Journal of Psychosomatic Research 163 (2022) 111064

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

journal homepage: www.elsevier.com/locate/jpsychores

Can the bodily distress syndrome (BDS) concept be used to assess functional somatic symptoms in adolescence?

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ARTICLE INFO

Keywords:
Bodily distress syndrome
Factor analyses
Functional somatic symptoms
Latent class analyses

ABSTRACT

Objective: Bodily Distress Syndrome (BDS) represents a new research concept for adult patients with various functional somatic syndromes. We evaluated the utility of the BDS research concept and the associated BDS-25-checklist as a screening tool for diverse functional somatic symptoms (FSS) in adolescence by investigating: 1) the psychometric and factorial structures of the checklist, 2) symptom cluster patterns and 3) illness classification and associations with emotional psychopathology and sociodemographic factors.

Methods: This cross-sectional study obtained data from the 16/17-year follow-up ($N = 2542$) of the general population Copenhagen Child Cohort 2000 (CCC2000). We used self-reported questionnaires to assess physical symptoms (the BDS-25 checklist), overall health (KidScreen), emotional psychopathology (Spence Children's Anxiety Scale; The Mood and Feelings Questionnaire), and illness worry (Whiteley-6 Index), and utilized data from Danish national registers to assess sociodemographic factors.

Results: The BDS-25 checklist items displayed satisfactory psychometric data quality. Factor analyses revealed a similar four-factor model as reported in adults (factor loadings $\lambda \geq 0.5$), representing distinct BDS symptom clusters: cardio-pulmonary, gastro-intestinal, musculoskeletal and general symptoms. Latent class analyses revealed a model with three latent classes, i.e. probable no to mild BDS, probable moderate, single-organ BDS and probable severe, multi-organ BDS, displaying acceptable class quality (Entropy = 0.904). Trend analyses revealed sociodemographic group differences across latent classes. Increased emotional psychopathology was associated with more pronounced BDS symptoms.

Conclusion: Our findings support the BDS concept with four symptom clusters and three illness severity groups (no BDS, single- organ and multi-organ BDS) to screen for FSS in adolescence.

1. Introduction

Functional somatic symptoms, which cannot be attributed to a well-defined somatic disease, are common in childhood and adolescence, and typically include abdominal pain, headaches, muscular soreness or fatigue [1–4]. Most symptoms are mild, short-lasting and without considerable adverse impact on daily functioning, but in some cases they develop into persistent symptomatology, which is associated with negative long-term consequences, such as school absenteeism, diminished school performance or psychosocial functioning, and a heavier reliance on health care services [5–10].

Severe, persistent functional somatic symptoms occur in various medical domains where they are conceptualized and diagnosed according to different medical specializations' classification systems [11,12], such as chronic primary pain syndromes like irritable bowel syndrome or fibromyalgia in somatic health care (ICD-11) [13,14], or

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https://doi.org/10.1016/j.jpsychores.2022.111064
Received 21 July 2022; Received in revised form 11 October 2022; Accepted 12 October 2022
Available online 18 October 2022
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bodily distress disorder (BDD) (ICD-11) or somatic symptom disorder (SSD) (DSM-5) in psychiatric settings [13,15]. However, studies have shown considerable overlap between different diagnoses, indicating they may represent the same underlying disorder phenomenon rather than distinct entities [16–19]. This has led to the umbrella term 'Functional Somatic Disorders', a common classification encompassing various conditions characterized by persistent and burdening physical symptoms, including specifiers that can be added to account for psychological features or co-occurring diseases [16].

Bodily distress syndrome (BDS) was originally developed in an effort to create an unifying accessible concept to capture various functional somatic symptoms across medical specialties [17]. This concept is based on findings from both clinical descriptive and epidemiological studies, and assembles symptoms within organ system clusters suggesting specific symptom patterns along four symptom clusters: 1) cardiopulmonary (CP), 2) gastrointestinal (GI), 3) musculoskeletal (MS) and 4) general symptoms (GS) [17,19]. The BDS concept should however not be confused with the ICD-11 BDD diagnosis, wherein specifiers of psychological features, i.e. excessive attention or distress associated with bodily symptoms, are included. BDS can be classified into a single−/oligo-organ (≥3 symptoms in one or two symptom clusters; or ≥ 4 symptoms across clusters), or a multi-organ subtype (≥3 symptoms in ≥3 symptom clusters) [17]. It has been suggested to change symptom cut-off criteria to ≥4 for both within and across symptom clusters, since these adaptations have provided clearer differentiating patterns [20,21]. Subtype categorization has been linked to severity dimensions, with more persistent symptomatology in adults with multi-organ BDS [22]. The BDS-checklist was developed to assess physical symptoms according to the BDS symptom clusters, originally including 30-items, and has been revised and validated as a 25-item version [20,21,23].

To date, the BDS concept has been verified in adults, both in clinical samples and in the general population [17,20,21,23], but not in younger populations. However, studies on children and adolescents using the Children Somatization Inventory (CSI) [24] to assess functional somatic symptoms have also revealed a general underlying functional somatic disorder phenomenon [25–28]. Therefore, the question remains if we could conceptualize severe functional somatic symptoms in young populations using the same concept in research, namely BDS. This would be of great advantage for research endeavors, especially if an associated assessment tool, i.e. the BDS-checklist, could be used for screening purposes across the age range, as this could unify communication across health care sectors as well as foster research alliance between medical specialties [17]. Therefore, the current study aims to evaluate the utility of the BDS concept in adolescence by exploring: 1) the psychometric properties of items and underlying factorial structure of the BDS-25 checklist (objective 1), 2) whether the same BDS symptom cluster patterns (CP, GI, MS and GS) can be rediscovered in adolescence (objective 2), and 3) the classification of adolescents into illness severity groups according to symptom presence within clusters, and associations with sociodemographic variables and psychological functioning (objective 3).

2. Method

The current study has been pre-registered on Open Science Framework (Registration DOI: 10.17605/OSF.IO/6QBMD) and is part of the innovative training network ETUDE (Encompassing Training in fUnctional Disorders across Europe; https://etude-itn.eu/), ultimately aiming to improve the understanding of mechanisms, diagnosis, treatment and stigmatization of functional somatic disorders [29].

2.1. Study population

The study utilizes data collected in the 16–17-year follow-up (CC16/17) of the Copenhagen Child Cohort, CCC2000 [30]. The CCC2000 is a general population-based birth cohort including 6090 children born in the year 2000 in the former Copenhagen County, Denmark. The original cohort was representative of the Danish child population concerning key perinatal and sociodemographic characteristics. For the CC16/17, cohort members were contacted through an established governmental e-mail system and asked to fill in online questionnaires. Socioeconomic adversities, perinatal adversities, and parental and child mental healthcare use were less common among participants compared to non-participants. For details on the CCC2000, including the CC16/17, see Olsen et al., 2020 [30].

2.2. Measures

2.2.1. Clinical variables

2.2.1.1. Functional somatic symptoms. Physical symptoms were assessed with the Danish version of the BDS-25 checklist [20]. The checklist asks '*Within the past 12 months, to what extent have you been bothered by*' on 25 physical symptoms along BDS symptom clusters and has displayed good psychometric properties in Danish adult populations [20,21,31] (Appendix A). Response options are presented on a 5-point response scale from 0 ('*Not at all*') to 4 ('*A lot*'). Additional items were included to assess symptom impairment: '*During the past 4 weeks, have you been bothered by any of the above-mentioned physical symptoms?*' measures whether any symptoms were present (response option '*Yes/No*'); '*If yes, to what extent did these symptoms affect your life?*' consecutively assesses impairment extent on a 10-point response scale from 1 ('*Not at all*') to 10 ('*A great deal*').

2.2.1.2. Overall health. Overall self-perceived health was measured using one self-report item from the KidScreen-10 [32,33], which has shown good psychometric properties. Participants are asked to respond to the instruction '*In general, how would you say your health is?*' on a 5-point response scale from 0 ('*Poor*') to 4 ('*Excellent*').

2.2.1.3. Depression. Depressive symptoms were self-reported using the Mood and Feelings Questionnaire, MFQ [34–36]. The following instructions are provided: '*The following questions are about mood and feelings. How have you been within the past 2 weeks*'. The MFQ includes 33 items. Response options range from 0 ('*Not true*') to 2 ('*True*') (total sum score range 0–66, higher scores indicating more depressive symptoms). The MFQ has demonstrated good psychometric properties and has been validated in the Danish setting [37].

2.2.1.4. Anxiety. The Spence Children's Anxiety Scale, SCAS [38–40], was used to assess anxiety. Participants are asked to respond to (frequency of) 44 situations that could cause anxiety. Response options are presented on a 4-point response scale ranging from 0 ('*Never*') to 3 ('*Always*'), including six filler items (total sum score range 0–114, higher scores indicating more anxiety symptoms). The SCAS has been validated and has shown good psychometric properties in Danish samples [38].

2.2.1.5. Illness worry. The Whiteley-8, W-8 was administered to measure illness worry, conforming with the validated Whiteley-7 version including an additional, deemed important item on illness rumination [41]. Here, we only used items respective to the Whiteley-6-R, W-6-R [42]. According to the instruction '*Within the past 12 months, to what extent have you been bothered by*', participants are asked to rate six different facets of this construct, i.e. rumination on having a serious illness. Response options are presented along a 5-point response scale, ranging from 0 ('*Not at all*') to 4 ('*A lot*') (total sum score range 0–24, higher scores indicating more illness worries). The W-6-R has shown good construct and criterion validity in a Danish adult general population [42].

2.2.1.6. Chronic medical condition. Presence of a chronic medical

condition was assessed by a priori list of well-defined conditions derived from the Soma Assessment Interview (SAI) [43]. According to the instruction, *'Within the past 12 months, have you experienced any of these physical illnesses or handicaps*?', the participant is asked whether a physician had diagnosed any of a list of ten chronic medical conditions (e.g. 'diabetes', 'asthma', 'kidney diseases') along binary *'Yes'/'No'* response options. An indication of one *'yes'* is considered presence of a chronic condition.

2.2.2. Socio-demographic variables

Sex was included as registered at birth (*'male'/'female'*, Danish Civil Registry) [44]. Parental education was categorized into either parent's highest education level (1) Primary school education (up to grade 9) and/or High School 2) Short Traineeship 3) Long Traineeship/University education (Integrated Labor Market Registry) [45]. Family composition was categorized into 1) Biological parents live together or 2) Other (i.e., biological parents do not live together) (Medical Birth Registry) [46]. Yearly household income comprised of a total sum score of parental yearly income in DKK in quantiles, 1) Low: 1st quantile (<25%), 2) Medium: 2nd and 3rd quantile (between 25 and 75%) and 3) High: 4rth quantile (>75%) (Integrated Labor Market Registry) [45].

2.3. Statistical analyses

The statistical analyses were conducted on Denmark Statistics server using STATA 16.0 [47] and R-studio [48]. Sample characteristics on socio-demographic variables were described. We employed list-wise deletion for missing responses on the BDS-25 checklist.

2.3.1. Psychometric properties of items and factorial structure of the BDS-25 checklist (objective 1)

BDS-25 checklist psychometric properties were assessed according to item response distribution, floor and ceiling effects, and polychoric correlations among items. The sample was randomly split into two subsamples to independently conduct exploratory (1/4 sub-sample) and confirmatory (3/4 sub-sample) factor analyses. Exploratory factor analysis (EFA) was performed on the 1/4 sub-sample using the R-package *'psych'* [49], using Oblimin rotation and WLS estimation. We investigated retainment of two to seven factors, based on Parallel Analysis and visual inspection of scree plots. Factor solutions were evaluated on being conceptually meaningful, having ≥3 items in each factor (loadings ε.3), and overall interpretability by clear factor associations [21].

2.3.2. Confirmation of suggested BDS symptom clusters (objective 2)

Based on the 3/4 sub-sample, confirmatory factor analysis (CFA) using R-package *'lavaan'* [50] was conducted on 1) the factor structure previously reported in adult populations [17,20,21], and 2) the structure(s) suggested from EFA results. Model fit was evaluated using overall χ^2, CFI and TLI > 0.95, RMSEA <0.05 and SRMR <0.08 [51].

2.3.3. Classification of BDS illness severity groups (objective 3)

Latent Class Analysis (LCA) [52] was performed using R-package *'poLCA'* [53] to 1) replicate severity classes found in adults [20], and 2) explore suitability of different symptom criteria per organ system for this adolescent sample. Dichotomous variables were derived from BDS-25 checklist responses, using a response option of ≥2 (*'somewhat'*) indicating symptom presence [20]. We used 1) symptom cut-off criteria from original work proposed by Fink et al. (i.e. ≥3 within a specific symptom cluster, ≥4 across clusters; referred to as 'min3min4') [19] and 2) criteria adapted in later verification studies on adults (≥4 within a cluster, ≥4 across cluster, referred to as 'min4min4') [20,21]. To determine number of classes, we used Akaike's Information Criterion (AIC), Bayesian Information Criterion (BIC); lowest values indicate better model fit [52]. To evaluate class quality, we employed entropy; values closer to 1 indicate better quality. Division into distinct classes was based on highest posterior probability of class membership. To explore characteristics of found classes, mean scores for described clinical variables were calculated, and participant's socio-demographic distribution across classes was visualized. We performed trend analyses using R-package *'DescTools'* [54] and *'MASS'* [55] on the mean scores of the clinical variables, and on frequencies of the given classes on the sociodemographic variables.

2.4. Ethical approval

The CCC2000 and associated sub-studies have been approved by the Danish Data Protection Agency (CSU-FCFS-2016-004, I-Suite 04544) and evaluated by the Committee on Health Research Ethics in the Capital Region of Denmark (protocol 16,023,242). Regulations on the use of personal data were handled in accordance with the Declaration of Helsinki. The cohort members received the invite to take part in the CC16/17 follow-up together with information on informed consent, privacy and confidentiality, including the reason of being invited to participate and the purpose of the research study, participation procedures, potential risks or side effects of participating, contact information of the project group to request further information, possibility to withdraw consent to participation at any time, confidentiality of stored data, funding sources as well as approval from Danish authorities. Accordingly, all participants gave informed consent to participate in the respective follow-up moment at age 16/17. Informed consent was automatically obtained for the online questionnaire part of the CC16/17 assessment moment by responding to the online questionnaires, whereas informed consent was obtained in written format from the participant themselves with regards to the face-to-face assessment at this assessment moment. We only employed online questionnaire data from the CC16/17 for the current study.

3. Results

3.1. Sample characteristics & psychometric properties of the BDS-25 checklist

Fig. 1 displays the flow of the current study, and Table 1 shows sample characteristics distributed on selected sociodemographic variables. Overall, the final study population constituted of $N = 2542$ participants with completed BDS-25-questionnaire data (female: $n = 1417$ (55.74%); male: $n = 1125$ (44.26%)), out of which 25.41% reported a chronic medical condition.

Concerning the psychometric properties of the BDS-25 checklist in this adolescent sample, the item response variation rate was 7.95–91.23% in the response category (*'Not at all'*) (highest frequency of response option in BDS20). The item response variation was 0.28–9.52% in the response category (*'A lot'*) (highest frequency of this response option in BDS22) (Table 2).

There was a tendency for females to respond higher for all items, with an average of 54.23% of females and 66.91% of males responding to *'Not at all'* and an average of 2.75% of females and 0.96% of males responding to *'A lot'* on any item. The greatest dispersion on the highest response option between sexes was observed on BDS18 (*'Back ache'*) (6.14% female; 2.13% male), BDS22 (*'Excessive fatigue'*) (12.77% female; 5.42% male) and BDS23 (*'Headache'*) (6.28% female; 0.80% male). Appendix B displays item statistics by sex separately.

3.1.1. Factorial structure of the BDS-25 checklist

We performed EFA on the 'exploratory' 1/4 subsample ($n = 637$). Polychoric correlations among BDS-25 items were evaluated as satisfactory, with the majority $0.3 < r < 0.7$ (Appendix C). A four and five factor solution showed good interpretability (i.e. clear factor associations) and overall fit while simultaneously having ≥3 items loading high (i.e. ≥0.3) on each factor (Table 3). In the 4-factor solution, item BDS5 and BDS8 did not load highly on any factor, while BDS9, BDS19 and

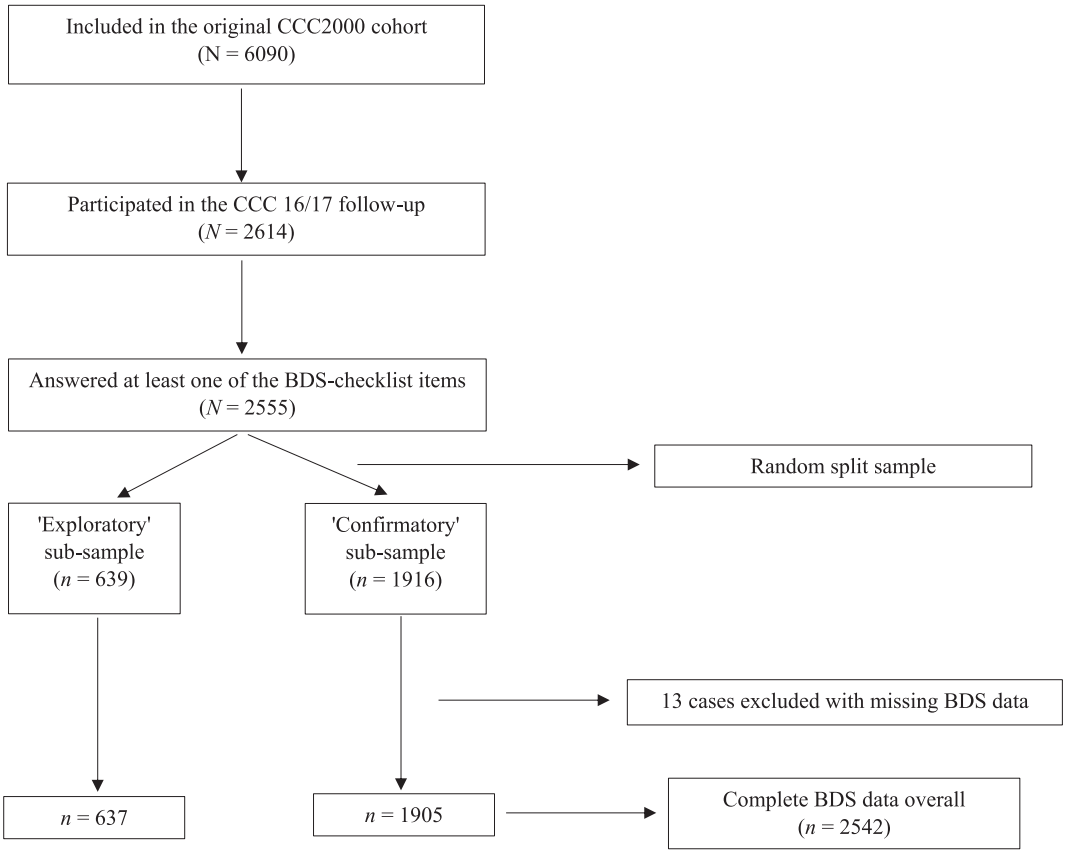

Fig. 1. Study flow chart.

Table 1
Study population characteristics ($N = 2542$).

	N	%
Sex		
Female	1417	55.74
Male	1125	44.26
One or more chronic medical conditions		
Yes	646	25.41
No	1896	74.59
Highest parental education		
Primary school/High School	214	8.42
Short Traineeship	1705	67.07
Long Traineeship/University education	603	23.72
Missing	*20*	*0.79*
Family composition		
Biological parents live together	1821	71.63
Other	703	27.66
Missing	*18*	*0.71*
Yearly parental household income in DKK		
Low (≤492.498)	571	22.46
Middle (492.499–816.943)	1144	45.01
High (≥816.944)	572	22.50
Missing	*255*	*10.03*

BDS25 loaded >0.30 on two factors. In the five-factor structure, BDS9, BDS19, BDS20 and BDS22 loaded >0.30 on two factors.

We conducted a second EFA for exploratory purposes on the larger 'confirmatory' 3/4 subsample ($n = 1905$) in order to investigate whether we could retrieve similar factor solutions as the ones obtained in the initial EFA in a larger sample of the same age group. Again, a four and five factor structure displayed good interpretability and overall fit, with items loading ≥3 on each factor (Table 3). In the four-factor solution, BDS5, BDS6, and BDS20 did not load on any factor, and item BDS13, BDS19 and BDS25 loaded >0.30 on two factors. In the five-factor solution, BDS5 and BDS6 did not load on any factor, and BDS23 and BDS25 loaded >0.30 on two factors. Given response statistics (Table 2), BDS5, BDS19, BDS20 and BDS25 were not very prevalent in the overall sample, potentially explaining lower factor loadings across both EFAs. Overall, results from both the 1/4 and 3/4 subsample indicate a broad resemblance to the adult factor structures representing BDS symptom clusters.

3.2. Confirmation of suggested BDS symptom clusters

We performed CFA using composed factor models on the 'confirmatory' 3/4 sub-sample according to highest factor loadings per item obtained from the exploratory EFA, and on the four-factor structure based on the adult BDS concept (i.e. CP, GI, MS and GS) (Appendix D). All tested models revealed good fit given chosen fit indices (Table 4). BDS7, BDS 9 and BDS10 loaded high on a fifth factor. Since the four-factor model suggested in adult populations displayed good fit indices also in this adolescent sample, result suggest it might represent a suitable solution also for adolescents. Fig. 2 therefore visualizes the four-factor solution based on adult samples, with factor loading and correlations among factors from the current adolescent sample.

3.3. Classification of BDS illness severity groups

We performed two LCAs on the full study population using the 'min3min4' and 'min4min4' models. Given chosen fit indices, i.e. AIC and BIC, the most optimal number of classes was found to be three in both LCAs (Table 5). Entropy values indicated better class quality for the

Table 2
Descriptive statistics of the BDS-25 checklist ($N = 2542$).

		Response option distribution *n* (%)					Item statistics
		'Not at all'	'A bit'	'Somewhat'	'Quite a bit'	'A lot'	*M(SD)*
Item		0	1	2	3	4	
CP symptoms							
BDS1	Palpitations and heart pounding	1613 (63.45)	529 (20.81)	269 (10.58)	104 (4.09)	27 (1.06)	0.58 (0.91)
BDS2	Precordial discomfort	1574 (61.92)	606 (23.84)	257 (10.11)	89 (3.50)	16 (0.63)	0.57 (0.86)
BDS3	Breathlessness without exertion	1666 (65.54)	485 (19.08)	230 (9.05)	129 (5.07)	32 (1.26)	0.57 (0.94)
BDS4	Hyperventilation	2087 (82.10)	251 (9.87)	134 (5.27)	51 (2.01)	19 (0.75)	0.29 (0.72)
BDS5	Hot or cold sweats	1526 (60.03)	605 (23.80)	267 (10.50)	108 (4.25)	36 (1.42)	0.63 (0.93)
BDS6	Dry mouth	1750 (68.84)	487 (19.16)	198 (7.79)	85 (3.34)	22 (0.87)	0.48 (0.84)
GI symptoms							
BDS7	Frequent, loose bowel movements	1579 (62.12)	664 (26.12)	209 (8.22)	68 (2.68)	22 (0.87)	0.54 (0.82)
BDS8	Abdominal pain	1078 (42.41)	819 (32.22)	406 (15.97)	188 (7.40)	51 (2.01)	0.94 (1.03)
BDS9	Feeling bloated/full of gas/distended	1526 (60.03)	552 (21.72)	282 (11.10)	152 (5.98)	30 (1.18)	0.67 (0.97)
BDS10	Diarrhea	1983 (78.01)	417 (16.40)	98 (3.86)	34 (1.34)	10 (0.39)	0.30 (0.64)
BDS11	Regurgitations	1585 (62.35)	663 (26.08)	197 (7.75)	72 (2.83)	25 (0.98)	0.54 (0.83)
BDS12	Nausea	1177 (46.30)	813 (31.98)	366 (14.40)	135 (5.31)	51 (2.01)	0.85 (0.99)
BDS13	Burning sensation of the chest or upper part of stomach/epigastrium	2119 (83.36)	262 (10.31)	92 (3.62)	48 (1.89)	21 (0.83)	0.27 (0.69)
MS symptoms							
BDS14	Pain in arms or legs	1577 (62.04)	602 (23.68)	221 (8.69)	102 (4.01)	40 (1.57)	0.59 (0.92)
BDS15	Muscular aches or pain	951 (37.41)	812 (31.94)	478 (18.80)	222 (8.73)	79 (3.11)	1.08 (1.09)
BDS16	Pain in the joints	1661 (65.34)	536 (21.09)	208 (8.18)	92 (3.62)	45 (1.77)	0.55 (0.92)
BDS17	Feeling of paresis or localized weakness	2305 (90.68)	164 (6.45)	49 (1.93)	17 (0.67)	7 (0.28)	0.13 (0.48)
BDS18	Back ache	1136 (44.69)	693 (27.26)	391 (15.38)	211 (8.30)	111 (4.37)	1.00 (1.15)
BDS19	Pain moving from one place to another	2104 (82.77)	284 (11.17)	108 (4.25)	34 (1.34)	12 (0.47)	0.26 (0.64)
BDS20	Unpleasant numbness or tingling sensations	2319 (91.23)	139 (5.47)	44 (1.73)	31 (1.22)	9 (0.35)	0.14 (0.52)
GS							
BDS21	Concentration difficulties	706 (27.77)	965 (37.96)	503 (19.79)	266 (10.46)	102 (4.01)	1.25 (1.09)
BDS22	Excessive fatigue	202 (7.95)	706 (27.77)	768 (30.21)	624 (24.55)	242 (9.52)	2.00 (1.11)
BDS23	Headache	963 (37.88)	854 (33.60)	412 (16.21)	215 (8.46)	98 (3.86)	1.07 (1.11)
BDS24	Memory impairment	1452 (57.12)	557 (21.91)	277 (10.90)	163 (6.41)	93 (3.66)	0.78 (1.10)
BDS25	Dizziness	1394 (54.84)	707 (27.81)	273 (10.74)	122 (4.80)	46 (1.81)	0.71 (0.96)

Note. Abbreviations: BDS = Bodily Distress Syndrome; CP = cardiopulmonary; GI = Gastrointestinal; MS = Musculoskeletal; GS = General Symptoms; M = Mean; SD = Standard Deviation.

min3min4 3-class solution compared to the min4min4 3-class solution.

Conditional probabilities of fulfilling symptom criteria per class suggest a potential interpretation as Class 1: probable no to mild BDS, Class 2: probable moderate, single-organ BDS subtype and Class 3: probable severe, multi-organ BDS subtype (Table 6).

To evaluate whether latent classes differed in illness severity, we calculated mean scores on clinical variables and present participant's distribution of socio-demographic variables across classes (Table 7).

Upon visual inspection, results appeared similar for both min3min4 and min4min4 models. Prominent differences appeared between mean scores of clinical variables, with a decreasing trend for self-perceived overall health (Class 1 > Class 2 > Class 3), and an increasing trend for self-perceived BDS impairment, depression and anxiety symptoms, illness worries and presence of comorbid a chronic medical condition (Class 1 < Class 2 < Class 3). The trend analyses revealed significant group differences on all sociodemographic variables between classes (Trend analysis column in Table 7): In comparison to the probable no to mild BDS class, the probable moderate, single-organ subtype and the probable severe, multi-organ subtype BDS classes were characterized by a relative higher percentages of females compared to males, as well as lower parental education, more parents not living together and a lower yearly parental household income. Most pronounced differences were observed with regard to the probable severe, multi-organ BDS class, except for the variable 'Family composition' (see Table 7).

4. Discussion

4.1. Main findings

In this population-based, cross-sectional study on adolescents aged 16–17 years, we found that the BDS-25 checklist items, capturing the BDS concept, had satisfactory psychometric data quality. Factor analyses revealed a similar distinct pattern of BDS with four symptom clusters as reported in adults, namely cardiopulmonary (CP), gastrointestinal (GI), musculoskeletal (MS) and general symptoms (GS). We found moderate to high correlations between symptom clusters, indicating the presence of a common underlying disorder phenomenon. Through performing LCA with specified symptom cut-off criteria to indicate symptom presence, we identified three subgroups of adolescents with different severity levels of probable BDS corresponding to a

Table 3
Exploratory factor analysis; factor loadings of the 4 and 5 factor solution (N = 2542, split into 1/4 exploratory sub-sample (n = 637) and 3/4 confirmatory sub-sample (n = 1905)).

			Factor Model								
			4				5				
			λ_{F1}	λ_{F2}	λ_{F3}	λ_{F4}	λ_{F1}	λ_{F2}	λ_{F3}	λ_{F4}	λ_{F5}
CP symptoms		Sub-sample									
BDS1	Palpitations	1/4	**0.86**	0.01	-0.03	-0.05	**0.84**	-0.04	-0.04	0.06	-0.02
		3/4	**0.73**	0.04	-0.03	0.06	**0.82**	0.01	-0.05	0.00	0.02
BDS2	Discomfort	1/4	**0.70**	0.04	0.07	-0.11	**0.77**	-0.03	0.05	-0.10	0.00
		3/4	**0.69**	0.07	0.04	0.03	**0.76**	0.04	0.02	-0.02	0.03
BDS3	Breathlessness	1/4	**0.63**	0.08	0.06	0.11	**0.55**	0.07	0.06	0.18	0.06
		3/4	**0.47**	0.02	0.10	0.26	**0.50**	0.03	0.09	0.22	0.02
BDS4	Hyperventilation	1/4	**0.53**	0.04	-0.06	0.18	**0.46**	0.14	-0.05	0.16	0.02
		3/4	**0.61**	-0.04	0.04	0.10	**0.58**	0.07	0.02	0.07	-0.10
BDS5	Sweats	1/4	0.29	0.17	0.07	0.29	0.29	**0.30**	0.07	0.05	0.14
		3/4	0.22	0.16	0.11	0.28	0.26	0.11	0.12	0.24	0.10
BDS6	Dry mouth	1/4	**0.44**	0.18	0.17	-0.01	**0.46**	0.05	0.16	-0.04	0.15
		3/4	0.09	0.09	0.17	0.29	0.14	0.00	0.18	0.26	0.11
GI symptoms											
BDS7	Bowel movements	1/4	0.04	**0.81**	-0.04	0.03	0.05	0.10	-0.04	-0.01	**0.77**
		3/4	-0.19	**0.67**	0.01	0.06	0.01	0.01	0.02	0.06	**0.79**
BDS8	Abdominal pain	1/4	-0.06	0.18	-0.01	**0.77**	0.00	**0.86**	-0.02	-0.06	0.10
		3/4	0.12	**0.74**	0.04	-0.02	0.00	**0.76**	0.04	-0.06	0.17
BDS9	Feeling bloated	1/4	0.08	**0.40**	0.01	**0.36**	0.13	**0.44**	0.00	-0.07	**0.34**
		3/4	0.07	**0.64**	0.03	0.07	0.06	**0.48**	0.04	0.05	0.27
BDS10	Diarrhea	1/4	0.00	**0.80**	0.06	-0.01	-0.03	-0.04	0.05	0.08	**0.86**
		3/4	-0.18	**0.69**	-0.05	0.02	-0.01	0.10	-0.03	0.01	**0.69**
BDS11	Regurgitations	1/4	0.00	0.16	0.16	**0.42**	-0.02	**0.37**	0.17	0.13	0.14
		3/4	0.06	**0.40**	0.06	0.16	0.04	**0.34**	0.07	0.14	0.16
BDS12	Nausea	1/4	-0.04	0.01	0.04	**0.82**	0.00	**0.78**	0.04	0.07	-0.02
		3/4	0.20	**0.48**	0.05	0.15	0.03	**0.71**	0.04	0.09	-0.02
BDS13	Burning sensation	1/4	-0.05	0.20	0.19	**0.54**	-0.03	**0.53**	0.19	0.05	0.17
		3/4	**0.31**	**0.52**	0.08	-0.11	0.25	**0.50**	0.07	-0.12	0.12
MS symptoms											
BDS14	Pain in arms or legs	1/4	-0.07	-0.05	**0.86**	0.00	-0.09	-0.05	**0.86**	0.08	-0.02
		3/4	-0.15	-0.01	**0.83**	0.08	-0.14	-0.01	**0.82**	0.08	0.01
BDS15	Muscular pain	1/4	0.03	0.00	**0.76**	-0.07	0.08	0.00	**0.75**	-0.11	-0.01
		3/4	-0.01	0.00	**0.75**	-.03	0.02	-0.02	**0.75**	-0.04	0.02
BDS16	Pain in the joints	1/4	0.02	0.10	**0.75**	-0.03	0.03	-0.02	**0.74**	0.00	0.10
		3/4	0.03	0.02	**0.78**	-0.09	0.01	0.05	**0.77**	-0.08	-0.02
BDS17	Feeling of paresis	1/4	0.18	0.02	**0.41**	0.24	0.14	0.19	**0.42**	0.13	0.02
		3/4	0.17	-0.02	**0.52**	0.07	0.21	-0.05	**0.52**	0.06	0.02
BDS18	Back ache	1/4	0.09	0.01	**0.52**	0.19	0.13	0.22	**0.51**	-0.03	0.00
		3/4	0.10	0.07	**0.45**	0.14	0.09	0.11	**0.46**	0.11	0.00
BDS19	Pain moving	1/4	0.16	0.00	**0.45**	**0.30**	0.17	**0.30**	**0.45**	0.04	-0.02
		3/4	**0.32**	0.10	**0.48**	0.02	0.29	0.16	**0.47**	0.00	-0.03
BDS20	Tingling sensations	1/4	**0.48**	-0.15	0.13	0.27	**0.33**	0.11	0.14	**0.35**	-0.12
		3/4	0.27	0.08	0.28	0.21	**0.38**	-0.09	0.28	0.18	0.15
GS symptoms											
BDS21	Concentration	1/4	0.28	-0.04	0.03	**0.42**	0.00	0.12	0.04	**0.69**	0.00
		3/4	-0.01	-0.03	0.02	**0.74**	0.04	-0.05	0.03	**0.71**	0.07
BDS22	Excessive fatigue	1/4	0.23	0.04	0.04	**0.50**	0.05	**0.30**	0.05	**0.47**	0.05
		3/4	-0.01	0.05	-0.02	**0.75**	-0.03	0.17	0.00	**0.68**	0.00
BDS23	Headache	1/4	0.10	-0.10	0.04	**0.68**	0.05	**0.58**	0.05	0.21	-0.12
		3/4	0.19	0.23	0.06	**0.35**	0.03	**0.52**	0.05	**0.30**	-0.13
BDS24	Memory	1/4	**0.36**	0.05	0.00	0.27	0.08	-0.09	0.00	**0.74**	0.13
		3/4	0.05	0.01	0.03	**0.71**	0.10	-0.03	0.05	**0.67**	0.09
BDS25	Dizziness	1/4	**0.30**	-0.09	0.05	**0.55**	0.25	**0.46**	0.06	0.19	-0.11
		3/4	**0.32**	0.15	0.06	**0.39**	0.19	**0.43**	0.05	**0.34**	-0.14
Factor correlations			F1	F2	F3	F4	F1	F2	F3	F4	F5
F1		1/4	-	0.19	0.45	0.57	-	0.52	0.43	0.50	0.17
		3/4	-	0.45	0.42	0.55	-	0.54	0.44	0.54	0.23
F2		1/4	-	-	0.31	0.43	-	-	0.50	0.48	0.41
		3/4	-	-	0.45	0.53	-	-	0.46	0.50	0.41
F3		1/4	-	-	-	0.54	-	-	-	0.40	0.28
		3/4	-	-	-	0.50	-	-	-	0.45	0.25
F4		1/4	-	-	-	-	-	-	-	-	0.22
		3/4	-	-	-	-	-	-	-	-	0.24

Note. BDS-25 checklist items are abbreviated in this table; Factor loadings ≥0.3 are marked in **bold**; BDS = Bodily Distress Syndrome; CP = Cardiopulmonary; GI = Gastrointestinal; MS = Musculoskeletal; GS = General symptoms; 1/4 = exploratory sub-sample; 3/4 = confirmatory sub-sample; λ = factor loadings; F1 = Factor 1; F2 = Factor 2; F3 = Factor 3; F4 = Factor 4; F5 = Factor 5.

larger subgroup not reporting any significant physical symptoms (probable mild to no BDS), a smaller subgroup with significant symptoms from one to two symptom clusters (probable moderate, single-organ BDS), and the smallest group with significant symptoms from multiple symptom clusters (probable severe, multi-organ BDS). The subgroups with more pronounced BDS symptoms reported lower overall health, more emotional distress and illness worries in a dose-response fashion. Furthermore, we found significant socio-demographic group

Table 4
Goodness of fit statistics of the confirmatory factor analyses on the BDS-25 checklist (3/4 confirmatory sub-sample (n = 1905).

	Factor model		
	4[a]	4[b]	5
RMSEA (90% CI)	0.026 (0.024;0.029)	0.032 (0.030;0.035)	0.026 (0.023;0.029)
CFI	0.986	0.979	0.986
TLI	0.984	0.976	0.985
χ2 (df)	625.275 (269)	797.824 (269)	606.549 (265)
SRMR	0.047	0.052	0.045

Note. RMSEA = Root mean square error of approximation; CFI = Comparative fit index; TLI = Tucker–Lewis fit index; χ2 = Chi-square statistic; df = degrees of freedom; SRMR = standardized root mean square residual; [a] = Four-factor-structure as specified in adult populations; [b] = Four-factor structure based on current EFA.

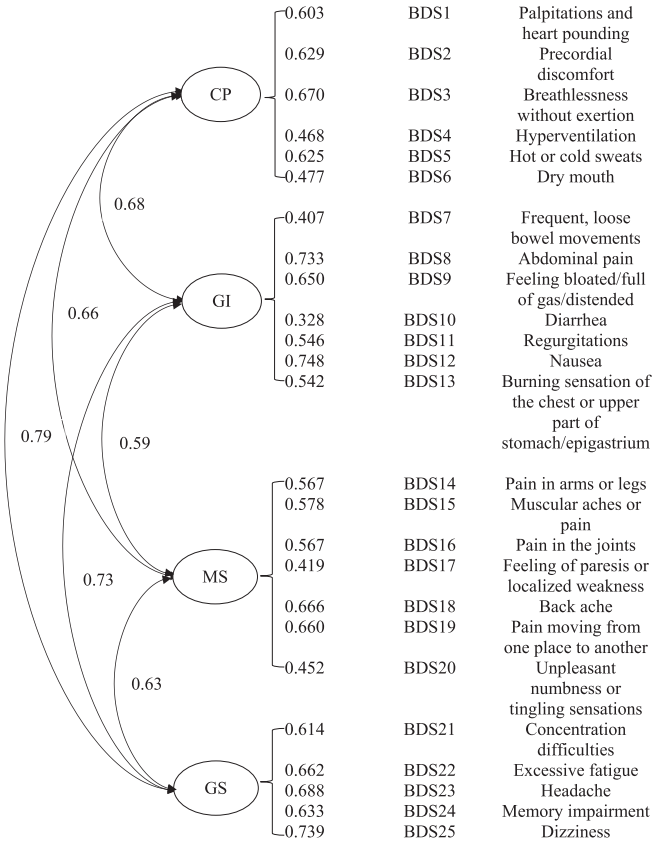

Fig. 2. Illustration of factor loadings and correlations among factors of the confirmatory factor analysis on the four factor structure reported in adult populations (N = 2542).

differences across BDS classes, such as for instance sex differences with the highest relative percentage of females in the probable severe, multi-organ BDS as compared to males.

4.2. Comparison with previous literature

Descriptive item statistics of the BDS-25 checklist in this adolescent sample appear comparable to previous studies in adults [20]. When looking at the only other study (to the author's best knowledge) that investigated the BDS-25 checklist in a larger sample also including adolescent participants, item descriptive statistics appeared slightly higher for the overall sample as compared to the current study [23]. However, response distributions split into different age groups indicate

Table 5
Latent Class Analyses model comparisons for optimal number of classes (N = 2542).

# of classes	Symptom cutoff criteria	AIC	BIC	Entropy
2	min3min4	9918.23	9982.478	.867
	min4min4	7706.777	7771.025	.756
3	min3min4	**9802.638**	**9901.93**	.904
	min4min4	**7643.431**	**7742.723**	.707
4	min3min4	9804.387	9938.724	.729
	min4min4	7655.431	7789.768	.729

Note. Smallest fit indices are marked in **bold**; min3min4 = ≥3 symptoms within a specific symptom cluster and ≥ 4 symptoms across cluster; min4-min4 = ≥4 symptoms within a specific symptom cluster and ≥ 4 symptoms across cluster; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

that younger age groups, i.e. 14–29 year olds, appear to report fewer symptoms as compared to older age groups [4]. Furthermore, and similarly to current results, males report fewer symptoms compared to females in this age group [23]. Furthermore, we obtained a high rate of comorbid chronic medical conditions, with an accompanying trend with increasing BDS symptomatology in the current study. Current concepts of functional somatic disorders emphasize the complex underlying aetiological mechanisms wherein the presence of medical comorbidity is recognized and acknowledged [16]. Current findings on the high rate of chronic medical conditions therefore support the notion that 'bodily distress', which the BDS concept aims to capture, is not a diagnosis of exclusion but commonly present together with co-occurring medical diseases [16,19].

We found broadly similar symptom clusters respective to the BDS concept as reported in the original work in adults [19], following validation studies [20,21] and related research investigating latent structures of functional somatic disorders [56,57]. Data from youth populations using the CSI-24 revealed only weak evidence for a multi-factor model including diverse symptom clusters, indicative of a single prominent underlying 'somatization' tendency [25,26]. This different finding could be explained by the inclusion of even younger participants in these former studies (i.e. mean age 11.66 and 11.80), as young patients frequently display fewer, commonly only a single physical symptom as compared to older patients, where a multi-symptom profile is more prevalent [12]. Thus, other work on adolescent participants (i.e. mean age 15.4) has suggested a four-factor structure in the CSI-24 with a pain-related, GI-, CP- and pseudo-neurological symptom cluster, broadly resembling the structure obtained in the current study [28].

A potential meaningful fifth cluster was identified, with the symptoms *'Frequent loose bowel'*, *'Diarrhea'* and *'Feeling bloated'*, thereby splitting GI symptoms into more than one organ clusters, possibly suggesting a separate lower GI factor corresponding to digestive issues. Petersen et al. [21] also reported a potential fifth cluster in a general population-based adult cohort, wherein few items such as *'Regurgitations'* loaded both with other GI symptoms, as well as on a separate upper GI organ factor. Studies from the Dutch Tracking Adolescents' Individual Lives Survey (TRAILS) cohort that assessed functional somatic symptoms by the Achenbach System of Empirically Based Assessment (ASEBA) in late adolescence and early adulthood [58,59] have also identified factor-structures with GI symptoms clustering distinctively, including headache/GI symptoms as one factor versus other physical symptoms, at age 16, and general physical symptoms versus a GI symptom cluster at the mid-twenties assessment [10,60]. Given that best-suitable factor solutions are obtained through correlations among items representing a common construct [61], and

Table 6
Three-class model classifications ($N = 2542$).

		Conditional class probabilities		
	Symptom cutoff criteria	Class 1 (Probable no to mild BDS)	Class 2 (Probable moderate, single-organ subtype)	Class 3 (Probable severe, multi-organ subtype)
Class size; n (%)	min3min4	1336 (52.56)	1038 (40.83)	168 (6.60)
	min4min4	1336 (52.56)	1132 (44.53)	74 (2.9)
CP symptoms	min3min4	0.003	0.150	0.684
	min4min4	<0.001	0.129	0.620
GI symptoms	min3min4	0.002	0.228	0.855
	min4min4	<0.001	0.170	0.707
MS symptoms	min3min4	0.006	0.205	0.641
	min4min4	<0.001	0.135	0.614
GS symptoms	min3min4	0.030	0.474	0.927
	min4min4	<0.001	0.293	>0.999
Any symptoms (across clusters)	min3min4	<0.001	>0.999	>0.999
	min4min4	0.192	>0.999	>0.999
n fulfilling symptom criteria per class*				
0	min3min4	1281	0	0
	min4min4	1336	-**	0
1	min3min4	55	275	0
	min4min4	0	675	0
2	min3min4	0	483	0
	min4min4	0	329	0
3	min3min4	0	258	0
	min4min4	0	127	0
4	min3min4	0	22	104
	min4min4	0	-**	49
5	min3min4	0	0	64
	min4min4	0	-**	25
Total	min3min4	1336	1038	168
	min4min4	1336	1132	74

Note. n = Group size; CP = Cardiopulmonary symptom cluster; GI = Gastrointestinal symptom cluster; MS = Musculoskeletal symptom cluster; GS = General symptoms symptom cluster; * 0 = Not fulfilling any of the composed symptom cut-off criteria (per symptom cluster and overall), 1 = fulfilling one of any of the composed symptom cut-off criteria, 2 = fulfilling two of any of the composed symptom cut-off criteria, 3 = fulfilling three of any of the composed symptom cut-off criteria, 4 = fulfilling four of any of the composed symptom cut-off criteria, 5 = fulfilling all of the composed symptom cut-off criteria; min3min4 = ≥3 within a specific symptom cluster and ≥ 4 across cluster; min4min4 = ≥4 within a specific symptom cluster and ≥ 4 across cluster; ** = Given regulations of data protection of the Denmark Statistics server, it is not allowed to present cell counts of >0 but <3 (i.e. microdata).

thereby highly depend on assessed symptoms within a specific instrument, it is reasonable to expect variation in symptom cluster structures across studies. In terms of current results, with suitable fit indices for the four-factor model as suggested in adults, and for the advantage of applying a concept with unifying potential to screen for a range of functional somatic symptoms, we suggest the model including CP, MS, GS and a common GI symptom cluster applicable for research purposes also in adolescence.

Moreover, comparable to results from Petersen et al. [31], who deemed the BDS checklist valuable to assess illness severity, we found that the BDS-25-checklist could be effective for this purpose in the adolescent context as well. We observed meaningful differences in clinical variables, with lower overall health, and more anxiety, depression and illness worries associated with more pronounced BDS symptoms. These findings are important when revisiting current classification systems, wherein clinical diagnoses such as BDD (ICD-11) [13] or SSD (DSM-5) [15] emphasize and include the presence of psychobehavioral features, such as excessive cognitions, emotions or behaviors in relation to symptoms or health concerns. We found clinical associations, which play a detrimental role in diagnosing conditions characterized by persistent functional somatic symptoms, with latent BDS classes also in this adolescent sample . Therefore, psychological features could be considered for the BDS concept as well, in an effort to assimilate to clinical diagnoses [16,62].

We employed symptom cut-offs based on clinical interviews in the original study (≥3 within and ≥ 4 across clusters) [17], and suggested

Table 7
Clinical and socio-demographic characteristics of participants across latent classes ($N = 2542$).

	Symptom cutoff criteria	Class 1 (Probable no to mild BDS)	Class 2 (Probable moderate, single-organ subtype)	Class 3 (Probable severe, multi-organ subtype)	Trend Analysis**, p-value
			Frequency N(%)		
	min3min4	1336 (52.56)	1038 (40.83)	168 (6.61)	
	min4min4	1336 (52.56)	1132 (44.53)	74 (2.91)	
Clinical variables			*M(SD)*		
BDS impairment*					
(BDS-25 checklist, range 1-10)	min3min4	2.63 (1.5)	4.03 (2.06)	5.73 (1.91)	<0.001
	min4min4	2.63 (1.5)	4.18 (2.1)	6.03 (1.76)	<0.001
Overall self-perceived health					
(KidScreen-10, range 0-4)	min3min4	3.12 (0.8)	2.45 (0.99)	1.82 (1)	<0.001
	min4min4	3.12 (0.8)	2.42 (1)	1.49 (0.88)	<0.001
Depression					
(MFQ, range 0-26)	min3min4	7.45 (8.07)	17.15 (11.88)	28.27 (14.61)	<0.001
	min4min4	7.45 (8.07)	17.76 (12.17)	33.36 (14.73)	<0.001
Anxiety					
(SCAS, range 0-114)	min3min4	13.95 (9.79)	25.53 (13.8)	40.95 (18.32)	<0.001
	min4min4	13.95 (9.79)	26.47 (14.32)	46.41 (19.95)	<0.001
Illness worries					
(W-6-R, range 0-24)	min3min4	1.53 (2.57)	4.67 (4.71)	9.77 (6.65)	<0.001
	min4min4	1.53 (2.57)	4.95 (4.99)	12.01 (5.97)	<0.001
			Frequency N (% relative to class size)		
Presence chronic medical condition					<0.001/<0.001
Indicated 'Yes'	min3min4	276 (20.66%)	304 (29.29%)	66 (39.29%)	
	min4min4	276 (20.66%)	333 (29.42%)	37 (50.00%)	
Indicated 'No'	min3min4	1060 (79.34%)	734 (70.71%)	102 (60.71%)	
	min4min4	1060 (79.34%)	799 (70.58%)	37 (50.00%)	
Socio-demographic variables					
Sex					<0.001/<0.001
Male	min3min4	770 (57.63%)	334 (32.18%)	21 (12.5%)	
	min4min4	770 (57.63%)	348 (30.74%)	7 (9.46%)	
Female	min3min4	566 (42.37%)	704 (67.82%)	147 (87.5%)	
	min4min4	566 (42.37%)	784 (69.26%)	67 (90.54%)	
Highest parental education (Missing $n = 20$ (0.79%))					0.007/0.015
Primary education/gymnasium	min3min4	98 (7.34%)	95 (9.15%)	21 (12.5%)	
	min4min4	98 (7.34%)	108 (9.54%)	8 (10.81%)	
Short traineeship	min3min4	878 (65.72%)	714 (68.79%)	113 (67.26%)	
	min4min4	878 (65.72%)	778 (68.73%)	49 (66.22%)	
Long traineeship/University education	min3min4	350 (26.20%)	220 (21.19%)	33 (19.64%)	
	min4min4	350 (26.20%)	236 (20.85%)	17 (22.97%)	
Family composition (Missing $n = 18$ (0.71%))					<0.001/<0.001
Biological parents live together	min3min4	1002 (75.00%)	703 (67.73%)	116 (69.05%)	
	min4min4	1002 (75.00%)	765 (67.58%)	54 (72.97%)	
Other	min3min4	324 (24.25%)	327 (31.50%)	52 (30.95%)	
	min4min4	324 (24.25%)	359 (31.71%)	20 (27.03%)	
Yearly parental household income in DKK (Missing $n = 255$ (10.03%))					<0.001/<0.001
Low (<492.498)	min3min4	241 (18.04%)	276 (26.59%)	54 (32.14%)	
	min4min4	241 (18.04%)	305 (26.94%)	25 (33.78%)	
Middle (492.499-816.943)	min3min4	627 (46.93%)	442 (42.58%)	75 (44.64%)	
	min4min4	627 (46.93%)	489 (43.20%)	28 (37.84%)	
High (>816.944)	min3min4	340 (25.45%)	213 (20.52%)	19 (11.31%)	
	min4min4	340 (25.45%)	220 (19.43%)	12 (16.22%)	

Note. BDS = Bodily Distress Syndrome; * = BDS impairment refers to one item assessing self-reported symptom impairment; MFQ = Mood and Feelings Questionnaire; SCAS = Spence Children's Anxiety Scale; W-6-R = Whiteley-6-Revised; M = Mean; SD = Standard deviation; min3min4 = ≥3 within a specific symptom cluster and ≥ 4 across cluster; min4min4 = ≥4 within a specific symptom cluster and ≥ 4 across cluster; ** = The following trend analyses were conducted: Simple linear regression (all clinical variables), Cochrane Armitage test (BDS impairment, sex, presence chronic medical condition) and Chi Square test (parental education, family composition and yearly household income), reported as p-value min3min4/p-value min4min4 for sociodemographic variables.

adapted criteria (≥4 within and ≥ 4 across clusters) [20,21]. Given current results, a 3-class model with ≥3 symptoms within and ≥ 4 symptoms across clusters had the best statistical class quality. However, associations with clinical functioning across latent classes were more notable in the probable severe, multi-organ BDS subtype class using ≥4 symptoms within and across clusters. Thus, these stricter criteria may be more relevant to be used for screening purposes in adolescence, i.e. representing the 'probable severe' cases. At the same time, an important notion is to consider the developmental aspects of diagnosing younger patients, as patients of this age group often display symptom profiles characterized by fewer symptoms [4]. This highlights the need for further investigating the BDS concept and symptom cut-off criteria, also at even younger age. Reasonably, the BDS model, the accompanying BDS 25-checklist and symptom cut-off criteria need to be verified by clinical assessments, for instance through using clinical interviews (i.e. the Schedules for Clinical Assessment in Neuropsychiatry, SCAN) [63] to differentiate specifically those cases changing class membership between 'probable moderate' to 'probable severe' when applying the stricter (≥4) versus the less strict (≥3) symptom cut-off criteria to establish the better suitable classification for 'threshold' cases in younger populations.

4.3. Strengths and limitations

Important strengths of this study include the representability of the CCC2000 compared to the overall Danish population of the same age group [30]. The large sample size rendered reliable results concerning psychometric properties and underlying factor structure of the BDS-25 checklist and latent classes [64]. All utilized self-report measures have been validated except for the W-6-R, for which validation research for adolescents is ongoing in our research group. In terms of potential limitations, participants were positively selected regarding sociodemographic factors compared to the entire original cohort. This might decrease variability regarding the number of participants reporting significant symptoms, also given the socio-demographic distribution in the current sample and associated latent illness severity classes. Furthermore, all variables were assessed through self-report questionnaires. Hence, responses might not always have assessed the concepts of interests accurately. Moreover, the time frame covered in the BDS-25 checklist is not consistent across studies which reduces comparability of results. In the current study, we chose a time frame of 12 months as used in the large DanFunD cohort study on adults [65]. However, such a long time frame could induce the risk of recall bias as well as the assessment of only temporary, transient rather than persistent symptoms. Finally, the different analyses were dependent on available self-reported symptom data. Thus, there may be other symptom clusters in adolescence that were not detected here, which might have increased the number of classes [66].

4.4. Clinical implications and future perspectives

This is the first study to provide empirical support that the BDS concept is excellent proof of the epidemiological fact of symptom clustering and its associations with psychological distress also in adolescence. BDS could thus represent a screening concept for functional somatic symptoms, with the unifying potential of eliminating dispersions in classification systems between medical specialties as well as in research [16] but also across the age span. Our data suggest the utility of the BDS-25 checklist as a simple screening tool for a range of functional somatic symptoms, which could provide the basis for future descriptive, longitudinal and interventional studies in a developmental perspective. Future research should address methodological limitations that the BDS-25 checklist still holds. Thus, the time criterion to assess for persistence of symptoms should be better established. Furthermore, clinical specifiers for associated psychological distress could be added to further strengthen its potential as a screening tool for clinical cases, thereby motioning the BDS concept closer to the BDD or SSD diagnoses for clinical significant and treatment demanding functional somatic symptoms.

Additional information on data access

We used sensitive personal data in the current study that cannot be shared publicly due to data protection laws in Denmark by the Danish Data Protection Agency. All data was pseudonymised and stored on a digital server of Statistics Denmark. Any researcher could receive access to the data under the same regulation as the authors (granted case-by-case through approval from the CCC2000 steering committee having legal responsibility as the data manager). Access will be granted to a permissible extent by the General Data Protection Regulation (GDPR) and the Danish Data Protection Act. If access is granted, the PI investigator and last author (Charlotte Ulrikka Rask, charrask@rm.dk) will make data available with approved authority to access pseudonymised data through Statistics Denmark. The General Data Protection Regulation (GDPR) and the Danish Data Protection Act and regulations prohibit any other forms of data sharing.

Declaration of Competing Interest

None.

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 956673 and is part of a collaborative research program (Encompassing Training in Functional Disorders across Europe; ETUDE; https://etude-itn.eu) aiming to integrate the understanding of Functional Disorders.

The funding source had no role in study design, the collection, analysis and interpretation of data, in the writing of the report and in the decision to submit the article for publication.

The authors wish to thank members of the CCC2000 cohort steering committee, Prof. Pia Jeppesen and Prof. Else-Marie Olsen, for sharing expert knowledge on the data and collection procedures.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychores.2022.111064.

References

[1] J.V. Campo, Annual research review: functional somatic symptoms and associated anxiety and depression - developmental psychopathology in pediatric practice, J. Child Psychol. Psychiatry 53 (5) (2012) 575–592.

[2] I.J. Bonvanie, et al., Life events and functional somatic symptoms: a population study in older adolescents, Br. J. Psychol. 108 (2) (2017) 318–333.
[3] I.J.M.D. Bonvanie, et al., Psychological interventions for children with functional somatic symptoms: a systematic review and Meta-analysis, J. Pediatr. 187 (2017) 272–281.e17.
[4] C.U. Rask, I.J. Bonvanie, E.M. Garralda, Risk and protective factors and course of functional somatic symptoms in young people, in: Understanding Uniqueness and Diversity in Child and Adolescent Mental Health, Elsevier, 2018, pp. 77–113.
[5] K.A.M.M. Janssens, et al., School absenteeism as a perpetuating factor of functional somatic symptoms in adolescents: the TRAILS study, J. Pediatr. 159 (6) (2011) 988–993.e1.
[6] D.P. Robinson, J.W. Greene, L.S. Walker, Functional somatic complaints in adolescents: relationship to negative life events, self-concept, and family characteristics, J. Pediatr. 113 (3) (1988) 588–593.
[7] H.-C. Steinhausen, C. Winkler Metzke, Continuity of functional-somatic symptoms from late childhood to young adulthood in a community sample, J. Child Psychol. Psychiatry 48 (5) (2007) 508–513.
[8] K. Kozlowska, Functional somatic symptoms in childhood and adolescence, Curr. Opin. Psychiatry 26 (5) (2013) 485–492.
[9] C.U. Rask, et al., Functional somatic symptoms and consultation patterns in 5- to 7-year-olds, Pediatrics (Evanston) 132 (2) (2013) e459–e467.
[10] A. Acevedo-Mesa, et al., Positive affect and functional somatic symptoms in young adults, J. Psychosom. Res. 127 (2019) 109847.
[11] A. Weigel, et al., A European research network to improve diagnosis, treatment and care for patients with persistent somatic symptoms: work report of the EURONET-SOMA conference series, J. Psychosom. Res. 97 (2017) 136–138.
[12] M. Kangas, K.H. Kallesoe, C.U. Rask, Functional somatic syndromes (FSS) in children and adolescents: conceptual, measurement and treatment issues, Z. Psychol. 228 (2) (2020) 81–92.
[13] WHO, International Statistical Classfication of Diseases and Related Health Problems (11th revision), 2018.
[14] M. Nicholas, et al., The IASP classification of chronic pain for ICD-11: chronic primary pain, Pain (Amsterdam) 160 (1) (2019) 28–37.
[15] APA, Diagnostic and Statistical Manual of Mental Disorders (DSM-5), 2013.
[16] C. Burton, et al., Functional somatic disorders: discussion paper for a new common classification for research and clinical use, BMC Med. 18 (1) (2020) 34.
[17] P. Fink, A. Schröder, One single diagnosis, bodily distress syndrome, succeeded to capture 10 diagnostic categories of functional somatic syndromes and somatoform disorders, J. Psychosom. Res. 68 (5) (2010) 415–426.
[18] S. Wessely, C. Nimnuan, M. Sharpe, Functional somatic syndromes: one or many? Lancet (British edition) 354 (9182) (1999) 936–939.
[19] P. Fink, et al., Symptoms and syndromes of bodily distress: an exploratory study of 978 internal medical, neurological, and primary care patients, Psychosom. Med. 69 (1) (2007) 30–39.
[20] A. Budtz-Lilly, et al., A new questionnaire to identify bodily distress in primary care: the 'BDS checklist', J. Psychosom. Res. 78 (6) (2015) 536–545.
[21] M.W. Petersen, et al., The unifying diagnostic construct of bodily distress syndrome (BDS) was confirmed in the general population, J. Psychosom. Res. 128 (2020) 109868.
[22] A.M.D. Budtz-Lilly, et al., The prognosis of bodily distress syndrome: a cohort study in primary care, Gen. Hosp. Psychiatry 37 (6) (2015) 560–566.
[23] B. Schmalbach, et al., Validation of the German version of the bodily distress syndrome 25 checklist in a representative German population sample, J. Psychosom. Res. 132 (2020) 109991.
[24] L.S. Walker, J. Garber, J.W. Greene, Somatization symptoms in pediatric abdominal pain patients: relation to chronicity of abdominal pain and parent somatization, J. Abnorm. Child Psychol. 19 (4) (1991) 379–394.
[25] L.S. Walker, et al., Children's somatization inventory: psychometric properties of the revised form (CSI-24), J. Pediatr. Psychol. 34 (4) (2009) 430–440.
[26] J.V. Lavigne, M. Saps, F.B. Bryant, Reexamining the factor structure of somatization using the Children's somatization inventory (CSI-24) in a community sample, J. Pediatr. Psychol. 37 (8) (2012) 914–924.
[27] H. KadioAlu, F.N. SiAman, A. Ergun, Reliability and validity of the Turkish version of children's somatization inventory, Asian Nurs. Res. 6 (1) (2012) 9–12.
[28] C.A. Essau, et al., Somatic symptoms among children and adolescents in Poland: a confirmatory factor analytic study of the children somatization inventory, Front. Public Health 1 (2013) 72.
[29] J.G.M. Rosmalen, et al., The European training network ETUDE (encompassing training in fUnctional disorders across Europe): a new research and training program of the EURONET-SOMA network recruiting 15 early stage researchers, J. Psychosom. Res. 141 (2021), 110345.
[30] E.M. Olsen, et al., Cohort profile: the Copenhagen child cohort study (CCC2000), Int. J. Epidemiol. 49 (2) (2020) 370–371l.
[31] M.W. Petersen, et al., The BDS Checklist as Measure of Illness Severity - A Cross-Sectional Cohort Study in the Danish General Population, Primary Care and Specialised Setting, 2020.
[32] U. Ravens-Sieberer, et al., The European KIDSCREEN approach to measure quality of life and well-being in children: development, current application, and future advances, Qual. Life Res. 23 (3) (2014) 791–803.
[33] U. Ravens-Sieberer, et al., Reliability, construct and criterion validity of the KIDSCREEN-10 score: a short measure for children and adolescents' well-being and health-related quality of life, Qual. Life Res. 19 (10) (2010) 1487–1500.
[34] A. Ancold, C. Stephen, Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents, Age (years) 6 (11) (1995) 237–249.
[35] A.M. Sund, B. Larsson, L. Wichstrøm, Depressive symptoms among young Norwegian adolescents as measured by the mood and feelings questionnaire (MFQ), Eur. Child Adolesc. Psychiatry 10 (4) (2001) 222–229.
[36] J.E. Frøkjær, N. Bilenberg, R. Wesselhoeft, A validation study of the mood and feelings questionnaire, Danish version, Europ. Psychiatry 41 (S1) (2017) S436.
[37] J. Eg, et al., Self- and parent-reported depressive symptoms rated by the mood and feelings questionnaire, Psychiatry Res. 268 (2018) 419–425.
[38] K. Arendt, E. Hougaard, M. Thastum, Psychometric properties of the child and parent versions of Spence Children's anxiety scale in a Danish community and clinical sample, J. Anxiety Disord. 28 (8) (2014) 947–956.
[39] S.H. Spence, Structure of anxiety symptoms among children: a confirmatory factor-analytic study, J. Abnorm. Psychol. (1965) 106 (2) (1997) 280–297.
[40] S.H. Spence, A measure of anxiety symptoms among children, Behav. Res. Ther. 36 (5) (1998) 545–566.
[41] P. Fink, et al., Screening for somatization and hypochondriasis in primary care and neurological in-patients: a seven-item scale for hypochondriasis and somatization, J. Psychosom. Res. 46 (3) (1999) 261–273.
[42] T.B.W. Carstensen, et al., Detection of illness worry in the general population: a specific item on illness rumination improves the Whiteley index, J. Psychosom. Res. 138 (2020) 110245.
[43] C.U. Rask, et al., The Soma assessment interview: new parent interview on functional somatic symptoms in children: focus on medically Unexplainde symptoms, J. Psychosom. Res. 66 (5) (2009) 455–464.
[44] M. Schmidt, L. Pedersen, H.T. Sørensen, The Danish civil registration system as a tool in epidemiology, Eur. J. Epidemiol. 29 (8) (2014) 541–549.
[45] F. Petersson, M. Baadsgaard, L.C. Thygesen, Danish registers on personal labour market affiliation, Scand. J. Publ. Health 39 (7_suppl) (2011) 95–98.
[46] M. Bliddal, et al., The Danish medical birth register, Eur. J. Epidemiol. 33 (1) (2018) 27–36.
[47] StataCorp, L, Stata Statistical Software: Release 15 (2017), StataCorp LP, College Station, TX, 2017.
[48] Team, R, RStudio: Integrated Development for R, RStudio, PBC, Boston, MA, 2020, p. 2021.
[49] W. Revelle, M.W. Revelle, Package 'psych', in: The Comprehensive R Archive Network 337, 2015, p. 338.
[50] Y. Rosseel, et al., Package 'lavaan', Retrieved June 17 (2017) 2017.
[51] L.-T. Hu, P.M. Bentler, Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives, Struct. Equ. Model. 6 (1) (1999) 1–55.
[52] B.E. Weller, N.K. Bowen, S.J. Faubert, Latent class analysis: a guide to best practice, J. Black Psychol. 46 (4) (2020) 287–311.
[53] D. Linzer, J. Lewis, M.D. Linzer, Package 'poLCA', Citeseer, 2014.
[54] A. Signorell, et al., DescTools: Tools for Descriptive Statistics. R Package (versión 0.99. 21) [Software], The R Project for Statistical Computing, Vienna, Austria, 2017. Recuperado de http ….
[55] B. Ripley, et al., Package 'mass'. Cran R 538, 2013, pp. 113–120.
[56] M. Witthöft, et al., The latent structure of medically unexplained symptoms and its relation to functional somatic syndromes, Int. J. Behav. Med. 20 (2) (2012) 172–183.
[57] J.G.M. Rosmalen, L.M. Tak, P. de Jonge, Empirical foundations for the diagnosis of somatization: implications for DSM-5, Psychol. Med. 41 (6) (2011) 1133–1142.
[58] T.M. Achenbach, L. Dumenci, L.A. Rescorla, DSM-oriented and empirically based approaches to constructing scales from the same item pools, J. Clin. Child Adolesc. Psychol. 32 (3) (2003) 328–340.
[59] T.M. Achenbach, L. Rescorla, Manual for the ASEBA Adult Forms & Profiles, University of Vermont, Research Center for Children, Youth …, Burlington, VT, 2003.
[60] K.A.M. Janssens, et al., Symptom-specific associations between low cortisol responses and functional somatic symptoms: the TRAILS study, Psychoneuroendocrinology 37 (3) (2011) 332–340.
[61] L.R. Fabrigar, D.T. Wegener, Exploratory Factor Analysis, Oxford University Press, 2011.
[62] W. Häuser, et al., Prevalence and overlap of somatic symptom disorder, bodily distress syndrome and fibromyalgia syndrome in the German general population: a cross sectional study, J. Psychosom. Res. 133 (2020) 110111.
[63] WHO, Schedules for Clinical Assessment in Neuropsychiatry, Version 2.1, World Health Organization, Division of Mental Health, Geneva, 1998.
[64] A. Rouquette, B. Falissard, Sample size requirements for the internal validation of psychiatric scales, Int. J. Methods Psychiatr. Res. 20 (4) (2011) 235–249.
[65] T.M. Dantoft, et al., Cohort description: the Danish study of functional disorders, Clin. Epidemiol. 9 (2017) 127.
[66] M. Eliasen, et al., Somatic symptom profiles in the general population: a latent class analysis in a Danish population-based health survey, Clin. Epidemiol. 9 (2017) 421.