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Positive affect and functional somatic symptoms in young adults

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ABSTRACT

Background: Functional Somatic Symptoms (FSS) are symptoms for which an underlying pathology cannot be found. High negative affect (NA) has been linked to the etiology of FSS, but little is known about the role of Positive Affect (PA).
Objective: The aim of this study was to test if PA is related to current and future lower levels of FSS. We also examined the interactions between PA and NA, and PA and sex on FSS.
Method: Data from the Dutch Tracking Adolescents' Individual Lives Survey (TRAILS) cohort were used (N = 1247 cases, 60% females, mean age T5 = 22.2, T6 = 25.6). PA was measured with the PANAS schedule and FSS with the Adult Self Report questionnaire (ASR). A Principal Component Analysis (PCA) was performed on the physical complaints subscale of the ASR. Regression analyses with bootstrapping were performed to assess the associations and interactions.
Results: PA had a significant negative association with current FSS when adjusted for NA, age, sex and socio-economic status (B = −0.004; BCa 95% CI = [−0.006; −0.002]), but the association was not significant longitudinally. No interactions were found. In secondary analysis, PA was significantly related to the component "General Physical Symptoms" (B = −0.019; BCa 95% CI = [−0.0028; −0.011]) but not to the component "Gastrointestinal Symptoms" (B = −0.008; BCa 95% CI = [−0.016;0.001]) in the cross-sectional analysis.
Conclusion: In conclusion, high PA was significantly related to current lower levels of FSS, but the effect was small. Further research on individual variations in affect is needed to obtain more insight in their contribution to FSS.

1. Introduction

Functional Somatic Symptoms (FSS) are symptoms for which an underlying pathology cannot be found. These cover a constellation of symptoms that include, amongst others, fatigue, dizziness, headache, abdominal pain, and musculoskeletal pain [1,2]. Around 33% of the symptoms in consultations with general practitioners remain unexplained by a pathology, and between 20% and 25% of these symptoms become chronic or recurrent [2]. Almost 25% of all adolescents and young adults report FSS [3,4]. These symptoms lead to difficulties in adolescents' and young adults lives, such as impaired daily physical and social activities, school absenteeism [5–7] and a higher risk of developing mental illnesses in adulthood [8].

The etiology of FSS remains unclear as it involves multiple physiological, psychological and social factors that interact with each other [1,9]. Nevertheless, previous studies have highlighted a consistent relationship between high Negative Affect (NA) and FSS [10–12]. For example, studies have shown that people with many FSS have a higher frequency of NA states compared with those with fewer FSS [13,14]. Although high NA could be considered a consequence of FSS, studies in children and adolescents have suggested that it is a risk factor rather than a result of the symptoms [15,16]. In addition, research shows that depression and anxiety [16–18], as well as neuroticism, and trait anxiety [11,19,20], which are characterized by high levels of NA, are strongly related to FSS.

Although high NA has been associated with more FSS, the role of Positive Affect (PA) in FSS is not well known. As PA and NA represent two different affective state dimensions, rather than two opposite poles from the same dimension [21], we cannot assume that high PA has the same effects on FSS as low NA. High PA is defined as a state of high

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energy, full concentration, and pleasurable engagement while low NA is a state of calmness and serenity [21].

Nowadays, media and advertisement encourage having high PA as a way to prevent and fight diseases. Several studies have attempted to address these issues empirically. A meta-analysis [22] pointed out that PA is related to a reduced mortality risk in healthy and diseased populations. Longitudinal studies have found that increased PA is related to lower incident coronary heart disease [23], a smaller probability to be diagnosed with hypertension or diabetes [24,25], and with lower levels of Allostatic Load, which is a system of inflammatory, cardiovascular and metabolic markers associated with stress [26]. However, results are not conclusive and it is necessary to explore to what extent PA influences health outcomes [27]. Regarding FSS, one study in a primary care population of 377 adult patients experiencing somatic symptoms without organic cause found that PA independently contributed to the variance in FSS at a cross-sectional level, after controlling for gender, neuroticism, alexithymia, and negative affect. After six months, participants who reported a decrease in PA compared to baseline had a 41% increase in the number of FSS [28,29]. Besides the mentioned study, research on the longitudinal association of PA and FSS is scarce and there are no studies exploring these associations in non-clinical cohorts. As FSS appear to be highly influenced by psychological states, and young adulthood is a critical period for mental health, addressing the relationship between PA and FSS in a large non-clinical cohort of young adults can give insight in the influence of PA on the development of FSS.

It has been suggested that a mood state characterized by the combination of low PA and high NA is associated to more general physical symptoms than only low PA or high NA [14,30], indicating that PA and NA might have an interactive effect on FSS. Sex differences have also been found in the association between PA and symptoms related to FSS. Males appear to be more sensitive than females to the effects of PA on clinical pain [31], and females appear to be more sensitive to the effects of PA on Allostatic Load [26].

The main aim of this study is to test if PA is related to FSS and if it can predict changes in the levels of FSS longitudinally, in young adults from the Tracking Adolescents' Individual Lives Survey (TRAILS) cohort study. We also want to test if sex and NA each interact with the effect of PA on FSS. Additionally, a previous study suggested that FSS in adolescents could be divided in two dimensions: one consisting of headache and gastrointestinal symptoms, and the other consisting of overtiredness, dizziness and musculoskeletal pain. Therefore, we aimed to explore the dimensionality of FSS in young adults as well, to assess whether the relationship between PA and FSS differs across FSS dimensions [32]. We hypothesize that high PA in young adulthood is associated with current lower levels of FSS, and with a lower risk of developing or increasing levels of FSS over time. Based on previous studies we also hypothesize that high PA in combination with low NA has a stronger effect on the variations of FSS than high PA alone and that males are more sensitive than females to the effect of PA on FSS.

2. Method

2.1. Participants

The participants of this study are part of the Tracking Adolescents' Individual Lives Survey (TRAILS) cohort study. TRAILS is an ongoing prospective cohort study of adolescents from the north of the Netherlands [33]. It consists of a population cohort of 2230 adolescents at baseline (T1), which has been followed from the age of 11 (mean age: 11.1, SD = 0.6) [34]. TRAILS participants have been assessed six times to date during a period of 15 years with 2 to 3 years in between. The sampling procedure is described elsewhere [33]. Data from the fifth (T5) and sixth (T6) waves were used in this study. Respondents participated in T6 3.4 years after participating in T5. The official response rate was 79.7% (n = 1.778) of the baseline participants (n = 2230) at T5, and 72.6% (n = 1618) of the baseline participants at T6.

2.2. Measures

2.2.1. Functional somatic symptoms

FSS were measured at T5 and T6 with the Physical Complaints subscale of the Adult Self-Report questionnaire (ASR) [35]. The Physical Complaints subscale includes 12 items referring to somatic complaints, which the participants report as symptoms without a medical cause in the past six months. The items ask if the participants 'never' (0), 'sometimes or a bit' (1), or 'often or a lot' (2) experienced the complaints. In the TRAILS cohort, the internal consistency for the Physical Complaints subscale was $\alpha = 0.75$ at T5, and $\alpha = 0.78$ at T6. In the main analysis, a mean score ranging from 0 to 2, including all 12 items, was used as an outcome measure. Analyses for dimensions of FSS were performed with the component scores found in Principal Component Analysis (PCA) of the Physical Complaints subscale of ASR, in order to explore if the relationship between PA and FSS was different for dimensions of FSS.

2.2.2. Positive and negative affect

PA and NA were measured with the Positive and Negative Affect Schedule (PANAS) [21]. The questionnaire asks to what extent the participants have felt 10 positive emotions and 10 negative emotions in the last month. The answers vary from "very slightly or not at all" (1) to "extremely" (5). The scores can range from 10 to 50 for each dimension. In the TRAILS cohort, the internal consistency of the PANAS at T5 was high for PA ($\alpha = 0.83$) as well as for NA ($\alpha = 0.89$). In the TRAILS cohort, PA and NA have a correlation of $r = -0.10$ at T5 which supports the hypothesis of independence of both constructs.

2.2.3. Socioeconomic status

Socioeconomic Status (SES) of the parents was measured at T1 and T4. The measure of parental SES was obtained by averaging five standardized variables: education level of both parents, occupational level of both parents, and household income. A continuous variable of SES was obtained and it was later categorized into lowest 25% SES, middle 50% SES and highest 25% SES to facilitate interpretation. For the main analysis, 103 participants lacked information on SES at T4, therefore, data from SES at T1 was used for them. The correlation between SES at T1 and SES at T4 was $r = 0.85$.

2.3. Statistical analysis

2.3.1. Missing data

Cases with data from both the predictor (PA) at T5 and the outcome (FSS) at T6 were selected for analysis. Differences between included and non-included cases were tested with independent sample t-test (PA, NA, and age), Mann-Whitney test (FSS) and Chi-Square test (sex and SES).

2.3.2. The relationship between PA and FSS

Multivariable linear regressions with bootstrapping were used to test the association between PA and FSS. Bootstrapping of 1000 samples with Bias Corrected and Accelerated (BCa) Confidence Intervals was performed in all analyses because the outcome measures were positively skewed, and the homoscedasticity assumption for performing linear regression was not met. The effects of a predictor were considered significant if 0 was not included in the BCa confidence intervals. First, cross-sectional analyses were performed with FSS mean score at T5 as the outcome, and PA at T5 as the predictor (Model 1). Sex, SES, age at T5, and NA at T5 were subsequently added as covariates (Model 2). Second, to test if PA predicted changes in FSS over time, longitudinal analyses were performed with FSS mean score at T6 as the outcome, and PA at T5 as the predictor (Model 3). FSS at T5 was added as a covariate as well as sex, SES, age at T5 and NA at T5 (Model 4). In

both cases, SES was used as a categorical variable, for which two dummy variables (middle SES, and highest SES) were entered into the model.

2.3.3. The interaction between PA and NA, and PA and sex

Interactions between PA and NA, and PA and sex were tested cross-sectionally and longitudinally, with linear regression with bootstrapping.

2.3.4. Dimension analysis

A PCA was performed on the Physical Complaints subscale of ASR at T5 and T6. In order to facilitate the interpretation of the components, oblique rotation was used because we assumed that the components were correlated. The optimal number of components was identified by a scree plot and Eigenvalue ≥ 1. Additionally, we computed component scores for each component, as the raw item responses weighted by the component loading. Due to the rotation used in the PCA, the loadings of items on one of the components were negative. For this reason, the scores of that component were multiplied by - 1 to ensure that high scores reflected a higher score on this component. Next, regression analyses with bootstrapping were performed with the dimensions found in the PCA. The associations between PA and each component of the FSS subscale found in the PCA were tested cross-sectionally (Model 5) and longitudinally (Model 6). Sex, SES, age at T5, and NA at T5 were used as covariates. The scores of each of the components at T5 were used as covariates for the longitudinal analysis in order to examine changes in component scores.

3. Results

3.1. Descriptive statistics

After excluding cases without data on PA at T5 and FSS at T6 ($n = 370$), the sample consisted of 1247 participants. From these, 59.9% were females and 40.1% were male. Regarding SES, 23.2% were in the lowest, 49.0% on the middle, and 27.4% on the highest SES group. Table 1 shows the descriptive statistics of the main variables on both waves of assessment.

Included and excluded cases, did not differ on PA ($p = .87$), NA (p = .87), and FSS ($p = .37$). Differences in age were significant ($p < .001$), but the mean difference was very small (-0.26 years). Within the excluded cases there were significantly less people from the highest SES group (Lowest SES = 104 cases, Middle SES = 190 cases, Highest SES = 74 cases [$p < .001$]), as well as more males (Males = 115, Females = 74 [p < .001]).

Table 1
Descriptive statistics.

Variable	T5	T6
Age. Mean (SD)	22.20 (0.64)	25.60 (0.60)
Functional Somatic Symptoms. Median (IQR)	0.17 (0.33)	0.25 (0.33)
Positive Affect. Mean (SD)	35.09 (5.25)	34.21 (5.64)
Negative Affect. Mean (SD)	20.55 (6.46)	19.81 (6.70)
Sex	**Frequency (Percentage)**	
Female	747 (59.9%)	
Male	500 (40.1%)	
Socioeconomic Status		
Lowest	289 (23.2%)	
Middle	611 (49.0%)	
Highest	340 (27.4%)	

Note: SD = Standard deviation. IQR = Interquartile range. Valid cases: Age, FSS, PA, NA, Sex = 1247, Socioeconomic Status = 1240.

3.2. The relationship between PA and FSS

The results of the cross-sectional and longitudinal analysis of the relationship between PA and FSS are shown in Table 2. In the cross-sectional analysis, PA predicted 1.8% of the variance and had a significant negative association with FSS at T5 (Model 1). When covariates were added (Model 2), the model predicted 31% of the variance, and all the variables, except for age, had a significant association with FSS. PA had a significant negative association with FSS, meaning that an increase of one unit on PA score represented a reduction in the score of FSS by 0.004 points on a scale of 0 to 2 points. This means that a person with the maximum score on PA (50 points) shows a decrease of 0.16 (8%) points on the FSS scale, compared with a person with the minimum score on PA (10 points).

In the longitudinal analysis, PA predicted 1.3% of the variance and had a significant negative association with FSS at T6 (Model 3). When the covariates were added to the model (Model 4), PA did not significantly predict FSS at T6.

Sensitivity analyses excluding participants with chronic diseases (asthma and migraine) provided comparable results (results available upon request).

3.3. Interaction analysis

The interaction between PA and NA was not significant in the cross-sectional analysis (B = 0.000; SE = 0.000; $p = .063$; BCa 95% CI = [−0.001; 0.000]) nor in the longitudinal analysis (B = 0.000; SE = 0.000; $p = .336$; BCa 95% CI = [−0.001; 0.000]).

The interaction between PA and sex was also not significant in the cross- sectional analysis (B = −0.004; SE = 0.003; $p = .171$; BCa 95% CI = [−0.009; 0.002]), nor in the longitudinal analysis (B = 0.001; SE = 0.003; $p = .829$; BCa 95% CI = [−0.006; 0.007]).

3.4. Dimension analysis

3.4.1. PCA

Table 3 shows the results of the PCA. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (T5 = 0.85; T6 = 0.87), showed that the sampling is adequate for structure detection, and the Bartlett's test of sphericity (T5 = $p < .001$, T6 = p < .001) showed that there are correlations between the items; therefore PCA is suitable for the subscale in both waves of assessment. A two-component solution was found in both waves, with all items loading highest on one of the components ($r > 0.3$). The items loading higher in component one were associated with “General Physical Symptoms” (e.g. feeling dizzy or tired, unspecific pain, palpitations) while component two was related to “Gastrointestinal Symptoms” (e.g. nausea, abdominal pain, and vomiting). The item “Headache” loaded higher in component two at T5, and on component one at T6.

3.4.2. The relationship between PA and the dimensions of FSS

Table 4 shows the cross-sectional relationship between PA and each of the components. PA had a negative significant association with the component “General Physical Symptoms” (Model 5a), but not with the component “Gastrointestinal Symptoms” (Model 5b), meaning that higher levels of PA are associated with current lower levels of general physical symptoms. Since the factor structure was slightly different at T5 and T6, we repeated these analyses applying either the structure of FSS at T5 or the structure at T6 to both waves. These analyses showed comparable results as our original analyses (results available upon request).

Table 5 shows the longitudinal relationship between PA and each component. PA was not longitudinally associated with any of the components of the Physical Complaints subscale.

Table 2
The cross-sectional and longitudinal association between PA and FSS.

Cross-sectional Bootstrapped regressions				**Adjusted R square**
Model 1	**B (SE)**	***p*-value**	**BCa 95% CI**	0.018
Positive affect	−0.006 (0.002)	0.001	[−0.010; −0.004]	
Model 2				0.31
Positive affect	−0.004 (0.001)	0.001	[−0.006; −0.002]	
Negative affect	0.018 (0.001)	0.001	[0.015; 0.020]	
Age	−0.005 (0.010)	0.627	[−0.023; 0.013]	
Female sex	0.098 (0.012)	0.001	[0.075; 0.122]	
Middle SES	−0.033 (0.016)	0.034	[−0.063; −0.005]	
Highest SES	−0.047 (0.017)	0.007	[−0.080; −0.016]	
Longitudinal Bootstrapped regressions				**Adjusted R square**
Model 3				0.013
Positive affect	−0.006 (0.002)	0.001	[−0.010, −0.003]	
Model 4				0.31
Positive affect	−0.002 (0.001)	0.181	[−0.005, 0.001]	
Negative affect	0.006 (0.001)	0.001	[0.003, 0.008]	
Age	−0.006 (0.010)	0.514	[−0.025, 0.012]	
Female sex	0.058 (0.013)	0.001	[0.035, 0.080]	
Middle SES	−0.002 (0.017)	0.888	[−0.038, 0.031]	
Highest SES	−0.014 (0.019)	0.462	[−0.053, 0.025]	
FSS at T5	0.480 (0.037)	0.001	[0.410, 0.550]	

Note: PA at T5 as predictor and FSS at T5 as the outcome in cross-sectional analysis. FSS at T6 as the outcome in the longitudinal analysis. B = unstandardized coefficient, SE = standard error, BCa 95% CI = Bias Corrected and Accelerated 95% Confidence Interval. Sex: "Male" as the reference group, SES: "Lowest SES" as the reference group.

4. Discussion

4.1. Main findings

To our knowledge, this is the first study to explore the association between PA and FSS in a young non-clinical sample, as well as the potential interaction effects of NA and sex on the relationship between PA and FSS. Firstly, we found that high PA was significantly associated with current lower levels of FSS. The association remained significant after adjusting for NA, age, sex, and SES. However, the size of the association that we found was small, and at a longitudinal level, PA did not predict changes in FSS over time. Cross-sectionally, an increase of one unit on PA score represents a reduction in the score of FSS by 0.004 points on a scale of 0 to 2 points, which may not be considered clinically relevant. Secondly, we did not find an interaction between PA and NA or PA and sex in the prediction of FSS.

4.2. Main findings in context

The cross-sectional relationship found between PA and FSS is consistent with the findings from De Gucht, Fischler, and Heiser [28], suggesting that high levels of PA are related to current low levels of FSS. However, this finding should be interpreted with caution. Unlike De Gucht et al. [29], we did not find a longitudinal association between PA and FSS. When FSS at T5 was added as a covariate for longitudinal analysis, the association between PA and FSS disappeared and most of the variance of FSS at T6 was predicted by FSS at T5. This could suggest that the association found at a cross-sectional level represents a reversed causation and that higher PA is a result of current lower levels of FSS. A potential explanation for the discrepancy between our study and

Table 3
Principal component analysis (PCA) of physical complaints subscale from ASR at T5 and at T6.

Item	**T5**		**T6**	
	Component 1	**Component 2**	**Component 1**	**Component 2**
I feel dizzy or light in my head	**0.61**	−0.03	**0.65**	−0.07
I feel tired without my knowing why	**0.68**	0.07	**0.64**	−0.01
Physical problems without known medical cause:				
Pains (no abdominal or headache)	**0.58**	−0.03	**0.53**	−0.21
Headache	0.26	**−0.53**	**0.53**	−0.20
Nausea	0.21	**−0.70**	0.27	**−0.70**
Eye problems (for which glasses or lenses do not help)	**0.40**	0.04	**0.43**	0.04
Skin rash or other skin problems	**0.32**	−0.08	**0.41**	0.17
Abdominal pain	0.17	**−0.68**	0.35	**−0.55**
Vomiting	−0.22	**−0.75**	−0.16	**−0.85**
Palpitations	**0.51**	−0.09	**0.59**	−0.02
Death sensation or tingling in body parts	**0.58**	−0.01	**0.64**	0.03
I have problems sleeping	**0.55**	0.04	**0.54**	−0.08

Note: Items loading > 0.30 are in boldface.

Table 4
The relationships between PA and current general physical symptoms, and PA and current gastrointestinal symptoms.

Cross-sectional Bootstrapped regressions				Adjusted R square
General physical symptoms (Component 1)				
Model 5a	**B(SE)**	***p*-value**	**BCa 95% CI**	0.28
Positive affect	−0.019 (0.005)	0.001	[−0.028; −0.011]	
Negative affect	0.069 (0.005)	0.001	[0.061; 0.077]	
Age	0.033 (0.035)	0.351	[−0.035; 0.101]	
Female sex	0.304 (0.043)	0.001	[0.218; 0.395]	
Middle SES	−0.091 (0.058)	0.129	[−0.206; 0.024]	
Highest SES	−0.119 (0.061)	0.059	[−0.235; −0.009]	
Gastrointestinal symptoms (Component 2)				
Model 5b				0.18
Positive affect	−0.008 (0.004)	0.081	[−0.016; 0.001]	
Negative affect	0.048 (0.004)	0.001	[0.041; 0.056]	
Age	−0.016 (0.037)	0.663	[−0.090; 0.560]	
Female sex	0.380 (0.044)	0.001	[0.289; 0.463]	
Middle SES	−0.119 (0.061)	0.056	[−0.240; 0.011]	
Highest SES	−0.245 (0.061)	0.001	[−0.363; −0.139]	

Note: PA at T5 as the predictor and each component at T5 as the outcome. B = unstandardized coefficient, SE = standard error, BCa 95% CI = Bias Corrected and Accelerated 95% Confidence Interval. Sex: "Male" as the reference group, SES: "Lowest SES" as the reference group.

the study of De Gucht et al. [29] is the study sample. In their study, a clinical sample of 377 adults was included, whereas we used a large population-based sample of young adults. PA could be more relevant for predicting changes in FSS in patients who already present with symptoms, compared with young adults from the general population.

Regarding the interaction analyses, we did not find evidence that males or females were more sensitive to the effects of PA on FSS. The studies that found a difference by sex focused on chronic pain and allostatic load [26,31], which reflect chronic manifestations of symptoms. In our study, FSS may not have been chronic yet; therefore, it could be the case that the effects of PA interact with sex only in chronic FSS. Another possibility is that, as FSS scores were very low, a floor effect would not allow observing a potential interaction effect between PA and other variables. According to our knowledge, no previous studies have examined the interaction between PA and NA, and its association with FSS. We expected that a combination of high PA and low NA would be more strongly related to lower levels of FSS; however, we did not find an interaction between them. We did find that both constructs had independent contributions to FSS, especially NA which predicted both current FSS and changes in FSS over time. This is consistent with the findings of previous studies, linking NA with FSS [11,16,20,28,29].

4.3. FSS dimensions

In the PCA, two dimensions of the physical complaints subscale of the ASR were found: A General Physical Symptoms dimension and a Gastrointestinal Symptoms dimension. In the secondary cross-sectional analyses, higher levels of PA were associated with lower levels of symptoms on both dimensions, but the association was only significant for the "General physical symptoms" dimension. In the longitudinal analysis, PA was not a significant predictor of changes in "General physical symptoms" nor "Gastrointestinal symptoms".

Two previous studies from the TRAILS cohort performed a PCA on the physical complaints subscale of the Youth-Self Report questionnaire. In adolescents between 11 and 16 years old, one dimension was found to underlie the construct of FSS [4]. In a subsample of adolescents with a mean age of 16 years, the PCA revealed that FSS were better explained by two dimensions: one consisting of headache and gastrointestinal symptoms and the other consisting of overtiredness, dizziness and musculoskeletal pain [32]. The results of our PCA in young adults reveal a similar dimension structure at T5 with the item "headache" loading in the gastrointestinal symptoms dimension. We found slight differences between the factor structures at T5 and T6, but these did not influence our results on the associations with PA. An

Table 5
The relationships between PA and changes in general physical symptoms, and PA and changes in gastrointestinal symptoms.

Longitudinal Bootstrapped regressions				Adjusted R square
General physical symptoms (Component 1)				
Model 6a	**B(SE)**	***p*-value**	**BCa 95% CI**	0.32
Positive affect	−0.006 (0.005)	0.196	[−0.017; 0.004]	
Negative affect	0.020 (0.004)	0.001	[0.011; 0.029]	
Age	−0.026 (0.035)	0.469	[−0.093; 0.043]	
Female sex	0.184 (0.044)	0.001	[0.093; 0.272]	
Middle SES	−0.026 (0.062)	0.682	[−0.167; 0.109]	
Highest SES	−0.081 (0.071)	0.263	[−0.228; 0.070]	
Comp. 1 at T5	0.451 (0.033)	0.001	[0.391; 0.511]	
Gastrointestinal symptoms (Component 2)				
Model 6b				0.09
Positive affect	0.001 (0.006)	0.894	[−0.011; 0.012]	
Negative affect	0.005 (0.005)	0.280	[−0.004; 0.015]	
Age	−0.041 (0.039)	0.297	[−0.120; 0.038]	
Female sex	0.243 (0.055)	0.001	[0.142; 0.341]	
Middle SES	0.017 (0.067)	0.790	[−0.118; 0.144]	
Highest SES	−0.017 (0.074)	0.827	[−0.177; 0.137]	
Comp. 2 at T5	0.244 (0.042)	0.001	[0.164; 0.331]	

Note: PA at T5 as the predictor and each component at T6 as the outcome. B = unstandardized coefficient, SE = standard error, BCa 95% CI = Bias Corrected and Accelerated 95% Confidence Interval. Sex: "Male" as the reference group, SES: "Lowest SES" as the reference group.

explanation for these differences might be that FSS start clustering and differentiating with aging, before becoming chronic or developing into syndromes. Although one study found that all depressive and anxiety disorders, except for dysthymic disorder, were independently associated with all dimensions of somatic symptoms [36], the results of the current study suggest that both PA and NA are more strongly related to the general physical symptoms dimension than to the gastrointestinal symptoms dimension.

4.4. Strengths

One of the main strengths of this study is the large sample size of this population-based cohort and the high response rate of the participants at both waves. Well-validated and reliable instruments were used for measuring all variables. The incorporation of PCA in the study, to assess the validity of the dimensional structure of the outcome measure, also gives strength to this study.

4.5. Limitations

This study has several limitations. Firstly, FSS were assessed by self-report. Chronic diseases may have contributed to the negative association between PA and FSS in the cross-sectional analysis. However, excluding participants with asthma and migraine, two of the most common chronic diseases in this age group, did not alter the associations. Secondly, since this study was performed in young adults from the general population, few of them may have had severe FSS, which could have reduced the strength of the association between PA and FSS. Thirdly, this study assessed the variation in PA and FSS levels between individuals, but it did not measure the variations in PA and FSS within individuals. This may have made the association appear smaller since the within-person variability in PA and FSS is not taken into account. A study from Schenk et al. found a non-significant cross-sectional association between PA and general somatic symptoms at a between-subjects level, but a significant negative association at a within-subjects level, revealing individual processes [37].

4.6. Future research

Considering the results of this study, it is worthwhile to keep exploring the relationship between PA and FSS in older populations. As FSS seem to increase with age [15,38], studying the associations between PA and FSS in older populations could give more information about the role of PA in FSS, as in these populations the FSS may be more severe and may become chronic or develop into functional somatic syndromes (e.g. fibromyalgia). It is also necessary to explore within-person differences in order to assess if the association between PA and FSS is stronger or weaker depending on individual variability. Given that PA can have day-to-day variations, and these are individual-specific, it is important to assess the influence of affect in the manifestation of FSS in a shorter time frame. This could be done by means of Intensive Longitudinal Measurement, where daily within-individual variations can be modeled both in PA and in FSS. This could provide more accurate estimates of the relationship. Moreover, since negative affective states have been found to be related to FSS, it would be relevant to explore the within-person variability in both PA, NA, and their independent and interactive associations with specific FSS and clusters of symptoms.

5. Conclusion

High PA was significantly related to current lower levels of FSS in young adults; however, PA did not predict changes in FSS over time. Neither NA nor sex modified the association of PA with FSS. The association between PA and current FSS should be interpreted with caution and further studies are necessary to unravel the associations between affect and FSS. Although the results are significant at a cross-sectional level, the effect size is small and therefore the relevance of this study is theoretical rather than clinical.

Declaration of Competing Interest

The authors have no competing interests to report.

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