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ORIGINAL CONTRIBUTION

Dimensions and subtypes of oppositionality and their relation to comorbidity and psychosocial characteristics

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Abstract

The symptoms of oppositional defiant disorder (ODD), or oppositionality, seem to constitute a three-dimensional structure of angry/irritable, vindictiveness and argumentative behavior dimensions. Also, subjects with oppositionality are characterized by different comorbidity and longitudinal trajectories, suggesting that they could be divided into subtypes. This study is the first to examine the dimensions and subtypes of oppositionality in Nordic children. Study participants included 3435 children aged 7–10 years from the Danish National Birth Cohort. Information was collected using the Development and Well-Being Assessment (DAWBA) online version. A three-factor ODD model was identified. The angry/irritable dimension was associated with emotional problems and disorders, fewer social skills and fewer personal positive attributes. The argumentative behavior dimension was associated with hyperactivity/conduct problems, reduced social skills and positive attributes. The vindictiveness dimension was associated with externalizing, internalizing and prosocial problems. Four ODD subtypes were identified. The subtypes with many or mainly angry/irritable symptoms were characterized by comorbid psychopathology, increased functional impairment and psychosocial problems. Children with ODD had fewer positive attributes, more friendship/school problems and higher functional impairment than children with emotional disorders and control group children. Oppositionality consists of three dimensions differently associated with comorbidity and psychosocial characteristics, and the same pattern is seen for the four ODD subtypes identified in this study. Children with ODD experience more adversities and functional impairment than children with emotional disorders. Our results indicate that treatment of children with ODD would improve from extended knowledge on individual ODD dimensions and subtypes and the related child psychosocial characteristics.

Keywords Oppositionality · Dimensions · Social skills · Personal strengths · Functional impairment

Introduction

Children with oppositional defiant disorder (ODD) are characterized by frequent comorbid disorders and by family and social dysfunction above and beyond that of children with

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other psychiatric disorders [32]. The comorbidity patterns vary between children with ODD. Similarly, the developmental trajectories seem to vary, with some children developing externalizing, and others, internalizing, psychopathology over time. This has led to the hypothesis that the ODD phenotype may consist of components or dimensions characterized by different co-occurring phenomena and longitudinal trajectories. Some studies find that the ODD phenotype consists of three dimensions: an affective (irritable) dimension and two behavioral dimensions (headstrong and hurtful) [2, 61]. Other studies have suggested two ODD dimensions [13, 36, 57], or a three-dimensional model with a different symptom distribution than originally suggested by Stringaris et al. [14]. As a result, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) has divided ODD symptoms into three dimensions: angry/irritable mood, argumentative behavior and vindictiveness [7], equivalent to the dimensions originally referred to as: irritable, headstrong and hurtful [61].

ODD dimensions

Prospective studies have found the ODD dimensions to be predictive of later psychopathology. The angry/irritable dimension seems to increase risk for emotional disorders [3, 57, 60, 63] and the argumentative behavior dimension is associated with later Attention Deficit Hyperactivity Disorder (ADHD), whereas the vindictiveness (hurtful) dimension is associated with later CD [60] and a criminal trajectory [3]. ODD can be effectively treated using cognitive behavioral therapy, parent management training and family intervention [41]. However, the treatment effect seems to depend on the ODD symptom presentation with the irritable dimension being associated with ODD treatment resistance [42].

The dimensions of ODD have been examined in the UK [61, 66], various countries (Belgium, Germany, Switzerland, Holland, Ireland, Spain, Israel) [2], Switzerland [3], Brazil [44], and in the US [13, 14, 36, 57]. However, no study has examined the dimensions of oppositionality in Nordic settings.

ODD subtypes

In addition to examining ODD dimensions from a variable-centered approach based on the oppositionality symptoms, researchers have tried to identify ODD subtypes based on the symptom presentation within groups [4]. Using this person-centered approach, a study identified four ODD subtypes characterized by 'no symptoms', 'all symptoms', 'irritable symptoms', or 'defiant symptoms' in children and adolescents [4]. A similar pattern for ODD subtypes has been documented in 7–12-year-old twins [45] and male adolescent offenders [1]. A study of 7–12-year-old boys identified three ODD subtypes characterized by oppositional behavior, irritable/affective symptoms and low-level symptoms [12].

Like the ODD dimensions, the ODD subtypes affect the longitudinal trajectories of subjects with oppositionality. Children and adolescents with the irritable ODD subtype seem to be at higher risk for mood disorders in adulthood, whereas children and adolescents with the ODD defiant subtype are at increased risk for adult violent behavior [4]. Similarly, young boys with the irritable ODD subtype have a higher risk for anxiety and depression in adolescence and depression and neuroticism at age 18 years [12]. Oppositionality subtypes have so far not been identified in a Nordic sample.

The Nordic countries differ from previously examined source populations on three important points, which support testing of ODD dimensions and subtypes in a Nordic setting. First, these countries are characterized by high living standards, high social welfare and high income taxes ('the Nordic welfare model'). This means that health care and education (from kindergarten to university) is available at no cost, minimizing socioeconomic inequality. Hence, potential associations between ODD dimensions/subtypes and psychosocial characteristics may be related more to individual difficulties rather than family socioeconomic problems in Nordic samples. Second, the prevalence rates of childhood disruptive disorders [ODD and Conduct Disorder (CD)] in Nordic countries are very low; for example, only half of those in Great Britain (1.5–2.5 vs 4.8%) [21, 34]. This is also found in a Finnish adolescent sample (1-year prevalence 1.1%) [33], and Danish preschool children present the lowest levels of mental health problems out of children from 24 countries [55]. This has led to the term 'the Nordic advantage' [34]. The lower Nordic ODD prevalence is probably due to both socioeconomic and cultural differences. A study in the US showed that prevalence rates of ODD and CD were highly influenced by family income [19], and a study including Western and Eastern European countries found that the prevalence of behavioral disorders was affected by socioeconomic status and country of origin [43]. Third, the Danish youth population is genetically homogenous, minimizing bias due to genetic variability [8]. Therefore, findings regarding childhood ODD, and in specific the ODD dimensions and subtypes, in a homogenous Danish population would contribute significantly to generalizability of findings regarding oppositionality in childhood.

Children with ODD generally have problems in self-control of emotions and behaviors leading to violation of the rights of others or to conflicts with norms and authorities [7]. They tend to show hostility towards peers and limited resistance to provocation [24], and they have decreased encoding and interpretation skills of social cues [50]. Hence, childhood ODD is strongly associated with social skill problems [9, 32, 40]. These impairments contribute

to peer problems that are more frequent for children with ODD compared to non-ODD children [52]. In addition, adolescents with disruptive disorders are less likely to receive positive social support from friends/class mates than adolescents with depression [39]. Friendships provide a context for the development of social skills [26] and, therefore, youth with disruptive disorders are additionally challenged. Finally, children with ODD display functional impairment that exceeds functional impairment of non-disruptive psychiatric disorders [32]. Still, no study has so far examined the association between the ODD dimensions and subtypes that are related to developmental trajectories and characteristics such as peer problems, life stressors and social skills.

Several stressors have been identified as risk factors for childhood ODD development. Low socioeconomic status [10] and harsh parenting [10, 15, 17] both increase the risk for ODD. Parental stress such as daily hassles, marital problems and parental psychopathology is related to dysfunctional discipline patterns and offspring externalizing symptoms [20, 58]. Mothers with depression give fewer positive statements to their children and maternal depression is specifically associated with dysfunctional parenting and child maladjustment [51].

Protective factors for development of ODD have also been identified. Child personal strengths (e.g., generous, easy-going, responsible, kind-hearted, or helpful behavior) seem to reduce the risk for developing externalizing disorders after 3 years [64]. However, whether these family and life stressors, and child-specific protective factors operate differently among the different ODD dimensions and subtypes is not yet determined.

Present study

Children with ODD are characterized by social dysfunction, functional impairment and a poor prognosis. The literature indicates that the trajectories of ODD are predicted by the oppositional symptomatology of the child. To date, no study has examined oppositionality dimensions and subtypes and their association with child psychosocial characteristics in a Nordic setting. We aimed to do so in a Danish sample focusing on the oppositionality dimensions outlined by DSM-5 to ensure comparability with future studies.

Our study had four aims: (1) to examine the construct validity of one-, two-, and three-dimensional ODD models in a Nordic sample; (2) to examine associations between the DSM-5 dimensions of oppositionality and comorbid psychopathology and child psychosocial characteristics (e.g., personal strengths, social skills, friendships, life stressors and parental psychopathology); (3) to identify ODD subtypes and examine their relation to comorbid psychopathology and psychosocial characteristics; (4) to compare psychosocial characteristics between children with ODD, children with emotional disorders and control group children.

We hypothesized that a three-factor ODD structure based on the dimensions of angry/irritable mood, argumentative/defiant behavior and vindictiveness would be identified in Danish children. Given the existing literature, we expected the angry/irritable dimension to be more associated with concurrent emotional symptomatology, and the behavioral dimensions, with disruptive symptomatology. We hypothesized that four ODD subtypes would be identified in Danish children, including a severe subtype and an angry/irritable subtype. Finally, we expected children with ODD to be characterized by life stressors and psychosocial challenges underlining the severity of the disorder compared to emotional disorder.

Methods and materials

Design

A two-phased nested case–control design consists of (1) a screening phase and (2) a diagnostic phase.

Study participants

The study sample was recruited from the Danish National Birth Cohort (DNBC) [54]. DNBC included more than 100,000 pregnant women in 1996–2002. The women repeatedly reported physical and psychological well-being about themselves and their children through questionnaires and interviews. These were carried out twice during pregnancy and at child age 6 months, 18 months and 7 years. Our study included a sub-cohort ($N=4500$) of DNBC children born 2000–2003 ($N=21{,}906$), who responded to the 7-year follow-up (see Procedures).

The pregnant women gave written informed consent on behalf of their children. The Regional Scientific Ethical Committee for the Municipalities of Copenhagen and Frederiksberg approved the study (01-471/94). This specific study was approved by the Danish Data Protection Agency (jr.nr 2010-41-4477).

Measures

The Strengths and Difficulties Questionnaire (SDQ)

The Strengths and Difficulties Questionnaire (SDQ) is a 25-item mental health screening questionnaire for children aged 4–17 years [29]. The SDQ is validated in different cultures [11, 27]. It has robust psychometric properties [11, 28] and shows satisfactory specificity and sensitivity with clinical diagnoses [28, 31]. The SDQ includes four problem

subscales (emotional problems, hyperactivity/inattention, conduct problems and peer relationship problems) and one strength subscale (prosocial behavior), and the total SDQ difficulties score is calculated by summing the four problem subscales. Also, SDQ includes four impairment items concerning distress and functional impairment (regarding family life, friendships, learning, leisure) and a total impact score (0–12) is calculated by summing these.

The Development and Well-Being Assessment (DAWBA)

The Development and Well-Being Assessment (DAWBA) covers present child psychiatric disorders [30]. The DAWBA has been used worldwide [21–23, 25, 35] and presents substantial validity [6, 30]. It includes both structured questions related to DSM diagnostic criteria and open-ended questions for qualitative responses. The DAWBA is designed to use skip rules for each disorder section not to burden participants and to keep response rates high.

The full set of oppositionality items was assessed if the mother confirmed that the behavior of her child was 'more awkward and troublesome than average compared to other children that age', or if the SDQ conduct problem subscale score was three or more. The DAWBA includes nine items regarding ODD, equivalent to the eight items in DSM-5, but dividing 'spiteful and vindictive behavior' into two items. The response categories for each item are; 'no more than others' (0), 'a little more than others' (1), and 'a lot more than others' (2).

Procedures

The first phase, the screening procedure, was based on maternal reports ($N = 21{,}906$) of child psychopathology using the SDQ, which was included in the DNBC 7-year follow-up. Initially, a random sample was selected for study participation ($N = 1500$). Next, based on the SDQ reports (scoring high on the SDQ emotional subscale score or SDQ total score), a sample of children at risk for psychopathology ($N = 3000$) was selected for study participation. In total, 4500 mothers were invited for a second-phase diagnostic assessment regarding their children (Fig. 1). For detailed information on inclusion procedure see [65].

The second phase, the diagnostic assessment, involved online maternal reports of child psychopathology using the DAWBA in addition with SDQ. Three experienced physicians trained in child and adolescence psychiatry assigned DSM-IV diagnoses after reviewing the full DAWBA information. Acceptable interrater reliability was achieved [65]. For the present study, we addressed the following child

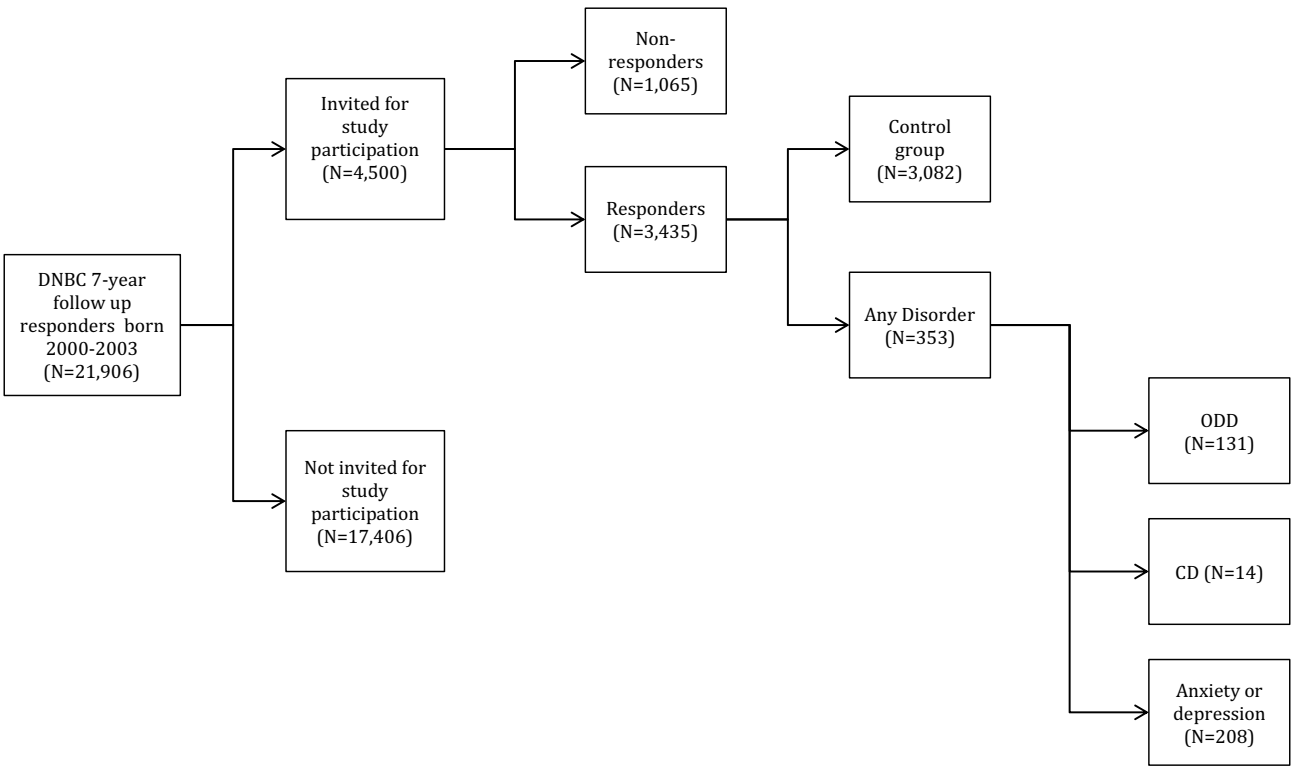


Fig. 1 Flow chart for study participation

psychiatric disorders from the DAWBA: ODD, Conduct Disorder (CD), Major Depressive Disorder and anxiety disorders (separation anxiety, social phobia, specific phobia, generalized anxiety, panic disorder, PTSD, obsessive compulsive disorder). In case of co-occurring ODD and CD, both diagnoses were assigned in accordance with DSM-5 diagnosis criteria [7].

The DAWBA also collects data on child characteristics. Social skills were assessed by the ten-item Social Aptitude Scale (SAS) [47]. Child personal strengths were assessed using the Youth Strengths Inventory (YSI). The YSI consists of 24 items divided into two subscales. YSI 1 describes child positive attributes (fi. caring, affectionate, generous) and YSI 2 describes what the child does to please others [64]. Furthermore, three DAWBA items addressed the child's ability to make friends.

Information regarding life stressors was collected using the background section of the DAWBA. The background section holds questions about health problems (9 items), school problems (4 items), stressful life events (SLE) (7 items) and family stressors (13 items). Mood problems and psychological distress of the mother and her partner were assessed using the Everyday Feelings Questionnaire (EFQ), a ten-item measure validated in both epidemiological [62] and clinical [49] samples.

Statistical analysis

Diagnostic hierarchy

The case groups were created hierarchically. According to the DSM-5 criteria, a CD condition did not dismiss an ODD diagnosis [7]. Hence, children who were assigned with a diagnosis of ODD were included in the ODD case group regardless of emotional or CD comorbidity. Children with CD (but not ODD) were included in the CD group regardless of emotional comorbidity. Children who were assigned with a diagnosis of Major Depressive Disorder or any anxiety disorder (but not ODD or CD) were included in the emotional disorders group. The control group included all study participants who were not assigned with any of the diagnoses mentioned above.

Oppositionality dimensions

Factor analyses were performed using nine variables created from the sum scores of the nine DAWBA ODD items (item range 0–2). In the one-factor ODD model, one common factor loaded on all nine ODD items. One-factor loading was estimated per item. Various two- and three-factor models of oppositionality have been reported in the literature and, therefore, we initially used Exploratory Factor Analysis (EFA) (with oblimin rotation and the minimum residuals method) to find the best fitting models to our data. The ODD models identified in the EFA as well as the DSM-5 model [7] and the three-factor ODD models suggested by Burke et al. [12, 14] and Aebi et al. [2] were compared. For this purpose, confirmatory factor analysis (CFA) was used. Given that the data were ordinal and the criterion of multivariate normality not fulfilled, a Diagonally Weighted Least Squares (DWLS) estimator with robust correction of standard errors was used to estimate correlations between factors in the two- and three-factor models.

No modifications or constraints to improve model fit were applied. No cross-loadings were allowed in the two- or three-factor models; only one-factor loading per item was estimated. Goodness-of-fit was examined in all models using root mean square error of approximation (RMSEA), Comparative Fit Index (CFI) and Tucker Lewis Index (TLI). For RMSEA, well-fitting models have a value < 0.08 [37]. For CFI and TLI, values higher ≥ 0.95 are preferred but values > 0.90 are considered acceptable [37]. Finally, model fits were compared between models using chi-square difference tests.

The internal consistencies of the ODD scale and the ODD subscales (based on the three DSM-5 ODD dimensions) were tested using Cronbach's alpha.

Comorbidity

The correlations between the three DSM-5 ODD dimensions and the SDQ subscales were assessed using linear regression. Each of the ODD dimensions and SDQ subscales were summed and standardized (i.e. by subtracting the mean and dividing by the standard deviation). A regression model was fitted for each of the SDQ subscales with the three ODD dimensions, as well as age and gender, as predictors. The significance level was Bonferroni adjusted to compensate for multiple comparisons. The internal consistencies of the SDQ subscales were tested using Cronbach's alpha.

Logistic regression was used to investigate the correlation between each ODD dimension and having a diagnosis. The three ODD dimensions were used as predictors along with age and gender for each of the diagnoses as the dichotomous outcome variable (ODD, CD, and emotional disorders). Odds ratios are reported with Bonferroni-adjusted *p* values.

Child psychosocial characteristics

Correlations between the three ODD dimensions and child characteristics and life stressors were tested by fitting linear models with each ODD dimension as predictor along with age and gender, with the outcome variables being each of the aforementioned child characteristics and life stressor variables. The reported beta-coefficients are standardized and

Bonferroni-adjusted *p* values were used in presentation and interpretation of the results.

ODD subtypes

The Latent Class Analysis (LCA) models are described to 'identify a categorical latent variable measured by a number of observed response variables [46]. The objective is to categorize people into classes using the observed items and identify items that best distinguish between classes' [53]. To identify ODD classes/subtypes in this sample, LCA was used to classify subjects into subtypes based on the probabilities of their response ('no more than others', 'a little more than others' or 'a lot more than others') to each of the nine ODD items in the DAWBA [4, 5]. Models with one to five latent classes were compared and scree plots of the Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), adjusted BIC, and entropy were used to determine the best fitting parsimonious model [53].

Two-sample tests for equality of proportions with continuity correction were used to compare proportions of comorbid disorders between the ODD subtypes defined by the LCA. Also, mean scores regarding dimensional psychopathology (SDQ subscales) and child psychosocial characteristics were compared between ODD subtypes.

Disorder groups

We compared the frequency of a range of child characteristics and life stressors between children with ODD, children with emotional disorders and control group children. The child characteristics included: child personal strengths (YSI 1 and 2, 12 items each), social skills (SAS, 10 items) and friendships (3 items). Life stressors consisted of: maternal mood problems (EFQ, 10 items), partner's mood problems as reported by mother (EFQ, 10 items), health problems (9 items), school problems (4 items), stressful life events (SLE) (7 items) and family stressors (13 items). The ten scales were summed and standardized. For each scale, a factorial ANOVA adjusted for age and gender was used to test differences between diagnosis groups. Significant differences were tested using Tukey's post hoc test and significance levels were Bonferroni adjusted to compensate for multiple comparisons. Due to missing data for some participants, the number of observations used in each analysis varied. The number is given for each ANOVA in Fig. 5.

Statistical analyses were performed using R 3.4.2 with the packages psych 1.7.8 (for exploratory factor analysis and calculation of Cronbach's alpha), lavaan 0.5–23.1097 (for confirmatory factor analysis), and poLCA 1.4.1 (for latent class analysis).

Results

A total of 3435 out of 4500 invited mothers participated in the study (non-responders $N = 1065$, response rate 76%) (Fig. 1). We previously showed no gender differences between responding and non-responding children [65]. Mean age for study participants was 8.94 years (SD 0.75, range 7–10 years) and 56.1% were boys. A total of 131 children (3.8%) had ODD (76.9% boys) and the mean age was 8.71 years (SD = 0.87) (Table 1). Fourteen children (0.4%) had CD (and not ODD) and 208 children (6.1%) had anxiety or depression (and not ODD or CD) and were included in the emotional disorder group. A total of 3082 study participants did not have any disorder and were included in the control group. ODD items were available for 915 children, and these children were used in the analyses of oppositionality dimensions.

Oppositionality dimensions

A one-factor model was created simply by loading each item on the same latent variable in the confirmatory factor analysis (CFA). Using exploratory factor analysis (EFA), the best fitting two-factor model had one factor with the variables; temper outbursts, touchy/easily annoyed, angry and resentful, argues with adults, ignores rules/disobedient, blames others, and a second factor with the variables; spiteful, vindictive, and deliberately annoys others (Table 2). The EFA showed that an alternative three-factor model made the best fit to our data. This model included the variables 'deliberately annoys others' and 'blames others' in the vindictiveness dimension instead of in the argumentative dimension (compared to the DSM-5 model). CFA was performed comparing the one- and two-factor models, the three-factor model identified in the EFA, the DSM-5 three-factor model and two three-dimensional ODD models proposed in the literature [2, 12, 14]. The model proposed by Aebi et al. is similar to the DSM-5 model except that the 'deliberately annoys others' variable is included in the vindictiveness dimension [2]. The model proposed by Burke et al. consists of an oppositional behavior dimension ('temper outbursts', 'argues', 'ignores rules/defies'), a negative affect/irritability dimension ('spiteful', 'touchy/easily annoyed', 'angry'), and an antagonistic behavior dimension ('deliberately annoys others', 'blames others') [12, 14].

Figure 2 shows goodness-of-fit indices for the factor analyses, as well as the full three-factor DSM-5 model. All goodness-of-fit indices considered in the CFA indicate that the three-factor models (except the model developed by Burke et al.) fit the ODD symptoms better than the

Table 1 Descriptive statistics and sample sizes for each disorder group and in total

Disorder group	Controls			ODD			Emotional Disorders			All		
Item	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*
Gender												
Female			1391			31			82			1508
Male			1691			100			126			1927
Age	8.94	0.75	3082	8.71	0.87	131	8.87	0.75	208	8.92	0.76	3435
SDQ Total	8.78	5.77	3075	20.97	5.55	131	15.96	6.42	207	9.73	6.5	3427
SDQ Conduct	1.46	1.49	3075	4.95	1.77	131	2.25	1.85	207	1.66	1.7	3427
SDQ Emotional	2.67	2.21	3075	4.89	2.38	131	6.15	2.41	207	2.97	2.41	3427
SDQ Hyperactivity	3.32	2.68	3075	7.48	2.46	131	4.89	2.88	207	3.6	2.83	3427
SDQ Peers	1.33	1.72	3075	3.65	2.33	131	2.66	2.21	207	1.51	1.86	3427
SDQ Prosocial	8.21	1.71	3075	5.97	2.22	131	7.59	2.14	207	8.08	1.82	3427
ODD Vindictiveness	0.19	0.51	698	1.27	1.25	131	0.44	0.82	72	0.39	0.83	915
ODD Angry/irritable	2.01	1.54	698	5.4	1.04	131	2.88	1.83	72	2.61	1.93	915
ODD Argumentative	1.83	1.65	698	5.88	1.65	131	2.36	1.92	72	2.51	2.22	915
Social skills (SAS)	22.12	6.26	3055	11.52	5.78	130	18.83	7.28	206	21.47	6.7	3405
Family stressors	2.32	2.06	2562	3.49	3.01	87	3.19	2.77	144	2.41	2.17	2804
EFQ (mother)	11.63	5.44	2551	15.82	7.16	87	14.63	6.48	143	11.93	5.65	2792
EFQ (partner)	11.62	5.4	2107	14.83	5.81	60	12.68	6.04	106	11.76	5.48	2279
Friendships	4.64	1.57	3053	2.87	1.58	129	3.64	1.7	206	4.51	1.63	3402
Strengths 1 (YSI 1)	19.64	3.36	2769	15.04	3.53	120	18.11	3.79	161	19.35	3.53	3063
Strengths 2 (YSI 2)	16.87	3.63	2767	12.3	3.69	119	15.56	4.1	161	16.6	3.79	3060
Stressful Life Events	0.5	0.77	2603	0.78	0.9	88	0.99	1.03	145	0.54	0.8	2848
Health problems	0.32	0.8	2609	0.76	0.99	88	0.6	1.03	145	0.35	0.82	2855
School problems	0.59	1.09	2607	2.01	1.64	88	1.18	1.42	145	0.67	1.17	2852
SDQ impairment	0.7	1.44	3075	4.7	2.53	131	3.05	2.71	207	1	1.86	3427

Table 2 Factor loadings, eigenvalues, and variance explained for the two-dimensional ODD model (loadings < 0.10 not shown)

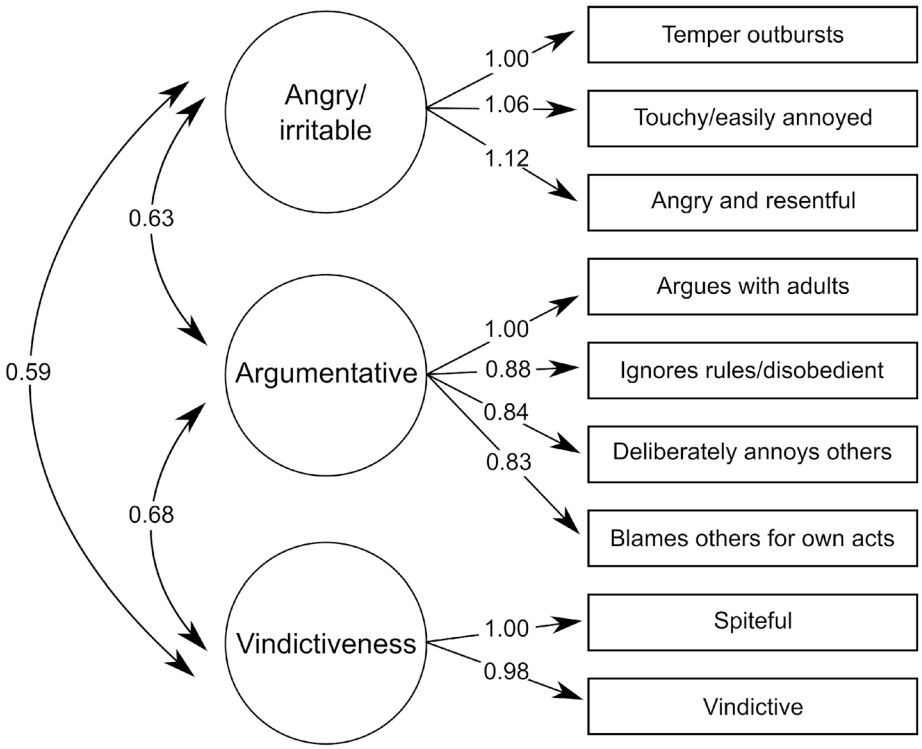
Loadings	Factor 1	Factor 2
Temper outbursts	0.77	
Argues with adults	0.72	
Ignores rules/disobedient	0.43	0.28
Deliberately annoys others	0.16	0.55
Blames others	0.31	0.38
Touchy/easily annoyed	0.80	
Angry and resentful	0.85	
Spiteful		0.76
Vindictive		0.77
Eigenvalue	4.67	1.06
Proportion of variance explained	0.33	0.21

one- and two-factor models. The CFI, TLI, and RMSEA all favor the three-factor model based on the EFA (although RMSEA is not below 0.08, which is the usual cut-off for acceptable fit). The model fits were compared using chi-square difference tests, which confirmed that the DSM-5 model was better than the Burke et al. model ($p < 0.001$) but not as good as the Aebi et al. model ($p < 0.001$) and the EFA model ($p < 0.001$). Still, we decided to proceed with the DSM-5 ODD model for further analyses to be consistent with the diagnostic classification and to provide results comparable for future studies.

The internal consistency of the ODD symptom scale was tested using Cronbach's alpha and found to be 0.88 (95% CI 0.87–0.89). The internal consistency of the ODD subscales based on the DSM-5 dimensions were also tested and found to be: Angry/irritable mood: 0.86 (95% CI 0.84–0.87), argumentative behavior: 0.78 (95% CI 0.75–0.80), vindictiveness: 0.75 (95% CI 0.72–0.78).

ODD dimensions and comorbid psychopathology

Figure 3 shows the correlations between each ODD dimension (angry/irritable mood, argumentative behavior, vindictiveness) and SDQ subscale scores (data for ODD dimensions and SDQ subscales were available for 915 children). The beta-coefficients indicate a significant positive correlation between the vindictiveness dimension and the conduct, emotional and peer problem SDQ subscales. The angry/irritable dimension was positively correlated with emotional



Dimensions	1	2	3 (DSM-5)	3 (Aebi)	3 (Burke)	3 (EFA)
Root mean square error of approximation (RMSEA)	0.129	0.116	0.107	0.102	0.117	0.091
Comparative fit index (CFI)	0.964	0.972	0.978	0.980	0.974	0.984
Tucker-Lewis index (TLI)	0.953	0.961	0.967	0.970	0.961	0.976

Fig. 2 Confirmatory factor analysis of the three-dimensional DSM-5 model of the ODD scale. Fit statistics are given for each model (one, two, and three dimensions)

and peer problems, and the argumentative behavior dimension was positively correlated with hyperactivity and conduct problems. Both the argumentative and vindictiveness ODD dimensions were negatively correlated with the prosocial scale, indicating that higher scores in these ODD dimensions were associated with poorer prosocial functioning. Finally, all three dimensions were correlated with functional impairment; however, the association was strongest for the angry/irritable dimension.

The internal consistency of the SDQ subscales was also estimated and found to be: Emotional: 0.72 (95% CI 0.70–0.73), peer problems: 0.66 (95% CI 0.65–0.68), hyperactivity: 0.84 (95% CI 0.83–0.85), conduct: 0.64 (95% CI 0.63–0.66) and prosocial: 0.70 (95% CI 0.69–0.72).

Logistic regression analyses revealed that the angry/irritable mood (OR: 2.95, 95% CI: 2.32-3.84, $p < 0.001$) and argumentative behavior (OR: 2.13, 95% CI 1.76–2.61, $p < 0.001$) dimensions, but not vindictiveness (OR: 0.80, 95% CI 0.58–1.09, $p = 0.16$), were associated with an ODD diagnosis. In contrast, the vindictiveness (OR: 1.53, 95% CI 1.05–2.28, $p = 0.03$) and argumentative behavior (OR: 1.48, 95% CI 1.11–2.02, $p = 0.01$) dimensions, but not angry/irritable mood (OR: 1.45, 95% CI 0.97–2.39, $p = 0.09$), predicted CD. Finally, the angry/irritable dimension (OR: 1.32,

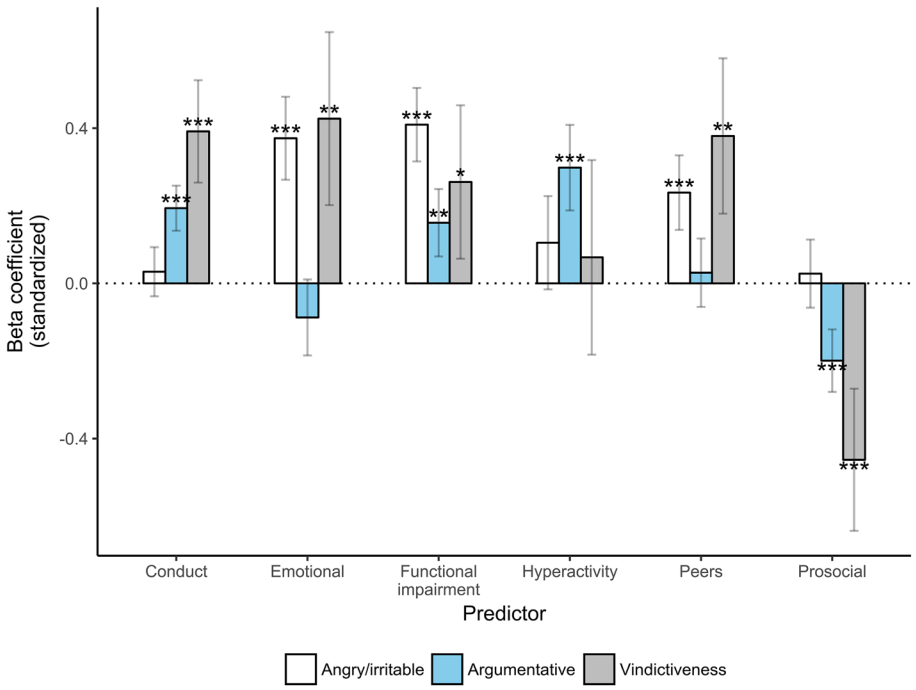


Fig. 3 Standardized beta-coefficients for linear regression with the SDQ subscale as outcome and ODD dimensions as predictors (adjusted for age and gender). Bonferroni-adjusted significance levels are marked (*<0.05, **<0.01, ***<0.001, after multiplying p with $n=6$). The regression was based on 915 children where both ODD and SDQ scores were available. Error bars show 95% confidence intervals

95% CI 1.13–1.54, $p<0.001$) was associated with an emotional disorder, whereas vindictiveness (OR: 1.27, 95% CI: 0.98-1.63, $p=0.07$) and argumentative behavior (OR: 0.95, 95% CI 0.83–1.08, $p=0.45$) were not.

ODD dimensions and child psychosocial characteristics

Figure 4 shows the correlation of each of the ODD dimensions with variables measuring personal strengths (YSI 1 and 2), ability to make friends, social skills (SAS) and various life stressors. Higher scores on the angry/irritable or argumentative dimensions were correlated with reduced social skills (measured by SAS). Higher scores on the angry/irritable dimension was furthermore correlated with lower scores on YSI 1 (positive attributes) and difficulties in making friends, whereas higher scores on the argumentative behavior dimension were correlated with school problems and a lower score on YSI 2 (what the child does to please others). Changes in the vindictiveness dimension were not associated with any significant changes in the child characteristics/stressor scales. This apparent lack of correlation is likely due to larger variation and hence larger confidence intervals that became insignificant after Bonferroni correction.

ODD subtypes

Latent class analysis showed that a four-class model gave the best fit for our data (one-class BIC: 13,343.42; two-class BIC: 11,397.19; three-class BIC: 10,787.48; four-class BIC: 10,746.18; five-class BIC: 10,755.37. Scree plots of AIC, adjusted BIC, and entropy also supported the selection of a four-class model). The four-class model represented four ODD subtypes; (1) 'low' scoring low on all variables (29.9%), (2) 'medium' scoring medium on all variables (42.2%), (3) 'high' scoring high on all variables (13.6%), and finally (4) an 'angry/irritable' subtype scoring high on 'temper outbursts', 'touchy/easily annoyed', and 'angry and resentful' (corresponding to the 'angry/irritable mood' dimension), but scoring low/medium on other variables (14.3%). In general, all subtypes scored lower on the vindictive/spiteful variables than on the others. Figure 5 illustrates the four ODD subtypes and their respective answer probabilities for each variable.

The 'high' ODD subtype had a significantly higher proportion of comorbid ODD diagnosis (79 vs 0%, $p<0.001$) and CD diagnosis (7 vs 0%, $p<0.001$) than the 'low' subtype (Supplement Table 1). The 'angry/irritable' subtype had a significantly higher proportion of comorbid ODD (23 vs 0%, $p<0.001$) and emotional disorder (15 vs 6%, $p=0.011$) than the 'low' subtype. The 'medium' subtype did not differ significantly from the 'low' subtype with regards to comorbid diagnoses.

Mean SDQ subscale scores for the four ODD subtypes are illustrated in Supplement Figure S1. The 'high' and 'angry/irritable' ODD subtypes were characterized by significantly more overall psychological problems than the 'low' and 'medium' subtypes. Also, they experienced more functional impairment—the 'high' subtype to an even higher extent than the 'angry/irritable' subtype.

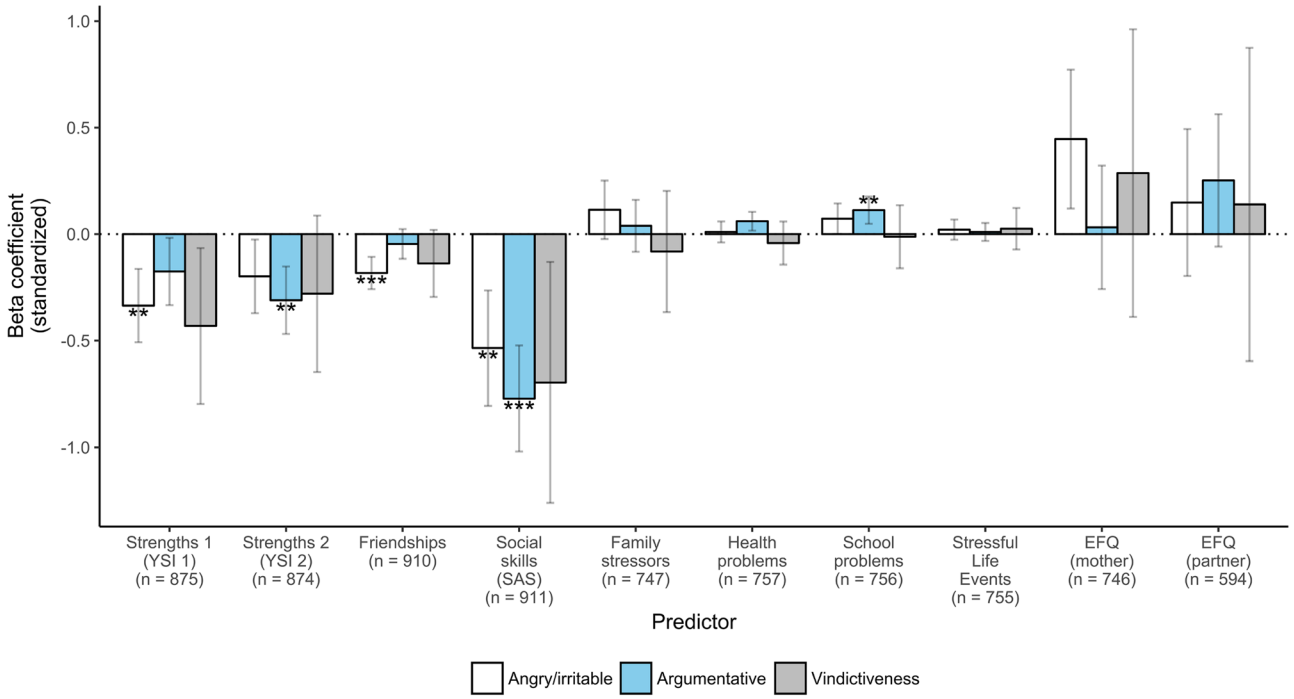


Fig. 4 Standardized beta-coefficients for linear regression with the various child characteristics as outcome and ODD dimensions as predictors (adjusted for age and gender). Bonferroni-adjusted significance levels are marked (*: < 0.05, **: < 0.01, ***: < 0.001, after multiplying p with n = 10). The number of observations used is noted for each regression. Error bars show 95% confidence intervals. *YSI* youth strengths inventory, *SAS* social aptitude scale, *EFQ* everyday feelings questionnaire

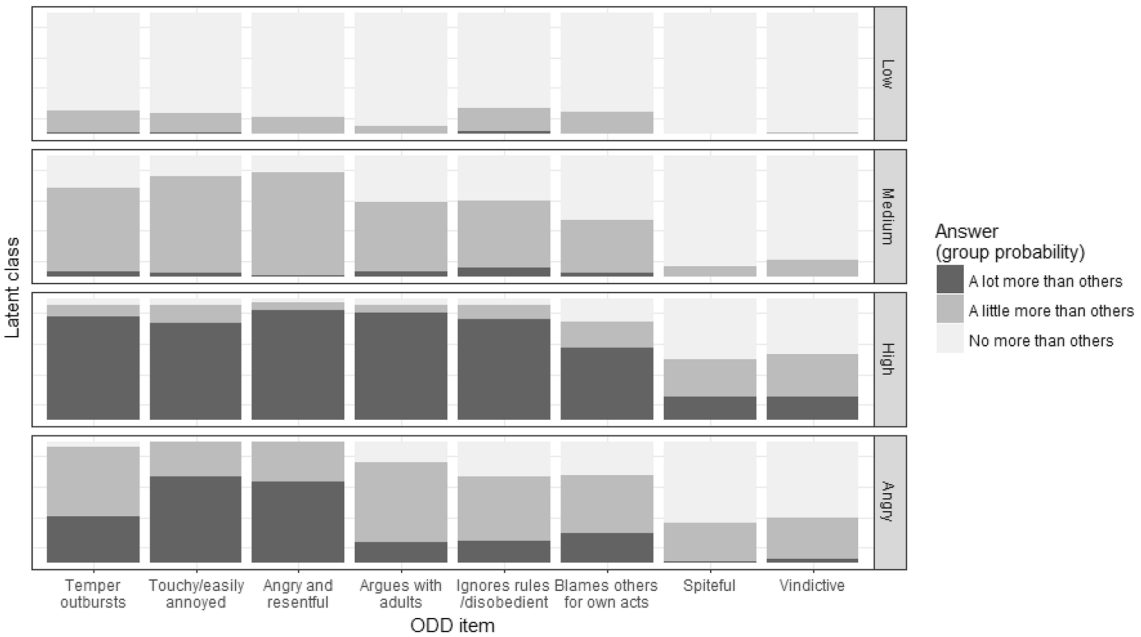


Fig. 5 The four subtypes identified by latent class analysis and their response probabilities to each ODD item

We also examined mean scores for various child psychosocial characteristics scales for each of the ODD subtypes (Supplement Figure S2). The 'high' ODD subtype generally experienced more difficulties in various aspects of life compared to the other ODD subtypes. This difference was statistically significant for social skills, friendships and school

problems. The 'angry/irritable' subtype also experienced more difficulties than the 'low' and 'medium' subtypes, but mostly not as many as the 'high' ODD subtype.

Childhood ODD and psychosocial characteristics

The children were grouped by diagnosis (ODD, emotional disorder and controls) and compared using ANOVA, adjusting for age and gender, on each of the parameters mentioned above. Results are shown in Fig. 6. Children with ODD generally scored worse than controls on each of the measured variables. When comparing children with ODD to children with emotional disorders, they presented similar results, except that children with ODD scored worse on a number of variables. Children with ODD were significantly more likely to have fewer friendships, reduced social skills and personal strengths (YSI 1 and 2) compared to children with emotional disorders. They also experienced significantly more school problems, and they were generally more functionally impaired (measured by SDQ) compared to children with emotional disorders.

Discussion

We conducted a population-based cross-sectional study in a Danish birth cohort examining dimensions and subtypes of oppositionality and comparing children with ODD to

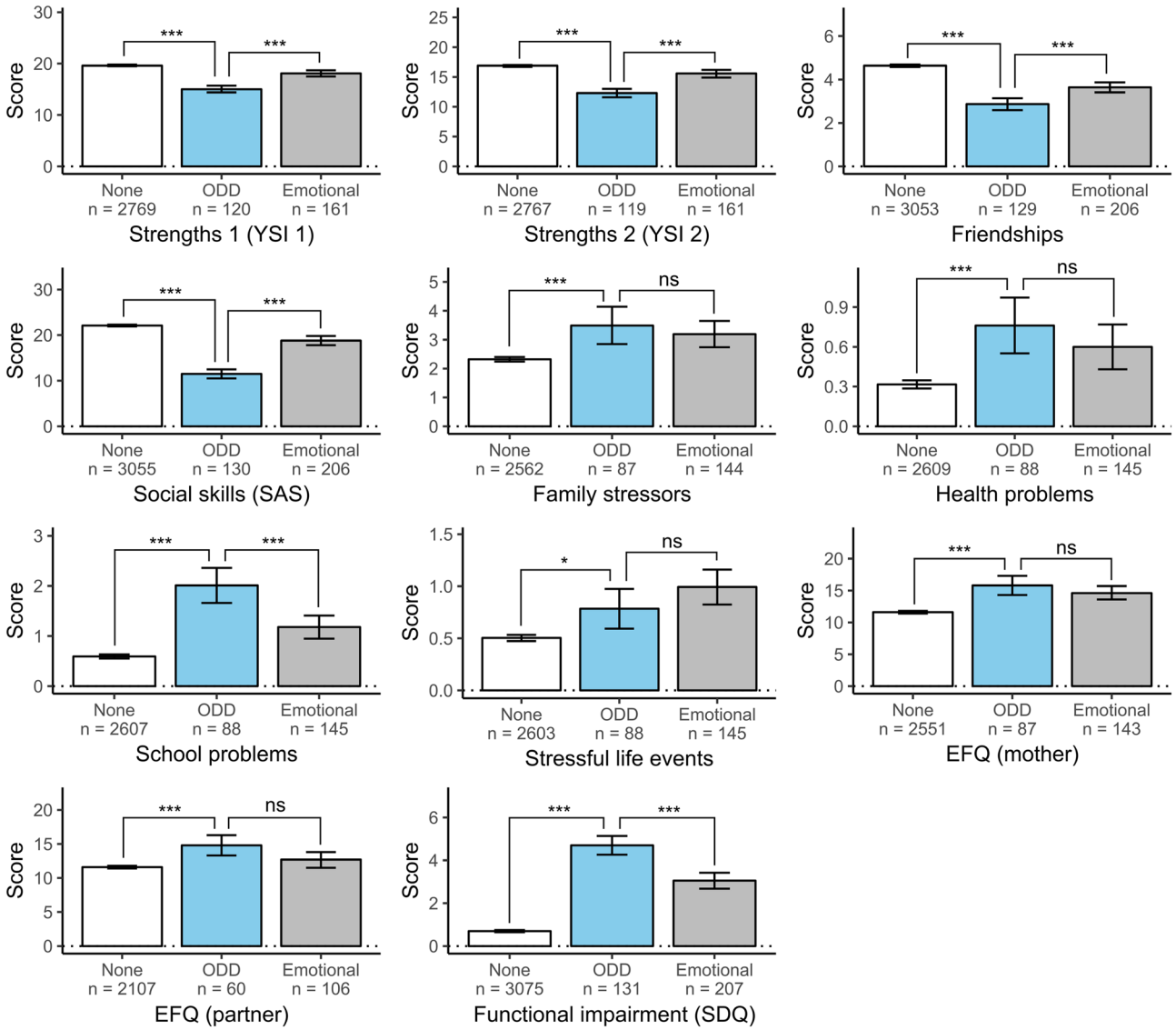


Fig. 6 ANOVA comparisons between control, ODD, and emotional disorder groups for various child characteristics. Number of observations used in each test (due to missing data) shown under plot. Error bars show 95% confidence intervals. *YSI* youth strengths inventory, *SAS* social aptitude scale, *EFQ* everyday feelings questionnaire

children with emotional disorders and to a control group of children. Our study supported a three-factor ODD model and that the ODD dimensions and subtypes are differently associated with comorbid psychopathology. In addition to being the first study examining the dimensions and subtypes of ODD in a Nordic setting, this is the first study to examining the relationship between childhood ODD dimensions/subtypes and personal strengths, life stressors and social skills.

We confirmed that a three-factor oppositionality model consisting of the dimensions angry/irritable mood, argumentative behavior and vindictiveness made the best fit for Danish children, similar to results from other cultural settings [12, 14, 61]. However, like a previous study [2], our data favored two models slightly different from the one outlined by DSM-5, where the items 'deliberately annoys others' and 'blames others' were located in the vindictiveness dimension instead of in the argumentative behavior dimension. In spite of this minor difference, the support to the three-factor ODD model is an important finding given the marked cultural and economic differences that exist between this Danish cohort sample and the populations previously examined. It indicates that the three dimensions of oppositionality are core, stable constructs of the ODD phenotype independent of socioeconomic status and cultural/geographical context.

The ODD dimensions outlined by the DSM-5 were subject to further analyses and they were differentially related to comorbid psychopathology. As in previous studies [3, 44, 61], we found the angry/irritable mood dimension to be associated with emotional problems and disorders. While the cross-sectional design does not allow us to address the temporal sequence, other studies have found the angry/irritable oppositionality dimension to predict subsequent development of emotional disorders [12, 57, 60, 66].

The argumentative behavior dimension was positively associated with hyperactivity and conduct problems, which has been documented previously in other studies [44, 61] Similar to the study by Stringaris and Goodman [61], we also found the argumentative behavior dimension to be associated with a diagnosis of CD. Finally, the vindictiveness dimension was significantly associated with conduct problems (including CD), peer problems and reduced social skills measured by the SDQ, as also observed in a Brazilian sample [44]. All three ODD dimensions were associated with functional impairment, but the angry/irritable mood dimension to a larger extent. This is supported by a previous study, finding the angry/irritable dimension to be significantly associated with high scores on two measures of impairment [42]. Somewhat unexpectedly, we found the vindictiveness dimension to be associated with concurrent emotional problems, although not with emotional disorders. The failure model hypothesizes that children with ODD have socializing problems and frequent conflicts with peers ultimately leading to rejection and a subjective feeling of failure [18]. This might trigger emotional symptoms and subsequently emotional disorders [16, 59]. It is possible that vindictive behavior is particularly culturally unacceptable in a Nordic setting leading to accentuated peer rejection and subsequent emotional symptoms in the child with vindictive oppositionality. This needs to be examined in longitudinal studies of Nordic children.

We also examined the associations between the dimensions of oppositionality and childhood characteristics. We found that the argumentative behavior and angry/irritable dimensions were associated with reduced social skills and reduced personal strengths. Also, the argumentative behavior dimension was related to more school problems. The vindictiveness dimension showed a large variation within these child characteristics, and probably, therefore, did not correlate significantly to any of these.

Using a person-centered approach, LCA identified four ODD subtypes in our sample that presented either 'low', 'medium', 'high' or 'angry/irritable' ODD symptomatology. The 'angry/irritable' subtype was characterized by a high frequency of the three symptoms also included in the 'angry/irritable mood' dimension. The 'angry/irritable' and 'high' ODD subtypes were the least frequent subtypes, constituting together one-third of the ODD subtypes. They were characterized by more comorbid psychopathology, psychosocial problems and functional impairment than the 'low' and 'medium' subtypes. [1]. For example, both subtypes were associated with comorbid ODD although the 'high' subtype to a much larger extent. The 'high' subtype was also correlated to comorbid CD. This partly supports a previous study, where the 'high symptom' subtype was associated with comorbid ODD and CD [4]. The 'angry/irritable' and 'high' ODD subtypes were also associated with comorbid emotional problems in our study, which has been found in a study of 7–12-year-old twins [45]. Furthermore, the 'angry/irritable' subtype was associated with emotional disorder, whereas the 'high' subtype was not. This is in line with a study of three different samples of children and adolescents [4] but differs slightly from a study of adolescent male offenders, where both subtypes were associated with anxiety disorders [1].

Danish children with ODD had significantly reduced social skills, personal strengths and fewer friendships than children with emotional disorders, or control group children. They also experienced more school problems and had higher functional impairment. However, this is a cross-sectional study and causal mechanisms cannot be determined. School stressors might induce ODD symptoms in a child, but it is also possible that ODD itself induces or exacerbates school-related problems. Nevertheless, our results support the existing literature showing that children with ODD have profound challenges in relations to peers and social relations that go beyond those of children with non-disruptive disorders [32].

We also found that the mothers of children with ODD (and her partner) presented more depressive and anxiety symptoms than the mothers of control group children. However, the level of parental mood problems was not different from that of children with emotional disorders.

This study has several strengths. It is the first study to describe ODD dimensions in a Nordic context. The study included a large population-based sample of pre-pubertal children. Thorough assessment was carried out and comprehensive data regarding social and personal strengths were collected. We decided to focus on the oppositionality model outlined by the DSM-5, which increases the possibility for comparisons with future studies. The study also has limitations. Although population based, the DNBC is not completely representative of the Danish population [38], with DNBC mothers being more likely to come from high-socioeconomic status backgrounds.

Only maternal report was available for this study. This might have influenced the relatively low numbers of children assigned with an ODD diagnosis. Studies show that using different informants strengthens the quality of the information regarding the description of behavioral disorders [48]. Similarly, child report data would probably have increased the numbers assigned with an internalizing disorder diagnosis [56]. Finally, due to DAWBA skip rules, children with low levels of oppositionality could be left out of the analyses. These circumstances might partly explain the low frequency of ODD in this sample.

In conclusion, our results support that childhood oppositionality constitutes a three-dimensional model as demonstrated in other cultural settings. The dimensions were differently related to comorbid psychopathology and also to child personal strengths and life stressors. The angry/irritable dimension was associated with pronounced emotional problems and functional impairment, as well as reduced social skills and personal strengths. The argumentative behavior dimension was associated with hyperactivity/conduct problems and reduced social skills and personal strengths. Finally, the vindictiveness dimension was associated with conduct problems/disorders, peer problems and impaired prosocial behavior.

As expected, we identified four ODD subtypes among children with oppositionality symptoms. The most frequent subtypes ('low' and 'medium') constituted two-thirds and were characterized by limited comorbidity and psychosocial problems. The subtypes that presented many ('high') or mainly 'angry/irritable' symptoms on the other hand were characterized by comorbid psychopathology also at a disorder level, increased functional impairment and a range of psychosocial problems.

Children with ODD have markedly reduced social skills and fewer personal positive attributes than control group children and children with emotional disorders. This makes them vulnerable to rejection from peers and adults and could contribute importantly to the poor trajectories of the condition. Our findings support that children with ODD have functional impairment above and beyond that of children with emotional disorders. Even so, many countries (including Denmark) do not offer treatment or support to children with ODD, in spite that effective treatment interventions are available [41]. Treatment interventions for children with ODD need to be initiated aiming at child adversities such as peer and social skill problems. Also, they should focus on children who present many or mainly angry/irritable ODD symptoms, since these children are characterized by particularly high comorbidity and functional impairment.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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