This cross-sectional study recruited 192 participants aged 18 years and over reporting a borderline personality disorder. Participants had to fill out an online survey collecting information about their mental health, sleep disorders, and physical activity habits. An analysis of covariance was computed with R.

Results:

The overall model explained a significant amount of variance in borderline personality disorder ($R^2 = .19$, $p < .001$). Being physically active was not significantly associated with lower borderline personality disorder after controlling for insomnia disorder ($F(1,189) = 1.18$, $p = .28$). Insomnia disorder was strongly and significantly associated with borderline personality disorder ($F(1,189) = 46.15$, $p < .001$).

Conclusion:

The findings suggest that insomnia disorder is a particularly relevant correlate of borderline personality disorder, whereas physical activity appears less central. Clinically, this highlights the importance of assessing sleep-related problems. Future research should examine these associations using experimental and longitudinal designs.

Keywords:

Borderline personality disorder, physical activity, physical exercise, insomnia disorder, sleep

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Introduction

Individuals with borderline personality disorder (BPD) experience acute sensitivity, intense (or labile) emotions, an unstable sense of self, and display impulsivity [1]. According to Orbach et al., intense psychological suffering appears to be associated with increased suicide rates [2]. BPD tends to be the result of both genetic and environmental factors, with those factors interacting with each other as well [3]. Moreover, individuals with BPD are likely to develop physical comorbidities like obesity or hypertension related to an unhealthy lifestyle, such as insufficient physical activity (PA) [4].

While the diagnosis of BPD occurs in approximately 1.6% of the general population, its prevalence rises significantly to 15-28% among patients attending psychiatric outpatient clinics [5]. Thus, patients with BPD are associated with high societal costs because of the frequent chronic course of the disorder [6]. Soeteman et al. emphasize that it is therefore important to prioritize appropriate, effective treatments [7].

In terms of one form of adjunctive therapy, a recent study by St-Amour et al. suggested that PA leads to a reduction of negative affect in BPD patients [8]. Moreover, another study indicated that regular PA could reduce daily negative emotions and negative emotions variability [9]. Being a core symptom of BPD, emotion dysregulation should be an important target for treatments [10]. PA has shown interesting effects in improving emotion regulation in other disorders such as attention deficit hyperactivity disorder; therefore, it could be efficient in BPD. However, few studies have analyzed this relationship [11].

In addition to PA, emotion regulation appears to be influenced by symptoms of insomnia disorder [12,13]. Additionally, Olthmanns et al. provide preliminary evidence that insomnia disorder and BPD are positively and bidirectionally related [14]. In this context, it was observed that patients with BPD had significantly higher rates of insomnia disorder than the control groups [15,16]. Moreover, BPD symptoms seem to contribute to an increased risk of suicide especially as mediated by insomnia disorder symptoms [17]. Therefore, Vanek et al. suggest that a more sleep-focused therapy for patients with BPD helps to alleviate their symptoms more strongly in the long term [18].

In conjunction with insomnia disorder, Kredlow et al. showed in their meta-analytic review that acute and regular PA can have beneficial effects on a wide variety of sleep parameters [19]. According to the authors, particularly regular PA seems to lead to significantly better sleep outcomes. Additionally, based on a literature review by Moreno Reyes et al., it can be emphasized that regular PA is a suitable alternative to pharmacological therapy for patients with insomnia disorder [20]. According to the authors, the advantages of regular PA over pharmacotherapy include lower health care costs, greater accessibility, and fewer side effects. Moreover, Lowe et al. demonstrated in their systematic review that subjective sleep quality can be improved by PA [21]. Based on another systematic review by Vanderlinden et al., it can be suggested that moderate-intensity training programs with a frequency of three times per week, lasting from 12 weeks to 6 months, have the strongest positive effect on various sleep parameters [22].

Thus, in light of the possible relationships between PA, insomnia disorder, and BPD, the following could be shown: PA may be linked to negative affect in patients with BPD [8] and with insomnia disorder [22]; Insomnia disorder appears to be linked to BPD severity [14]. Therefore,

when analyzing the relation between PA and BPD severity, one must control for insomnia severity.

Since, in the overall view, only the studies by St-Amour et al. follow an experimental design regarding the relationship between PA and BPD symptoms, it is of great value to substantiate this initial indication [8,9]. Furthermore, it becomes necessary to examine in more detail the insufficiently empirically validated state of research regarding the influence of sleep disturbances in patients with BPD [18].

Research objective

Against this background, the conceptual model emerges that a higher amount of PA is associated with a lower severity of insomnia disorder [19,23] and a lower severity of BPD [8]. Additionally, with a view to the conceptual model, a lower severity of insomnia disorder is associated with a lower severity of BPD [18,24]. For this reason, the aim of the study is to explore a potential negative association between PA and BPD, while controlling for insomnia disorder. First, it is supposed that a high amount of PA is significantly associated with a lower severity of BPD, while controlling for insomnia disorder (H1). Second, it is supposed that a higher severity of insomnia disorder is significantly associated with a higher severity of BPD (H2).

The hypothesized relationships of the study with PA as an independent variable, insomnia disorder as a covariate and BPD as a dependent variable can be seen in Figure 1.

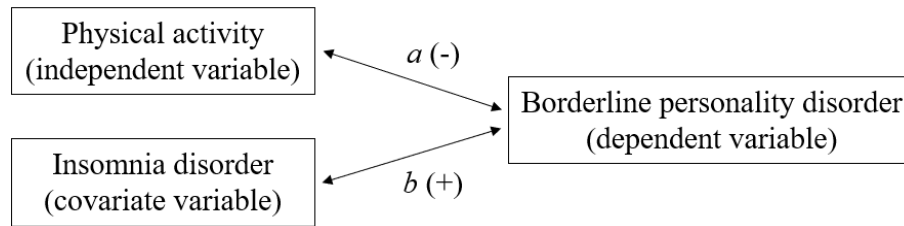


Figure 1 An overview of the study's analysis of covariance derived by the results of [9,18,19,23,24]. The arrows indicate the presumed bidirectional relationships between the variables. Symbol a represents the potential negative relationship between PA and BPD, controlled for insomnia disorder. Symbol b shows the potential positive relationship between insomnia disorder and BPD.

Method

Research Design

In this study (secondary analysis), an analysis of covariance was calculated. The study follows a cross-sectional design, collecting self-reported data from patients with a BPD diagnosis across French- and English-speaking international communities.

Setting and subject sample

Data used in this study were collected from February to December 2021. For the detailed data collection method, see [Removed for review]. Here, however, is a brief description pertaining to these results. Participants were included if they were: 1) 18 years or older; 2) reported living in Canada, France, England, the United States, New Zealand, Switzerland, Belgium, or Australia; and 3) reported having received a BPD diagnosis by a healthcare professional. Of the 400 individuals who began the survey, 192 participants met the inclusion criteria and answered the relevant questionnaires for the present study. A one-way power analysis

calculated with R, assuming a medium effect size of $f^2 = .15$ based on heuristics with one independent variable with two levels, a fixed Type I error of $\alpha = .05$, and a fixed acceptable statistical power of $1 - \beta \geq .80$, indicated that a sample size of $n = 56$ subjects would be sufficient to compute an analysis of covariance [25–27].

Data collection

The study was set up internationally and subjects were recruited through posts on Facebook, YouTube, and Twitter. In addition, promotion was facilitated by psychiatrists in Canada and France who informed their patients about the study. The LimeSurvey platform was used to collect data. Upon participation in the study, subjects completed sociodemographic and validated health-related online questionnaires.

Questionnaires

Sociodemographic and general health questions were drawn from the “Canadian Health Measures Survey”. Furthermore, the Borderline Symptom List – Short form (BSL-23) evaluated the severity of BPD. The questionnaire consists of 23 items with a 5-point Likert scale from 0 = “not at all” to 4 = “very strong” and the total score is calculated as a mean score by item (/4). A mean score of 0–0.28 corresponds to “absent or low”, 0.28–1.07 to “mild”, 1.07–1.87 to “moderate”, 1.87–2.67 to “high”, 2.67–3.47 to “very high”, and 3.47–4 to “extremely high” severity of BPD [28]. The questionnaire demonstrated excellent internal consistency in this study (Cronbach’s $\alpha = .95$). Moreover, to explore insomnia disorder, the Insomnia Severity Index (ISI) was completed. The questionnaire consists of 7 items with 5 response options, ranging from 0

(lowest) to 4 (most severe) for insomnia symptoms. The sum of the scores for each question is analyzed using cut-off values of ≤ 7 for “no insomnia”, 8–14 for “subthreshold insomnia”, 15–21 for “moderate clinical insomnia”, and 22–28 for “severe clinical insomnia” [29]. The questionnaire demonstrated good internal consistency in this study (Cronbach’s $\alpha = .87$). Additionally, the frequency and duration of PA at work, during leisure time, during transportation, and sedentary behavior were assessed by the Global Physical Activity Questionnaire (GPAQ). The questionnaire consists of 16 items, which have dichotomous (yes/no) or ratio-scaled (frequency and duration) expressions depending on the item [30]. Further psychometric properties of the questionnaires, particularly those of this questionnaire, are illustrated in the supporting information S1.

Ethical concerns

The data collection and conduct of the study are congruent with the ethical principles of the Declaration of Helsinki and were approved by the ethics review committees from [Removed for review] and [Removed for review]. The participants read the information leaflet regarding the course of the study and complied with the consent form. It was pointed out in this context that participation was voluntary, anonymous, and could be stopped at any time. Furthermore, participants had the opportunity to contact the research team before participating in the study. Additionally, for each potentially unpleasant question, auxiliary resources were listed for the participant's country of residence at the end of each questionnaire. Thus, care was taken to minimize the psychological stress of the subjects before, during and after the study.

Statistical analysis

The statistical program R (R-4.5.2) was used to perform the analyses [27,31]. The research materials, data, and R code are publicly available on the first author's OSF account at the following link: [Removed for review]. In addition, the study dataset can be accessed via the following link: [Removed for review].

Descriptive statistics (N, %, M) were calculated for sociodemographic variables. For the first main variable, PA, an overall variable was first calculated by summing the minutes of light, moderate, and vigorous PA during work, leisure time, and transportation over the last week. Subsequently, a dichotomous PA variable (active/inactive) was created based on a 150-minute-per-week cut-off, representing the minimum PA recommended by the World Health Organization for adults [32]. Insomnia disorder was the second main variable in the analyses and was measured by symptom severity over the past two weeks. BPD was the third main variable and was measured as symptom severity on the previous day.

Extreme values were excluded by winsorizing the variables PA, insomnia disorder, and BPD (values with z-scores of ± 3.29 were adjusted) [33]. Normality of those variables was then verified [34]. Pearson correlations, using the pairwise deletion method for missing values, were calculated in preparation for the analysis of covariance. Afterward, an analysis of covariance with listwise deletion method for missing values was calculated for PA (independent dichotomous variable), insomnia disorder (variable of covariance with ratio scale) and BPD (dependent variable with ratio scale) [35,36]. Additionally, the effect sizes of the overall model and the effects regarding the relationship *a* between PA and BPD and regarding the relationship *b* between insomnia disorder and BPD were calculated.

Results

Table 1 shows the characteristics of the sample, including residence, sex, age, language, educational level, marital status, physical illnesses, comorbid mental disorders, average frequency of hospitalizations in the last year, suicide attempts, use of psychotherapy and its form, as well as medication.

Table 1 Descriptive characteristics

	<i>n</i> (%)
Residence	
Canada	96 (50.00)
France	78 (40.62)
United States	9 (4.69)
Great Britain	7 (3.65)
Switzerland	2 (1.04)
Female	164 (85.86)
Age M (SD)	33.17 (11.11)
Education	
University degree	74 (38.54)
Marital status	
Single	95 (49.48)
Engaged	49 (25.52)
Married	23 (11.98)
Divorced	19 (9.90)
Widowed	2 (1.04)
Physical illness	

Yes	42 (21.88)
Comorbid mental disorder	
Yes	101 (52.60)
Hospitalization in the previous year M (SD)	1.57 (0.88)
Suicide attempt	
Yes	126 (65.62)
Psychotherapy	
Yes	95 (49.48)
Form of Psychotherapy	
Mentalization-based	25 (26.32)
Trauma-focused	4 (4.21)
Dialectical-behavioral	22 (23.16)
Medication	
Antidepressants	107 (55.73)
Antipsychotics	58 (30.21)
Anxiolytics	46 (23.96)
Mood stabilizers	34 (17.71)

Note: N Total sample size = 192; *M* Arithmetic mean; *SD* Standard deviation.

Table 2 illustrates the correlations between PA, insomnia disorder and BPD in addition to the respective arithmetic means and standard deviations of the variables to represent descriptively the relationships between the variables. All data appeared normal (kurtosis of -.99–1.18 and skewness of -.12–1.50) [34].

Table 2 Correlation matrix for numerical variables in preparation for analysis of covariance

Variable	<i>M</i>	<i>SD</i>	ID	BPD
PA	689.05	846.70	.06 [-.09 – .20]	.00 [-.14 – .14]
ID	13.20	6.49		.44*** [.32 – .55]
BPD	1.87	0.93		

Note: *M*: Arithmetic mean; *SD*: Standard deviation; values in square brackets show the 95% confidence interval for each correlation [37]; PA: Physical activity; ID: Insomnia disorder; BPD: Borderline Personality disorder; *** $p < .001$.

Table 3 presents the results of the analysis of covariance. The overall model and the effects regarding the independent dichotomous variable PA (relationship *a*) and the covariate insomnia disorder (relationship *b*) on the dependent variable BPD by the respective F-value, degree of freedom, p-value and effect size are shown.

Table 3 Results of the analysis of covariance

Level	Effect/variable	<i>F</i>	<i>df</i>	<i>p</i>	Effect size
Model	Overall model	24.02	2, 189	< .001	$R^2 = .19$ [.10 – .30]
Effect	PA cut-off	1.18	1,189	.28	$\eta p^2 = .01$ [.00 – 1.00]
Effect	ID	46.15	1,189	< .001	$\eta p^2 = .20$ [.12 – 1.00]

Note: PA cut-off: dichotomous independent variable physical activity; ID: insomnia disorder; *F*: F-value; *df*: degrees of freedom; *p*: p-value; R^2 : Adjusted explained variance of the overall model; ηp^2 : partial eta-squared as the effect size of each individual effect; values in square brackets show the 95% confidence interval for each effect size.

Figure 2 illustrates adjusted mean borderline personality disorder symptom scores after controlling for insomnia severity in the inactive group ($M = 1.97$, 95% CI [1.76, 2.18]) and the active group ($M = 1.83$, 95% CI [1.69, 1.97]). The difference between groups was not statistically significant, $t(189) = 1.09$, $p = .279$.

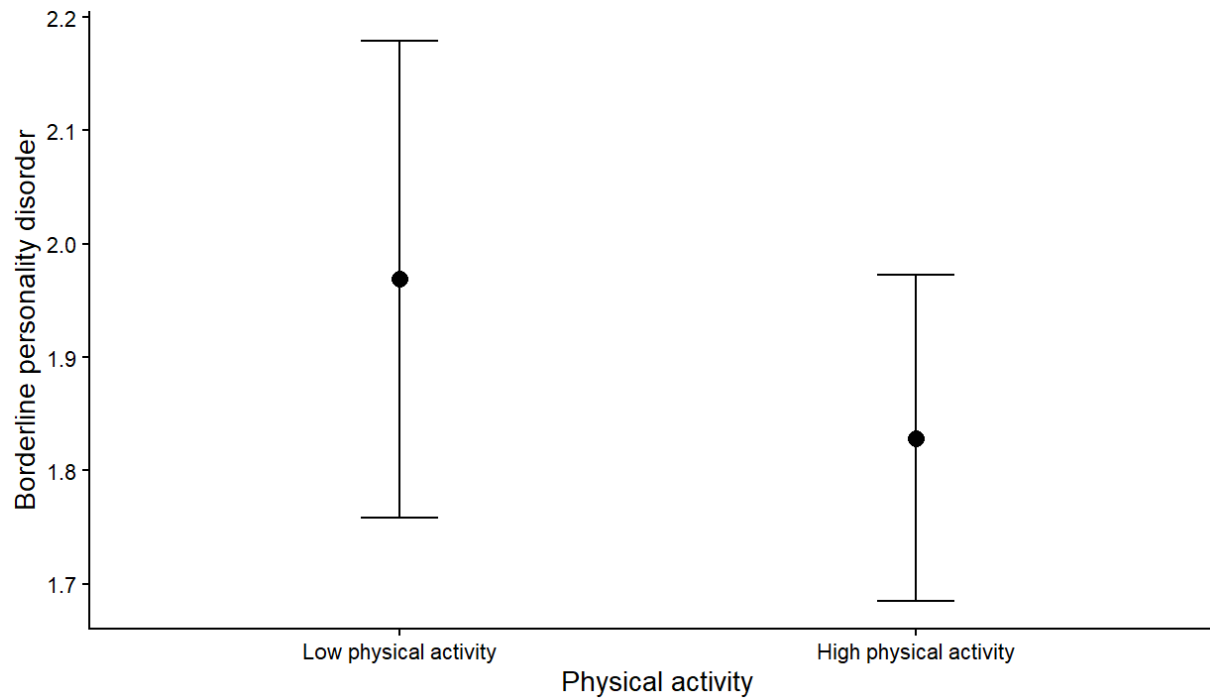


Figure 2: Adjusted means of BPD are shown for inactive and active participants, accounting for insomnia disorder. Error bars represent 95% confidence intervals [37]. No significant difference was observed between the PA groups.

Figure 3 shows the association between insomnia severity and borderline personality disorder symptom scores, with separate regression lines for inactive and active groups. Insomnia severity was significantly associated with borderline personality disorder symptom scores ($\beta = 0.048$, $SE = 0.016$, $t(188) = 2.96$, $p = .004$).

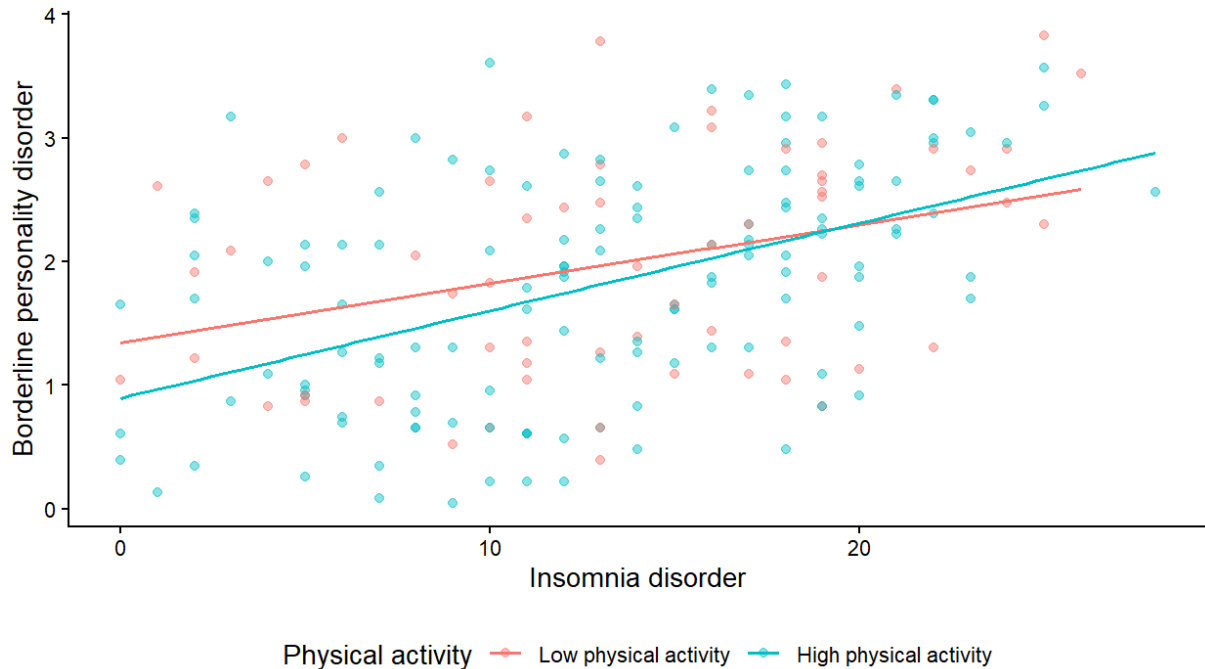


Figure 3: The relationship between insomnia disorder and BPD is shown for inactive and active participants. Separate regression lines are plotted for each PA group. The plot illustrates the significant positive association between insomnia disorder and BPD, indicating that higher insomnia scores are related to higher BPD scores.

Discussion

This study indicates that the overall statistical model accounted for a meaningful proportion of variance in BPD. Contrary to Hypothesis 1, active participants did not show lower severity of BPD compared with inactive ones after controlling for insomnia disorder, and the observed effect was small. In line with Hypothesis 2, higher severity of insomnia disorder was significantly associated with higher levels of BPD symptoms, showing a strong effect. Overall, the findings suggest that insomnia disorder, rather than PA, was a relevant correlate of BPD in the present sample.

Upon closer examination of the first result of the study, it is surprising that PA was not significantly negatively related to BPD symptoms. Previous research indicated a possible association between PA and emotion regulation, which is a core variable of BPD [8,9,38]. However, this study's result might be explained by attenuation of the examined relationship due to other BPD symptoms unrelated to emotion dysregulation [39]. Moreover, other observed associations, such as that between sleep problems and BPD, could influence a possible association between PA and BPD [14]. Similarly, Atoui et al. showed in their systematic review and meta-analyses that, at the individual-level daily assessment, self-reported insomnia disorder parameters and PA parameters were not significantly associated, which could explain this result [40].

However, the second result of the study with respect to the significant positive relationship between insomnia disorder and BPD is supported by previous research. Congruent with the findings of Jenkins et al., Kaurin et al. affirmed the relationship and emphasized that insomnia disorder may exacerbate suicidal crises in people with BPD [15,41]. In addition, consistent with the findings of Galbiati et al., one of the main symptoms of BPD, emotional dysregulation, appears to be exacerbated by decreased sleep quality and, therefore, less sleep efficiency [12,42]. Thereby, according to the authors, adequate sleep-related treatment aiming at lower sleep deprivation in patients with BPD may reduce the tendency to impulsive behavior such as non-suicidal self-injury and suicidal behavior. In this regard, one possibility of potential adjunct therapy is light therapy [43]. The authors nevertheless showed that no significant differences were observed in BPD symptoms, although patients' daytime alertness improved. Another possibly more effective adjunct treatment option would be mindfulness-based methods, such as meditation, for patients with insomnia disorder and BPD [44,45].

A limitation is that this study does not include a control group and possesses an observational, cross-sectional design. Consequently, it is not possible to draw confident causal inferences, and the validity of the research results can be limited [46]. Moreover, the GPAQ, used to measure PA, is a self-reported questionnaire that is susceptible to reporting bias [30,47]. Nevertheless, the questionnaire appears to have good to very good test-retest reliability and small to high correlations for criterion validity, so it was used in this study [30,47,48]. Additionally, it is insufficiently clear in which direction the hypotheses are directed, or whether bidirectional relationships exist, for example, regarding relationship *b* between insomnia disorder and BPD in this study [49]. Furthermore, the predominance of female participants in the sample may restrict the applicability of the results to the male population.

One strength of this study is that it is the first study to investigate the relationship between PA and BPD, controlling for insomnia disorder. In this context, the relevance of the research topic can be emphasized, especially from the point of view of the high suicidality of patients with BPD and the lack of alternative therapies [17]. Moreover, the multicultural spread of the data enabled by the study's online format increases the transferability of the results to patients with BPD across different countries.

Future research should investigate if PA characteristics (intensity, type, context) influence its potential effect on BPD symptoms. This could provide a more nuanced understanding of the relationship between PA and BPD. In this context, it is interesting that, especially, higher-intensity PA seems to have a positive impact on sleep health, but supporting these results in a sample of patients with BPD would be beneficial [50]. Additionally, Mead et al. and Štefan et al. emphasize that sleep duration appears to have a positive, unidirectional influence on PA, which warrants further investigation [51,52]. Regarding the measurement of PA, it would also be

advisable to use objective measures, such as accelerometers, to assess the extent of PA [53]. Additionally, experimental and longitudinal designs should examine the relationships between PA, insomnia disorder, and BPD.

Since lifestyle habits and alternative therapies may play a critical role in treatment efficacy in addition to standard treatment of BPD, this study examined the relationships between PA, insomnia disorder, and BPD. It was shown that PA was not meaningfully negatively related to the severity of BPD, whereas higher levels of insomnia disorder were consistently associated with higher BPD symptoms. These results underline the relevance of insomnia disorder as a key correlate of BPD. Overall, the findings suggest that targeting sleep problems may be more directly related to BPD symptoms severity than increasing PA. Against this background, it would be of particular interest to further investigate the positive relationship between insomnia disorder and BPD to better understand the possible benefits regarding the treatment of patients with BPD.

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Authors' contributions

The authors participated in the conception of the study and design, participated in the data collection of the study, performed data analyses as well as implemented correction suggestions.

Availability of data, code, and material

The data, code and material including the supporting information S1 can be accessed via the following link: [Removed for review]

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