Depressive symptom networks in the UK general adolescent population and in those looked after by local authorities

Pascal Schlechter, Tamsin Ford, Sharon A S Neufeld

ABSTRACT

Background Despite the importance of understanding depressive symptom constellations during adolescence and specifically in looked-after children, studies often only apply sum score models to understand depression in these populations, neglecting associations among single symptoms that can be elucidated in network analysis. The few network analyses in adolescents have relied on different measures to assess depressive symptoms, contributing to inconsistent cross-study results.

Objective In three population-based studies using the Short Mood and Feelings Questionnaire, we used network analyses to study depressive symptoms during adolescence and specifically in looked-after children.

Method We computed cross-sectional networks (Gaussian Graphical Model) in three separate datasets: the Mental Health of Children and Young People in Great Britain 1999 survey (n=4235, age 10–15 years), the mental health of young people looked after by local authorities in Great Britain 2002 survey (n=643, age 11–17 years) and the Millennium Cohort Study in the UK 2015 (n=11,176, age 14 years).

Findings In all three networks, self-hate emerged as a key symptom, which aligns with former network studies. I was no good anymore was also among the most central symptoms. Among looked-after children, I was a bad person constituted a central symptom, while this was among the least central symptom in the other two datasets. The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition symptom I did not enjoy anything was not central.

Conclusions Findings indicate that looked-after children’s depressive symptoms may be more affected by negative self-evaluation compared with the general population.

Clinical implications Intervention efforts may benefit from being tailored to negative self-evaluations.

BACKGROUND

In most countries around the world, depressive symptom incidence increases from childhood onwards, with new onset cases peaking around age 21 years. Meta-analyses estimate a worldwide prevalence of any depressive disorder of 2.6% (95% CI 1.7 to 3.9) for children and adolescents. Adolescence is characterised by profound psychobiological changes and major life events. Therefore, we need to understand the development of depressive symptoms during this sensitive developmental phase. Depressive symptoms may present differently as a function of age or life circumstances. Specifically, looked-after children, defined as young people in the care of the local authority, had an OR of 2.28 for having depression compared with those living in a private household. Looked-after children experience poorer mental health and educational attainment, more learning disabilities and special educational needs and suffer more adverse experiences, including exclusion from mainstream schools or stigmatisation by other pupils.

This population is further at risk of childhood maltreatment, which is associated with both higher risk of depression and unfavourable treatment outcomes. Accordingly, for mental health services to be effective, depressive symptom presentations need to be...
understood accurately during development and specifically for looked-after children.

Potential developmental differences in the presentation of depression are not currently reflected in nosological classifications of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) and International Classification of Diseases (ICD)-11, as neither vary substantially in their disorder specification as a function of development. Only the DSM describes irritability rather than depressed mood as an alternate hallmark symptom for children and adolescents. Sum score models that assume symptoms are interchangeable indicators of an underlying common cause are thus often applied to measure depression during adolescence and specifically in looked-after children.  

To understand the presentation of adolescent depressive symptoms better, network analytic methods have been applied. The network perspective conceptualises a disorder as a causal system emerging from complex interactions among symptoms. The importance of symptoms is indicated by their centrality or interconnectedness, and core symptoms can reflect clinically relevant targets. 

However, few studies have examined properties of depressive symptoms across different populations during adolescence. Analyses in adult samples indicated that sadness and loss of interest were central depressive symptoms, consistent with nosological systems. The few studies in children and adolescents point to different symptom profiles in these ages compared with adulthood, which has important implications for the nosological understanding of depression. Table 1 summarises the main findings from previous studies, with a broad range of core symptoms emerging across different populations using different questionnaires: self-hatred, loneliness, sadness, pessimism, fatigue, self-deprecation, crying, school dislike, low self-esteem, low mood, feelings of worthlessness and no good anymore. This research sheds light on symptom centrality and connectivity across different developmental stages, identifying core symptoms often not covered by the DSM or ICD. The identification of heterogenous core symptoms in children and adolescents aligns with the overall wide range of depressive symptoms observed clinically in this age range.  

Core symptoms during adolescence appear to encompass negative self-evaluation and may reflect endorsement of the DSM-5 depressive symptom covering feelings of worthlessness. Previous network studies have used different measures of depression, limiting their comparability. A consistent instrument must be used to elucidate possible differences in network structures across different populations. The self-reported Moods and Feelings Questionnaire (MFQ) is recommended by the National Institute for Health and Clinical Excellence guidelines as a screening tool for childhood and adolescent depression.

As shown in Table 1, only three studies have used the MFQ or the short MFQ (SMFQ) to conduct network analysis, indicating their potential importance for intervention targets to remedy further symptom escalation. These symptoms may indicate cognitions and perceptions that constitute the development of self-worth.

In addition, adolescence is a period of increased vulnerability to loneliness with detrimental mental health consequences. Accordingly, the interplay of these symptoms may be key for understanding depressive symptoms in adolescence. However, symptom presentations may differ for looked-after children, who are in the care of local authorities for a variety of reasons including physical, sexual or emotional abuse or neglect and other circumstances that hinder parents’ caregiving, such as incarceration. These experiences are likely to lead to a dysfunctional attachment style in the young person, which can in turn lead to repeated experiences of negative interactions and unmet emotional needs throughout the young person’s life. While stable care can restore secure attachment to a certain degree, looked-after children show lower levels of secure attachment and higher levels of insecure and disorganised attachment compared with the general population. Indeed, looked-after children are at great risk of negative financial, educational, legal and health outcomes. Identification of core symptoms is paramount to better understand the symptom presentation in this vulnerable population. It could be that these life circumstances result

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<td>High schools in urban and suburban areas in the USA; N=1409 adolescents aged 13–19 years; Children’s Depression Inventory (CDI)</td>
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<td>Gossage et al</td>
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in elevated symptoms, but that underlying symptom presentation in looked-after children otherwise remains equivalent to the general population. This would indicate that similar approaches for symptom reduction could be used in this vulnerable population as in the general population. Alternatively, different depressive symptom networks differed in looked-after children compared with the general population. For instance, concentration problems or seeing oneself as a bad person may constitute more central symptoms in looked-after children, as attention deficit hyperactivity disorder and conduct disorders are also more prevalent in this population.5

OBJECTIVES
Our aims were twofold. First, we aimed to understand depressive symptom constellations in adolescents across two population-based UK studies. Second, we sought to understand whether depressive symptom networks differed in looked-after children compared with these general population samples. Using data from the Mental Health of Children and Young People in Great Britain (MHCYP), the Millennium Cohort Study (MCS) and the mental health of young people looked after by local authorities in Great Britain (LAC),2,23 we investigated depressive symptoms measured with the SMFQ in three different studies, representing different UK populations regarding experienced adversities. Separate analyses per sample aimed to elucidate network structure replicability across populations with different demographic backgrounds. As former studies showed central symptoms of self-hate, sadness, I was no good anymore and loneliness,15 16 17 18 we expected these symptoms to be central in our analyses. We investigated exploratorily whether the symptom structure in the LAC sample differed from the other two samples.

METHODS
Datasets
The 1999 MHCYP survey is representative of children from the general population of England, Scotland and Wales.23 A total of 4235 children aged 10–15 years responded to the SMFQ (mean age=12.95 years; table 2).

The MCS is a longitudinal cohort study following young people born in the UK in 2000–2001.25 Children from ethnic minority backgrounds and families living in disadvantaged circumstances were oversampled. We took data from wave 6 when participants were aged 14 years (2015, n=11 176), when SMFQ was collected closest in age to MHCYP data. Predictors of attrition over time included disadvantaged families (eg, lower socioeconomic status, greater neighbourhood deprivation), ethnic minorities and single parent households.28

In LAC, data from three nationally representative surveys from 2002 to 2003 were combined (one each in England, Scotland and Wales) to gather data on looked-after children.7 23 Random samples of looked-after children were selected from the relevant databases in each country. Six hundred forty-three children aged 11–17 years (SD=3.4) responded to the SMFQ.

Data are available to researchers via the UK data service. As data could not be used to re-identify individuals, no further ethical approval was needed for our secondary data analysis.

Measures
Short Moods and Feelings Questionnaire
Depressive symptoms were assessed with the 13-item SMFQ.29 Participants indicated depressive symptoms over the last 2 weeks with response categories ‘not true’ (0), ‘sometimes’ (1) and ‘true’ (2), leading to scores from 0 to 26. Showing good reliability and validity, the SMFQ was designed as a depression screener in children and adolescents.29 Internal consistencies were good in the MHCYP (α=0.87), LAC (α=0.90) and MCS (α=0.93). Items are listed in full in table 3.

Analysis procedure
Analyses were performed in R.30 Given that items had three response options, they were treated as ordinal. We computed a separate Gaussian Graphical Model (GGM) for the SMFQ in each of the samples. A GGM consists of nodes that constitute symptoms, which are connected by edges. These edges are the estimates of the partial correlation between pairs of nodes, after adjusting for the influence of all other nodes in the network.12 For the three cross-sectional networks, we applied the least absolute shrinkage and selection operator. A regularisation term ensures only the most robust associations between nodes appear in the networks.31 We compared the overall connectivity of the three networks with the network comparison test (NCT).31 For each symptom, we estimated the expected influence centrality, a measure of a node’s interconnectedness with other nodes (ie, sum of edge weights connected to a node). This way, we aimed to quantify the importance of a symptom. Further analyses estimated network accuracy and stability (online supplemental 1). The edge weight difference test indicates whether specific symptom connections (ie, edges) are significantly different from other symptom connections. Similarly, the centrality difference test quantifies whether some symptoms are significantly more central in the networks than others. More detailed information on the analytical details of fitting the networks is provided in online supplemental material 1.
Most looked-after children (≤6.10 for all items) (see sample. Items exhibited skew (≤2.58 for all items) and kurtosis (KT) were higher in the LAC sample as others, did everything wrong (Table 3). Item differences were mixed when comparing the LAC sample with MCS: tiredness and concentration problems were higher in MCS whereas anhedonia and negative self-evaluations (bad person, nobody loved me, not as good as others, did everything wrong) were higher in the LAC sample. Items exhibited skew (≤2.58 for all items) and kurtosis (≤6.10 for all items) (see Table 2). Histograms of all items can be found in online supplemental figures s1-s3. Accuracy plots showed small to moderate CIs, indicating edge weight stability across the samples were moderate for LAC with the other two samples (r=0.48 (MCS), r=0.66 (MHCYP)) and high between the MHCYP and MCS network, r=0.91.

**FINDINGS**

Samples had comparable demographics except as follows. MHCYP participants were younger than MCS participants; compared with both other samples, looked-after children were more likely male, and MCS more likely non-white (Table 2). Most looked-after children lived with foster parents, but the sample included children living in children’s home and secure units. MHCYP had lower SMFQ item response means than the other two samples (Table 3). Item differences were mixed when comparing the LAC sample with MCS: tiredness and concentration problems were higher in MCS whereas anhedonia and negative self-evaluations (bad person, nobody loved me, not as good as others, did everything wrong) were higher in the LAC sample. Items exhibited skew (≤2.58 for all items) and kurtosis (≤6.10 for all items) (see Table 2). Histograms of all items can be found in online supplemental figures s1-s3. Accuracy plots showed small to moderate CIs, indicating edge weight stability across the samples were moderate for LAC with the other two samples (r=0.48 (MCS), r=0.66 (MHCYP)) and high between the MHCYP and MCS network, r=0.91.

The expected influence centrality of each symptom per sample can be found in Figure 1. Importantly, centrality estimates did not correlate with item variance (r>0.18), indicating that centrality is not driven by the variance of the symptoms. In all samples, hated myself and nobody loved me emerged as central symptoms in the networks (Figure 1). The symptom no good anymore was very central in the MHCYP and MCS networks, and to a lesser extent in the LAC network. In all samples, the items lonely, miserable and did everything wrong were also among the more central symptoms. In contrast, the symptom bad person was a central symptom in the LAC network, but was one of the least central symptoms in the other datasets. The symptom did not enjoy anything was among the least central symptom in all networks. These symptoms had significantly higher and lower expected influence centrality, respectively, than many other symptoms within the networks, as indicated by the expected influence centrality difference plots in online supplemental figures s13-s15. Correlations of expected influence centralities across the samples were moderate for LAC with the other two samples (r=0.48 (MCS), r=0.66 (MHCYP)) and high between the MHCYP and MCS network, r=0.91.

**DISCUSSION**

We examined depressive symptom constellations among adolescents in UK general population samples and in adolescents looked-after by local authorities. Symptoms surrounding self-hate and the perception that the adolescent was no good anymore were core symptoms in the two general population samples, and among the most core symptoms in LAC. These symptoms were also central in previous network studies using the SMFQ[18, 17, 18] and networks studies using the CDI.[17, 19-21] These symptoms encompass feelings of worthlessness as covered in depression diagnoses in the DSM-5.[10] The emergence of such symptoms may constitute a vicious circle. When adolescents feel that nobody loves them, they may conclude they are no good anymore or start to hate themselves. Alternatively, when adolescents perceive that love is conditional on being good, feeling no good anymore may lead to perceptions that nobody loves them. These central symptoms highlight the importance of self-esteem...
in depression,\textsuperscript{10} and the necessity to detect and counteract feelings of worthless as early as possible at both home and school.

In former cross-sectional network analyses using SMFQ and CDI, loneliness was consistently one of the most central symptoms from ages 11 to 19 years.\textsuperscript{14,15,17,19,20} In all three datasets we studied, loneliness was also among one of the most central symptoms, with important connections to core symptoms, especially the feeling that \textit{nobody loved} the young person. Adolescence is a period of increased vulnerability to loneliness with detrimental mental health consequences.\textsuperscript{22} Thus, the emergence of feelings of loneliness needs to be carefully monitored and counteracted before other depressive symptoms manifest. Across networks, \textit{not enjoying anything} was consistently one of the least central symptoms, indicating that anhedonia is not strongly influencing, or influenced by, other symptoms. This is consistent with former reports that anhedonia is more important in symptom presentations in adults (aged 18 years and above) compared with adolescents.\textsuperscript{4}

While overall the three network structures were similar, there was one key difference between the looked-after children network compared with the general population networks. In the looked-after children, the symptom \textit{bad person} had the highest centrality, yet this was one of the least central symptoms in the other two networks. This symptom also had higher mean levels in looked-after children. In addition, \textit{hated myself} and \textit{no good anymore} had strong connections in the other two datasets but a comparably weak connection among looked-after children. In looked-after children, the strongest edges were found between \textit{hated myself} and \textit{bad person}. In contrast with \textit{no good anymore} (a key symptom across all three datasets), being a \textit{bad person} constitutes a more holistic assessment of the adolescent’s worth. \textit{I was no good anymore} suggests one believes their abilities or

\textbf{Figure 1} Cross-sectional networks for the three studies along with the centrality plot for these networks. We used an average layout across all three cross-sectional networks. This means that nodes of all three networks were placed at the same position so that the networks can be more easily compared visually. Nodes represent symptoms and arrows represent estimates of partial correlation. The colour of the arrows represents the directionality of the effect (green=positive effect, red=negative effect). LAC, looked after by local authorities; MCS, Millennium Cohort Study; MHCYP, Mental Health of Children and Young People in Great Britain; thicker arrows indicate stronger edges within the network. Tired, felt tired; selfhate, I hated myself; restl, restless; no love, nobody really loved me; nogoodasoth, not as good as other kids; nogood, I was no good anymore; miser, miserable/unhappy; lonl, felt lonely; evthwrong, did everything wrong; enjoy, did not enjoy anything; cried, cried a lot; concert, hard to concentrate; badpers, I was a bad person.
worthiness have declined, implying a perceived loss of competence or value, which may be domain specific. However, being a bad person represents a broader and more pervasive negative self-evaluation encompassing one’s overall character and identity. Understanding this distinction is important in clinical practice as it guides the assessment process, treatment planning and interventions aimed at modifying maladaptive cognitions. Due to life circumstances, looked-after children are more likely to experience exclusion from mainstream schools, bullying or stigmatisation than young people in the general population. Throughout these experiences and the abuse many have suffered, it may have been explicitly or implicitly suggested that they were a bad person. Indeed, children’s experiences of abuse and neglect have resulted in their global and stable attributions of being bad people. This may be exacerbated by comorbidity with conduct disorder which is more common among looked-after children and may have led to even more negative feedback. Additionally, the attachment styles of looked-after children are more likely to have been damaged, resulting in increased negative interactions with subsequent non-abusive caregivers—which may bolster the young person’s perception of being a bad person. Looked-after children show less secure attachment and more insecure and disorganised attachment compared with the general population. Stable, loving, caring environments and psychotherapy are crucial to help counteract such attachment styles and perceptions in looked-after children.

The overall connectivity of the MCS network was somewhat higher compared with the other two networks, which in theory suggests that this network is more easily activated by a single symptom than the other networks. This could reflect secular increases in mental health problems over time or differences based on demographic characteristics, as the MCS had more non-white participants. However, the network structure of the two population-based studies was similar (eg, central symptoms and edge weights), aligning with recent population-based networks studies of the SMFQ.

We also found a lower proportion of significantly different edge weights and expected centrality scores for the LAC sample compared with the other samples, possibly due to a lower sample size. Future larger samples of looked-after children could determine whether this reflects fewer core symptoms and more homogeneity in symptom correlations in looked-after children. Such a finding could mean that symptoms are equally important in looked-after children, making it difficult to discern which ones to target. Or, if fewer are central, then it may be easier to target key symptoms.

Clinical implications
Theoretically, targeting core symptoms in a network should reduce overall network connectivity, but this is yet to be examined. Nonetheless, our findings indicate a different symptom profile in adolescents versus adults, where sadness and loss of interest are core symptoms, which we did not observe. Our central symptoms identified across three samples were more consistent than findings from other adolescent studies (table 1). Our findings provide impetus for targeting symptoms of self-worth in adolescent depression intervention studies, to test whether alleviating these symptoms aids recovery from depression. In looked-after children, additionally targeting feeling like a bad person appears important, although our network findings would benefit from replication prior to testing this in a clinical setting.

Strengths and limitations
This study used the same analysis procedure and measure across three different samples which varied in their population representativeness in terms of their experienced adversities. The large sample sizes allowed for a detailed network analytical approach. However, our analyses were cross-sectional. Longitudinal network studies help elucidate the temporal role of symptom centrality, highlighting symptoms which subsequently influence other symptoms, and thus may be more meaningful for intervention. Furthermore, significant associations between symptoms may not be clinically meaningful. Future research should therefore assess the relevance of our findings in clinical populations. The MCS data are more recent than the other two datasets, and mean symptom levels of the other population-based study (MHCYP) were significantly lower, suggesting a possible secular increase in levels of depressive symptoms over time. The MHCYP and LAC datasets were collected within a year of each other, and thus the higher symptoms observed in LAC appear indicative of greater symptomatology in this vulnerable population. As the key differences in the looked-after children’s networks were comparable for both population-based datasets, this seems to reflect genuine differences instead of being an artefact of different time lags between studies. Furthermore, demographics differed between samples. While network structures can differ based on ethnicity, this is unlikely to have been influential in our study, as the network structures of the MHCYP and MCS were similar despite MCS having more non-white participants. Similarly, age differences between these two samples did not appear to have a role in driving network differences, although the further age differences in LAC may have contributed to the network differences observed in this study. Finally, as LAC participants were more likely to be male, this may have influenced results if boys for instance are more likely to conclude that they are a bad person. Future studies should also examine potential differences in the network structure based on specific care arrangements, for which we lacked power in the present study.

CONCLUSION
This research sheds light on depressive symptom interrelations in adolescents. Across three studies, self-hate and I was no good anymore emerged as key symptoms, aligning with prior work but more clearly underscore the importance of these symptoms. In looked-after children, I was a bad person had the highest centrality, yet this was one of the least central symptoms in the other datasets. Thus, negative self-evaluation may exert a more significant impact on looked-after children’s depressive symptoms than the general population.

Contributors PS serves as guarantor for the overall content and played lead role in conceptualisation, formal analysis, investigation, methodology, software, writing and editing of original draft. TF played supporting role in supervision and editing the original draft. SN played lead role in supervision, conceptualisation, methodology and writing and editing of original draft.

Funding PS was funded by the Causanuswerk. SN was supported by the Wellcome Trust (Institutional Strategic Support Fund 204845/Z/16/Z) and Early Career Award 226392/Z/22/Z). TF received support from the National Institute for Health Research (NIHR) Cambridge Biomedical Research Centre.

Disclaimer The views and opinions expressed are those of the authors and do not necessarily reflect those of the NIHR, NHS or the Department of Health and Social Care.

Competing interests None declared.

Patient consent for publication Not applicable.
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