When the children do not sleep: the association with paternal mental health

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Abstract

Background: The relationship between children's sleep and paternal mental health has been neglected in spite of robust relationships being observed in mothers and increasing involvement of fathers in childcare.

Aims: The aim of this study was to investigate the relationship between school-aged children's sleep and fathers' mental health and childcare involvement.

Methods: Using a cross-sectional design, we recruited 268 dyads of fathers and children (between the ages of five and eleven). Fathers completed measures of their children's sleep, and reported on their own sleep, mental health and involvement in childcare. Initially these items served as correlation variables and in subsequent analyses they were introduced in a network of partial correlations together with further sleep and demographic information, controlled by an Extended Bayesian Information Criterion.

Results: Initially, significant positive correlations were retrieved between children's sleep quality and paternal depression, stress and anxiety, but not fathers' involvement. In the networks, no association was found between children's sleep indicators and indicators related to paternal mental health or involvement. These effects prevailed even after excluding fathers and children with mental and/or physical health diagnoses.

Conclusions: Our findings highlight the importance of including fathers in paediatric sleep research, and the need to incorporate more sophisticated analyses, such as network modelling, to understand the nuanced dynamics of family functioning and its association with children's sleep.

Keywords: Sleep, paediatric sleep, parents, networks

Introduction

The relationship between children's sleep quality and maternal night-time behaviour has been repeatedly documented in healthy children populations (Hall, Moynihan, Bhagat, & Wooldridge, 2017; Meltzer & Mindell, 2007; Mindell, Sadeh, Kwon, & Goh, 2015), and in children populations with physical or mental ill health (Chu & Richdale, 2009; Yuksel et al., 2007). This association extends to daytime impairments (Mindell et al., 2015), with children's sleep difficulties linked to depression, stress and anxiety in mothers (Hall et al., 2015; Lee, 2013; Safa, Khalilzadeh, Talischi, & Alizadeh, 2012). The putative mechanism behind this association remains the focus of scientific debate (El-Sheikh & Kelly, 2017). Initial sources of evidence proposed family functioning as a predictor of children's sleep quality. However, in recent studies the relationship between family functioning and children's sleep appears to be reciprocal (El-Sheikh & Kelly, 2017; Kouros & El-Sheikh, 2017).

Evidently, an omission in this literature is that family functioning is usually indexed as the mother's relationship with the child, and the mother-father relationship as a couple. As such, fathers are often excluded from this line of research. This is despite the evidence that fathers' involvement in childcare has increased over the past decades (Gregory & Milner, 2008), and that paternal involvement and emotional support has a direct positive influence on children's sleep quality (Bernier, Tétreault, Bélanger, & Carrier, 2017). Consequently, the specific association between children's sleep and paternal mental health remains unexplored (Cook et al., 2017).

Among the few studies in this area, Urfer-Maurer and colleagues (2017) showed that fathers' insomnia symptoms were related to their reports of their children's sleep quality and behaviour. Paternal insomnia symptoms were, however, not related to objectively measured sleep problems via polysomnography. Cook and colleagues (2017) showed an association between sleep problems in infants and increased anger and depression symptoms in fathers. In

line with these findings, Hall, Moynihan, Bhagat and Wooldridge (2017) observed an association between fathers' depression, sleep quality and fatigue, and their doubts about managing their children's sleep. On the contrary, other studies have found mothers' but not children's sleep quality to be predictive of fathers' sleep fluctuation (Kouros & El-Sheikh, 2017), and children's sleep quality to be related to father's health in infancy but not in later years (Martin, Hiscock, Hardy, Davey, & Wake, 2007).

A factor that may explain the divergent findings in the literature is the level of fathers' involvement in daytime and night-time childcare activities. Tikotzky, Sadeh and Glickman-Gavrieli (2010) found that fathers are less involved in daytime and night-time activities than mothers. Additionally, paternal involvement predicted sleep quality outcomes in one- and six-month old infants, with higher paternal involvement leading to fewer night-time awakenings for the infants. Bernier and colleagues (2017) also found that fathers who provided more emotional support had children with longer sleep durations. Another potentially important confounding factor is children's age. The disparity in effects between infants and school-aged children could be explained by differences in parental involvement and awareness of sleep problems varying across childhood, with paternal awareness of their children's sleep decreasing as the children move from infancy to childhood (Mindell, Kuhn, & Lewin, 2006).

Finally, as a relatively new area of scientific inquiry, the literature on children's sleep and parental mental health has not incorporated sophisticated analytic procedures that would illuminate the nuance of the relationships under investigation. Research thus far has focused on singular items, i.e. either sleep duration or sleep quality, with analyses restricted to dyadic correlations. These practices may fail to capture the potential complexity of the association between several indicators of a child's sleep and their parent's mental health (El-Sheikh & Kelly, 2017) and involvement. As such, the analytic framework adopted here is that of network modelling. Network models are dynamic systems of several mutually interacting components

and their inter-relationships, commonly visualised as network structures (Isvoranu et al., 2016). This framework allows for more detailed investigations of complex relationships whose nuance cannot be captured by traditional analytic procedures. Although such approaches have led to notable advancements in behavioural biomedicine, this is the first time such approach is implemented in paediatric sleep research.

The present study aims to document and represent, under the framework of network modelling, the relationship between school-aged children's sleep quality, and paternal mental health and involvement in childcare activities. In accordance with prior research in mothers, we expect children's sleep quality to be associated with depression, stress and anxiety in fathers. Additionally, the association of paternal involvement with children's sleep and fathers' mental health outcomes is examined in an exploratory manner.

Methods

In the interest of transparency and to allow for this research area to flourish and build upon our work, the collected data, administered materials and analysis script are all freely available online, at: <https://osf.io/sn2tc/>.

Participants

Participants were 268 dyads of fathers and their children. The children's age ranged from five to eleven years old and the fathers' age from 25 to 54 years old. Further demographic characteristics are provided in Table 1. The only inclusion criteria were for participants to identify as male and have a child within the aforementioned age range. No exclusion criteria were applied. Some participants (n=15) preferred not to specify the gender of their child and in those instances the children's gender was recorded as 'other'.

[INSERT TABLE 1 HERE]

Measures

Demographic Questionnaire: The demographic questionnaire was designed to depict socio-educational information, sleep problems of the fathers, and self-reported physical and mental health problems of both the fathers and the children. A copy of the demographic questionnaire can be found on our Open Science Framework page.

Children's Sleep Habit Questionnaire-abbreviated (CSHQ-a; (Owens, Spirito, & McGuinn, 2000): CSHQ is a parent-reported measure of sleep quality in school-aged children. The abbreviated version includes 22 items rated on a five-point scale from 1="always" to 5="never". Higher scores indicate more disturbed sleep. The respondents are also asked to indicate the child's usual bed and wake-up time on weekdays and weekends, as well as an estimate of their total sleep time.

Patient Health Questionnaire-9 (PHQ-9; (Kroenke, Spitzer, & Williams, 2001): PHQ-9 is commonly used to make a tentative assessment in populations diagnosed with or at risk of depression. The nine-item questionnaire reflects the nine DSM-5 criteria for depression. Each item is scored from 0="not at all" to 3="nearly every day". Total scores range from 0 to 27, with participants scoring 1 to 4 classified as having a depression severity of "none" and those scoring between 20 and 27 as having a depression severity of "severe".

Perceived Stress Scale-10 (PSS-10; (Cohen, Kamarck, & Mermelstein, 1983): PSS is a self-report questionnaire that aims to examine feelings of stress. It includes 10 items. Each item is rated on a five-point scale ranging from 0="never" to 4="very often". Total scores range from 0 to 40, with 0 to 13 being considered low stress and 27 to 40 being considered high stress.

State Trait Anxiety Inventory-Trait (STAI-T; (Spielberger, 1983): The trait subscale of the STAI was administered to explore the fathers' general feelings of anxiety. The STAI-T

consists of 20 items assessed on a four-point scale from 1= “almost never” to 4= “almost always”. Higher scores imply greater anxiety.

Paternal Involvement in Child Care Index (PICCI; (Radin, 1981): PICCI is a 22-item questionnaire measuring the level of engagement that fathers show in both daytime and night-time childcare activities. The questionnaire consists of five independent components with a higher score being interpreted as signifying higher involvement. Following measurement recommendations, we extracted the availability index based on the statement of involvement component of the PICCI.

Procedure

The current study was approved by the ethics committee of the College of Science and Engineering at the University of Glasgow. Recruitment extended over a period of three weeks and took place at the Glasgow Science Centre. Eligible visitors (fathers) were approached by a member of the research team who provided them with informed consent and participant information sheets. If the fathers were interested in participating, they were asked to complete the consent form and questionnaires described above. During recruitment, the children engaged in educational activities regarding sleep and circadian rhythms. Completion of the study lasted approximately 20 minutes.

Network modelling

To comprehensively examine the relationships between children's sleep, paternal mental health and involvement in their children's everyday activities, we applied a network modelling approach. Due to data omissions that could not otherwise be accounted for, 15 dyads were excluded from the network analysis. Therefore, the network structures include data from 253 father-child dyads. The network analysis was performed by fitting a Mixed Graphical

Model (MGM) to the data. An MGM is an undirected network model that enables users to estimate the underlying graphical structure of variables with different domains, such as binary, continuous or categorical (Haslbeck & Waldorp, 2015). This method allowed us to include further confounding variables in the model, such as fathers' sleep behaviour and children's age. Further, it allowed us to convey the nuance of the inter-relationship between the included variables, not restricted by decisions regarding directionality and concerns regarding overfitting. The network inter-relationships are partial correlations, meaning that the relationship between two variables is controlled for the effect of all other items in the network. This approach offers the unique advantage of minimising the effect of spurious relationships and therefore presents a constellation of unique associations. Regarding the computational parameters, we used the *mgm*-R-function with the Extended Bayesian Information Criterion (EBIC) and a default hyperparameter $\gamma .25$ as tuning parameter for controlling the Lq-penalization.

In terms of the network structure itself, each circle represents one variable and is referred to as a node. The colours of the nodes were artificially set by us to group together variables that belong in the same item-category (e.g. paternal depression, stress and anxiety are all grouped together in a cluster called paternal mental health). Each line connecting two nodes is a partial correlation and is called an edge. Green edges illustrate positively valenced associations, whereas red edges illustrate negatively valenced ones. The thickness and boldness of each edge is proportional to the magnitude of the effect it represents, where the larger the effect the thicker and bolder the edge. Finally, following the Fruchterman-Reingold algorithm, we positioned nodes with stronger and/or more associations close to each other and near the centre (Fruchterman & Reingold, 1991).

Results

The responses on the demographic questionnaire as well as on the sleep, depression, stress, anxiety and parental involvement measures are reported in Table 1.

[INSERT TABLE 1 HERE]

Children's sleep was found to have small to moderate, significant positive correlations with fathers' depression ($r = 0.16$, $p = 0.010$), stress ($r = 0.25$, $p < 0.001$) and anxiety ($r = 0.23$, $p < 0.001$), but not with paternal involvement ($r = 0.01$, $p = 0.831$). Depression was also found to be strongly and positively associated with both stress ($r = 0.60$, $p < 0.001$) and anxiety ($r = 0.64$, $p < 0.001$). Finally, stress also had a strong significant positive relationship with anxiety ($r = 0.75$, $p < 0.001$). The above associations were not affected when adjusted for physical and/or mental health diagnosis of the father and/or the children.

[INSERT FIGURE 1 HERE]

As it can be observed from Figure 1, all of the father's sleep variables correlated well with each other. Being not rested (node 8) was strongly connected with sleep difficulties since being parent (node 5), current (node 3) and ever sleep difficulties (node 4). Current sleep difficulties (node 3) and waking up early (node 7) were both related being unable to go back to sleep (node 6) and ever having sleep difficulties (node 4). The father's sleep cluster was only connected with the father's mental health cluster via a partial correlation between the father's sleep difficulties at any time (node 4) and both depression (node 15) and stress (node 16). Regarding the cluster of paternal mental health, depression (node 15), anxiety (node 14) and stress (node 16) were all associated with each other. In contrast, the three child sleep variables

were not related to each other. Specifically, nap (node 12) and *CSHQ-a* total sleep scores (node 13) were represented as single nodes without any edges with other variables. Sleep duration (node 11) was associated with the gender of a child (node 10). This association was found to be non-significant ($t(251)=0.633$, $p=0.527$) when examined using an independent samples t-test. Out of the parental involvement variables, involvement (node 17) and availability (node 21) were associated with being the primary care giver (node 18), which in return was associated with bathing, dressing (node 19) and putting the child to bed (node 20). The variable of putting to bed (node 20) was linked to whether the father was in the same household as the child (node 1). The age of the father (node 2) and of the child (node 9) were not related to any other node.

To investigate whether the network changes when excluding fathers and children with physical and/or mental health diagnoses, we fitted another MGM excluding these participants. Afterwards, we plotted both estimated networks with the *qgraph-R*-function. The network structure did not change at all when excluding fathers and children with physical or mental health diagnoses.

To assess the reliability of our network estimates, we bootstrapped the dataset with the *bootnet-R*-function, using EBIC model selection, glasso estimation, and 1,000 iterations. Confidence intervals (CI) were calculated to investigate the stability of the edges. As represented in Figure 2a, the edge weights are not stable, because the CIs (i.e. the dark grey area) do not lie close to the sample scores (i.e. the red line).

[INSERT FIGURE 2 HERE]

Subsequently, we investigated the centrality of each node as an indicator of their importance in the network. We looked at node strength, betweenness, and closeness (Opsahl, Agneessens, & Skvoretz, 2010). Node strength measures how strongly a node is directly connected with

other nodes, closeness measures the average distance from one node to all other nodes, and betweenness measures how often one node lies on the shortest path between every combination of two nodes in the network. Node strength was the only stable element out of all the centrality estimates. Therefore, correlation-stability estimates were calculated to provide a metric for the level of stability that the estimated strength yields. As it can be seen from Figure 2b, the strongest items in the network were waking up frequently (node 6), followed by current sleep difficulties (node 3), not feeling rested (node 8), ever experiencing sleep difficulties (node 4), and sleep difficulties experienced since becoming a father (node 5). Naturally, the four items with no connections in the network (i.e. father and child's age, napping, and sleep total) were the ones scoring the lowest in node strength.

Finally, a correlation stability analysis with case-drop bootstrapping of 1,000 iterations was conducted to investigate the stability of the centrality indices. The correlation stability coefficient CS ($\text{cor} = 0.7$) was chosen to represent the maximum proportion of cases that can be dropped, such that with 95% probability the correlation between the original centrality indices and centrality of networks based on subsets is 0.7 or higher (Epskamp, Borsboom, & Fried, 2018). To interpret centrality differences, the CS-coefficient should not be below 0.25, and preferably above 0.5. As shown in Figure 3, the CS-coefficients indicate that betweenness ($\text{CS}(\text{cor} = 0.7) = 0.00$), and closeness ($\text{CS}(\text{cor} = 0.7) = 0.00$) were not stable under sub-setting cases, but node strength ($\text{CS}(\text{cor} = 0.7) = 0.51$) was. Therefore, only the orders of node strength, and not closeness or betweenness, were interpretable.

[INSERT FIGURE 3 HERE]

Discussion

The current study highlights the complex interplay of children's sleep, paternal mental health and involvement. It also shows how network modelling can unmask the instrumental influence of several confounding variables on this association. When bivariate correlations were computed, children's sleep was found to be strongly associated with paternal depression, stress and anxiety scores. However, we presented suggestive evidence that this relationship might rely on the strong inter-correlation of the mental health outcomes per se. Specifically, when network modelling was employed, paternal mental health outcomes were found not to have a link to paediatric sleep or paternal involvement. Our findings are in line with some previous research demonstrating that children's sleep is not directly associated with paternal health outcomes (Urfer-Maurer et al., 2017). Paternal depression and stress were only positively associated with the frequency of self-reported sleep problems by the fathers.

Further, no association was found between the children's sleep variables and parental involvement indicators. This is not in line with previous literature (Bernier et al., 2017; Tikotzky, Sadeh, & Glickman-Gavrieli, 2010) that suggested paternal involvement might play a determining role in children's sleep. One possible explanation for this discrepancy is that our study explored school-aged children, whereas Tikotzky et al. (2010) and Bernier et al. (2017) focused on children younger than school-aged, specifically infants and toddlers, respectively. It may be that in infancy and toddlerhood paternal availability is more crucial to reducing maternal stress or coordinating early childcaring strategies, both of which may have a positive impact on children's sleep (Millikovsky-Ayalon, Atzaba-Poria, & Meiri, 2015). A further explanation for the discrepancy in findings may relate to the different methodological and analytical approaches adopted. Notably, both Tikotzky et al. (2010) and Bernier et al. (2017) incorporated actigraphy to assess children's sleep, which may have led to more accurate data related to sleep quality and duration as compared to the current study, which utilised

questionnaires. On the other hand, these previous studies did not control for as many confounding variables, and did not use network modelling as their analytical approach.

The present study has a number of notable strengths. Importantly, it responds to calls for greater investigation of fathers' role in paediatric sleep research (Cook et al., 2017; El-Sheikh & Kelly, 2017), paying particular attention to the role of paternal mental health and involvement in childcare. Furthermore, the study employs a sophisticated method of analysis, namely network modelling, which represents an effective approach to controlling for a large number of confounding variables. Therefore, this study is responsive to arguments made by El-Sheikh and Kelly (2017) regarding the need to employ methodologically sound approaches that would allow for exploration of a greater number of sleep parameters.

Further, by demonstrating the discrepancy between traditional and novel analytical approaches, the present study also carries broader implications for evidence-based clinical practice. Specifically, it highlights the necessity to question the quality of the evidence on which clinical interventions rest. By doing so, clinicians may be able to shift their time and monetary resources from addressing possibly spuriously correlated mental health variables to those where intervention may achieve genuine benefits. Although this study alone might not be able to guide clinical practice, it explores an omission in the current literature, highlights the drawbacks of traditional analyses, and by engaging in open science practices paves the way for future research to build upon our work.

However, the findings of this study should also be interpreted with a few limitations in mind. First, fathers' sleep quality was measured solely via several sleep-related items included within the demographic questionnaire. Furthermore, data on children's sleep were based on fathers' subjective report. Future research should progress towards more robust subjective and objective measures of both children's and fathers' sleep parameters. Second, for network models to produce more comprehensive evidence related to sleep, we suggest that future

studies utilise measures that produce meaningful data on the item-level rather than relying on total scores (Cramer et al., 2012). On the same note, it is imperative that future research not only extends but also validates and replicates our network model. In the correlation stability analysis, node strength was the only reliable centrality index. Thus, although the evidence base for the magnitude of the associations is strong, the findings regarding closeness and betweenness should be interpreted with particular caution. Finally, future studies should consider adopting a more systemic approach to paediatric sleep investigations, including all the members of a family unit as well as the quality of the home environment (El-Sheikh & Kelly, 2017). Such an approach might provide new insights into the role of family dynamics in paediatric sleep and guide clinicians to more effectively aid family members to support each other and improve the sleep of children and adults alike.

In conclusion, the present study adds to the evidence base on the relationship between children's sleep and paternal mental health and involvement. It stands in contrast to the longstanding tendency of excluding fathers in paediatric research, as it explores the multifaceted dynamics of the father-child relationship and encourages further studies in this area.

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Author contributions:

Dr Gardani and Ms Zouharova conceived the original idea, while Mr Bisdounis and Ms Zouharova developed the study. Mr Bisdounis, Ms Hatton and Ms Zouharova conducted the study. Mr Bisdounis performed the statistical analyses. Mr Bisdounis, Ms Hatton and Ms Zouharova co-drafted the manuscript. Dr Gardani supervised the whole process. All authors contributed to and approved the final manuscript.

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Disclosure statement:

The authors disclose no conflict of interests.

Data availability and deposition statement:

All data, analysis scripts and non-copyrighted measures are freely available on our Open Science Framework page at: <https://osf.io/sn2tc/>

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1	The estimated Mixed Graphical Model with 253 father-child dyads and embedded partial correlation values
2	Confidence intervals (a) and strength (b) of the edges.
3	Correlation stability analysis with case-drop bootstrapping of the centrality measures.

Table 1. Self-reported sample characteristics

Outcome measures	Paternal information	Children information
General (fathers and children)		
Gender, no (%)		
Male	-	126 (47.01%)
Female	-	127 (47.39%)
Other	-	15 (5.60%)
Age, mean (SD)	39.60 (6.32)	7.34 (1.83)
Highest qualification, no (%)		
No qualifications	1 (0.37%)	-
Low secondary education	9 (3.36%)	-
Upper secondary education	19 (7.09%)	-
College degree	116 (43.28%)	-
Undergraduate degree	70 (26.12%)	-
Postgraduate degree	51 (19.03%)	-
Other	2 (0.75%)	-
Living situation, no (%)		
Fathers and children living in the same household	251 (93.66%)	-
Fathers and children not living in the same household	17 (6.34%)	-
Health (fathers and children)		
Diagnosis of ill physical health, no (%)	19 (7.09%)	15 (5.60%)
Diagnosis of ill mental health, no (%)	16 (5.97%)	5 (1.49%)
Sleep characteristics (fathers)		
Current sleep difficulties, no (%)	42 (15.67%)	-
Ever sleep difficulties, no (%)	56 (20.90%)	-
Sleep worse since fatherhood, no (%)	64 (23.88%)	-
Specific sleep-related issues, no (%)		
Unable to fall asleep	35 (13.06%)	-
Unable to go back to sleep after waking up	51 (19.03%)	-
Waking up too frequently	41 (15.30%)	-
Waking up too early	49 (18.28%)	-
Not feeling well rested after sleep	59 (22.01%)	-
Excessive sleepiness during the day	24 (8.96%)	-
Unusual sleep times (not by choice)	27 (10.07%)	-
Abnormal breathing during sleep	7 (2.61%)	-
Excessive limb movements during sleep	7 (2.61%)	-
Nightmares or night-terrors	5 (1.87%)	-
Sleepwalking	1 (0.37%)	-
Sleep-talking	5 (1.87%)	-
How often do the sleep problems occur, no (%)		
Not during the past month	125 (46.64%)	-
Less than once a week	84 (31.34%)	-
Once or twice a week	29 (10.82%)	-
Three or more times a week	30 (11.19%)	-
How disruptive are the sleep difficulties, no (%)		
Not disruptive at all	107 (39.93%)	-
Not very disruptive	131 (48.88%)	-
Fairly disruptive	29 (10.82%)	-
Extremely disruptive	1 (0.37%)	-
Sleep quality (CSHQ-a; children)		
Sleep quality total score, mean (SD)	-	40.60 (7.40)
Mental health outcomes (fathers)		

Depression; PHQ-9 total score, mean (SD)	2.79 (3.37)	-
Stress; PSS total score, mean (SD)	12.26 (6.19)	-
Anxiety; STAI-I total score, mean (SD)	33.59 (8.10)	-
Paternal involvement (PICCI-a; fathers)		
Involvement, mean (SD)	10.93 (1.91)	-
Primary caregiver (percentage), mean (SD)	43.18 (16.53)	-
Bathing and dressing (percentage), mean (SD)	41.97 (20.02)	-
Putting to bed (percentage), mean (SD)	45.23 (18.97)	-
Parental availability, mean (SD)	8.71 (1.67)	-

Abbreviations: CSHQ-a, Children's Sleep Health Questionnaire (abbreviated); no, number of respondents; PHQ-9, Patient Health Questionnaire; PICCI-a, Parental Involvement in Child Care Index (availability score); PSS, Perceived Stress Scale; SD, standard deviations; STAI-I, State-Trait Anxiety Index

Figure 1. The estimated Mixed Graphical Model with 253 father-child dyads and embedded partial correlation values.

Figure 2. Confidence intervals (a), and strength (b) of the edges.

Figure 3 Correlation stability analysis with case-drop bootstrapping of the centrality measures.

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