Research in Developmental Disabilities 128 (2022) 104290

Contents lists available at ScienceDirect

Research in Developmental Disabilities

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

A cross-cultural comparison of sleep patterns between typically developing children and children with ASD living in Saudi Arabia and the United Kingdom

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ARTICLE INFO

Keywords:
Sleep
ASD
Autism
Saudi Arabia
United Kingdom
CSHQ
Cross-culture

ABSTRACT

Background: Sleep is crucial for child development, especially for children with ASD. While it is known that children with ASD experience more severe sleep problems and that these problems tend to persist compared to their typically developing counterparts, these findings tend to come from only Western countries. A cross-cultural study is important to understand if the prevailing understanding of sleep in children with ASD can be extended to different cultural backgrounds.
Aim: A cross-cultural study is conducted, involving typically developing children and children with ASD aged 5–12 across two countries: Saudi Arabia and the United Kingdom.
Methods and procedures: Using a combination of questionnaires measuring ASD severity (CARS-2), sleep quality (CSHQ), sociodemographic and lifestyle variables and sleep diaries, 244 children were sampled using a mixture of snowball and convenience sampling methods.
Outcomes and results: Children with ASD experience more sleep problems compared to typically developing children in Saudi Arabia, and these problems similarly persist across time. Specifically, it was found that children with ASD in Saudi Arabia experience greater sleep onset latency and a greater number of night awakenings. Additionally, across the ASD groups, it was found that children from Saudi Arabia generally experienced poorer sleep than children in the United Kingdom in terms of shorter sleep duration, although children in the United Kingdom tended to report more instances of sleep anxiety and parasomnias.
Conclusions and implications: Several reasons such as parental education about sleep hygiene, cultural influences and social hours were put forward as potential explanations for cross-cultural differences. Findings served to emphasise the importance of culturally-appropriate interventions and public education regarding child sleep.

1. Introduction

The prevailing theoretical proposition that sleep serves an important role in child development has been around for many decades (e.g., Karmiloff-Smith, 2017). In fact, the National Sleep Foundation states that young children should spend more than half a day

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https://doi.org/10.1016/j.ridd.2022.104290
Received 27 April 2022; Received in revised form 10 June 2022; Accepted 19 June 2022
Available online 7 July 2022

sleeping (Hirshkowitz et al., 2015). If sleep problems begin and persist from a young age, then these negative effects may compound over time to worsen neuropsychological and behavioural functioning. Insufficient sleep leads to multiple problems with cognition, behaviour, physical and mental health (Ashworth et al., 2014; Paiva et al., 2015; Pawl et al., 2013; Pulopulos et al., 2020; Shattuck et al., 2018), especially for children with neurodevelopmental conditions (Cotton & Richdale, 2010; Esbensen & Schwichtenberg, 2016). Children with neurodevelopmental conditions such as Autism Spectrum Disorder (ASD) also tend to face more complex and long lasting sleep problems. In a review by Cohen et al. (2014), it was found that sleep problems were present in 80% of children with ASD, regardless of ASD severity. Children with ASD who experience sleep problems have more affective problems and poorer social interactions (Malow et al., 2006; Veatch et al., 2017), indicating poorer outcomes when compared to other children with ASD who do not experience sleep problems. Furthermore, unlike typically developing children whose sleep problems decrease as they grow older (McVeigh et al., 2021; Sivertsen et al., 2017; Wang et al., 2016; Gregory & O'Connor, 2002), the same cannot be concluded about children with ASD. Indeed, a meta-analysis conducted by Elrod and Hood (2015) found consistent differences in sleep trajectories between typically developing children and children with ASD.

Despite the association established between ASD and sleep problems, current literature has room for development. This is because a majority of sleep-related studies were carried out in Western countries (Henrich et al., 2010) and only a few in Asian countries (e.g., Hong Kong, Japan, Singapore). It is pivotal to understand sleep across different cultures and populations, because cultural and societal norms have a strong influence in dictating appropriate sleep behaviour. For example, previous findings showed that typically developing Singaporean children slept an average of 6.5 h per night, whereas typically developing children in Hong Kong and Turkey had much longer sleep duration averaging approximately 9 h (Li et al., 2010; Sahin et al., 2009). In recent years, cross-cultural studies have indicated that cultural factors play a role in sleep; however, this relationship is still poorly understood since methodologies used across studies are inconsistent (Jeon et al., 2021). In Jeon et al., (2021) systematic review, studies focusing on child, parent and environmental factors associated with sleep were examined. They concluded that several factors are country-specific and should be considered as cultural factors associated with sleep. These factors included paternal education level, family composition, maternal employment status and sleeping arrangement. Thus, more culturally-specific studies are required to investigate sleep and particularly sleep in the context of ASD.

Middle Eastern countries such as Saudi Arabia (SA), when compared to Western countries, have several factors that make it difficult to achieve sufficient sleep. Factors that are associated with later sleep times in the Middle East include religious ceremonies (Bahammam, 2006), hot climates, and late opening times of social venues. However, to date, only one study in Riyadh, SA has examined sleep duration in a large cohort (N = 1012) of typically developing school-aged children (BaHammam & AlFaris, 2006; BaHammam, Al-Faris et al., 2006; BaHammam et al., 2006). Authors of this study designed a questionnaire on bedtimes, wake times, night-time sleep duration, and daytime nap duration on weekdays and weekends. They reported a mean sleep time of 8 h and 40 min during weekdays, which extended to a mean of 9 h and 50 min during weekends. However, when age was included as a covariate, sleep duration decreased in older age groups. From this study, bedtime resistance, sleep onset delay, and screen time had been raised as potential factors affecting sleep. While this seminal study allowed an insight into sleep behaviours of children in the Middle East, the main limitation of this study was the use of an author-developed sleep questionnaire that omitted a validation process, in addition to a lack of procedural details in the article. Moreover, only typically developing children were investigated in this study, and a lack of data from other countries prevented a quantitative cross-cultural comparison between populations.

Therefore, the present study aims to profile sleep in both typically developing children and children with ASD in SA and to provide a cross-cultural perspective between the Middle East and the West. To achieve this, the present study extends upon the methodology of BaHammam and colleagues (2006a, b, c) by including two elements: (1) recruiting both typically developing children and children with ASD, and (2) recruiting participants (both typically developing and with ASD) from both SA and the United Kingdom (UK) for a final cross-cultural comparative analysis. It is hypothesised that due to the cultural differences between SA and UK, there will be significant differences in sleep duration and other sleep parameters, where children from SA will experience poorer sleep as compared to children from UK. Additionally, it is hypothesised that children with ASD will experience poorer sleep than typically developing children, in alignment with existing literature.

2. Methodology

This study was approved by the University College London Institute of Education Research Ethics Committee (16682/001). All participants gave written informed consent. Prior to their participation, the research team met with the participants to inform them of their rights in relation to confidentiality, anonymity and withdrawal. Participants were also encouraged to ask questions prior to providing consent. These steps were taken to ensure that caregivers and their children were aware of all procedural elements of the study.

2.1. Participants

Participants from two countries, SA and UK, were recruited. A total of 244 parents of children aged between 5 and 12 years were included (M = 8.74 years, range = 5.8–11.9 years), of which 157 children were male (i.e., 64.34% of the sample) and 116 children had a diagnosis of ASD (i.e., 47.54% of the sample). The participant characteristics of each country are reported in the subsequent sections below. Inclusion criteria were children and parents who were habitually living in SA or the UK for at least 5 years. Children should also be aged between 5 and 12 years. This age range was selected as regular sleep habits should have been established by the age of 5 due to the introduction of regular schooling. Exclusion criteria: children who had comorbid medical or psychiatric disorders (e.g., epilepsy,

poorly controlled asthma or eczema, cyanotic heart disease, severe respiratory disease), or if they were taking hypnotics or medication which were likely to interfere with their natural sleep architecture.

2.1.1. Participants from Saudi Arabia

As there were constraints regarding logistics, prevailing research practices and policy guidelines of SA, a majority of participants recruited from SA were from the city of Riyadh, the capital of the country. This is because participants generally preferred not to provide their responses online or via post due to privacy and data breach concerns. Therefore, the location of data collection was restricted based on where the female researcher (W.B.E.) was able to travel without an escort.

ASD diagnosis of the child was verified in SA by a healthcare professional and is required for enrollment into ASD centres or schools, typically using the Childhood Autism Rating Scale (CARS-2; Schopler et al., 2010). Parents of children with ASD were identified from the contact lists provided by one large school and two ASD centres. At the time of the study, Saudi Arabia was undergoing a number of major changes to develop centralised professional organisations linked to governmental bodies and create national health guidelines similar to the NICE guidelines in the UK. Before these changes were realised, however, each ASD educational setting could only be identified by the authors either through in-house websites or through word-of-mouth. Therefore, recruitment relied on search engines and personal enquiries to find these educational settings. W.B.E. then contacted each institution individually over phone to obtain permission to recruit participants for study from these institutions, but only the three organisations as mentioned above agreed to participate in the study. Meetings and calls were conducted with the organisations to clarify any questions related to the studies before recruitment was launched. Of the 92 parents who were identified and invited, 81 completed and returned all questionnaires, yielding an overall response rate of 88.04%. Reasons for non-participation included participants who could not be contacted despite multiple attempts to reach them (n = 8) and participants who declined participation (n = 3).

Parents of typically developing (TD) children were identified from the contact lists of mainstream schools and the Ministry of Education. These schools were geographically located within a close proximity to the ASD schools and centres. Of the 89 parents who expressed their initial interest in the study, 78 completed and returned all questionnaires, yielding an overall response rate of 86.67%. Reasons for non-participation included participants who did not complete all questionnaire measures and were therefore excluded from the final sample (n = 7) and participants who declined participation (n = 2). The remaining participants (n = 2) did not provide any reason for study withdrawal.

The final sample from the SA population consisted of 81 children with ASD (mean age = 8.18, SD = 1.56 years; 67 males and 14 females) and 78 TD children (mean age = 9.09, SD = 1.78 years; 36 males and 41 females). Among the children with ASD, 50 (i.e., 61.73%) had severe symptoms while 31 (i.e., 38.27%) had mild to moderate symptoms according to their CARS-2 scores. The full demographic details are reported in Supplementary Information (Table S1). Parents of one child from the TD group failed to return a completed medical history section of the questionnaire, and thus the data were available for 77 children out of 78 involved in this part of the study (98.72%).

2.1.2. Participants from the United Kingdom

The recruitment of participants in the UK was carried out via online advertisements and snowball sampling methods (Jupp, 2006), as well as through ASD-related social events organised by the Sleep Education and Research Laboratory (SERL). The data collection took place only during the school term period from October 2018 to December 2019.

The final sample from the UK population consisted of 35 children with ASD (mean age = 9.21, SD = 1.97 years; 26 males and 9 females) and 50 TD children (mean age = 8.75, SD = 1.80 years; 28 males and 22 females). Among the children with ASD, 18 had severe symptoms (i.e., 51%) while 17 (i.e., 49%) had mild to moderate symptoms according to their CARS-2 scores.

2.2. Materials

2.2.1. Demographic questionnaire

A demographic questionnaire was developed in-house by the SERL team to record information about the child, parental and environmental factors based on frameworks described in Ashworth and colleagues (2015) and Mughal and colleagues (2020). The questions included information about the child's age, sex, child-related lifestyle variables such as number of snacks in a day, the number of meals in a day, frequency and duration of screen time, and if any of the screen time activities occurred within 30 min before the child's bedtime. Also, information on parental education status and family composition (e.g., number of older or younger siblings) were collected.

2.2.2. The childhood autism rating scale - second edition (CARS-2)

CARS-2 (Schopler et al., 2010) is a 15-item screening questionnaire that determines the severity of ASD symptoms using a seven-point Likert scale, ranging from typical to atypical behaviour. Items include the following domains: relating to people, imitation, emotional and intellectual responsiveness, body or object use, adaptation to change, sensory responses, verbal and non-verbal communication, activity levels, and general observations. Scores range from 15 to 60 with 30 being the cut-off rate for a diagnosis of mild autism. CARS-2 demonstrated moderate to good sensitivity and specificity (.81 and.79 respectively) and good internal consistency (Cronbach's alpha =.79). CARS-2 score higher or equals to 33 indicates possible ASD.

2.2.3. Children's sleep habits questionnaire (CSHQ)

CSHQ (Owens et al., 2000) is a 33-item retrospective parent report which screens for common sleep problems in school-aged

children. Parents indicate the frequency of various sleep related characteristics, using a Likert Scale with three options: 'rarely/never' for an event that occurs 0–1 times per week; 'sometimes' for an event that occurs 2–4 times per week; 'usually' for an event that occurs between 5 and 7 times per week. Questions include occurrences of problems around bedtime routines, indications that the child is not sleeping a normal amount, or indications that the child is waking during the night. Scores are added to yield scores on eight subscales: bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep disordered breathing and daytime sleepiness, as well as a total sleep disturbance score. The CSHQ is a widely used assessment tool in paediatric sleep, with high internal validity and Cronbach's alpha of.83. Owens and colleagues (2000) found that a cut-off score of 41 yielded the best diagnostic confidence by correctly identifying 80% of the clinical sample. Within populations with ASD specifically, CSHQ has been used previously on children in the same age range (Johnson et al., 2012; Giannotti et al., 2011; Cortesi et al., 2010; Reed et al., 2009; Souders et al., 2009; Malow et al., 2006; Couturier et al., 2005) with acceptable internal reliability within these samples (e.g., Cronbach's alpha =.68 in Johnson and colleagues' (2012) study).

2.2.4. Sleep diary

As a means of supplemental data, caregivers completed a sleep diary for their child's sleep for a period of one week (five consecutive days of a school week). Further details, analysis and results from the sleep diary are presented in Supplementary Information (Table S2).

2.2.5. Material translation from english to arabic

To our knowledge, at the time of the study, there were no studies that validated Arabic translations of the questionnaires. The research team thus conducted the translation process of the above questionnaires and materials in line with the guidelines for cross-cultural adaptation of self-report measures (Beaton et al., 2000). Firstly, all materials, including ethical documents, were translated into Arabic by a certified translator with a degree in Arabic-English translation. Due to complexities related to Arabic grammar and the style of Arabic writing, two other Arabic native speakers with PhD-level education were consulted to provide their expertise in reviewing the translated versions of the documents. The Arabic translation of the materials was then back translated to English by a different certified translator with a degree in Arabic-English translation. Once the back translation was completed, W. B. E. reviewed all translated materials to determine if there were any discrepancies between the back translation and the original document. In the instances where changes were required, further edits were carried out following the same procedure until the English and Arabic versions were deemed equivalent. Finally, all original and translated questionnaires were piloted with four PhD students, two of whom are Arabic native speakers and two English native speakers. Cronbach's alphas for reliability were calculated and deemed satisfactory (.73).

2.3. Procedure

Following participant recruitment as described above, caregivers were provided with a study information sheet and their fulfilment of inclusion and exclusion criteria was verified. Then, participants gave written informed consent for their child to take part in the study. Then, parents were provided with the questionnaires and sleep diary along with instructions for their completion. The total time to complete all the questionnaires ranged from 20 to 25 min. The sleep diary was then brought home for completion. After a week, the research team contacted the participants again to arrange for the sleep diary to be submitted.

2.4. Analytic plan

In cases where items were left blank or had arbitrary numbers (e.g., all "1"s), it may not be possible to calculate subscale scores and total scores for all variables for every participant. If one or more item response on a subscale was missing, then the subscale was not calculated, and the participant was excluded from subsequent analysis.

Data were analysed using IBM SPSS version 26. Skewness and Kurtosis, Shapiro-Wilk tests of normality and a visual inspection of histograms suggested that the data followed a non-normal distribution for the majority of variables in ASD samples. Cook's distances were used to identify outliers. Outliers are commonly observed in cases when data are gathered from or about children with developmental disorders. These outliers were then treated in one of two ways: (1) outliers were first removed to see if this changes the *p*-value and effect sizes. If there was no change in results, then (2) outliers were included to provide a full picture of group variability. This approach takes into account that data gathered from clinical groups is seldom normally distributed and transforming and/or removing data points would not provide a true picture of the clinical group.

To investigate age-related effects on the questionnaire scores, Pearson's product moment correlations were first used to establish whether a relationship with age was present for the variable in question. If a relationship existed, age-related changes in performance were investigated using the developmental trajectory approach described by Thomas and colleagues (2009). Specifically, ANCOVA or MANCOVA models, where appropriate, with age as a covariate were created and group by age interactions were analysed. Variables were treated as continuous where possible. Trajectories of the ASD group were then plotted and compared to the typically developing trajectory to see whether or not the performance of these groups are similar (Annaz et al., 2008; Karmiloff-Smith et al., 2004; Thomas et al., 2009). Effect sizes are displayed as partial eta squared (ηp^2) and interpreted as small ($.10 \leq \eta p^2 \leq .30$), medium ($.30 \leq \eta p^2 \leq .50$), or large ($>.50$), according to Cohen (2013).

3. Results

3.1. Descriptive demographic statistics of saudi arabian participants

Table 1 provides detailed characteristics of data drawn from questions on the child's lifestyle. There was no difference in the distribution of meals consumed between the two groups ($\chi^2(2) = 1.19$, $p = .82$). However, it is important to note that 13.58% of children with ASD and 16.67% of TD children were reported not to have regular meals. Also, a large majority of children in both groups snack during the day, although they have similar distributions in the total number of snacks consumed in a day ($\chi^2(2) = 1.19$, $p = .75$).

Questions related to screentime (i.e., amount of time spent watching TV/playing on the computer each school day and during the weekends) revealed some interesting outcomes. Surprisingly, 8.64% of children with ASD had no screen time at all, in comparison to 5.13% of typically developing children. In the ASD group, 48.15% of children spent up to 2 h exposed to the screen, which was significantly higher than the typically developing group (30.77%). In contrast, 29.49% of TD children had a screen time between 2 and 4 h, which was significantly higher than children with ASD (17.28%).

The next factor was related to exposure to screen time before bed (i.e., watching TV and/or videos 30 min before falling asleep). Parents answered on a four-point scale as depicted in Table 2. It was noted that 30.86% of children with ASD did not watch TV in 30 min before bedtime, while 19.75% watched TV on a daily basis before bedtime. For typically developing children, these numbers are significantly higher, with 25.64% of the children watching TV every night and only 19.75% who did were not exposed to screen time before sleep at all.

A number of one-way ANOVA were also run on parental and familial factors (Table 2). Some interesting differences were observed in the paternal education status where fathers of children with ASD had a significantly higher educational status at the top end. There were also significant differences in maternal education across all educational levels, with mothers of children with ASD having lower educational attainment than mothers of typically developing children.

3.2. Descriptive CSHQ statistics of Saudi Arabian participants

According to the clinical cut-off criterion (Owens et al., 2000), all TD children (mean = 68.90) and children with ASD (mean = 69.86) in the SA sample scored higher than the clinical cut-off and thus may be classified as having sleep problems.

Overall, tests of between-subject effects on CSHQ total scores showed that there were no significant differences between TD and ASD groups ($F(2157) = .317$, $p = .571$), and a similar outcome was observed when considering the interaction of group and chronological age ($F(2157) = 2.217$, $p = .211$). There were no significant differences on the other variables, nor were there sex differences in CSHQ total scores and subscale scores across groups. However, when considering groups separately, there was a significant effect of age, showing that CSHQ total score changed with age for the TD group, with older children scoring significantly lower in sleep problems than younger children ($R^2 = .19$, $p = .03$; Fig. 1a). This developmental change on sleep improvement with age was not found in children with ASD ($R^2 = .004$, $p > .05$; Fig. 1b).

Analyses of CSHQ subscales showed that children with ASD scored significantly higher than the typically developing group on four subscales, namely sleep onset latency (i.e., time taken to fall asleep), sleep anxiety, parasomnias and number of nocturnal wakings.

Table 1
Comparison of lifestyle factors between children with ASD and typically developing children in SA.

Lifestyle factors	ASD/No. (%)	TD/No. (%)	p-value
No. snacks/day			*All ps > .05*
0	6 (7.41%)	2 (2.56%)	
1–2	60 (74.07%)	66 (84.62%)	
3–4	12 (14.81%)	8 (10.26%)	
≥ 5	3 (3.70%)	2 (2.56%)	
No. meals/day			*All ps > .05*
≤ 2	12 (14.81)	16 (20.51%)	
3	42 (51.85%)	37 (47.44%)	
4	11 (13.58%)	10 (12.82%)	
≥ 5	5 (6.17%)	3 (3.85%)	
Irregular	11 (13.58%)	12 (15.38%)	
Screen time hours/day			
0	7 (8.64%)	4 (5.13%)	< 0.001
Between 0 and 2	39 (48.15%)	24 (30.77%)	< 0.001
Between 2 and 4	14 (17.28%)	23 (29.49%)	< 0.001
Between 4 and 6	12 (14.81)	23 (29.49%)	< 0.001
Between 6 and 8	9 (11.11%)	4 (5.13%)	< 0.001
Frequency of screen time before bed/week			
Every night	16 (19.75%)	20 (25.64%)	< 0.005
5–6 nights	9 (11.11%)	26 (33.33%)	< 0.001
3–4 nights	14 (17.28%)	10 (12.82%)	< 0.001
1–2 nights	17 (20.99%)	6 (7.69%)	< 0.001
Not at all	25 (30.86%)	16 (19.75%)	< 0.001

Note: As a number of comparisons were done and as equal variances were assumed, the Bonferroni correction was used.

Table 2
Comparison of parental factors between children with ASD and TD children.

Parental Factors	ASD	TD	p-value
Mean maternal age (SD)	37 (6.4)	36 (6.8)	
Mean paternal age (SD)	42 (7.2)	41 (6.1)	
Mother's education level/%			< 0.001
No qualification	6 (7.41%)	5 (6.41%)	
GCSE O-Levels, vocational level 2 or equivalent	13 (16.05%)	9 (11.54%)	< 0.001
GCSE A-Levels, vocational level 3 or equivalent	19 (23.46%)	13 (16.67%)	< 0.001
Undergraduate Degree	43 (53.01%)	46 (58.97%)	
Postgraduate Degree	0 (0.00%)	5 (6.41%)	< 0.001
Father's education level/%			
No qualification	6 (7.41%)	5 (6.41%)	
GCSE O-Levels, vocational level 2 or equivalent	10 (12.35%)	8 (10.26%)	
GCSE A-Levels, vocational level 3 or equivalent	15 (18.52%)	16 (20.51%)	
Undergraduate Degree	32 (39.51%)	37 (47.44%)	< 0.001
Postgraduate Degree	18 (22.22%)	12 (15.38%)	< 0.001

Note: As a number of comparisons were conducted and as equal variances were assumed, the Bonferroni correction was used.

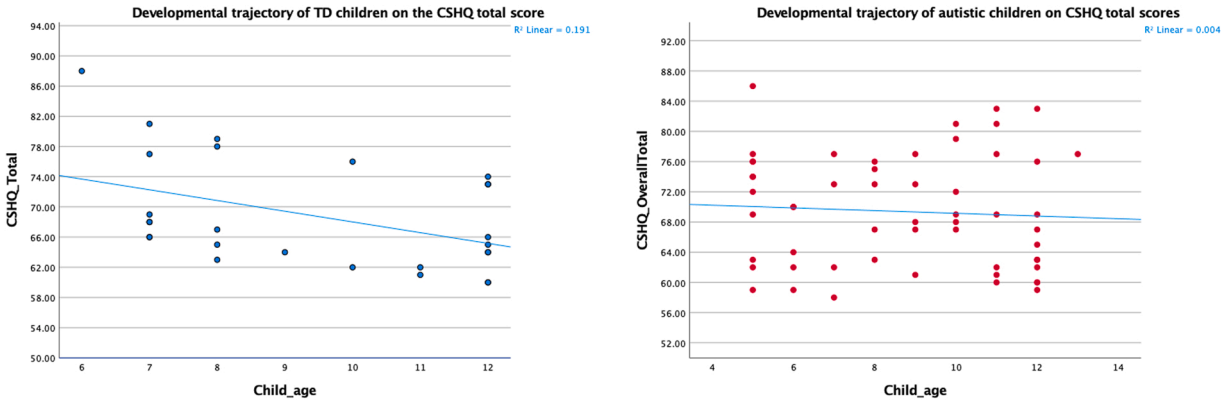

Fig. 1. Developmental trajectory scatter plot showing CSHQ total score against chronological age in the (A) typically developing group and (B) group with ASD. The typically developing group shows a significant change in scores with chronological age, but the same trend was not found in the group with ASD. Note that many of the individual points overlay each other; however, all data points were used for the analysis and the graph.

Unexpectedly, children in the typically developing group scored significantly higher on the sleep disordered breathing subscale than children with ASD. Results are summarised in Fig. 2 and Table 3.

As there were significantly different developmental trends between groups in sleep problems, separate analyses were carried out for each group using MANCOVA with CSHQ subscales and chronological age as a covariate. In the ASD group, there were no interactions

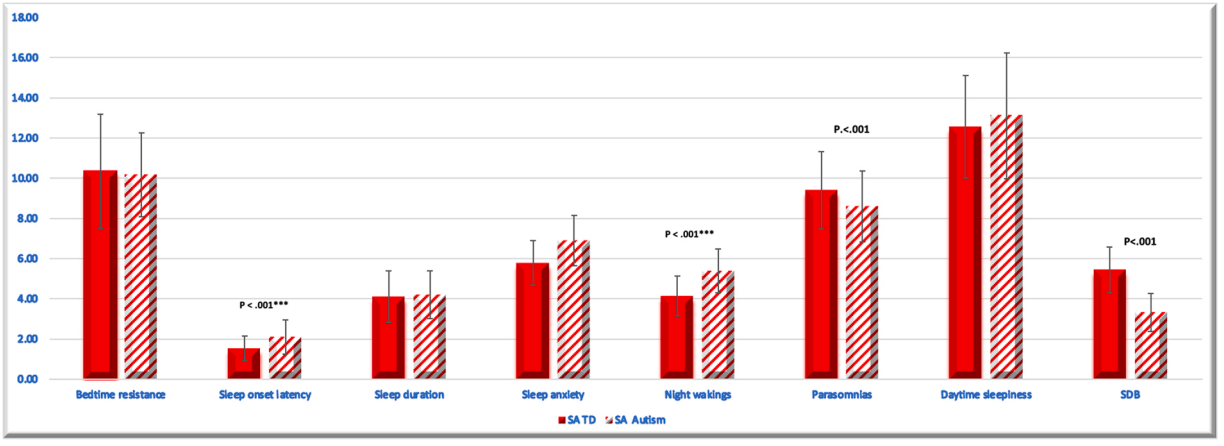

Fig. 2. Comparison of scores by group for CSHQ subscales. Error bars show standard deviation. Higher scores correspond to more severe sleep problems.

between chronological age and scores on the CSHQ subscales, thus revealing that chronological age of these children had no bearing on their sleep patterns as recorded by CSHQ. For the typically developing group, chronological age appeared to play a role, where older children appeared to have lower scores on sleep disordered breathing than their younger counterparts ($F(1,76) = 4.70$, $p = .042$, $R^2 = .12$). In-depth analyses based on medical data showed no correlation with the outcomes on these scores.

To provide a finer granularity of sleep patterns between groups, and to establish whether group differences were apparent for specific sleep characteristics, individual items in CSHQ were also analysed (Supplementary Information, Table S3).

3.3. Comparison between Saudi Arabian and United Kingdom participants

Participants' age and gender were compared across four groups (SA typically developing and ASD; UK typically developing and ASD) using one-way ANOVA for ages and χ^2 test for gender. A one-way ANOVA indicated no significant age difference between the four groups ($F(3160) = 1.787$, $p = .152$). However, as predicted, Chi-square test indicated significant gender differences between the four groups ($\chi^2(3) = 9.58$, $p = .019$) driven by ASD groups having a larger proportion of male children.

Comparisons between SA and UK children on lifestyle data can be seen in Table 4, where a number of significant differences were found. Some of the most striking differences in a number of snacks reported by parents of UK children with ASD, where these children tended to snack more frequently than their counterparts in SA. Parental reports on dietary habits also showed that all children in the UK eat fewer but more regular meals throughout the day, whereas this was not the case for the SA sample. The data suggest that a significant proportion of children in SA did not have regular mealtimes.

Analysis by amount of screen time revealed some interesting outcomes. Children with ASD in SA are exposed to more screen time than any other group. The next question related to screen time just before bed (i.e., 30 min before falling asleep) revealed that up to 62% of typically developing children in the UK were not exposed to screen time before bed. This was in direct contrast to SA children where only 20.51% of typically developing children did not have any screen time before bed. For ASD groups, differences were similarly significant in the same direction, albeit not as striking as in the typically developing groups.

Sleep-related analyses were conducted separately based on developmental status (i.e., children with ASD in SA and UK; typically developing children in SA and UK). Comparisons of CSHQ scores between children with ASD in SA and UK can be seen in Table 5. Data analysis revealed that there were group differences reported by UK parents on sleep duration, sleep anxiety, parasomnias, sleep disordered breathing, whereas overall sleep disturbances score was higher in the SA population (all $p < .001$).

Comparing CSHQ scores between typically developing children in SA and the UK found significantly higher scores in UK children on bedtime resistance and sleep disordered breathing problems, but higher total CSHQ scores in SA children (all $p < .001$; Table 6). A combination of comparisons in CSHQ subscales across all four groups is represented in Fig. 3.

4. Discussion

The primary aims of this study were to characterise sleep patterns of children with ASD and typically developing children in SA and to compare their sleep patterns with the same groups of children in the same age range in the UK. In terms of comparative analysis, two hypotheses were formulated: (1) It is hypothesised that due to the cultural differences between SA and UK, there will be significant differences in sleep duration and other sleep parameters, where children from SA will experience poorer sleep as compared to children from the UK. Additionally, (2) it is hypothesised that children with ASD will experience poorer sleep than typically developing children, in alignment with existing literature.

4.1. Profiling sleep in ASD and typically developing populations in Saudi Arabia

In terms of the sleep profiles of children with ASD in SA, all children with ASD were within the clinically classified range of sleep problems, which is higher than past estimated prevalence of approximately 40–80% (Liu et al., 2006; Maskey et al., 2013). Additionally, when age was added as a covariate, these sleep problems did not attenuate as the children aged, which may mean that sleep problems faced by children with ASD tend to be more chronic and persistent than those faced by typically developing children. However, this particular finding derived from the present cross-sectional study should be verified with a longitudinal study design.

Table 3
Mean, standard deviation and tests of group differences using MANOVA for CSHQ subscales.

CSHQ Subscales (theoretical range)	ASD Mean (SD)	TD Mean (SD)	F	p	η_p^2
Bedtime resistance (6–18)	10.35 (1.95)	10.17 (2.48)	1.79	.39	.07
Sleep onset delay (1–3)	2.10 (.70)	1.70 (.76)	4.55	.02 *	.19
Sleep duration (3–9)	4.11 (1.55)	4.10 (1.81)	1.57	.22	.04
Sleep anxiety (4–12)	6.90 (1.26)	5.78 (1.10)	18.06	< .001 * **	.28
Night wakings (3–9)	5.40 (.95)	4.13 (1.09)	31.56	< .001 * **	.46
Parasomnias (7–21)	9.40 (1.93)	8.60 (1.62)	3.60	.041 *	.11
Sleep disordered breathing (3–9)	3.37 (.94)	5.45 (1.64)	20.94	< .001 * **	.36
Daytime sleepiness (8–24)	13.11 (2.86)	12.55 (2.48)	.31	.73	.01

Note: Significant differences are denoted by "* ".

Table 4
Comparison of lifestyle factors between TD children and children with ASD in SA and UK.

Lifestyle factors	ASD-SA/No. (%)	ASD-UK/No. (%) 35	TD-SA/No. (%) 78	TD-UK/No. (%) 50	p-value
No. snacks/day					
None	6 (7.41)	1 (2.86)	2 (2.56)	0 (0.00)	
1–2	60 (74.07)	22 (62.86)	66 (84.62)	31 (62.00)	$< 0.001^{b}$
3–4	12 (14.81)	7 (20.00)	8 (10.26)	16 (32.00)	$< 0.001^{a}$
≥ 5	3 (3.70)	5 (14.29)	2 (2.56)	3 (6.00)	$< 0.001^{a}$
No. meals/day					
≤ 2	12 (14.81)	7 (20.00)	16 (20.51)	3 (6.00)	$< 0.001^{a}$
3	42 (51.85)	22 (62.86)	37 (47.44)	42 (84.00)	$< .0.001^{a,b}$
4	11 (13.58)	5 (14.28)	10 (12.82)	5 (10.00)	
≥ 5	5 (6.17)	1 (2.86)	3 (3.85)	0 (0.00)	
Irregular	11 (13.58)	0 (0.00)	12 (15.38)	0 (0.00)	$< .0.001^{a,b}$
Screen time hours/day					
0	7 (8.64)	3 (8.57)	4 (5.13)	2 (4.00)	
Between 0 and 2	39 (48.15)	23 (65.71)	24 (30.77)	42 (84.00)	$< .0.001^{a,b}$
Between 2 and 4	14 (17.28)	5 (14.29)	23 (29.49)	1 (2.00)	$< .0.001^{b}$
Between 4 and 6	12 (14.81)	4 (11.43)	23 (29.49)	5 (10.00)	$< .0.001^{b}$
Between 6 and 8	9 (11.11)	0 (0.00)	4 (5.13)	0 (0.00)	$< .0.001^{a,b}$
Frequency of screen time before bed/week					
Not at all	25 (30.86)	17 (48.57)	16 (20.51)	31 (62.00)	$< .0.001^{a,b}$
1–2 nights	17 (20.99)	7 (20.00)	6 (7.69)	4 (8.00)	$< .0.001^{a}$
3–4 nights	14 (17.28)	7 (20.00)	10 (12.82)	7 (14.00)	$< .0.001^{b}$
5–6 nights	9 (11.11)	4 (11.43)	26 (33.33)	5 (10.00)	$< .0.001^{a,b}$
Every night	16 (19.75)	0 (0.00)	20 (25.64)	3 (6.00)	

Note: "* " indicate significant differences using one-way ANOVA. As there were a number of comparisons and as equal variances were assumed, the Bonferroni Correction was used. Post-hoc t-tests were conducted for significant values and indicated as such: "a" = Significant difference between ASD groups in SA and UK; "b" = Significant difference between typically developing groups in SA and UK.

Table 5
Comparison of ASD groups in the UK and SA for CSHQ variables.

CSHQ Subscale (range)	Mean UK (SD) (n = 62)	Mean SA (SD) (n = 81)	F	p-value	η_p^2
Bedtime resistance (60–18)	10.20 (2.50)	10.35 (1.95)	.006	.938	.001
Sleep onset latency (1–3)	2.20 (.72)	2.10 (.70)	.007	.923	.002
Sleep duration (3–6)	5.66 (1.12)	4.11 (1.55)	18.67	< .001 * **	.187
Sleep anxiety (4–12)	7.61 (1.90)	6.90 (1.26)	27.57	< .001 * **	.212
Night waking (3–9)	5.28 (1.80)	5.40 (.95)	.004	.971	.001
Parasomnias (7–21)	10.37 (2.75)	9.40 (1.93)	18.98	< .001 * **	.251
Sleep Disordered Breathing (3–9)	4.32 (1.08)	3.37 (.94)	16.86	< .001 * **	.219
Daytime sleepiness (8–24)	13.66 (4.02)	13.11 (2.86)	.710	.367	.008
Total (33–96)	58.19 (10.0)	69.86 (5.44)	29.45	< .001 * **	.021

Note: As there were a number of comparisons and as equal variances were assumed, the Bonferroni Correction was used.

Table 6
Comparison of TD groups in the UK and SA for CSHQ variables.

CSHQ Subscale (range)	Mean UK (SD) (n = 80)	Mean SA (SD) (n = 78)	F	p-value	η_p^2
Bedtime resistance (60–18)	7.70 (2.50)	10.17 (2.48)	31.47	< .001 * **	.283
Sleep onset latency (1–3)	1.48 (.72)	1.70 (.76)	.772	.398	.008
Sleep duration (3–6)	4.23 (1.12)	4.10 (1.81)	.056	.822	.001
Sleep anxiety (4–12)	4.81 (1.20)	5.78 (1.10)	1.547	.068	.007
Night waking (3–9)	4.18 (1.40)	4.13 (1.09)	.934	.811	.007
Parasomnias (7–21)	8.92 (2.05)	8.60 (1.62)	.109	.937	.001
Sleep Disordered Breathing (3–9)	3.82 (1.08)	5.45 (1.64)	21.006	< .001 * **	.189
Daytime sleepiness (8–24)	12.28 (3.42)	12.55 (2.48)	.210	.732	.004
Total (33–96)	43.69 (7.07)	68.90 (7.57)	29.415	< .001 * **	.195

Note: As there were a number of comparisons and as equal variances were assumed, the Bonferroni Correction was used.

Nonetheless, the persistence of sleep problems among individuals with ASD has previously been found to be common and lasting till adulthood, with up to 83% of individuals affected (Halstead et al., 2021). In fact, based on the findings of a cohort study, Verhoeff and colleagues (2018) suggest that these sleep problems should be considered as part of the construct of ASD. Preliminary findings have also surfaced indicating that more severe symptoms of ASD are predictive of sleep problems (Adams et al., 2014; Hollway & Aman, 2011; Mayes & Calhoun, 2009) and vice versa (Tudor et al., 2012), highlighting the indisputable relationship between ASD and sleep.

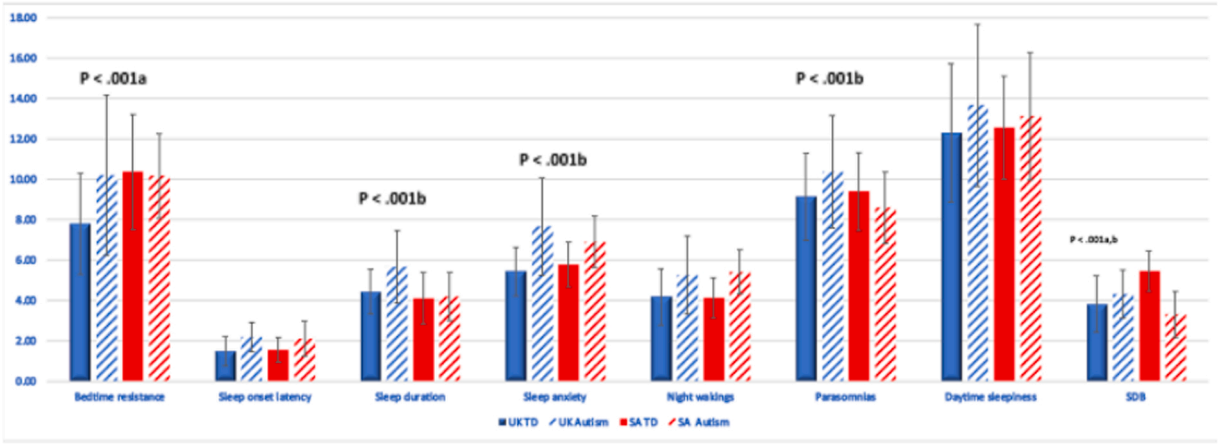

Fig. 3. Histogram of CSHQ subscale scores by groups. Bars indicate standard deviation. Higher scores correspond with greater sleep disturbances. *P*-values indicate significant differences between the UK and SA groups for typically developing or children with ASD ("a" denotes significant differences between the typically developing groups while "b" denotes significant differences between the ASD groups).

A further examination of CSHQ subscales showed that SA children with ASD had significantly higher scores than TD children in four subscales, namely sleep onset latency, sleep anxiety, parasomnias and higher number of nocturnal wakings. Therefore, the hypothesis that children with ASD have poorer sleep than TD children has been fulfilled. A number of reasons have been made to explain the longer sleep onset delay and more nocturnal wakings experienced by children with ASD. These include the inability to self-soothe or relax due to hyperarousal (Hundley et al., 2016; Richdale & Schreck, 2009; Schreck & Richdale, 2020), lack of understanding bedtime expectations (Meltzer & Mindell, 2006), sensory hypersensitivity (Tzischinsky et al., 2018) as well as high anxiety before bedtime (Ashworth et al., 2014; Richdale & Prior, 1995). In contrast to the previous studies (Giannotti et al., 2008; Paavonen et al., 2008; Park et al., 2012), daytime sleepiness, sleep disordered breathing and bedtime resistance were reported to be of less concern to the parents of children with ASD in this study. In fact, sleep disordered breathing was a significantly higher concern for TD children in SA. This finding is rather curious as a closer examination of medical history data (please see Supplementary Information Table S1) showed that children with ASD had a significantly higher percentage of respiratory issues, although these issues could have been well-managed by the time of study recruitment (as outlined in the inclusion criteria). To explain the higher prevalence of sleep disordered breathing among TD children, we may look to recent studies that investigated environmental factors such as air pollution. SA and in particular Riyadh where recruitment was carried out has been classified to have "unsafe" air quality due to high emissions and frequent dust storms (International Association for Medical Assistance to Travellers, 2020). Unfortunately, while schools where participants were recruited from were in close geographical proximity, the location of participants' residences were not taken into account. Another potential factor which was not taken into consideration in the current study is body mass, as obesity tends to be correlated with a higher likelihood of sleep disordered breathing (Beebe et al., 2007; Young et al., 2005). Although a related study conducted in Turkey has found that the body mass index of children with ASD are higher than that of TD children (Bicer & Alsaffar, 2013), the same remains to be verified with the SA sample.

In terms of the sleep profiles of TD children in SA, all children were similarly within the clinically classified range of sleep problems. This finding was also supported by sleep diary data, showing that TD children sleep an average of 6 h a night (see Supplementary Information), which is well below the recommended 9–11 h by the National Sleep Foundation for school-going children (Hirshkowitz et al., 2015). To find all CSHQ scores above the clinical cut off was unexpected, as it is in contrast with previous studies which found a much lower prevalence of approximately 20% (Ipsiroglu et al., 2001; Liu et al., 2005; Owens et al., 2000). However, some more recent findings trending towards the present ones were reported in a similar study among adolescents in SA where approximately half of all adolescents surveyed experienced sleep deprivation (Nasim et al., 2019). Another study in the UK by Holley and colleagues (2010) also showed that over half of their sample of school-aged typically developing children scored above the cut-off, and points towards the common trend of insufficient sleep even among typically developing children. While it is established that adolescents and older children tend to be sleep deprived (Roberts & Duong, 2014; Roberts et al., 2009), this pattern might have its roots much earlier in the developmental stages. When taking age into consideration, TD children showed fewer sleep problems with older age in alignment with past studies (McVeigh et al., 2021; Sivertsen et al., 2017; Wang et al., 2016; Gregory & O'connor, 2002).

Nonetheless, taking into account that all participants in Saudi Arabia, including both ASD and typically developing samples, fall within the clinical range when measured with CSHQ is surprising. Given that there were a large number of studies adapting and translating the CSHQ into various languages and cultural settings (e.g., Dutch, German, Indonesian, Italian, Portuguese, Spanish) with success, acceptable psychometric properties (Borrelli et al., 2021; Hartini et al., 2017; Schlarb et al., 2010; Silva et al., 2014; Waumans et al., 2010) and significant correlation with objective sleep measures (Lucas-de la Cruz et al., 2016), the CSHQ should be similarly applicable in the Middle East. However, the present findings instead warrant a deeper investigation into the applicability of the CSHQ in this particular region of the world. The CSHQ translation in this study followed the guidelines suggested by Beaton and colleagues (2000) and yielded acceptable internal reliability, but it should be noted that its factor structure had not previously been validated in a

Middle Eastern sample. Future studies may wish to validate the use of CSHQ in the Middle East. More specific translation and adaptation guidelines for paediatric sleep questionnaires (e.g., Sagheri et al., 2010) may also be used to provide a more targeted framework for translation in the future.

4.2. Cross-culture comparative analysis

Comparison of ASD groups between countries showed stark differences in the subscales of sleep duration, sleep anxiety, parasomnias with children with ASD in the UK scoring significantly higher on these scales, which is an outcome in the opposite direction from the initially formulated hypothesis. However, general CSHQ scores are still significantly higher among the SA sample as compared to the UK sample, indicating that the first hypothesis is partially supported. This may point to cultural differences in self-reporting patterns between countries, which may have led to over- or under-reporting of specific sleep behaviours in various populations. Research using objective sleep measures is needed to confirm this conjecture.

Additionally, differences in sleep may be driven in part by environmental and lifestyle factors, as well as parental expectation of sleep routines. For example, there are significant differences in the distribution of screen time hours across UK and SA, particularly for typically developing subgroups. Specifically, children in SA are more likely to be exposed to more screen time as compared to their counterparts in the UK. Unsurprisingly, a systematic review has found that there are consistent associations between screen time and poor sleep (Hale & Guan, 2015), although exact mechanisms and causality are not yet established. Moreover, a cohort study conducted by Przybylski (2019) showed only modest correlation between the two, suggesting that a combination of other environmental factors may be needed to influence child sleep. Future studies are needed to ascertain if this difference is culturally-driven, or if there may be significant differences in parenting styles and attitudes towards sleep across countries that contribute to this finding.

Next, children in the UK are significantly more likely to have regular mealtimes compared to children in SA regardless of developmental status. This is in line with some adult studies examining sleep deprivation, where it was found that energy expenditure of sleep-deprived individuals is much higher due to a lack of energy conservation obtained from an optimal sleep duration (Spaeth et al., 2013). As a result, sleep-deprived individuals tend to eat at different times and more snacks (Spaeth et al., 2013). This is a very relevant finding for children in SA with 28.96% of the sample reporting irregular meals, as well as for children with ASD in the UK who showed significantly more snacking than other groups. Similar to the adult study conducted by Spaeth and colleagues (2013), sleep-deprived children may experience more food cravings to obtain more energy and make up for the lack of sleep, thereby eating a significantly higher number of snacks and more irregular meals in a day.

4.3. Limitations and future research

The first limitation of the present study is its cross-sectional design. Ideally, a longitudinal approach should be used to study developmental domains strongly related to age and physiological changes across time, such as sleep. However, materials, procedure and findings of the present study have provided an initial research platform to enhance the current understanding on sleep. Hopefully, future studies can extend upon these findings by using a longitudinal approach. Another potential extension of the current findings lies in their translation to public health domains to provide parents and caregivers with culturally-sensitive information and recommendations on improving sleep for both typically developing children and children with neurodevelopmental disabilities. As noted in this study and many preceding studies, maintaining good quality sleep is important for health, learning and functional behaviour (Ashworth et al., 2014; Karmiloff-Smith, 2017; Paiva et al., 2015; Pawl et al., 2013; Pulopulos et al., 2020; Shattuck et al., 2018). Future research may develop tools and guidelines to enhance parental understanding and management of sleep in children.

Additionally, an important limitation of this study lies in the recruitment methods. Recruitment of children with ASD in Saudi Arabia was limited due to practical limitations described above, and the sample of UK participants was obtained through convenience sampling. A lack of random sampling may lead to the presence of self-selection bias or other hidden biases (Etikan et al., 2016; Farrokhi & Mahmoudi-Hamidabad, 2012), but it may also be argued that non-probabilistic sampling is most realistic when dealing with large samples (i.e., children with ASD in large countries). Nonetheless, with centralisation in the management of ASD organisations in Saudi Arabia, it may be possible for future studies to conduct random sampling based on the databases that would be created as a result of these changes. Additionally, the exclusion of children currently taking hypnotics or medications that affect sleep may lead to the omission of data representing the most severe sleep issues, as individuals who are greatly affected by sleep problems would correspondingly be the most likely to be seeking medical help for these issues. While this exclusion criteria was introduced because it is beyond the scope of the present paper to consider the interaction of medication and sleep, it must be acknowledged that the current sample of participants may not be representative of those who have sought medical interventions for the most severe sleep problems.

Relatedly, it should also be noted in the current study's data that there are different proportions of males and females in the ASD and typically developing samples, as it is well-established that ASD is more commonly diagnosed among males (Duvekot et al., 2017; Wood-Downie et al., 2021). However, findings have been mixed on whether sex is significantly related to different prevalences and types of sleep difficulties faced by both children with ASD and typically developing children. Studies by Mayes and Calhoun (2009) and Liu and colleagues (2006) found no significant differences in sleep disturbance between children with ASD of different genders. Additionally, a population cohort study by Verhoeff and colleagues (2018) have found no interaction between gender and sleep problems among children with ASD. On the other hand, other studies (e.g., Saré & Smith, 2020; Mazurek & Sohl, 2016) have uncovered sex-based differences in sleep problems, even though it is unclear if these differences may be due to an interaction between sex and other behavioural or lifestyle factors (Uebergang et al., 2017), or if it is due to underlying differences in ASD severity and therefore associated sleep difficulties between genders among those diagnosed with ASD (Lai & Szatmari, 2020; Mussey et al., 2017). Before

more definitive findings emerge, future studies may consider conducting participant gender matching across samples to eliminate the potentially confounding effect of gender on sleep.

Next, the assessment of sleep and other lifestyle factors in the current study was conducted with subjective self-report measures, which may be prone to various biases and do not allow for insight into participants' actual sleep patterns and sleep quality. Future studies may include objective measures of sleep such as actigraphy. Finally, Halstead and colleagues (2021) discussed the role of parental sleep knowledge in the moderation of the child's sleep duration and sleep behaviours. This factor was not considered in our study, but may be an important factor for inclusion in future studies as it may be a moderator of several sleep behaviours observed in children. In the current study, it appears that parents in SA may not yet appreciate the importance of sleep hygiene, as seen in the allowance of late bedtimes, unstructured meals and exposure to screen time before sleep. Therefore, future studies may consider measuring parental attitudes and knowledge towards sleep to provide firmer evidence which could be used in eventual translation of sleep education.

Finally, other culture-specific factors beyond screen time and eating patterns may also be investigated. For example, other variables that may be measured include the frequency and intensity of physical activity or play time, as well as timings, duration and frequency of social meetings, family gatherings and religious, work- or school-related obligations. A meta-analysis conducted by Kredlow et al. (2015) found that acute and regular physical activity has small to moderate benefits on sleep duration, sleep onset latency, sleep efficiency, sleep quality and wake time. Related factors of physical activity, namely body weight and body mass index (BMI), may also be included due to their simultaneous relevance to sleep disordered breathing (Beebe et al., 2007; Young et al., 2005). Similarly, due to the late opening times of social venues in Saudi Arabia and the presence of religious duties such as fasting during Ramadan previously described (i.e., Muslims can only break their fast early before dawn or after the sun sets), it becomes much more likely for people in Saudi Arabia to have more fragmented or shorter sleep.

What this paper adds

The paper investigates the first cross-cultural comparison of sleep habits between the Middle East and the West, involving two distinct child populations (typically developing and with ASD). By incorporating both questionnaires and sleep diaries, findings highlight the role of sociodemographic, medical and lifestyle factors in influencing sleep quality.

CRediT authorship contribution statement

W. Bin Eid: Conceptualization, Methodology, Software, Investigation, Writing – original draft, Visualization, Funding acquisition. **M. Lim:** Writing – original draft, Writing – review & editing. **E. Halstead:** Supervision. **G. Esposito:** Software, Formal analysis, Writing – original draft, Writing – review & editing. **D. Dimitriou:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. All authors have read and agreed to the published version of the manuscript.

Data Availability

Data are not publicly accessible but can be made available on request to the corresponding author.

Acknowledgement

W.B. was funded by the Ministry of Education in Saudi Arabia. D.D. was funded by John and Lorna Wing Foundation, UK. We would like to thank all parents and their children for participation in this study.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ridd.2022.104290.

References

Adams, H. L., Matson, J. L., Cervantes, P. E., & Goldin, R. L. (2014). The relationship between autism symptom severity and sleep problems: Should bidirectionality be considered. *Research in Autism Spectrum Disorders, 8*(3), 193–199. https://doi.org/10.1016/j.rasd.2013.11.008

Annaz, D., Karmiloff-Smith, A., & Thomas, M. S. (2008). The importance of tracing developmental trajectories for clinical child neuropsychology. In R. Reed, & J. Warner-Rogers (Eds.), *Child neuropsychology: Concepts, theory and practice*. UK: John Wiley & Sons.

Ashworth, A., Hill, C. M., Karmiloff-Smith, A., & Dimitriou, D. (2014). Sleep enhances memory consolidation in children. *Journal of Sleeping Research, 23*(3), 304–310. https://doi.org/10.1111/jsr.12119

Bahammam, A. (2006). Does Ramadan fasting affect sleep? *International journal of clinical practice, 60*(12), 1631–1637.

BaHammam, A., Al-Faris, E., Shaikh, S., & Saeed, A. B. (2006a). Sleep problems/habits and school performance in elementary school children. *Sleeping and Hypnosis, 8*(1), 12–18. Retrieved 26 April, 2022 from ⟨https://www.sleepandhypnosis.org/ing/Pdf/f02a007d6bff4abfa2ee0286936238af.pdf⟩.

BaHammam, A., AlFaris, E., Shaikh, S., & Saeed, A. B. (2006b). Prevalence of sleep problems and habits in a sample of Saudi primary school children. *Annals of Saudi Medicine, 26*(1), 7–13. https://doi.org/10.5144/0256-4947.2006.7

BaHammam, A., Bin Saeed, A., Al-Faris, E., & Shaikh, S. (2006c). Sleep duration and its correlates in a sample of Saudi elementary school children. *Singapore Medical Journal, 47*(10), 875. Retrieved 26 April, 2022 from ⟨https://www.researchgate.net/profile/Ahmed-Bahammam/publication/6803472_Sleep_duration_and_its_correlates_in_a_sample_of_Saudi_elementary_school_children/links/5672388a08ae3aa2fceec10b/Sleep-duration-and-its-correlates-in-a-sample-of-Saudi-elementary-school-children.pdf⟩.

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine, 25*(24), 3186–3191. Retrieved 26 April, 2022 from ⟨https://journals.lww.com/spinejournal/Citation/2000/12150/Guidelines_for_the_Process_of_Cross_Cultural.14.aspx⟩.

Beebe, D. W., Lewin, D., Zeller, M., McCabe, M., MacLeod, K., Daniels, S. R., & Amin, R. (2007). Sleep in overweight adolescents: shorter sleep, poorer sleep quality, sleepiness, and sleep-disordered breathing. *Journal of Pediatric Psychology, 32*(1), 69–79. https://doi.org/10.1093/jpepsy/jsj104

Bicer, A. H., & Alsaffar, A. A. (2013). Body mass index, dietary intake and feeding problems of Turkish children with autism spectrum disorder (ASD). *Research in Developmental Disabilities, 34*(11), 3978–3987. https://doi.org/10.1016/j.ridd.2013.08.024

Borrelli, M., Scala, I., Festa, P., Bruzzese, D., Michelotti, A., Cantone, E., & Santamaria, F. (2021). Linguistic adaptation and psychometric evaluation of Italian version of children's sleep habits questionnaire. *Italian Journal of Pediatrics, 47*(1), 1–5. https://doi.org/10.1186/s13052-021-01119-z

Cohen, J. (2013). *Statistical Power Analysis for the Behavioral Sciences*. New York, NY: Routledge. https://doi.org/10.4324/9780203771587

Cohen, S., Conduit, R., Lockley, S. W., Rajaratnam, S. M., & Cornish, K. M. (2014). The relationship between sleep and behavior in autism spectrum disorder (ASD): A review. *Journal of Neurodevelopmental Disorders, 6*, 44. https://doi.org/10.1186/1866-1955-6-44

Cortesi, F., Giannotti, F., Ivanenko, A., & Johnson, K. (2010). Sleep in children with autistic spectrum disorder. *Sleeping Medicine, 11*(7), 659–664. https://doi.org/10.1016/j.sleep.2010.01.010

Cotton, S. M., & Richdale, A. L. (2010). Sleep patterns and behaviour in typically developing children and children with autism, Down syndrome, Prader-Willi syndrome and intellectual disability. *Research in Autism Spectrum Disorders, 4*(3), 490–500. https://doi.org/10.1016/j.rasd.2009.11.006

Couturier, J. L., Speechley, K. N., Steele, M., Norman, R., Stringer, B., & Nicolson, R. (2005). Parental perception of sleep problems in children of normal intelligence with pervasive developmental disorders: prevalence, severity, and pattern. *Journal of the American Academy of Child & Adolescent Psychiatry, 44*(8), 815–822. https://doi.org/10.1097/01.chi.0000166377.22651.87

Duvekot, J., van der Ende, J., Verhulst, F. C., Slappendel, G., van Daalen, E., Maras, A., & Greaves-Lord, K. (2017). Factors influencing the probability of a diagnosis of autism spectrum disorder in girls versus boys. *Autism, 21*(6), 646–658. https://doi.org/10.1177/1362361316672178

Elrod, M. G., & Hood, B. S. (2015). Sleep differences among children with autism spectrum disorders and typically developing peers: A meta-analysis. *Journal of Developmental & Behavioral Pediatrics, 36*(3), 166–177. https://doi.org/10.1097/DBP.0000000000000140

Esbensen, A. J., & Schwichtenberg, A. J. (2016). Sleep in neurodevelopmental disorders. *International Review of Research in Developmental Disabilities, 51*, 153–191. https://doi.org/10.1016/bs.irrdd.2016.07.005

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Farrokhi, F., & Mahmoudi-Hamidabad, A. (2012). Rethinking convenience sampling: Defining quality criteria. *Theory & Practice in Language Studies, 2*(4), 784–792. https://doi.org/10.4304/tpls.2.4.784-792

Giannotti, F., Cortesi, F., Cerquiglini, A., Vagnoni, C., & Valente, D. (2011). Sleep in children with autism with and without autistic regression. *Journal of Sleeping Research, 20*(2), 338–347. https://doi.org/10.1111/j.1365-2869.2010.00882.x

Giannotti, F., Cortesi, F., Cerquiglini, A., Miraglia, D., Vagnoni, C., Sebastiani, T., & Bernabei, P. (2008). An investigation of sleep characteristics, EEG abnormalities and epilepsy in developmentally regressed and non-regressed children with autism. *Journal of Autism and Developmental Disorders, 38*(10), 1888–1897. https://doi.org/10.1007/s10803-008-0584-4

Gregory, A. M., & O'connor, T. G. (2002). Sleep problems in childhood: a longitudinal study of developmental change and association with behavioral problems. *Journal of the American Academy of Child & Adolescent Psychiatry, 41*(8), 964–971. https://doi.org/10.1097/00004583-200208000-00015

Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: A systematic literature review. *Sleeping Medicine Reviews, 21*, 50–58. https://doi.org/10.1016/j.smrv.2014.07.007

Halstead, E. J., Joyce, A., Sullivan, E., Tywyn, C., Davies, K., Jones, A., & Dimitriou, D. (2021). Sleep disturbances and patterns in children with neurodevelopmental conditions. *Frontiers in Pediatrics, 9*, 91. https://doi.org/10.3389/fped.2021.637770

Hartini, S., Sunartini, S., Herini, E. S., & Takada, S. (2017). Item analysis and internal consistency of Children's Sleep Habit Questionnaire (CSHQ) in Indonesian version. *Belitung Nursing Journal, 3*(6), 645–655. https://doi.org/10.33546/bnj.184

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature, 466*(7302). https://doi.org/10.1038/466029a

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., … Hillard, P. J. A. (2015). National Sleep Foundation's sleep time duration recommendations: Methodology and results summary. *Sleeping Health, 1*(1), 40–43. https://doi.org/10.1016/j.sleh.2014.12.010

Hollway, J. A., & Aman, M. G. (2011). Sleep correlates of pervasive developmental disorders: A review of the literature. *Research in Developmental Disabilities, 32*(5), 1399–1421. https://doi.org/10.1016/j.ridd.2011.04.001

Hundley, R. J., Shui, A., & Malow, B. A. (2016). Relationship between subtypes of restricted and repetitive behaviors and sleep disturbance in autism spectrum disorder. *Journal of Autism and developmental Disorders, 46*(11), 3448–3457. https://doi.org/10.1007/s10803-016-2884-4

International Association for Medical Assistance to Travellers. (2020). Saudi Arabia General Health Risks: Air Pollution. Retrieved 22 April, 2022 from ⟨https://www.iamat.org/country/saudi-arabia/risk/air-pollution⟩.

Ipsiroglu, O. S., Fatemi, A., Werner, I., Tiefenthaler, M., Urschitz, M. S., & Schwarz, B. (2001). Prevalence of sleep disorders in school children between 11 and 15 years of age. *Wiener Klinische Wochenschrift, 113*(7–8), 235–244. Retrieved 26 April, 2022 from ⟨https://europepmc.org/article/med/11383383⟩.

Jeon, M., Dimitriou, D., & Halstead, E. J. (2021). A systematic review on cross-cultural comparative studies of sleep in young populations: The roles of cultural factors. *International Journal of Environmental Research and Public Health, 18*(4), 2005. https://doi.org/10.3390/ijerph18042005

Johnson, C. R., Turner, K. S., Foldes, E. L., Malow, B. A., & Wiggs, L. (2012). Comparison of sleep questionnaires in the assessment of sleep disturbances in children with autism spectrum disorders. *Sleeping Medicine, 13*(7), 795–801. https://doi.org/10.1016/j.sleep.2012.03.005

Jupp, V. (2006). *The Sage Dictionary of Social Research Methods*. London, UK: Sage.

Karmiloff-Smith, A. (2017). From constructivism to neuroconstructivism: The activity-dependent structuring of the human brain. In E. Martí, & C. Rodrí-guez (Eds.), *After Piaget* (pp. 1–14). New Brunswick, NJ: Transaction Publishers.

Karmiloff-Smith, A., Thomas, M., Annaz, D., Humphreys, K., Ewing, S., Brace, N., & Campbell, R. (2004). Exploring the Williams syndrome face-processing debate: The importance of building developmental trajectories. *Journal of Child Psychology and Psychiatry, 45*(7), 1258–1274. https://doi.org/10.1111/j.1469-7610.2004.00322.x

Kredlow, M. A., Capozzoli, M. C., Hearon, B. A., Calkins, A. W., & Otto, M. W. (2015). The effects of physical activity on sleep: A meta-analytic review. *Journal of Behavioral Medicine, 38*(3), 427–449. https://doi.org/10.1007/s10865-015-9617-6

Lai, M. C., & Szatmari, P. (2020). Sex and gender impacts on the behavioural presentation and recognition of autism. *Current Opinion in Psychiatry, 33*(2), 117–123. https://doi.org/10.1097/YCO.0000000000000575

Li, S., Zhu, S., Jin, X., Yan, C., Wu, S., Jiang, F., & Shen, X. (2010). Risk factors associated with short sleep duration among Chinese school-aged children. *Sleeping Medicine, 11*(9), 907–916. https://doi.org/10.1016/j.sleep.2010.03.018

Liu, X., Hubbard, J. A., Fabes, R. A., & Adam, J. B. (2006). Sleep disturbances and correlates of children with autism spectrum disorders. *Child Psychiatry and Human Development, 37*(2), 179–191. https://doi.org/10.1007/s10578-006-0028-3

Liu, X., Ma, Y., Wang, Y., Jiang, Q., Rao, X., Lu, X., & Teng, H. (2005). Brief report: an epidemiologic survey of the prevalence of sleep disorders among children 2 to 12 years old in Beijing, China. *Pediatrics*, 266–268. https://doi.org/10.1542/peds.2004-0815I

Malow, B. A., Marzec, M. L., McGrew, S. G., Wang, L., Henderson, L. M., & Stone, W. L. (2006). Characterizing sleep in children with autism spectrum disorders: a multidimensional approach. *Sleep, 29*(12), 1563–1571. https://doi.org/10.1093/sleep/29.12.1563

Maskey, M., Warnell, F., Parr, J. R., Le Couteur, A., & McConachie, H. (2013). Emotional and behavioural problems in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 43*(4), 851–859. https://doi.org/10.1007/s10803-012-1622-9

Mayes, S. D., & Calhoun, S. L. (2009). Variables related to sleep problems in children with autism. *Research in Autism Spectrum Disorders, 3*(4), 931–941. https://doi.org/10.1016/j.rasd.2009.04.002

Mazurek, M. O., & Sohl, K. (2016). Sleep and behavioral problems in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 46*(6), 1906–1915. https://doi.org/10.1007/s10803-016-2723-7

McVeigh, J. A., Smith, A., Howie, E. K., Stamatakis, E., Ding, D., Cistulli, P. A., & Straker, L. (2021). Developmental trajectories of sleep during childhood and adolescence are related to health in young adulthood. *Acta Paediatrica, 110*(8), 2435–2444. https://doi.org/10.1111/apa.15911

Meltzer, L. J., & Mindell, J. A. (2006). Sleep and sleep disorders in children and adolescents. *Psychiatric Clinics, 29*(4), 1059–1076. https://doi.org/10.1016/j.psc.2006.08.004

Mussey, J. L., Ginn, N. C., & Klinger, L. G. (2017). Are males and females with autism spectrum disorder more similar than we thought. *Autism, 21*(6), 733–737. https://doi.org/10.1177/1362361316682621

Nasim, M., Saade, M., & AlBuhairan, F. (2019). Sleep deprivation: prevalence and associated factors among adolescents in Saudi Arabia. *Sleeping Medicine, 53*, 165–171. https://doi.org/10.1016/j.sleep.2018.08.031

Owens, J. A., Spirito, A., & McGuinn, M. (2000). The Children's Sleep Habits Questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. *Sleep, 23*(8), 1043–1052. Retrieved 26 April, 2022 from ⟨http://depts.washington.edu/dbpeds/Screening%20Tools/CSHQ%20article.pdf⟩.

Paavonen, E. J., Vehkalahti, K., Vanhala, R., von Wendt, L., Nieminen-von Wendt, T., & Aronen, E. T. (2008). Sleep in children with Asperger syndrome. *Journal of Autism and Developmental Disorders, 38*(1), 41–51. https://doi.org/10.1007/s10803-007-0360-x

Paiva, T., Gaspar, T., & Matos, M. G. (2015). Sleep deprivation in adolescents: correlations with health complaints and health-related quality of life. *Sleeping Medicine, 16*(4), 521–527. https://doi.org/10.1016/j.sleep.2014.10.010

Park, S., Cho, S. C., Cho, I. H., Kim, B. N., Kim, J. W., Shin, M. S., & Yoo, H. J. (2012). Sleep problems and their correlates and comorbid psychopathology of children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*(3), 1068–1072. https://doi.org/10.1016/j.rasd.2012.02.004

Pawl, J. D., Lee, S. Y., Clark, P. C., & Sherwood, P. R. (2013). Sleep loss and its effects on health of family caregivers of individuals with primary malignant brain tumors. *Research in Nursing & Health, 36*(4), 386–399. https://doi.org/10.1002/nur.21545

Przybylski, A. K. (2019). Digital screen time and pediatric sleep: evidence from a preregistered cohort study. *The Journal of Pediatrics, 205*, 218–223. https://doi.org/10.1016/j.jpeds.2018.09.054

Pulopulos, M. M., Hidalgo, V., Puig-Perez, S., Montoliu, T., & Salvador, A. (2020). Relationship between cortisol changes during the night and subjective and objective sleep quality in healthy older people. *International Journal of Environmental Research and Public Health, 17*(4), 1264. https://doi.org/10.3390/ijerph17041264

Reed, H. E., McGrew, S. G., Artibee, K., Surdkya, K., Goldman, S. E., Frank, K., & Malow, B. A. (2009). Parent-based sleep education workshops in autism. *Journal of Child Neurology, 24*(8), 936–945. https://doi.org/10.1177/0883073808331348

Richdale, A. L., & Prior, M. R. (1995). The sleep/wake rhythm in children with autism. *European Child & Adolescent Psychiatry, 4*(3), 175–186. https://doi.org/10.1007/BF01980456

Richdale, A. L., & Schreck, K. A. (2009). Sleep problems in autism spectrum disorders: prevalence, nature, & possible biopsychosocial aetiologies. *Sleeping Medicine Reviews, 13*(6), 403–411. https://doi.org/10.1016/j.smrv.2009.02.003

Roberts, R. E., & Duong, H. T. (2014). The prospective association between sleep deprivation and depression among adolescents. *Sleep, 37*(2), 239–244. https://doi.org/10.5665/sleep.3388

Roberts, R. E., Roberts, C. R., & Duong, H. T. (2009). Sleepless in adolescence: prospective data on sleep deprivation, health and functioning. *Journal of Adolescence, 32*(5), 1045–1057. https://doi.org/10.1016/j.adolescence.2009.03.007

Sagheri, D., Wiater, A., Steffen, P., & Owens, J. A. (2010). Applying principles of good practice for translation and cross-cultural adaptation of sleep-screening instruments in children. *Behavioral Sleeping Medicine, 8*(3), 151–156. https://doi.org/10.1080/15402002.2010.487460

Sahin, U., Ozturk, O., Ozturk, M., Songur, N., Bircan, A., & Akkaya, A. (2009). Habitual snoring in primary school children: Prevalence and association with sleep-related disorders and school performance. *Medical Principles and Practice, 18*(6), 458–465. https://doi.org/10.1159/000235895

Saré, R. M., & Smith, C. B. (2020). Association between sleep deficiencies with behavioral problems in autism spectrum disorder: Subtle sex differences. *Autism Research, 13*(10), 1802–1810. https://doi.org/10.1002/aur.2396

Schlarb, A. A., Schwerdtle, B., & Hautzinger, M. (2010). Validation and psychometric properties of the German version of the Children's Sleep Habits Questionnaire (CSHQ-DE). *Somnologie-Schlafforschung und Schlafmedizin, 14*(4), 260–266. https://doi.org/10.1007/s11818-010-0495-4

Schopler, E., Reichler, R. J., & Renner, B. R. (2010). The childhood autism rating scale (CARS). Los Angeles, CA: WPS. Retrieved 26 April, 2022 from ⟨https://deputadoeverton.com.br/wp-content/uploads/2021/10/2-CARS_22–09-2021.pdf⟩.

Schreck, K. A., & Richdale, A. L. (2020). Sleep problems, behavior, and psychopathology in autism: Inter-relationships across the lifespan. *Current Opinion in Psychology, 34*, 105–111. https://doi.org/10.1016/j.copsyc.2019.12.003

Shattuck, N. L., Matsangas, P., & Dahlman, A. S. (2018). Sleep and fatigue issues in military operations. In E. Vermetten, A. Germain, & T. Neylan (Eds.), *Sleep and Combat-Related Post Traumatic Stress Disorder* (pp. 69–76). New York, NY: Springer. https://doi.org/10.1007/978-1-4939-7148-0_7.

Silva, F. G., Silva, C. R., Braga, L. B., & Serrão Neto, A. (2014). Portuguese Children's Sleep Habits Questionnaire-validation and cross-cultural comparison. *Jornal Délelőtt Pediatria, 90*, 78–84. https://doi.org/10.1016/j.jped.2013.06.009

Sivertsen, B., Harvey, A. G., Pallesen, S., & Hysing, M. (2017). Trajectories of sleep problems from childhood to adolescence: a population-based longitudinal study from Norway. *Journal of Sleeping Research, 26*(1), 55–63. https://doi.org/10.1111/jsr.12443

Souders, M. C., Mason, T. B., Valladares, O., Bucan, M., Levy, S. E., Mandell, D. S., & Pinto-Martin, J. (2009). Sleep behaviors and sleep quality in children with autism spectrum disorders. *Sleep, 32*(12), 1566–1578. https://doi.org/10.1093/sleep/32.12.1566

Spaeth, A. M., Dinges, D. F., & Goel, N. (2013). Effects of experimental sleep restriction on weight gain, caloric intake, and meal timing in healthy adults. *Sleep, 36*(7), 981–990. https://doi.org/10.5665/sleep.2792

Thomas, M. S., Annaz, D., Ansari, D., Scerif, G., Jarrold, C., & Karmiloff-Smith, A. (2009). Using developmental trajectories to understand developmental disorders. *Journal of Speech, Language, and Hearing Research, 52*(2), 336–358. https://doi.org/10.1044/1092-4388(2009/07-0144)

Tudor, M. E., Hoffman, C. D., & Sweeney, D. P. (2012). Children with autism: sleep problems and symptom severity. *Focus on Autism and Other Developmental Disabilities, 27*(4), 254–262. https://doi.org/10.1177/1088357612457989

Tzischinsky, O., Meiri, G., Manelis, L., Bar-Sinai, A., Flusser, H., Michaelovski, A., & Dinstein, I. (2018). Sleep disturbances are associated with specific sensory sensitivities in children with autism. *Molecular Autism, 9*(1), 1–10. https://doi.org/10.1186/s13229-018-0206-8

Uebergang, L. K., Arnup, S. J., Hiscock, H., Care, E., & Quach, J. (2017). Sleep problems in the first year of elementary school: The role of sleep hygiene, gender and socioeconomic status. *Sleeping Health, 3*(3), 142–147. https://doi.org/10.1016/j.sleh.2017.02.006

Veatch, O. J., Sutcliffe, J. S., Warren, Z. E., Keenan, B. T., Potter, M. H., & Malow, B. A. (2017). Shorter sleep duration is associated with social impairment and comorbidities in ASD. *Autism Research, 10*(7), 1221–1238. https://doi.org/10.1002/aur.1765

Wang, B., Isensee, C., Becker, A., Wong, J., Eastwood, P. R., Huang, R. C., & Rothenberger, A. (2016). Developmental trajectories of sleep problems from childhood to adolescence both predict and are predicted by emotional and behavioral problems. *Frontiers in Psychology, 7*, 1874. https://doi.org/10.3389/fpsyg.2016.01874

Waumans, R. C., Terwee, C. B., Van den Berg, G., Knol, D. L., Van Litsenburg, R. R., & Gemke, R. J. (2010). Sleep and sleep disturbance in children: Reliability and validity of the Dutch version of the Child Sleep Habits Questionnaire. *Sleep, 33*(6), 841–845. https://doi.org/10.1093/sleep/33.6.841

Wood-Downie, H., Wong, B., Kovshoff, H., Mandy, W., Hull, L., & Hadwin, J. A. (2021). Sex/gender differences in camouflaging in children and adolescents with autism. *Journal of Autism and Developmental Disorders, 51*(4), 1353–1364. https://doi.org/10.1007/s10803-020-04615-z

Young, T., Peppard, P. E., & Taheri, S. (2005). Excess weight and sleep-disordered breathing. *Journal of Applied Physiology, 99*(4), 1592–1599. https://doi.org/10.1152/japplphysiol.00587.2005