Child and Adolescent Mental Health
a journal for all professionals working with children and young people

Child and Adolescent Mental Health 19, No. 2, 2014, pp. 83–89 doi:10.1111/camh.12026

ADHD and functional somatic symptoms: structural equations of a conceptual model

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Aims: To examine the effect of anxiety and parental overprotection on functional somatic symptoms (FSS) in children with attention deficit hyperactivity disorder (ADHD). **Method:** Seventy-six children and adolescents (aged 6–17) with ADHD and their parents completed a clinical interview about psychiatric and somatic symptoms. Parents also reported about parenting styles. Structural equation modeling (SEM) was used. **Results:** The generalized anxiety, overprotection, and specific phobia variables each had a direct effect on FSS. **Conclusions:** Anxiety symptoms and parental overprotection may play a role in the development of FSS in children with ADHD. Further research is necessary to corroborate our findings.

Key Practitioner Message:

- Children with ADHD and anxiety symptoms should be considered a group at risk of showing functional somatic symptoms (FSS)
- Physical symptoms can be associated with increased functional impairment in ADHD children
- Parental overprotection as reported by parents was associated with FSS. Training parents to use other strategies may be helpful for the prevention and treatment FSS

Keywords: ADHD; functional somatic symptoms; structural equation modeling

Introduction

Physical complaints and recurrent pain are common in children and adolescents (Beck, 2008; Janssens, Oldehinkel & Rosmalen, 2009; Vila et al., 2009). Many of these symptoms have an unknown pathology (Dimsdale & Creed, 2009). The term somatization is commonly used to refer to the presence of physical symptoms for which medical evaluations do not prove the existence of any disease or biological process that can explain them. These symptoms have also been referred to as functional somatic symptoms (FSS; Campo & Fritz, 2007).

According to Beck (2008), between 10% and 30% of children and adolescents in the United States have FSS. Similar frequencies have been found in studies of European samples (Serra Giacobo, Jané, Bonillo, Ballespő & Dőaz-Regañon, 2012).

Most research in clinical and general population samples show that the frequency of FSS is similar in boys and in girls until late childhood and puberty. However, girls tend to show higher rates than boys in adolescence (Domènech-Llaberia et al., 2004; Steinhausen & Metzke, 2007).

There is considerable evidence of high levels of psychopathology among children and adolescents with physical symptoms of unknown pathology. The association of these physical symptoms with anxiety disorders and depression has been widely studied and corroborated by several studies in both clinical and general population samples (Campo et al., 2004; Janssens, Rosmalen, Ormel, van Oort & Oldehinkel, 2010; Liakopoulou-Kairis et al., 2002).

Children and adolescents with attention deficit hyperactivity disorder (ADHD) also manifest FSS (Cho et al., 2009; Egger, Costello, Erkanli & Angold, 1999). In general population samples, some authors have found positive associations between children diagnosed with ADHD and recurrent abdominal pain, sleep problems, and fatigue (Holmberg & Hjern, 2006). The prevalence of physical symptoms in such children is lower compared with children with internalizing symptoms. To our knowledge, specific studies of FSS in children and adolescents with ADHD are limited.

ADHD is a behavioral disorder that is characterized by excessive inattention-disorganization (e.g. difficulty paying attention to detail and making mistakes in home and work tasks or in other activities) and/or hyperactivity/impulsivity (e.g. shaking hands or feet, squirming in the seat, and difficulty taking turns). The Diagnostic and Statistical Manual of Mental Disorders,

fourth edition (DSM-IV) classifies ADHD into three subtypes: predominantly inattentive, predominantly hyperactive-impulsive, and a combined subtype (American Psychiatric Association, 2000).

Many affected children have difficulties in both social and cognitive functioning. Compared with healthy children, adolescents and children with ADHD have more academic difficulties, poorer school performance, and more reading problems, among others (Biederman, 2005). School performance may be affected not only by attention deficits but also by possible impairment of intelligence (Steinhausen, 2009).

In addition to the impairments caused by ADHD, overall functioning may be affected by the presence of FSS. Compared with healthy children, children and adolescents with physical complaints commonly have higher rates of school absenteeism, which can lead to academic difficulties and limitations in social functioning (Hughes, Lourea-Waddell & Kendall, 2008). They also use more health services than healthy children; thus, they may undergo more medical procedures or unnecessarily use medications (Beck, 2008; Campo & Fritz, 2007).

FSS are the result of a multifactorial process in which the contributing factors may have cognitive, social, and biological aspects (Husain, Browne & Chalder, 2007). One social factor is parenting style. Previous works have found that the parents of children and adolescents with physical complaints of unknown pathology usually show traits of overprotection (Garralda, 2004; Husain et al., 2007; Janssens et al., 2009; Masi, Favilla, Millepiedi & Mucci, 2000). However, there is currently insufficient evidence to claim that parental overprotection is associated with the presence of functional physical symptoms in children diagnosed with ADHD.

Taking into account the findings in the literature, this study aims to examine the effect of anxiety, depression, and parental overprotection on the FSS presented by children with ADHD. In turn, this study aims to determine whether the FSS are associated with the level of overall functioning impairment of the participants.

The research hypothesis is that these variables are similarly associated with the presence of FSS in children with ADHD. To test this hypothesis, we created a conceptual model and tested it in a clinical sample of children and adolescents with ADHD. We used structural equation modeling (SEM) to assess the possible direct effects of the independent variables on FSS. We also performed standardized procedures to construct the structural model, including the development of a measurement model.

Method

Participants

A total of 76 children and adolescents aged 6–17 years (mean = 11.7, *SD* = 2.3) and their parents participated in the study (mothers = 65, fathers = 11). This clinical sample comprises children who were diagnosed with ADHD by child psychiatrists based on DSM-IV diagnostic criteria. Participants were from the region of Osona (Catalonia, Spain).

The children were being treated at the Mental Health Center for Children and Youth (MHCCY) of the Vic Hospital Consortium (VHC). The ethnic distribution was 88% Caucasian, 5% Hispanic, 4% Maghrebian, and 3% Slavic. Most of the participants were male (84.2%, $n = 64$). Participants with mental retardation or developmental disorders were excluded.

Measures

Anxiety disorders, major depression, and presence of FSS

The Kiddie-Schedule for Affective Disorders and Schizophrenia, Present and Lifetime Version (K-SADS-PL; Kaufman et al., 1997) is a semi-structured diagnostic interview designed to evaluate both the present episode and the lifetime history of psychiatric disorders in childhood and adolescence. Each question was answered on a 3-point severity scale. Scores of 1 suggest that the symptom is not present; scores of 2 indicate subthreshold levels of symptomatology; and scores of 3 represent threshold criteria. The interview applies the diagnostic criteria of the DSM. This interview has proven to be a reliable and valid tool for psychiatric diagnosis (Kaufman et al., 1997).

In addition to being used for psychopathology measures, the K-SADS-PL was used to develop the FSS variable. Respondents scored to what extent they experienced bodily problems without a medical cause during the past 6 months. To assess the severity of the FSS, the interviewer considered the presence of the most frequent complaints in the general population (e.g. headache, abdominal pain, fatigue) during the clinical interview (Domènech-Llaberia et al., 2004). Only data from the present episode were used.

Overprotection

Based on the original EMBU (Egna Minnen Beträffande Uppfostran; My memories of upbringing), the EMBU-P (Parent version; Castro, de Pablo, Gómez, Arrindell & Toro, 1997) is a questionnaire for parents to assess parenting styles. The EMBU-P has the same items, format, and scoring key as the original questionnaire. In the EMBU-P, the verb tense was changed from past to present and past perfect by the authors while trying to not change the meaning of the items. This feature allows for the description of past and current parenting.

The questionnaire classifies parenting styles into four subscales: 'rejection', 'emotional warmth', 'overprotection/control', and 'favouring subject'. Items are scored 1 (never), 2 (sometimes), 3 (often), or 4 (always). To assess parental overprotection, the subscale 'overprotection/control' was used. Examples of overprotection items are 'You have had an exaggerated anxiety that something might happen to your child' and 'You have forbidden your child to do things that other children were allowed to do because you were afraid that something might happen to him/her.' The EMBU-P has been adapted to the Spanish population, and the scales have demonstrated good internal consistency (Castro et al., 1997).

Functional impairment

The Children's Global Assessment Scale (CGAS; Shaffer et al., 1983) evaluates the level of functional impairment caused by psychiatric symptoms. The scores used range from 1 (maximum impairment) to 100 (excellent functioning). Scores above 70 indicate normal functioning. The scale has demonstrated good test-retest reliability and significant correlations with other measures of psychopathology (Ezpeleta, Granero & de la Osa, 1999).

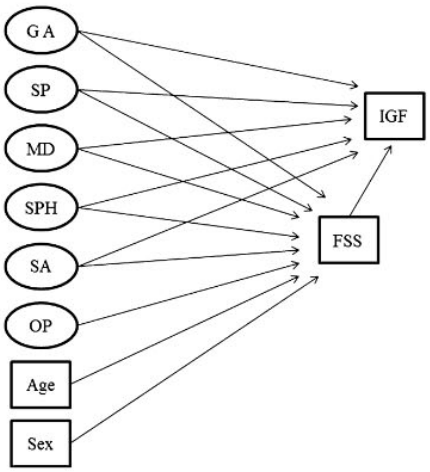

Figure 1. Conceptual model. GA = Generalized Anxiety. SP = Social Phobia. MD = Major Depression, SPH = Specific Phobia. SA = Separation Anxiety. OP = Overprotection. FSS = Functional Somatic Symptoms. IGF = Impairment of General Functioning.

Procedure

The study was subject to acceptance by the ethics committee of the Vic Hospital Consortium. All children between 6 and 17 years old with an ADHD diagnosis who were treated at the Department of Mental Health for Child and Youth of the Vic Hospital Consortium and agreed to participate were selected for study. Participation was requested via parents' informed consent and verbal consent of the children who were involved in the research.

During a focused session, the diagnostic interview (K-SADS-PL) was administered to the children. Simultaneously, another researcher conducted the same interview with the parents (65 mothers, 11 fathers). After the interview, both interviewers established the CGAS score, considering all the information obtained in the diagnostic interview. The EMBU-P was completed at home by the parents. In 19 cases, the EMBU-P was completed by both parents. The other EMBU-P questionnaires were answered by 46 mothers and 11 fathers.

Statistical analysis

Descriptive statistics were calculated using SPSS version 15.0. To examine the relationships of the variables proposed in the conceptual model (Figure 1), the structural equation model was estimated using the program Mplus version 6.11 (Muthén & Muthén, 1998). The method of maximum likelihood estimation was used because it allows all valid data, including incomplete responses, to be analyzed (Little & Rubin, 2002). SEM was chosen because of its many advantages over regression models, path analysis, and factor analysis (Schumacker & Lomax, 2004).

Development of the model

To use the SEM method, a conceptual model must be developed based on the theoretical framework of the study. Based on the research objectives, we constructed latent variables that gave rise to the conceptual model (Figure 1). The latent variables relating to psychopathology (generalized anxiety, separation anxiety, specific phobia, social phobia, and major depression) were developed from the K-SADS-PL items that were present in the specific sections of each disorder. To avoid spurious results, the question on physical complaints was not used to construct the latent variable generalized anxiety. In turn, the latent variable overprotection was originated from the items of the 'overprotection/control' subscale of the EMBU-P.

Two models were constructed based on the information from the diagnostic interview: one based on the information from the children and one based on the responses of the parents. The decision to develop two models was made because there is very limited evidence concerning who is the better informed about FSS (Steinhausen & Metzke, 2007). In general, discrepancies between the reports of parents and children are quite common (Campo & Fritz, 2007). Therefore, we made two models to detect and compare possible differences in our results. Furthermore, we can assess the fit (the validity) of the conceptual model, even with data provided by two informants.

After defining the latent constructs, that is, the measurement model, we assessed its fit with a confirmatory factor analysis (CFA) before testing the final models (structural model). CFA is frequently used as a first step to assess the proposed measurement model in a structural equation model (Muthén & Muthén, 1998).

The fit of the final models and the measurement were considered adequate when the comparative fit index (CFI) and the Tucker-Lewis index (TLI) were higher than .90, and when the root mean square error of approximation (RMSEA) was less than .05 (Hoyle, 1995). In addition to the above values, the chi-squared value (x^2) should not be significant ($p > .05$). Guided by the Mplus program, in the final models of parents and children, we performed correlations between some variables to improve the fit indices of the model. The coefficients shown in the figures have been standardized.

Results

Conceptual model

When performing the CFA, Table 1, we obtained good fit indices for the latent variables generalized anxiety, specific phobia, separation anxiety, and overprotection. However, the constructs major depression and social phobia did not show valid fit values due to the lack of variability in the sample. For this reason, the two variables were removed from the final structural models.

Child model. The results from the analysis of the structural models based on the children's reports are shown in Figure 2. Considering the statistical indices, the model fit was optimal [model fit: χ^2 ($df = 153$) = 157.6, $p = .38$, CFI = .98, TLI = .98, RMSEA = .02].

According to the model (see Figure 2), the latent construct generalized anxiety was associated with FSS ($\beta = 1.51$, t = 3.1, $p < .01$). That is, for each standard deviation increase in generalized anxiety, the FSS increased by 1.51 standard deviations. The latent variable specific phobia was also significantly associated with FSS but with a negative effect ($\beta = -.47$, t = −2.7, $p < .01$). In addition, female gender had a direct effect on FSS ($\beta = .54$, t = 2.8, $p < .01$). In turn, FSS were

Table 1. Demographic data and main psychiatric disorders according to the presence of FSS by children and parents.

	Functional Somatic Symptoms			
	Children		Parents	
	Yes 25 (32.9%)	No 51 (67.1%)	Yes 30 (39.5%)	No 46 (60.5%)
Gender Male	18 (28.1%)	46 (71.9%)	22 (34.4%)	42 (65.6%)
Female	7 (58.3%)	5 (41.7)	8 (67%)	4 (33.3%)
Age (Years/*SD*)	11.4/2.15	11.8/2.48	11.5/2.18	11.9/2.49
Ethnicity Caucasian	22 (32.8%)	45 (67.2%)	26 (38.8%)	41 (61.2%)
Hispanic	1 (25%)	3 (75%)	2 (50%)	2 (50%)
Maghrebian	1 (33.3%)	2 (66.7%)	1 (33.3%)	2 (66.7%)
Slave	1 (50%)	1 (50%)	1 (50%)	1 (50%)
GAD	10 (100%)	–	3 (60%)	2 (40%)
SAD	3 (100%)	–	1 (100%)	–
SPD	6 (85.7%)	1 (14.3%)	2 (100%)	–
DD	–	1 (100%)	1 (100%)	–
ODD	1 (33.3%)	2 (66.7%)	3 (75%)	1 (25%)
TD	1 (25%)	3 (75%)	1 (50%)	1 (50%)

GAD, Generalized Anxiety Disorder; SAD, Separation Anxiety Disorder; SPD, Specific Phobia Disorder; DD, Disocial Disorder; ODD, Oppositional Defiant Disorder; TD, Tourette Disorder. Psychiatric disorders were measured by the diagnostic interview K-SADS-PL using standardized procedures.

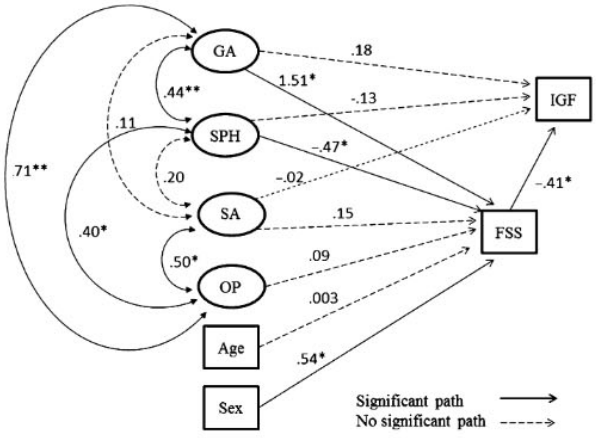

Figure 2. Child Structural Equation Model. GA = Generalized Anxiety reported by children. SPH = Specific Phobia reported by children. SA = Separation Anxiety reported by children. OP = Overprotection reported by parents. FSS = Functional Somatic Symptoms reported by children. IGF = Impairment of General Functioning. * = $p < .01$. ** = $p < .001$.

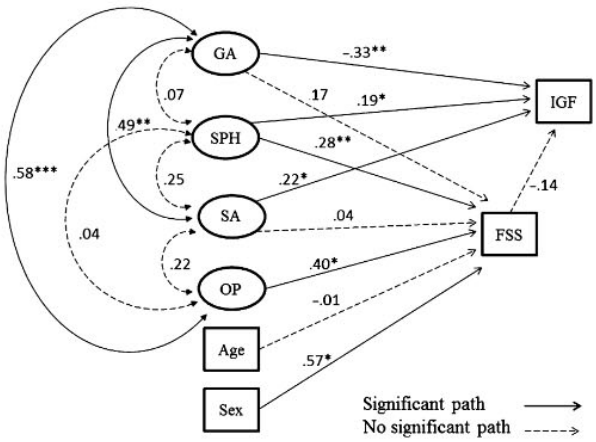

Figure 3. Parent Structural Equation Model. GA = Generalized Anxiety reported by parents. SPH = Specific Phobia reported by parents. SA = Separation Anxiety reported by parents. OP = Overprotection reported by parents. FSS = Functional Somatic Symptoms reported by parents. IGF = Impairment of General Functioning. * = $p < .05$. ** = $p < .01$. * * * = $p < .001$.

significantly associated with the level of impairment of general functioning ($\beta = -.41$, t = −3.4, $p < .01$).

The results revealed that the ratios between some of the proposed relationships were not significant. Specifically, the latent variables separation anxiety and overprotection did not show a significant estimated effect on FSS.

The constructs generalized anxiety, separation anxiety, and specific phobia did not exert a significant direct effect on the general functioning of the participants. In addition, age did not show a direct correlation with FSS.

We calculated the indirect effects of the latent variables generalized anxiety, specific phobia, and separation anxiety on the level of impairment of the general functioning of the participants. These effects were mediated by FSS. The results that are not shown in Figure 2 indicated a significant indirect effect only between the construct generalized anxiety and the level of impairment of general functioning ($\beta = -.62$, t = −1.9, $p < .05$).

Parent model. The results obtained in the analysis as reported by parents are shown in Figure 3. According to the statistical indices evaluated, the model also provided an excellent fit [model fit: χ^2 ($df = 156$) = 184.3, $p = .06$, CFI = .91, TLI = .91, RMSEA = .04].

The latent variable specific phobia had a statistically significant direct effect on FSS ($\beta = .28$; t = 3.1; $p < .01$). The effect was also verified between the construct overprotection ($\beta = .40$, t = 2.4, $p < .05$) and females ($\beta = .57$, t = 2.4, $p < .05$) on FSS. The other variables evaluated did not show a significant direct effect on FSS.

In the parent model, no indirect effect on the level of impairment of general functioning was observed. However, a direct effect of the latent variables generalized

anxiety ($\beta = -.33$, $t = -2.9$, $p < .01$), specific phobia ($\beta = .19$, $t = 2.3$, $p < .05$), and separation anxiety ($\beta = .22$, $t = 2.2$, $p < .05$) was observed. The FSS, in turn, had no effect on the level of impairment of general functioning.

Discussion

In this study, we found that children and adolescents with ADHD show FSS, as indicated by previous studies (Cho et al., 2009; Holmberg & Hjern, 2006). According to the parents' reports, no participant showed any chronic illness at the time of the study. This finding suggests that FSS are not better explained by the presence of a medical condition.

According to the indices that we used, both structural equation models (child and parent) showed an excellent fit based on the data. However, the results suggest some differences, which will be mentioned in this discussion.

As shown in the children model, the latent variable generalized anxiety exerted a direct effect on somatic symptoms. This finding is consistent with previous studies (Janssens et al., 2010; Liakopoulou-Kairis et al., 2002). Specifically, Campo et al. (2004) verified a positive association in children and adolescents between recurrent abdominal pain and generalized anxiety disorder. In addition, other studies have confirmed significant associations between somatic symptoms and generalized anxiety disorder (Domènech-Llaberia et al., 2004; Egger et al., 1999).

Our first consideration is that children with ADHD who show FSS may show symptoms of anxiety at the same time. As a result of this anxiety, these children may be more vulnerable to FSS. This vulnerability could be based on genetic, temperamental, or psychobiological factors (Serra Giacobo et al., 2012).

Another hypothesis is that this anxiety in children might change their perception of body changes. A high sensitivity and concern over body changes would culminate in amplified changes, which in turn is one of the processes involved in the development of somatic symptoms (Beck, 2008). This hypothesis needs further investigation to provide more scientific evidence.

The same effect was not observed in the parent model, but we found a significant association between specific phobia and FSS. Many previous studies do not discriminate between the various anxiety disorders associated with the presence of physical symptoms (Liakopoulou-Kairis et al., 2002; Masi et al., 2000). For this reason, it is difficult to make comparisons with previous studies.

We believe that phobic children may have temperamental characteristics or an information-processing pattern towards the symptoms, similar to the characteristics of children with other anxiety disorders. These characteristics may explain the effect found in our study.

In the children model, the effect of overprotection on FSS was not statistically significant. However, in the parent model, a direct effect between both variables was verified. This finding is consistent with previous research (Janssens et al., 2009).

Although our findings are consistent with previous studies, it is difficult to compare our results because of the lack of consistency among the methodologies of the different studies. For example, the study conducted by Janssens and colleagues (2009) used adolescent report to evaluate overprotection. In contrast, we used parental reports. In addition, the sample investigated by Janssens and colleagues is from the general population, whereas our participants are children diagnosed with ADHD (clinical sample).

In clinical practice, parents of children with FSS tend to be overprotective because they see their children as 'vulnerable' (Campo & Fritz, 2007; Masi et al., 2000). Overprotective parents are characterized by an excessive attempt to control and protect the child in various situations. Such attempts are based on the parents' extreme concern that something negative might happen. Some authors claim that the extreme concern could be extended to children's physical symptoms, thus reinforcing the symptom and acting as a maintenance factor for it (Garralda, 2004; Husain et al., 2007). Based on previous research, whether FSS can also lead to parental overprotection is unclear. Clarifying the possibility of a bi-directional relationship in future studies would be helpful and would increase our understanding of the nature of this association.

There was a high, positive, and significant correlation between the latent variables overprotection and generalized anxiety ($r = .71$) in the children model, which suggests that these factors are interrelated. In other words, parental overprotection may contribute to increased symptoms of generalized anxiety, which in turn has a direct and important effect on the FSS. At the clinical level, health professionals should assess both anxiety symptoms and parental overprotection because the combination of both factors may increase the functional physical complaints.

In the parent model, we also found a positive correlation between generalized anxiety and overprotection, but there was no significant direct effect of generalized anxiety on FSS.

According to the SEM analysis of the children model, FSS had a direct effect on the level of impairment of general functioning. This finding indicates that physical symptoms were associated with increased functional impairment in children. This result is consistent with previous research (Beck, 2008). In the same model, we also found a statistically significant indirect effect between the latent variable generalized anxiety and the level of impairment of general functioning, with the FSS as the mediating variable.

The findings support the initial hypothesis of the study and also warn about the possibility that the general functioning of children and adolescents with ADHD, which is usually characterized by academic difficulties (Biederman, 2005), may be even more affected due to FSS. Situations such as school absences related to physical complaints could increase such difficulties (Hughes et al., 2008).

In the parent model, we did not find direct or indirect effects of FSS on the level of impairment of general functioning. Perhaps this result is because the significant direct effects of the latent variables generalized anxiety, specific phobia, and separation anxiety on impairment are sufficient to explain the level of functional impairment of the participants in the parent model.

Most previous research indicates that girls are more likely than boys to suffer from somatic complaints (Steinhausen & Metzke, 2007; Vila et al., 2009). In fact,

the results in both models confirm the literature results. The direct effect of female gender on FSS indicates that girls are more likely to suffer from such complaints than boys in our study.

Some characteristics, such as coping mechanisms, lifestyle, temperament, and physiological (hormonal) differences, between genders may explain the association that we found (Campo et al., 2004). In addition, cultural differences may influence the manifestation of the FSS (Steinhausen, 2009). Traditionally, girls are encouraged to express feelings and pain, while boys are encouraged to repress them. In short, all the factors discussed in this study may play an important role in the gender differences that we found.

According to the SEM results, both models are valid, although there are important differences between them. In the literature, parents and children commonly present different reports (Campo & Fritz, 2007). If we consider both models, our findings suggest that the constructs generalized anxiety, specific phobia, and female gender can have a significant effect on the FSS in children and adolescents with ADHD. In the clinical context, children with ADHD and anxiety symptoms should be considered a group at risk of showing FSS. They may also be subject to functional impairment, which can occur as a result of physical complaints.

In addition, parental overprotection as reported by parents was associated with FSS. Thus, parents of children with FSS should be educated about their parenting styles. Being overprotective can lead to the maintenance of symptoms. Learning to use other strategies may be helpful for the prevention and treatment of FSS.

Strengths and limitations

Although most studies use screening instruments, one of the strengths of this study was the use of a diagnostic interview for the measurement of psychiatric disorders and the presence of FSS (Janssens et al., 2010; Steinhausen & Metzke, 2007), which contributes to better measurement quality. Mathematically, SEMs are more complex to estimate than other models, such as linear regression. For this reason, the use of a reliable instrument is very important for determining how well the model fits the data. SEM analysis allows both confirmatory and exploratory modeling, which is an advantage over other methods (Schumacker & Lomax, 2004).

This study has some limitations that should be considered when interpreting the results. First, the sample was limited mostly to Caucasian individuals, which means that the results are not directly generalizable to other ethnic groups.

Second, the small sample size for the SEM analysis. However, according to the literature, the use of SEM in small samples is a valid method (Baker, 2007; Bentler & Yuan, 1999). In addition, the TLI and RMSEA tend to falsely reject models when the sample size is small (Hu & Bentler, 1999). In our study, the TLI and RMSEA showed a good fit to the data, which confirms the validity of the two proposed models. Nevertheless, further research is necessary to verify our findings in a larger and more representative sample.

Third, although we utilized a clinical sample, a medical diagnosis was not available to confirm that medical symptoms could not be explained by a medical condition. This limitation can be found in many similar studies (Domènech-Llaberia et al., 2004; Steinhausen & Metzke, 2007). Finally, a cross-sectional study design does not allow for the interpretation of the findings as causal inferences.

Future research

It would be interesting to replicate the study in a larger sample and with different ethnic groups, thus making it possible to generalize our findings to different cultures. The variable temperament should also be added to the conceptual model because it would contribute to a more complete SEM-based model.

Regarding the methodological procedures, the use of diagnostic interviews is an important aspect to consider in future studies. These instruments provide a more reliable measure compared with screening instruments. This reliability is an essential condition for SEM analysis. Finally, longitudinal studies would enable the stability of FSS over time to be analyzed.

Acknowledgments

This study was conducted with a clinical sample of participants at Vic Hospital Consortium and received no external funding. The authors have declared that they have no competing or potential conflicts of interest.

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Accepted for publication: 21 January 2013
Published online: 14 March 2013