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Cross-country comparison of parental reports and objective measures of sleep patterns of typically developing children and autistic children between the UK and South Korea

Mina Jeon [a,*], Gianluca Esposito [c], Elizabeth Halstead [a], Arvin Haghighatfard [a], Dagmara Dimitriou [a], Michelle Jin Yee Neoh [b]

[a] Sleep Education and Research Laboratory, UCL Institute of Education, London, UK
[b] Psychology Program, School of Social Sciences, Nanyang Technological University, Singapore
[c] Department of Psychology and Cognitive Science, University of Trento, Rovereto, Italy

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ABSTRACT

Sleep duration and disturbances in typically developing (TD) children have been found to vary across countries. Given the impact of culture on sleep patterns in TD children, it is also necessary to examine the impact of culture on sleep patterns in children with atypical development. However, previous studies have often relied only on parent reports of children's sleep. Hence, the present study conducted a cross-cultural comparison of sleep duration and disturbances of school-aged TD children and autistic children in the UK and South Korea (hereafter Korea) using both subjective and objective sleep measurements. Cultural differences were observed in both actigraphy measures and parent reports of children's sleep duration and disturbances. Both TD children and autistic children in Korea had a later bedtime, later getting up time and shorter nocturnal sleep duration than their peers in the UK ($p < .05$). Furthermore, greater parent-reported sleep disturbances were reported in TD children in Korea compared to TD children in the UK and in autistic children in the UK compared to autistic children in Korea. Correlational analyses indicated that most parent-reported measures of children's sleep did not significantly correlate with objective measures and child reports, suggesting that studies on children's sleep can benefit by collecting data from multiple sources. Taken together, these findings suggest a cultural influence on sleep duration and disturbances of both TD children and autistic children. This study raises questions for further research to identify factors underlying cultural differences in children's sleep duration and disturbances.

1. Introduction

Although there has been a limited number of cross-cultural paediatric sleep studies that employed a cross-country comparison approach, previous studies have shown that children's sleep duration and disturbances vary across countries. For example, a study recruited 2590 parents of preschool-aged children (aged 3–6 years) from predominantly Asian (P-A) countries and predominantly Caucasian (P–C) countries found that children from P-A countries had a significantly later bedtime, later wake up time, shorter nocturnal sleep duration, and more frequent and longer duration of habitual naps during the day, compared with children from P–C countries [1]. Similar findings were shown in a study that compared infants and toddlers' sleep between P-A and P–C countries [2]. However, most previous cross-country sleep studies have used only a parent-reported questionnaire in their methodological approach to measure children's sleep [1–5], and only one study has used both a parent-reported questionnaire and actigraphy to examine sleep duration of school-aged children in Australia and Canada [6]. Biggs et al. (2016) found significant differences in parental reports of children's nocturnal sleep duration where children in Canada showed significantly shorter nocturnal sleep duration than those in Australia [6], which is consistent with other previous findings [1,2]. However, it should be noted that in their

Abbreviations: TD, Typically developing; P-A, Predominantly Asian; P–C, Predominantly Caucasian; CSHQ, Children's Sleep Health Questionnaire; ASD, Autism Spectrum Disorder; SSR, Sleep Self Report.

* Corresponding author.
E-mail address: mina.jeon.12@ucl.ac.uk (M. Jeon).

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study, actigraphy data and parent reports were inconsistent where there were no significant differences between sleep patterns of children in Australia and Canada based on actigraphy data. This inconsistency in findings highlights the importance of implementing both subjective and objective sleep measurements when assessing children's sleep duration and disturbances. Furthermore, none of these cross-cultural studies have utilised child-reported sleep measurements even though school-aged children are able to respond to questions by themselves and may have different perceptions about their sleep. Therefore, it would be beneficial to examine children's perception of their own sleep.

Several cross-cultural sleep studies that employed a cross-country approach have grouped a number of countries according to their regions and compared the sleep of children living in different regions. For example, a study investigated the sleep of preschool-aged children in 14 countries by grouping them into P–C and P-A countries [1]. Although these studies provide insights into cultural differences between Asian and Western cultures through broad cross-cultural comparisons, some studies that conducted a country-specific comparison of children's sleep have also reported cultural differences associated with children's sleep within the same region. For example, one study compared sleep duration and disturbances of preschool-aged children in Japan with their peers in China and found that children in China had a later bedtime, later wake up time, longer total sleep duration, longer sleep latency and more night awakening problems than children in Japan [5]. Furthermore, another study examined sleep duration and disturbances of infants and toddlers in Korea compared to their peers in P-A and P–C countries [7]. The study found that infants and toddlers in Korea had the latest bedtime, the shortest total sleep time, the shortest daytime sleep duration and the least number of naps per day compared with P–C countries and with P-A countries. Additionally, despite the fact that Korean infants and toddlers had the shortest total sleep time, their parents identified significantly less “severe” sleep problems in their children (2.3%) compared to the P-A countries (18.1%). This country-specific approach of comparisons has implications for providing specific information on sleep duration and disturbances that may be useful for parents and clinicians in each individual country. Therefore, it is important to compare countries rather than regions when conducting cross-cultural comparisons on sleep in children. The current study aimed to contribute to cross-cultural sleep research by investigating sleep duration and disturbances of school-aged TD children in Korea compared with their peers in the UK. To the best of the authors' knowledge, no previous studies have conducted a country-specific comparison of sleep in children in the UK with children in Korea.

The increasing recognition that culture has a great impact on TD children's sleep highlights the importance of investigating cultural differences associated with sleep duration and disturbances in autistic children as well. Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that affects approximately 1 in 100 children around the world with a range of 1.09/10,000 to 436.0/10,000 [8]. The core symptoms of autism include social communication and interaction difficulties and limited repetitive patterns of behaviours and interests [9], however a growing number of studies have also indicated that autistic children experience greater problems with sleep quantity and quality than their peers [10–13]. Short sleep duration and sleep disturbances in autistic children should be considered an important issue since insufficient sleep and sleep disturbances could aggravate core autistic symptoms. Specifically, short sleep duration, sleep onset latency and overall sleep disturbances in autistic children were associated with increased stereotyped behaviour, communication and social interaction deficits and severity of autism [14]. Although insufficient sleep and severe sleep disturbances are more of a concern in autistic children than those with typical development [12,13], few studies have compared sleep disturbances of autistic children between countries to the best of the authors' knowledge. For example, one cross-cultural study demonstrated that the prevalence of sleep problems in autistic children was higher in Indonesia (60%) than in Japan (16%), with greater sleep problems in waking during the night and waking up in the morning in autistic children in Indonesia than autistic children in Japan. However, the study had a small sample size with significant age differences between groups and only utilised parent reports. Another study compared their results with results from other previous studies. Wang and colleagues (2016) compared the results of the Children's Sleep Health Questionnaire (CSHQ) from autistic children in the U.S. from Souders et al.‘s study (2009) with their CSHQ results from autistic children in China [15]. The results demonstrated that parents of autistic children in China reported significantly greater problems in sleep onset delay and sleep-disordered breathing than parents of autistic children in the U.S. However, the results should be interpreted with caution due to methodological differences between studies in terms of the age range of participants and the year of data collection. Therefore, more direct comparisons of sleep duration and disturbances of autistic children between countries need to be encouraged. Furthermore, since previous studies only compared sleep disturbances of autistic children using a parent-reported questionnaire, it is necessary to conduct a cross-cultural study examining sleep duration and disturbances of autistic children using objective sleep measurements.

Therefore, the present study aimed to investigate i) a cross-cultural comparison of objective measures and parent reports of sleep duration and disturbances of TD children and autistic children in the UK and Korea, ii) a cross-syndrome comparison of objective and parent reports of sleep duration and disturbances between TD children and autistic children in each country and iii) the level of agreement between parent-reported children's sleep with objectively measured children's sleep and self-reported children's sleep.

2. Methods

2.1. Participants

Parents of children from TD and ASD groups in the UK and Korea were recruited via online advertisements and snowball sampling methods. Parents of autistic children in the UK were additionally recruited through autism-related social events and parents of autistic children in Korea were recruited through special needs schools. Inclusion criteria for selecting the participants were as follows: (i) aged between 6 and 12 years, and (ii) participants in the UK should be born and raised in the UK while participants in Korea should be born and raised in Korea. Autistic children should have a clinical diagnosis of autism by a healthcare professional. Autism functioning was also examined using the Childhood Autism Rating Scale, 2nd Edition (CARS2). Exclusion criteria were as follows: (i) if participants were taking any sleep medication, (ii) if participants were having conditions that could affect sleep such as flu, poorly controlled epilepsy, asthma or eczema, and problems with adenoids or tonsils, (iii) if participants were diagnosed with attention deficit hyperactivity disorder (ADHD), and (iv) if participants were having hearing or vision difficulties. Additionally, parents of TD children confirmed their children had no developmental concerns and no diagnosis of developmental disorders.

In total, 167 parents took part in a study (*UK TD* $N = 51$; *UK ASD* $N = 36$; *Korea TD* $N = 45$; *Korea ASD* $N = 35$), however one autistic child in the UK and two autistic children in Korea were excluded as they refused to take part in the study. Demographic information for the final samples are shown in Table 1. A total of 96 TD children (*UK* $N = 51$; *Korea* $N = 45$) and 68 autistic children (*UK* $N = 35$; *Korea* $N = 33$) aged between 6 and 12 years were included in the final sample. The mean ages of the TD and ASD groups in the UK were 8.75 years ($SD = 1.87$) and 9.21 years ($SD = 1.97$), respectively. The mean ages of the TD and ASD groups in Korea were 9.14 years ($SD = 1.97$) and 8.27 years ($SD = 1.89$), respectively. Participants' age and gender were compared across the four groups using one-way ANOVA and χ^2 test. A one-way ANOVA indicated no significant age difference between the four groups ($F(3,160) = 1.787$, $p = .152$). However, a Chi-square test indicated significant gender differences between the four groups ($\chi^2(3) = 9.581$, $p = .022$). A separate Chi-square test indicated only a significant difference between Korea TD and ASD groups ($\chi^2(1) = 6.244$, $p = .012$) (See Table 1). CARS2 versions and scores were compared between UK and Korea ASD groups using independent samples *t*-test and χ^2 test, and no significant differences in CARS2 versions ($\chi^2(1) = 3.024$, $p = .082$) and CARS2 scores ($t(66) = -.210$, $p = .834$) were found. Parental education level and the number of family members in a household were compared across the four groups using Kruskal-Wallis test, and there was a significant difference only in the mother's education level ($H(3) = 7.817$, $p = .05$). However, pairwise comparisons between groups did not reveal any significant results (adj. $p > .05$).

2.2. Materials

2.2.1. Actigraphy

Actigraphy (MotionWatch8, CamNTech, Cambridge, UK) was used to measure children's sleep and wake movements objectively. The use of actigraphy for at least five days is recommended to obtain reliable and representative sleep patterns [16]. Therefore, children were asked to wear the actigraphy device on a non-dominant wrist for seven consecutive days. An actigraphy provides nocturnal sleep data including bedtime, getting up time, time in bed, assumed sleep time, actual sleep time, sleep latency, sleep efficiency, number of nocturnal awakenings, duration of nocturnal awakenings and fragmentation index (see Table 2 for the description of actigraphy variables). The sampling rate was 30-s epochs as this was validated for sleep analysis [17], and data were analysed using MotionWare software (CamNtech, Cambridge, UK).

2.2.2. Sleep diary

Parents completed a sleep diary of their child's sleep for the same period as the actigraphy, which was used to support the analysis of actigraphy data [18]. The sleep diary included information about light-out time, final wake-up time, time and duration of daytime naps, time and duration of night awakenings, and if it was a typical bedtime for the child. All questions were open-ended.

2.2.3. Children's sleep habits questionnaire (CSHQ)

The CSHQ is a parent-reported questionnaire examining a child's sleep behaviour during a recent typical week [19]. The CSHQ has 35 items relating to eight major sleep-related subscales (e.g., bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep-disordered breathing and daytime sleepiness). The items were rated on a 3-point scale: scoring 3 if the sleep behaviour occurred "*5 to 7 times per week (usually)*", 2 if it occurred "*2 to 4 times per week (sometimes)*", and 1 if it occurred "*0 to 1 time per week (rarely)*". A total score of 33 items with the exclusion of 2 items that are identical in the bedtime resistance and sleep anxiety subscales represents a child's sleep disturbance. Higher scores indicate more severe sleep disturbances and the cut-off score is 41 according to the original paper [19]. The CSHQ demonstrated satisfactory internal consistencies in community samples of TD children, children who attended a paediatric sleep clinic and populations with developmental disorders [19,20]. Parents of TD children and autistic children in Korea completed a version of the CSHQ translated into Korean (K-CSHQ) which has been validated in a previous study [21]. Cronbach's alpha coefficients for K-CSHQ subscales ranged from 0.37 to 0.68 [21]. Cronbach's alpha coefficients for CSHQ subscales in the current study ranged from 0.59 to 0.83 and from 0.29 to 0.89 for UK TD and UK ASD groups respectively. Cronbach's alpha coefficients for K-CSHQ subscales also ranged from 0.57 to 0.79 and from 0.41 to 0.82 for Korea TD and ASD groups respectively.

2.2.4. Sleep self report (SSR)

The SSR is a self-reported questionnaire assessing the sleep habits of school-aged children (aged between 7 and 12 years) [20]. It consists of 26 items which are similar to some of the CSHQ items. The scoring system of the SSR is the same as the CSHQ scoring system where items are rated on a 3-point scale, ranging from 1 "*0 to 1 time per week (rarely)*", 2 "*2 to 4 times per week (sometimes)*"

Table 1
Child's Demographic information.

Demographic Variables	UK TD ($n = 51$)	Korea TD ($n = 45$)	UK ASD ($n = 35$)	Korea ASD ($n = 33$)
Chronological Age in years (mean ± SD)	8.75 ± 1.87	9.14 ± 1.97	9.21 ± 1.97	8.27 ± 1.89
Age Range	6.00–12.92	6.00–12.92	6.00–12.92	6.00–12.92
Male (%)	28 (54.9%)	23 (51.1%)	26 (74.3%)	26 (78.8%)
CARS2 versions (%)				
Standard version	–	–	16 (45.7%)	22 (66.7%)
High functioning version	–	–	19 (54.3%)	11 (33.3%)
CARS2 Scores (SD)	–	–	32.9 (5.70)	33.2 (4.64)
Mother's education level (%)				
No qualification	3 (6.1%)	0 (0%)	0 (0%)	0 (0%)
GCSE/O-Level Grade A*C, vocational level 2 or equivalents	6 (12.2%)	0 (0%)	0 (0%)	0 (0%)
A-levels, vocational level 3 or equivalents	7 (14.3%)	15 (33.3%)	9 (25.7%)	3 (9.4%)
Undergraduate Degree	24 (49.0%)	25 (55.6%)	14 (40.0%)	22 (68.8%)
Postgraduate Degree	9 (18.4%)	5 (11.1%)	12 (34.3%)	7 (21.9%)
Father's education level (%)				
No qualification	3 (6.7%)	0 (0%)	1 (3.8%)	0 (0%)
GCSE/O-Level Grade A*C, vocational level 2 or equivalents	6 (13.3%)	0 (0%)	2 (7.7%)	1 (3.1%)
A-levels, vocational level 3 or equivalents	9 (20.0%)	16 (35.6%)	6 (23.1%)	3 (9.4%)
Undergraduate Degree	21 (46.7%)	23 (51.1%)	13 (50.0%)	21 (65.6%)
Postgraduate Degree	6 (13.3%)	6 (13.3%)	4 (15.4%)	7 (21.9%)
Number of family members in a household	4.38 (1.09)[a]	4.20 (1.01)	4.14 (0.97)	3.91 (0.84)

Note. Korea = South Korea; SD = Standard Deviation.

Table 2
Description of actigraphy variables.

Actigraphy variables	Description
Bedtime	The light out time when a child goes to bed.
Getting up time	The get up time when a child gets up from a bed.
Time in bed	The total length of time between the bedtime and getting up time.
Assumed sleep time	The total length of time between the time a child falls asleep and wake up time.
Actual sleep time	The total length of sleeping time based on the epoch-by-epoch wake and sleep classification.
Sleep latency	The total length of time between bedtime and fall asleep time.
Sleep efficiency	A percentage of actual sleep time from time in bed.
Number of nocturnal awakenings	The number of segments classified as wake in the epoch-by-epoch wake and sleep categorisation.
Duration of nocturnal awakenings	The average length of each of the segments classified as wake.
Fragmentation index	An indicator for the level of fragmented sleep period.

and 3 "*5 to 7 times per week (usually)*". A higher score indicates more severe sleep disturbances and a reverse scoring is applied when a high score indicates less severe sleep disturbances in some items. Cronbach's alpha coefficient for a total SSR score (23 items obtained from factor analysis) was 0.88 [22]. The SSR consists of a smaller number of questions. Therefore, SSR items were not categorised into specific subscales like the CSHQ subscales. The original authors instead examined Spearman's correlation for each corresponding SSR and CSHQ questions. The results found that the mean of significant r values was 0.22, with a range of r values from 0.13 to 0.36 [22]. The current study developed the Korean version of the SSR through a forward and backward translation of the original SSR questionnaire.

2.2.5. Demographic questionnaire

A demographic questionnaire was used to collect basic demographic information and other information about the child (e.g., the number of family members in a household). Also, information on parental education level was collected. Children's age in years were calculated based on the date of participation and the date of birth of a child obtained from parental responses. Gender was coded as male versus female.

2.3. Procedure

All parents were contacted by telephone to (i) ensure that children met eligibility criteria and (ii) arrange a home visit. All parents and children were met in-person and parents were provided with an information sheet with the details of the study. Then, parents provided written informed consent for their child to take part in a study, and their child also provided verbal assent to participate in the study. The overall response rate was unable to be calculated due to the various recruitment methods employed in this study. Ethical approval was obtained from the UCL Institute of Education Research Ethics Committee and considered the use of risk assessments.

Children were instructed to wear an actigraphy for seven consecutive days while parents were asked to complete a sleep diary during the same period when children were wearing the actigraphy. Although SSR has been used in TD children and children with ADHD [20,22], none of the studies has used SSR to examine self-reported sleep of autistic children. The current study attempted to obtain self-reported sleep of autistic children. However, autistic children who had less than expected cognitive skills found it difficult to answer SSR questions by themselves. Therefore, SSR was mainly obtained from TD children. All parents were also asked to complete the CSHQ and demographic questionnaires. After 7 days of wearing the actigraphy, participants were revisited to collect the actigraphy and questionnaires. All parents completed the sleep diary and CSHQ, and provided information on children's age and gender ($N = 164$). However, there were missing data in the actigraphy data set as some children refused to wear or lost the actigraphy watch (*UK TD* $N = 1$; *UK ASD* $N = 1$; *Korea TD* $N = 1$; *Korea ASD* $N = 3$).

2.4. Statistical analyses

All analyses were carried out using Statistical Package for Social Sciences (SPSS) for Windows Version 26 (SPSS Inc., Chicago, IL). The study included a dataset for four groups (UK TD, Korea TD, UK ASD, and Korea ASD groups). Outliers were screened using Cook's distance. It is typical to gain nonparametric data from atypical populations, therefore outliers have been excluded per analysis if the significance of results was changed after excluding outliers. Excluded outliers were indicated by 'OR' (Outliers Removed).

The normal distribution of data was assessed using the Shapiro-Wilk test. Demographic variables were compared using one-way Analysis of Variance (ANOVA; for age), independent samples t-test (for CARS2 scores), χ^2 test (for gender and CARS2 versions) and Kruskal-Wallis test (for mother's and father's education level and the number of family members in a household). The results were expressed as mean and standard deviation (*SD*) for age; and the number and percentage of males for gender (see Table 1).

Linear regression was used to examine age-related changes in actigraphy and CSHQ variables in each group of children. Spearman's rho was calculated to examine if gender is associated with actigraphy and CSHQ variables. The results found that gender was associated with actigraphy variables only in ASD groups (e.g., time in bed and duration of nocturnal awakenings) and with CSHQ variables only in TD groups (e.g., sleep amount and night wakings) (All $p < .05$). Since gender showed a limited correlation with actigraphy and CSHQ variables while age was significantly correlated with actigraphy and CSHQ variables in both TD and ASD groups, one-way Analyses of Covariance (ANCOVA) was used to examine sleep variables between countries and between TD children and autistic children with a age as a covariate. Dependent variables were actigraphy and CSHQ variables. Fixed variables were UK and Korea TD groups or UK and Korea ASD groups for cross-country comparisons and UK TD and ASD groups or Korea TD and ASD groups for comparisons between TD children and autistic children. Levene's test was used to assess the assumption of homogeneity of variance. Analyses were performed on continuous variables of actigraphy and CSHQ, including bedtime, getting up time, time in bed, assumed sleep time, actual sleep time, sleep-onset latency, duration and number of nocturnal awakenings, sleep efficiency, fragmentation index, CSHQ subscales, and CSHQ total scores. In this study, total sleep time of children was not examined since parents confirmed that their children did not take a nap during the time children were wearing the actigraphy.

A further comparison of the SSR variables was conducted between TD groups in the UK and Korea, and partial correlations were computed to assess the level of agreement between CSHQ and actigraphy variables and between CSHQ and SSR items after controlling for the effect of age. A p-value of less than 0.05 was considered significant.

3. Results

3.1. Cross-cultural comparisons of actigraphy variables of TD children and autistic children in the UK and Korea

3.1.1. Cross-country comparisons of actigraphy variables of TD groups in the UK and Korea

A comparison of actigraphy data between TD children in the UK and those in Korea after controlling for the effect of age was conducted using ANCOVA, and the results are shown in Table 3 and Fig. 1. Comparison of group differences found significant effects in all actigraphy variables (*All* $p \le .05$), except for fragmentation index ($p = .173$). Partial eta squared indicated medium and large effect sizes (all >0.06).

3.1.2. Cross-country comparisons of actigraphy variables of ASD groups in the UK and Korea

The comparison of actigraphy results between autistic children in the UK and those in Korea after controlling for the effect of age was conducted using ANCOVA, and the results are shown in Table 4 and Fig. 2. Comparison of group differences found significant differences between UK and Korea ASD groups in bedtime, getting up time, time in bed, assumed sleep time, actual sleep time and sleep latency (All $p < .05$).

3.1.3. Cross-syndrome comparisons of actigraphy variables between TD and ASD groups in the UK and Korea

The comparison of actigraphy results between TD children and autistic children after controlling for the effect of age in each country was conducted using ANCOVA and the results were shown in Table 5 and Fig. 3. The comparison of actigraphy variables between TD children and autistic children in the UK found significant differences in sleep latency ($F(1,79) = 7.376$, $p = .008$, $\eta^2_p = .085$) and the number of nocturnal awakenings ($F(1,81) = 7.870$, $p = .006$, $\eta^2_p = .089$). Contrastingly, the comparison of actigraphy variables between TD children and autistic children in Korea found significant differences in time in bed ($F(1,71) = 6.141$, $p = .016$, $\eta^2_p = .08$), assumed sleep time ($F(1,71) = 6.541$, $p = .013$, $\eta^2_p = .084$), and duration of nocturnal awakenings ($F(1,71) = 16.837$, $p < .001$, $\eta^2_p = .192$).

3.2. Cross-cultural comparison of parent-reported sleep of TD children and autistic children in the UK and Korea

3.2.1. Cross-country comparison of CSHQ variables of TD groups in the UK and Korea

A comparison of CSHQ variables between TD children in the UK and TD children in Korea after controlling for the effect of age was conducted using ANCOVA, and the results are shown in Table 6 and Fig. 4. Comparison of group differences found significant effects in bedtime resistance, sleep anxiety, daytime sleepiness and overall sleep disturbances (all $p < .001$).

3.2.2. Comparison of CSHQ variables of ASD groups in the UK and Korea

A comparison of CSHQ variables between autistic children in the UK and autistic children in Korea after controlling for the effect of age was conducted using the ANCOVA, and the results are shown in Table 7 and Fig. 5. Comparison of group differences found significant effects in sleep duration ($p = .004$) and parasomnias ($p = .047$).

3.2.3. Cross-syndrome comparison of CSHQ variables between TD and ASD groups in the UK and Korea

The comparison of CSHQ results between TD children and autistic children after controlling for the effect of age in each country was conducted using ANCOVA and the results are shown in Table 8 and Fig. 6. The comparison of CSHQ variables between TD children and autistic children in the UK found significant differences in 6 CSHQ subscales (e.g., bedtime resistance, sleep onset latency, sleep duration, sleep anxiety, night waking and parasomnias) and a total CSHQ score (all $p < .05$). Contrastingly, the comparison of CSHQ variables between TD children and autistic children in Korea found significant differences in 2 CSHQ subscales such as sleep onset latency ($p = .004$) and daytime sleepiness ($p = .015$).

3.3. Examining the agreement between parent-reported Children's sleep with objectively measured Children's sleep and self-reported Children's sleep

3.3.1. Correlations between parent-reported Children's sleep and objectively measured Children's sleep

Partial correlation was used to study correlations between parental responses to three subscales of CSHQ (i.e., sleep duration, sleep latency, and night waking) and actigraphy variables that correspond to the CSHQ subscales (i.e., time in bed, assumed sleep time, actual sleep time, sleep latency, and the number and duration of nocturnal awakenings) after controlling for the effects of children's age (see Table 9). For parent-reported children's problems with sleep duration, significant negative associations were found

Table 3
Mean(SD) and TD group differences in the UK and Korea using ANCOVA for actigraphy variables.

	TD Groups				
	UK ($n = 50$)	Korea ($n = 44$)	F	P	η^2_p
Bedtime (hh:mm)	20:53 (0:45)	22:17 (0:42)	88.790	<.001***	.494
Getting up time (hh:mm)	7:02 (0:35)	7:47 (0:35)	40.283	<.001***	.307
Time in bed (hrs)	10.14 (0.64)	9.31 (0.74)	36.227	<.001***	.285
Assumed sleep time (hrs)	9.57 (0.61)	8.79 (0.85)	28.31	<.001***	.237
Actual sleep time (hrs)	8.25 (0.61)	7.33 (0.73)	46.043	<.001***	.336
Sleep latency (mins) OR	25.3 (14.6)	19.3 (11.7)[a]	5.103	.026*	.055
Number of nocturnal awakenings	43.0 (7.15)	36.3 (8.20)	16.523	<.001***	.154
Duration of nocturnal awakenings (mins)	1.85 (0.46)	2.44 (0.61)	28.563	<.001***	.239
Sleep efficiency (%)	81.3 (3.87)	78.0 (5.0)	12.883	.001***	.124
Fragmentation index	26.0 (5.83)	27.3 (6.43)	1.889	.173	.020

Note. [a] $n = 41$. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

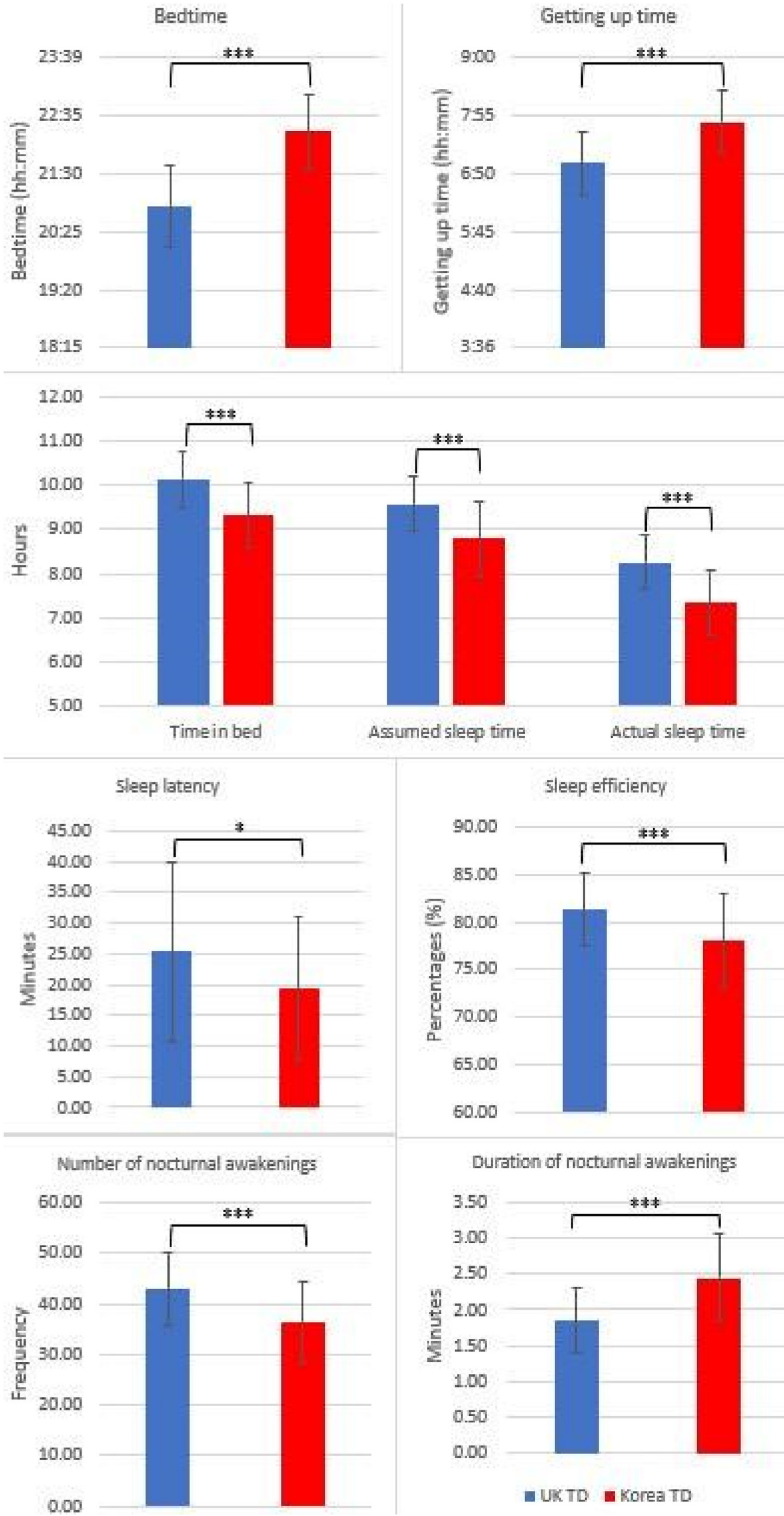

Fig. 1. Mean(SD) of actigraphy variables between UK and Korea TD groups.
Note. * represents $p \leq .05$. ** represents $p \leq .01$. *** represents $p \leq .001$.

Table 4
Mean(SD) and ASD group differences in the UK and Korea using ANCOVA for actigraphy variables.

	ASD groups				
	UK ($n = 34$)	Korea ($n = 30$)	*F*	*P*	η^2_p
Bedtime (hh:mm)	20:56 (1:00)	22:19 (0:55)	49.830	<.001***	.450
Getting up time (hh:mm)	7:06 (0:54)	7:33 (0:51)	4.024	.049*	.062
Time in bed (hrs)	10.13 (0.92)	9.10 (0.78)	40.166	<.001***	.397
Assumed sleep time (hrs)	9.28 (0.79)	8.48 (0.88)	20.778	<.001***	.254
Actual sleep time (hrs)	7.99 (0.87)	7.21 (0.70)	21.701	<.001***	.262
Sleep latency (mins)	42.09 (39.51)	25.38 (17.84)	5.723	.020*	.090
Number of nocturnal awakenings	37.31 (10.31)	37.96 (9.50)	.000	.999	.000
Duration of nocturnal awakenings (mins)	2.28 (1.55)	1.90 (0.48)	1.138	.290	.018
Sleep efficiency (%)	78.98 (8.05)	78.93 (5.79)	.038	.845	.001
Fragmentation index	26.84 (9.27)	25.61 (6.50)	.067	.797	.001

Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

between (i) assumed sleep time and actual sleep time of TD children in the UK, and between (ii) time in bed and assumed sleep time of autistic children in Korea. For parent-reported children's problems with sleep latency, significant positive associations were found between actigraphy-measured sleep latency of autistic children both in the UK and Korea. For parent-reported children's problems with night waking, significant associations were found between actigraphy-measured the number of nocturnal awakenings of TD children in Korea and duration of nocturnal awakenings of autistic children in Korea.

3.3.2. Comparison of parent-reported Children's sleep with self-reported Children's sleep in TD groups in the UK and Korea

All TD children were able to complete the SSR, except for two TD children in the UK who refused to complete the SSR. There were no significant age differences between TD children in the UK ($M = 8.65$, $SD = 1.80$) and those in Korea ($M = 9.14$, $SD = 1.97$) who completed the SSR ($t(92) = -1.249$, $p = .215$). Comparisons of some items from SSR and a total SSR score between those two groups are shown in Table 10. The SSR items on which UK TD group had significantly lower scores than Korea TD group include ‘go to bed at same time every night’ ($p = .002$), ‘fall asleep with a family member’ ($p < .001$), ‘afraid of sleeping alone’ ($p = .001$), ‘have nightmares’ ($p < .001$), ‘take naps during the day’ ($p = .001$) and ‘total SSR scores’ ($p < .001$)., whereas significantly higher scores were found in the item ‘go to someone else's bed during the night ($p = .012$).

3.3.3. Correlations between parent-reported Children's sleep and self-reported Children's sleep

Partial correlation was used to study correlations between parental responses to 12 CSHQ items and children's corresponding responses to 12 similar items from SSR after controlling for the effect of children's age (see Table 11). For TD children in the UK, two items from CSHQ and SSR showed statistically significant correlations, such as ‘fall asleep in other people's bed’ ($p = .003$), and ‘trouble waking up in the morning’ ($p < .001$). Other SSR items, relating to bedtime, sleep latency, sleep resistances, sleep anxiety and sleep duration, did not show significant correlations ($p > .05$). For TD children in Korea, four items from CSHQ and SSR showed statistically significant correlations, including ‘fall asleep in other people's bed’ ($p = .006$), ‘afraid of the dark’ ($p = .001$), ‘go to someone's bed’ ($p = .03$) and ‘trouble waking up in the morning ($p = .021$). Other SSR items, relating to bedtime, sleep latency, sleep resistances, and sleep duration did not show significant correlations ($p > .05$).

4. Discussion

The primary aims of this study were to investigate objectively measured and parent-reported sleep duration and sleep disturbances of TD children and autistic children and how they would differ between countries (e.g., the UK vs. Korea) and between neurodevelopmental conditions (e.g., TD children vs. autistic children). The present study also examined associations between parent-reported children's sleep and objectively measured and self-reported children's sleep. The results revealed a number of expected and unexpected findings which will be discussed in detail below.

4.1. Cross-country comparisons of objectively measured sleep duration and disturbances of TD children and autistic children in the UK and Korea

Actigraphy data were consistent with previous reports of earlier bedtime, earlier wake up time, and longer sleep duration in infants or pre-school aged children in predominantly-Caucasian countries than those in predominantly-Asian countries [1,2]. The current study also found that TD children in the UK had earlier bedtime, earlier getting up time, longer time in bed, longer assumed sleep time and longer actual sleep time compared to TD children in Korea. The similar finding was found in ASD groups that autistic children in the UK had significantly earlier bedtime and getting up time and longer time in bed, assumed sleep time and actual sleep time than those in Korea. Therefore, these findings suggest that children in Asian countries generally have shorter sleep duration than children in Caucasian countries, regardless of neurodevelopmental conditions. These cultural differences in bedtime and sleep duration may be attributed to the cultural value of cosleeping and solitary sleeping. In general, infants and children in Asian countries were more likely to cosleep with their family members while their peers in Caucasian countries were more likely to sleep alone [1,2]. However, a study comparing cosleepers and solitary sleepers in Italy found that cosleepers had a significantly later bedtime and shorter nocturnal sleep duration than solitary sleepers [23]. Thus, cultural values of cosleeping in Asian countries may result in a later bedtime and shorter sleep duration for children. A further study is required to confirm the relationship between cosleeping and children's sleep duration and bedtime. Furthermore, during childhood, children's bedtime and sleep duration may also be influenced by parents' perceptions of the importance of sleep for children, since parents play a crucial role in ensuring children's sleep habits. There is a high emphasis on education in Asian countries such as Korea, causing parents to have great pressure on their children to reduce their sleep and increase their study time in order to prepare for a competitive college entrance exam. This has been confirmed by Yang et al.‘s study (2005) which found that students in Korea (grades 5 to 12) reported later bedtime and decreased total sleep time, and the main reason for sleep deprivation was academic

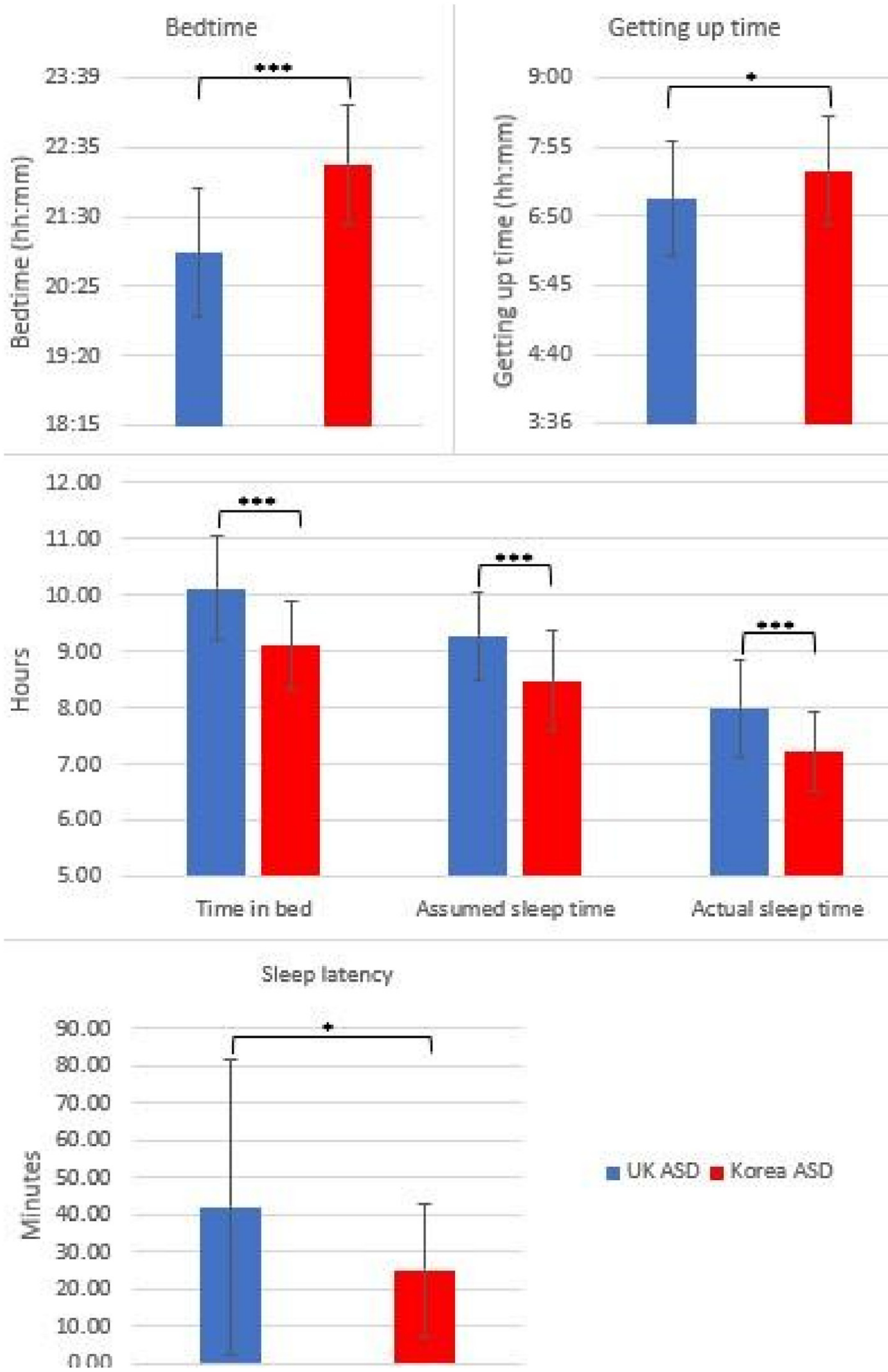

Fig. 2. Mean(SD) of actigraphy variables between UK and Korea ASD groups.
Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

demands from all children across different grade levels [24]. The reduced value of sleep has also been demonstrated in general population, showing the tendency to sleep less and work longer in Asian societies than Western societies [25,26]. Accordingly, parents in Asian countries may place a lower value on sleep while raising their children than Western parents. This could also be true for parents of autistic children.

Furthermore, it was predicted that TD children in the UK would have less frequent nocturnal awakenings than TD children in Korea. However, the current study found more frequent nocturnal awakenings in TD children in the UK. The finding could be due to a significant difference in sleep duration between TD children in the UK and Korea. Since the TD children in the UK had longer nocturnal sleep duration, they might have an increased chance of having nocturnal awakenings than their TD peers in Korea who had shorter nocturnal sleep duration. When comparing the actigraphy results of autistic children in the UK and Korea, no significant differences in the number of nocturnal awakenings and sleep efficiency were found. A similar number of nocturnal awakenings and similar sleep quality between autistic children in the UK and Korea provided an

Table 5
TD and ASD group differences in the UK and Korea using ANCOVA for actigraphy variables.

	UK				Korea			
	Comparison	F	P	η^2_p	Comparison	F	P	η^2_p
Bedtime (hh:mm)	TD < ASD	.054	.818	.001	TD < ASD	.563	.455	.008
Getting up time (hh:mm)	TD < ASD	.092	.762	.001	TD > ASD	3.298	.074	.044
Time in bed (hrs)	TD > ASD	.223	.638	.003	TD > ASD	6.141	.016*	.080
Assumed sleep time (hrs)	TD > ASD	2.472	.120	.030	TD > ASD	6.541	.013*	.084
Actual sleep time (hrs)	TD > ASD	1.719	.194	.021	TD > ASD	2.478	.120	.034
Sleep latency (mins)	TD < ASD	7.376	.008**	.085	TD < ASD	.874	.353	.013
Number of nocturnal awakenings	TD > ASD	7.870	.006**	.089	TD < ASD	.018	.893	.000
Duration of nocturnal awakenings (mins)	TD < ASD	3.046	.085	.036	TD > ASD	16.837	<.001***	.192
Sleep efficiency (%)	TD > ASD	3.086	.083	.037	TD < ASD	.817	.369	.011
Fragmentation index	TD < ASD	.191	.663	.002	TD > ASD	3.002	.087	.041

Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

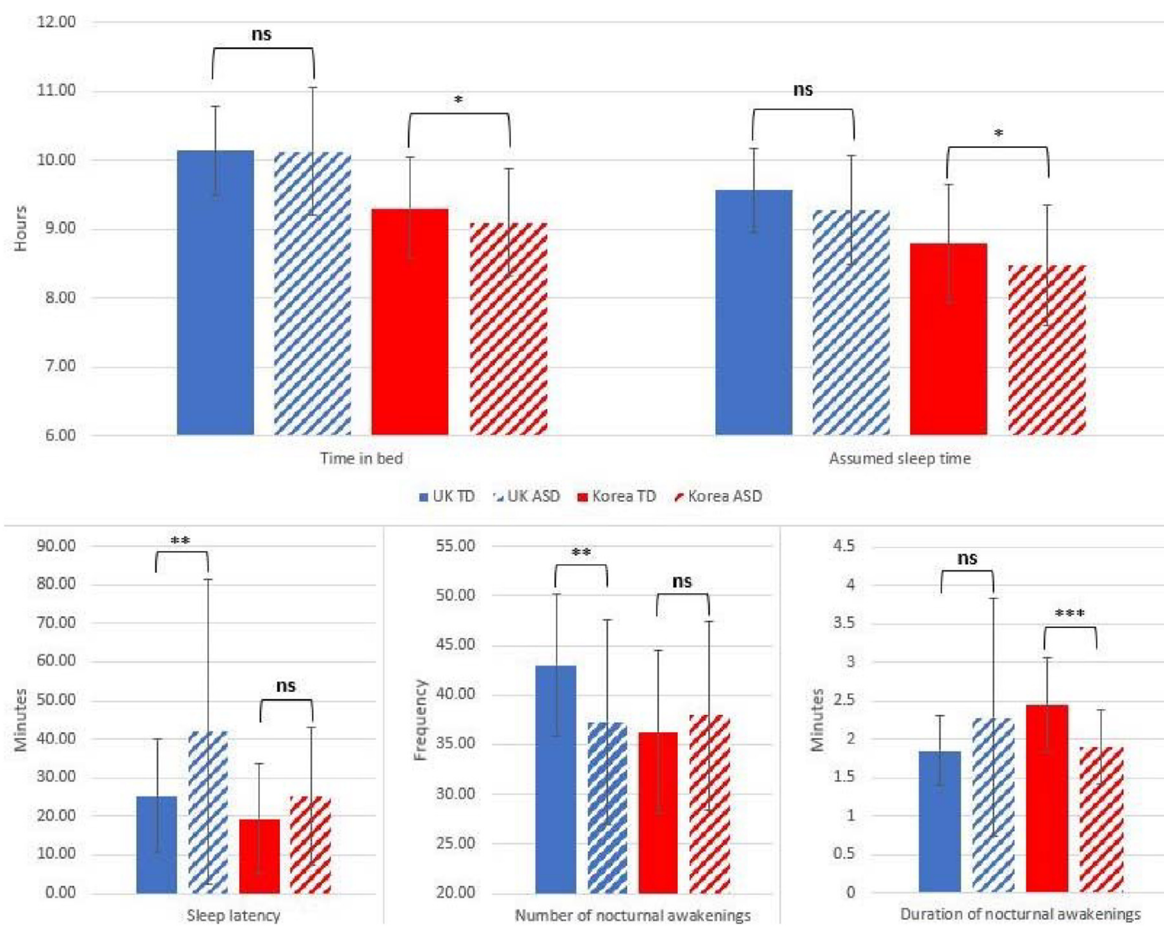

Fig. 3. Mean(SD) of actigraphy variables and comparison of TD and ASD groups in the UK and Korea.
Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001. ns represents nonsignificance.

insight that nocturnal awakenings and sleep quality of autistic children were less likely to be influenced by cultural factors and instead, they are more likely to be related to their clinical characteristics (e.g., sensory overresponsivity [27]). Nevertheless, the findings of significant cultural differences associated with bedtime, getting up time and nocturnal sleep duration of autistic children may represent that timing of sleep and wake and sleep duration are associated with cultural factors.

Previous literature that investigated sleep disturbances of autistic children compared with their TD peers found that the most prevalent sleep disturbances observed in autistic children are insufficient sleep, longer sleep latency and frequent nocturnal awakenings [28–31]. Findings in the current study were consistent with previous studies where autistic children in Korea were observed to have shorter nocturnal sleep duration than their TD peers in Korea, and autistic children in the UK had significantly longer sleep latency than their TD peers in the UK. Thus, sleep of autistic children seems to be influenced by genetic risk factors. Several shared genetic risk factors in dopamine pathway were found between autism and anxiety and low resilience to stress [32,33]. These biological factors have role in maintenance of post-stress activation hypothalamic-pituitary-adrenal (HPA) axis that

Table 6
Mean(SD) and TD group differences in the UK and Korea using ANCOVA for CSHQ variables.

	TD Groups				
	UK (n = 51)	Korea (n = 45)	F	P	η^2_p
Bedtime resistance (6–18)	7.80 (2.55)	10.44 (2.85)	31.479	<.001***	.253
Sleep onset latency (1–3)	1.49 (0.78)	1.36 (0.61)	.722	.398	.008
Sleep duration (3–6)	4.43 (1.42)	4.56 (1.58)	.057	.812	.001
Sleep anxiety (4–12)	5.43 (1.83)	7.07 (2.60)	18.006	<.001***	.162
Night waking (3–9)	4.18 (1.40)	4.29 (1.33)	.434	.512	.005
Parasomnias (7–21)	9.14 (2.15)	9.09 (1.93)	.006	.937	.000
Sleep disordered breathing (3–9)	3.59 (1.08)	3.44 (0.97)	.547	.461	.006
Daytime sleepiness (8–24)	12.29 (3.42)	15.00 (3.55)	15.280	<.001***	.141
Total score (33–96)	45.69 (8.07)	51.27 (7.95)	14.455	<.001***	.135

Note. Possible score range is shown in brackets for each CSHQ subscales. Higher scores correspond with greater sleep disturbances. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

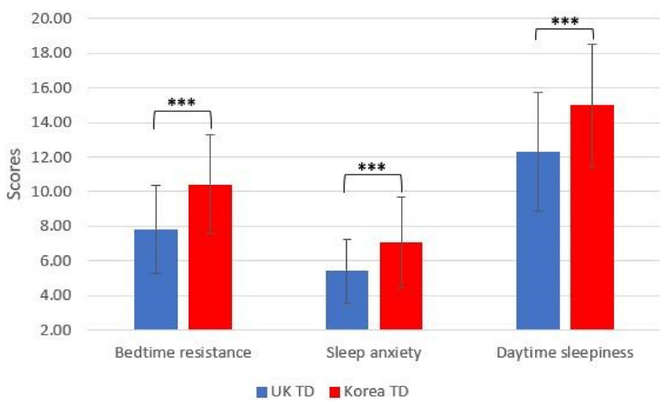

Fig. 4. Mean(SD) of CSHQ variables between UK and Korea TD groups.
Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

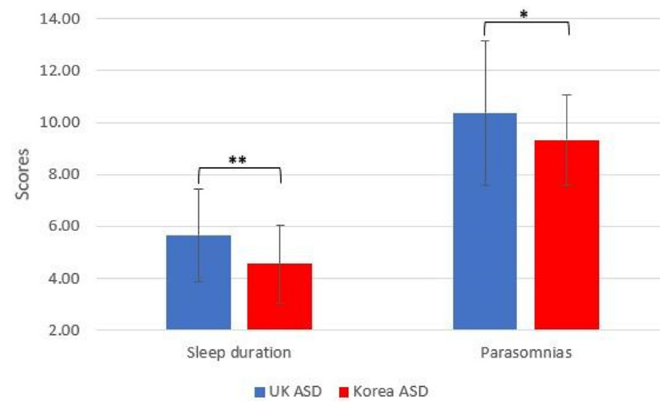

Fig. 5. *Mean(SD) of CSHQ variables between UK and Korea ASD groups.*
Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

in turn could be associated with sleep disruption [34]. However, in contrast to previous findings, the current study found a less frequent number of nocturnal awakenings in autistic children in the UK than their TD peers in the UK and no significant difference in the number of nocturnal awakenings between TD children and autistic children in Korea. It is important to note that the current study excluded children who were unable to wear actigraphy due to tactile sensitivity issues. A growing body of evidence has demonstrated that sensory hypersensitivity in autistic children is related to greater sleep disturbances with a stronger relationship found in younger autistic children than older autistic children [27,35]. Moreover, a recent study of school-aged TD children also found that sensory problems, specifically, increased sensory avoidance was associated with an increased incidence of night wakings [36]. Thus, this finding of the present study may rather represent the nocturnal awakening patterns of autistic children who do not have sensory hypersensitivity issues. Further cross-cultural examination of sleep patterns of autistic children with sensory over-responsivity would be needed. Furthermore, differences in sleep disturbances between TD children and autistic children seem to be country-specific because significant group differences in sleep duration were only found in children in Korea, while TD and ASD group differences in sleep latency were only found in the UK. This finding may be the result of cultural differences in bedtime. According to the present study, autistic children in the UK had a significantly earlier bedtime than autistic children in Korea. However, alterations of circadian hormones such as melatonin and cortisol have been found to be promising biomarkers for ASD [37,38], which, in turn, has been

Table 7
Mean(SD) and ASD group differences in the UK and Korea using ANCOVA for CSHQ variables.

	ASD groups				
	UK (n = 35)	Korea (n = 33)	F	P	η^2_p
Bedtime resistance (6–18)	10.20 (3.96)	11.76 (2.18)	2.661	.108	.039
Sleep onset latency (1–3)	2.20 (0.72)	1.88 (0.86)	3.119	.082	.046
Sleep duration (3–6)	5.66 (1.80)	4.55 (1.48)	9.049	.004**	.122
Sleep anxiety (4–12)	7.66 (2.40)	7.73 (1.86)	.078	.781	.001
Night waking (3–9)	5.26 (1.92)	4.85 (1.89)	.532	.469	.008
Parasomnias (7–21)	10.37 (2.79)	9.33 (1.76)	4.095	.047*	.059
Sleep disordered breathing (3–9)	3.40 (0.74)	3.88 (1.50)	2.253	.138	.034
Daytime sleepiness (8–24)	13.66 (4.02)	13.15 (3.14)	.092	.763	.001
Total score (33–96)	54.89 (11.51)	52.18 (7.14)	1.544	.218	.023

Note. Possible score range is shown in brackets for each CSHQ subscales. Higher scores correspond with greater sleep disturbances. * represents p < .05, ** represents p < .01, *** represents P < .001.

Table 8
TD and ASD group differences in the UK and Korea using ANCOVA for CSHQ variables.

	UK				Korea			
	Comparison	F	P	η^2_p	Comparison	F	P	η^2_p
Bedtime resistance	TD < ASD	13.345	<.001***	.139	TD < ASD	2.208	.141	.029
Sleep onset latency	TD < ASD	18.671	<.001***	.184	TD < ASD	8.698	.004**	.104
Sleep duration	TD < ASD	11.759	.001***	.124	TD > ASD	.001	.976	.000
Sleep anxiety	TD < ASD	26.235	<.001***	.240	TD < ASD	.201	.655	.003
Night waking	TD < ASD	9.618	.003**	.104	TD < ASD	1.763	.188	.023
Parasomnias	TD < ASD	5.353	.023*	.061	TD < ASD	.028	.867	.000
Sleep disordered breathing	TD > ASD	.802	.373	.010	TD < ASD	2.288	.135	.030
Daytime sleepiness	TD < ASD	2.613	.110	.031	TD > ASD	6.207	.015*	.076
Total score	TD < ASD	19.229	<.001***	.188	TD < ASD	.025	.875	.000

Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

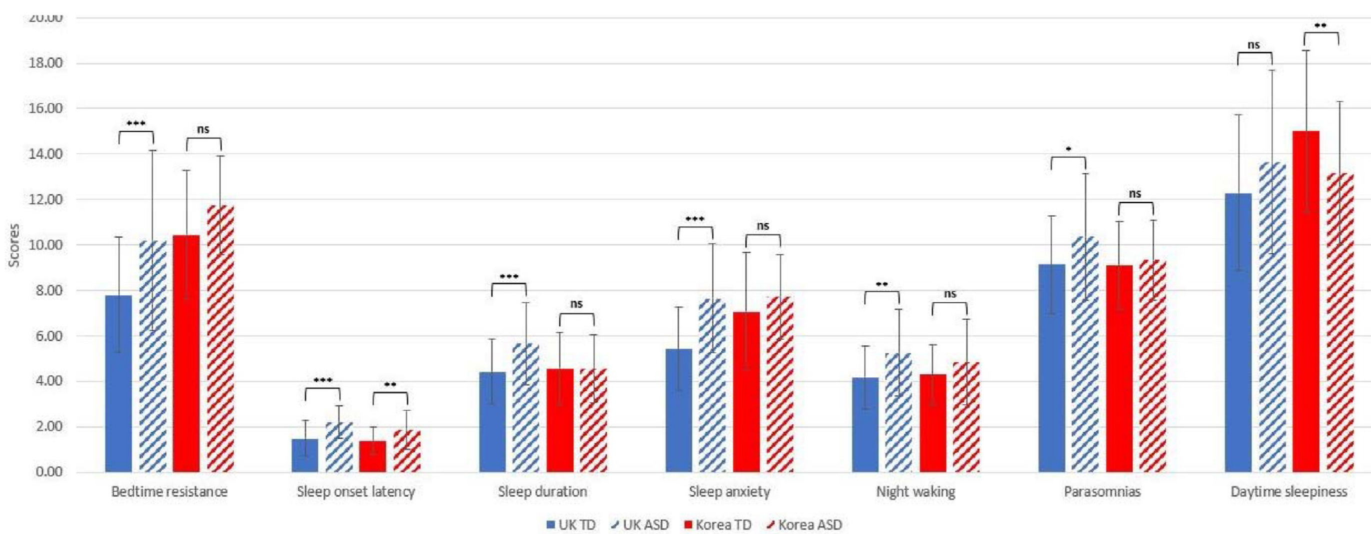

Fig. 6. Mean(SD) of CSHQ subscale scores and group comparisons of TD and ASD groups in the UK and Korea.
Note. P-values indicate significant differences between TD and ASD groups. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001. ns represents nonsignificance.

related to delayed sleep-wake cycles [39]. The delayed sleep phase type of sleep problem is defined by a significant later initiation of sleep than the desired bedtime [40]. Therefore, it is possible that autistic children in the UK may have earlier bedtime despite the delayed sleep phase type of sleep problems that autistic children may experience, since it is desired in the UK society, and this may result in them staying awake until late, resulting in a longer sleep onset latency. Alternatively, autistic children in Korea had later bedtimes, which resulted in a shorter sleep onset latency because their bedtimes were closer to their delayed sleep phase. Consequently, this suggests that biology and culture are intertwined in determining the sleep patterns of autistic children. Although the results could also be attributed to moderating effects of other factors such as concurrent intellectual disabilities on sleep of autistic children [28,30], such cultural variations in TD and ASD group differences of sleep disturbances have to be considered by practitioners when designing and implementing interventions for sleep disturbances of autistic children in each country. The findings of the current study may suggest that sleep latency should be more concerned in autistic children in the UK, while insufficient sleep should be more concerned in autistic children in Korea. More research is needed to confirm this finding.

4.2. Cross-country comparisons of parent-reported sleep duration and disturbances of TD children and autistic children in the UK and Korea

The comparison of parent-reported sleep of TD children in the UK and Korea found that parents of TD children in Korea were more likely to report bedtime resistance, sleep anxiety, daytime

Table 9
Correlation between CSHQ and actigraphy variables in TD and ASD groups in the UK and Korea.

		UK TD			Korea TD			UK ASD			Korea ASD		
CSHQ variables	Actigraphy variables	N	R	P	N	R	p	N	R	p	N	R	p
Sleep duration	Time in bed	47	−.27	.066	41	−.12	.432	31	−.08	.664	27	−.41	.029*
	Assumed sleep time	47	−.33	.020*	41	−.04	.802	31	−.34	.054	27	−.47	.009**
	Actual sleep time	47	−.32	.024*	41	−.03	.838	31	−.29	.107	27	−.26	.166
Sleep latency	Sleep latency	47	.268	.063	40	−.16	.305	29	.48	.007**	26	.41	.032*
Night waking	Number of nocturnal awakenings	47	−.11	.451	41	−.32	.037*	31	−.22	.211	27	.04	.834
	Duration of nocturnal awakenings	47	.11	.440	41	.28	.075	31	.17	.334	27	.44	.017*

Note. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

Table 10
Comparison of SSR results of TD groups in the UK and Korea.

SSR Items	TD groups UK (*n* = 49)	Korea (*n* = 45)	*F*	*p*	η^2_p
Hard for you to go to bed	1.53 (0.71)	1.53 (0.79)	.000	.993	.000
Fight with parents about bedtime	1.31 (0.59)	1.31 (0.60)	.017	896	.000
Go to bed at same time every night	1.55 (0.77)	2.07 (0.84)	10.616	.002**	.104
Fall asleep in 20 min	1.82 (0.86)	1.67 (0.74)	.931	.337	.010
Fall asleep with a family member	1.51 (0.74)	2.62 (0.75)	61.608	<.001***	.404
Afraid of sleeping alone	1.35 (0.69)	1.82 (0.94)	11.581	.001***	.113
Afraid of dark	1.61 (0.84)	1.58 (0.78)	.000	.998	.000
Sleep too little	1.39 (0.64)	1.40 (0.65)	.001	.976	.000
Up late when parents think you're asleep	1.45 (0.61)	1.58 (0.66)	1.036	.311	.011
Pain wakes you up at night	1.12 (0.44)	1.11 (0.32)	.013	.911	.000
Go to someone else's bed during the night OR	1.31 (0.55)	1.05 (0.22)	6.556	.012*	.070
Have nightmares	1.33 (0.56)	2.07 (0.89)	24.032	<.001***	.209
Take naps during the day	1.04 (0.20)	1.36 (0.61)	12.831	.001***	.124
SSR total score	18.31 (3.21)	21.24 (2.99)	25.150	<.001**	.217

Note. OR = Outliers Removed. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

Table 11
Correlation between CSHQ and SSR items in TD groups in the UK and Korea.

CSHQ items	SSR items	UK (*n* = 49) CSHQ	SSR	*r*	*p*	Korea (*n* = 45) CSHQ	SSR	*r*	*p*
Goes to bed at same time	Bed at same time	1.16 (0.43)	1.55 (0.77)	.194	.186	1.47 (0.55)	2.07 (0.84)	.057	.713
Fall asleep in other people's bed	Fall asleep in other people's bed	1.45 (0.79)	1.51 (0.74)	.423	.003**	1.84 (0.93)	2.62 (0.75)	.406	.006**
Fall asleep in 20 min	Fall asleep in 20 min	1.43 (0.74)	1.82 (0.86)	.143	.333	1.36 (0.61)	1.67 (0.74)	−.136	.380
Struggles at bedtime	Fight about going to bed	1.20 (0.50)	1.31 (0.58)	.123	.403	1.07 (0.25)	1.31 (0.60)	.014	.929
Afraid sleeping in the dark	Afraid of the dark	1.55 (0.74)	1.61 (0.84)	.097	.514	1.78 (0.82)	1.58 (0.78)	.483	.001***
Afraid sleeping alone	Afraid sleeping alone	1.37 (0.67)	1.35 (0.69)	.040	.787	2.02 (0.87)	1.82 (0.94)	.100	.520
Sleeps too little	Sleep too little	1.59 (0.64)	1.39 (0.64)	.139	.346	1.51 (0.73)	1.40 (0.65)	−.118	.444
Move to other people's bed	Go to someone's bed OR	1.33 (0.59)	1.31 (0.55)	.213	.146	1.56 (0.66)	1.13 (0.34)	.327	.030*
Hard time getting out of bed	Trouble waking up in the morning	1.49 (0.68)	1.76 (0.88)	.552	<.001***	1.80 (0.84)	1.98 (0.94)	.348	.021*
Awakens during night	Awakens during night	1.14 (0.35)	1.45 (0.61)	.181	.217	1.04 (0.21)	1.58 (0.66)	.152	.326
Needs parent in room to sleep	Fall asleep alone	1.37 (0.76)	1.63 (0.91)	.145	.326	1.96 (0.93)	2.51 (0.82)	−.011	.945
Alarmed scary dream	Have nightmares	1.35 (0.52)	1.33 (0.55)	.091	.537	1.24 (0.43)	2.07 (0.89)	.249	.103

Note. OR = Outliers Removed. * represents p ≤ .05. ** represents p ≤ .01. *** represents p ≤ .001.

sleepiness and overall sleep disturbances in their children compared to parents of TD children in the UK. This is consistent with the findings of Liu et al.'s study (2015) which also found that parents of children in China (aged 4–13 years) reported significantly greater problems in bedtime resistance, daytime sleepiness and overall sleep problems than parents of their peers in the U.S [4]. Perhaps this could be due to more prevalent cosleeping in Asian countries [1,2], so parents of TD children in Korea might be more likely to cosleep with their children and thus become more aware of their children's sleep problems during the night. This explanation could be supported by the results of a study that compared parental perceptions of sleep problems in young children between co-sleeper and solitary sleeper groups in the USA [41]. According to this study, parents of reactive co-sleepers were most likely to believe that their child had a sleep problem (23%), followed by parents of intentional co-sleepers (18%) and parents of solitary sleepers (11%) [41]. It should be noted, however, that the difference was not statistically significant, and further research is necessary to determine whether cosleeping contributes to sleep problems in children or whether pre-existing sleep problems in children result in cosleeping. Significantly higher daytime sleepiness in TD children in Korea could be explained by actigraphy results which indicated significantly shorter nocturnal sleep duration in TD children in Korea compared to TD children in the UK. Due to the insufficient sleep of TD children in Korea, they might be more likely to show daytime sleepiness than their peers in the UK. However, it should be noted that in contrast to this actigraphy finding, parent-reported results of TD children's sleep in the UK and Korea did not show significant differences in parental concerns on children's sleep duration. For example, although TD children in the UK had 8.27 h of actual sleep compared to those in Korea who had 7.33 h of actual sleep as determined by actigraphy, parental perceptions of children's sleep problems did not significantly differ between the UK and Korea. These results may represent that there may be cultural differences associated with parental expectations or beliefs about the ideal amount of sleep that their children need to have. Such cultural differences in parental expectations could possibly lead parents of TD children in the UK to overestimate sleep problems or parents of TD children in Korea to underestimate sleep problems related to sleep duration of their child.

Similarly, there were cultural differences in parent-reported sleep disturbances between parents of autistic children in the UK and parents of autistic children in Korea. More specifically, parents of autistic children in the UK reported greater problems in sleep duration and parasomnias than parents of autistic children in Korea. This finding is in line with the previous study which also found cultural differences in parent-reported problems in autistic children between Indonesia and Japan [42], despite variations in the CSHQ subscales that showed cultural differences between studies. However, it should be noted that while parents of autistic children in the UK reported greater sleep duration-related problems in their children than parents of autistic children in Korea, actigraphy results indicated that time in bed (M = 10.13 h) and assumed sleep time (M = 9.28 h) of autistic children in the UK were within the range of recommended sleep duration for school-aged children (e.g., 9–11 h [43]) whereas autistic children in Korea had shorter assumed sleep duration (M = 8.48 h) than the recommended sleep time. Consequently, the cultural differences in sleep disturbances of ASD groups found in parent reports were not supported by actigraphy data. Instead, it suggests that cultural differences may be the result of the differences in parental expectation or beliefs regarding the ideal sleep amount or patterns for children.

Greater sleep disturbances were observed in autistic children in the UK than their TD peers in various CSHQ subscales (e.g., bedtime resistance, sleep onset latency, sleep duration, night wakings and parasomnia). Significantly higher scores on those subscales are consistent with previous literature describing settling and sleep maintenance difficulties in autistic children [29,30,44]. In contrast, autistic children in Korea only showed greater parent-reported problems with sleep onset latency than TD children in Korea and even less problems with daytime sleepiness were reported by parents of autistic children in Korea. This may represent cultural variations in the differences between parent-reports of sleep disturbances of TD children and that of autistic children. It is possible that these cultural differences in parent-reports of sleep disturbances between TD and ASD groups may result from cultural differences in challenging behaviours of autistic children between countries. The findings of a cross-cultural study examining cultural differences in challenging behaviours and social skills in autistic children in four countries (including Israel, South Korea, the UK, and the USA) indicated greater problems in Western cultures than Eastern cultures [45]. Symptoms of neurodevelopmental disorders can result in greater parenting stress than normal [46,47], which may increase the likelihood of developing parental depression [48] which in turn impairs accurate assessments of current conditions of their child [49]. Therefore, it is plausible that autistic children in the UK may have more challenging behaviours than autistic children in Korea, which could result in parents of autistic children in the UK overestimating sleep disturbances in their children. This may result in cultural differences in how sleep disturbances of autistic children differ from their TD peers in different countries. In fact, such cultural variation in parent reports may not be due to actual differences in sleep disturbances between TD children and autistic children in the UK and Korea. Instead, it may represent cultural differences associated with parents' perception of sleep disturbances in autistic children. For example, parents of autistic children in the UK perceived their children's sleep duration to be more problematic than parents of TD children in the UK and parents of autistic children in Korea reported significantly more problems in sleep onset latency than parents of TD children in Korea when actigraphy results did not find a significant difference in sleep duration between TD and autistic children in the UK and no significant differences found in sleep latency between TD and autistic children in Korea. These results, thus, suggest that parents of autistic children tend to underestimate the sleep duration of their children and overestimate problems with sleep onset latency. This result is supported by the previous studies that also reported overestimating children's sleep disturbances among parents of autistic children [50].

Furthermore, parents of autistic children in Korea reported significantly less daytime sleepiness in their children than parents of TD children in Korea. However, in fact, actigraphy results revealed significantly shorter nocturnal sleep duration in autistic children than TD children in Korea. This finding contrast to most previous research that found daytime sleepiness to be higher in autistic children than their TD peers [51–53]. This might be because TD children in Korea had approximately 7 h of actual sleep, which is insufficient for children of this age group. Studies have shown that if TD children have a less than optimal sleep duration, their daytime sleepiness is likely to be increased [54,55], which could be the case in our sample.

4.3. Agreement between parent-reported Children's sleep with objectively measured Children's sleep

Parent reports were not always in agreement with actigraphy data, and the agreement between parent reports and actigraphy varied between groups. Parents of TD children in the UK and parents of autistic children in Korea were reasonably accurate at reporting sleep duration-related problems, while parents of autistic children both in the UK and Korea were reasonably accurate in reporting sleep latency problems. In contrast, parent reports were generally inconsistent with actigraphy data for nocturnal awakening problems. For example, parents of all groups of children underestimated the nocturnal awakening problems in their children, except parents of autistic children in Korea. Parents of autistic children in Korea were accurate in reporting nocturnal awakening problems only if the duration of nocturnal awakening was longer. This finding is in line with a previous study which also found smaller correlations between parent-reported numbers and duration of nocturnal awakenings and objectively measured nocturnal awakenings ($r = .274$, $r = 0.243$, respectively) in the ASD group of children, compared to the correlations found in sleep duration and sleep onset latency ($r = .580$, $r = 0.425$, respectively) [50]. A possible explanation for this finding might be that parents are unable to know the frequency of night awakenings unless they have constant watch over their child during the night. Although parent reports might be useful for identifying specific sleep disturbances such as sleep anxiety and parasomnias compared to actigraphy, due to its inaccuracy in reporting subjective sleep characteristics, future studies should combine the use of parent reports with objective measures or children's reports to supplement one another.

4.4. Agreement between parent-reported Children's sleep with self-reported Children's sleep

The current study examined TD children's self-reported sleep cross-culturally and found differences in various areas of sleep. For example, TD children in the UK were less likely to take naps during the day and reported less sleep anxiety (e.g., afraid of sleeping alone), less nightmares and less overall sleep disturbances (e.g., SSR total scores) compared to TD children in Korea. In contrast, the previous study comparing infants and toddlers in Korea with those in P–C countries found the least frequent and shortest habitual naps in infants and toddlers in Korea ($M_{frequency} = 1.64$, $M_{duration} = 2.47$ h) than those in P–C countries ($M_{frequency} = 2.04$, $M_{duration} = 3.01$ h) [7]. This inconsistency may be due to methodological differences between the studies. For example, Ahn et al.'s study not only examined infants and toddlers in the UK, but also included infants and toddlers in Australia, Canada, New Zealand, and the United States [7]. Involvement of infants and toddlers in other Caucasian countries with different napping patterns may result in inconsistent findings between the studies. Furthermore, inconsistent results between the studies may partly be due to the cultural differences associated with the age a child stops taking naps. For example, a population-based longitudinal British cohort study examined changes in the sleep of children aged 6 months to 11 years and reported that almost all children in the UK took naps until the age of 1.5 years, which rapidly decreased to 2% at the age of 5.75 years [56]. However, a population-based Korean cohort study found that 15.1% of children in Korea still took naps at 5 years [57]. Despite the noted cultural differences in children's daytime naps, it is important to note that the children participating in this study did not take a nap during the day, so the cultural differences found in objectively measured sleep duration were unlikely to be due to differences in daytime napping patterns between TD children in the UK and Korea.

The current study also found that TD children in the UK were more likely to go to someone else's bed during the night compared to their peers in Korea. These results might be related to another finding in children's self-sleep reports that TD children in the UK were less likely to fall asleep with a family member than TD children in Korea. Such differences are likely related to different sleep practices that parents educated their children since they were young. For example, a study found that 5.5% of infants and toddlers in Korea slept in their own room, whereas 63.9% slept in their parents' bed [7]. However, the same study reported 66.2% of infants and toddlers in P–C countries slept in their own room, whereas 12.5% slept in their parents' bed. This may suggest that TD children in the UK were raised to find comfort in sleeping alone and just go to someone else's bed if they have trouble sleeping, while TD children in Korea were raised to find comfort in co-sleeping throughout the night. This finding suggests that it is important to understand cultural variations in values and practices of sleep in children's sleep research.

Considering the associations between 12 items from CSHQ and SSR, significant associations were identified in two items for TD children in the UK and in four items for TD children in Korea. This indicates that parents' and children's perception of sleep disturbances are not compatible in most cases. A similar finding was shown in an original study done by Owens et al. (2000) that no correlation between parental and children's perceptions about sleep disturbances was reported in the American population [19]. However, it should be noted that significant correlations were reported in other studies. For instance, significant correlations between SSR and CSHQ items were shown in 9 items out of 13 items in Portugal's study [58] and 6 of the 11 items in the Netherlands' study [59]. Furthermore, it is important to note that two SSR items were significantly associated with parental reports both in the UK and Korea. Those two items are the questions related to sleep behaviours that could be observed by parents during bedtime and wake up time. Additionally, only TD children in Korea showed significant association with their parent's perception in the items related to sleep anxiety and night awakenings during the night. Given the fact that TD children in Korea were more likely to sleep in someone else's bed (e.g., parents), there is a high possibility that their parents were more likely to notice their children's sleep anxiety and night awakenings during the night compared to parents of TD children in the UK who were more likely to sleep in a separate room. This suggests that parents' and children's perception would be similar if sleep behaviour is observable.

4.5. Implications

The findings of the current study have a number of potential practical implications on child sleep health. In particular, it would be beneficial to directly raise the public's perception that children's sleep duration and disturbances would vary across countries, not only in typical population but also in atypical population. Furthermore, most importantly, the present study found shorter assumed and actual sleep duration in both TD and ASD groups of children in Korea, which was even shorter than the recommended sleep duration for school-aged children by the National Sleep Foundation [43]. Therefore, the findings highlighted the need to increase sleep duration in children in Korea, regardless of their developmental conditions. In order to achieve this, there would be a need to implement sleep education in Korea to raise the parents or public's awareness of the importance of sleep for children. Secondly, according to the results of this study, cultural differences in children's sleep reported by parents may not necessarily reflect differences in children's sleep, rather they may reflect differences in parental expectations or beliefs regarding the ideal amount or patterns of sleep in their children. Therefore, sleep researchers should conduct sleep research in a family sensitive way, exploring how the beliefs, pressures and practical situations of a family may influence sleep patterns of children. Furthermore, culture seems to play a role in how sleep patterns of autistic children differ from sleep patterns of TD children. This finding has important implications for professionals, suggesting the need for autistic children to be provided with customized sleep interventions as a means to address sleep disturbances that are common in certain countries. For instance, based on the comparison of objectively measured sleep between TD and ASD groups in each country, sleep latency problem should be of greater concern for the UK ASD group while sleep duration problem should be of greater concern for the Korea ASD group. Therefore, it would be more beneficial to develop a country-specific intervention by using the results of research conducted in each individual country.

4.6. Limitations

The current study has a few limitations that need to be considered when interpreting the results. First, some autistic children (one child from the UK and three children from Korea) could not tolerate wearing an actigraphy. Considering the previous studies that found greater sleep disturbances if children have high sensory sensitivity [60], those autistic children who could not tolerate the tactile sensitivity might have greater sleep disturbances than their peers with typical development. Thus, the inclusion of those children could result in more profound differences in sleep duration and disturbances from their peers with typical development. Future research should be encouraged to develop an objective sleep measurement for children who have tactile sensitivity. Second, this study explored children's self-sleep reports only for TD groups. Autism spectrum disorder is a complex neurodevelopmental disorder with different levels of severity of symptoms such as language difficulties. The current study included autistic children who have typical language skills, and those who experience language deficits. Therefore, SSR could not be completed by those autistic children who have language deficits. Future studies may be encouraged to recruit autistic children who have verbal fluency to investigate the feasibility of SSR in the ASD population, and explore those children's perception of their sleep duration and disturbances. Furthermore, the present study has a limitation in generalizability because the present study only recruited TD and autistic children who did not meet the exclusion criteria (e.g., not having sleep medications, co-occurring conditions that may affect sleep, ADHD and hearing/vision difficulties). Nevertheless, it was necessary to control these criteria in both groups of children since it is beyond the scope of this study to consider the interaction of sleep with medical and comorbid conditions. It is therefore important to note that children recruited in this study are unlikely to represent the sleep patterns of the broader TD and autism population, but may rather represent the sleep patterns of TD and autism population without medical conditions that can affect their sleep and the comorbidity of ADHD. Lastly, although the current study examined cultural differences associated with children's sleep duration and disturbances between countries, there were limited demographic factors presented in this study, making it difficult to determine if there are other culture-specific demographic variables that may influence sleep patterns of children. For example, children's weekday getting up time is primarily determined by school start times, which may vary across countries. Based on a literature review of 38 studies examining associations between school start times and sleep in teenagers, it was concluded that the majority of studies found that later school start times were associated with a longer weekday sleep duration, including studies that reported a later bedtime [61]. This finding was consistent across Asian and Western countries such as the USA [62], Israel [63], Hong Kong [64], and China [65]. Therefore, future studies may consider measuring school start times to provide explanations for cultural differences in children's bedtime, getting up time and nocturnal sleep duration. Another factor that may also impact children's sleep is screen time; however, a cross-cultural study comparing screen time of early years children in Canada and South Korea found cultural differences in children's screen time, showing children in Canada to have more screen time than children in Korea (e.g., 159 vs. 110 min per day) [66]. Considering significant relationships between screen time and sleep in children [67], it is important to examine if cultural differences in children's screen time could be a contributing factor to cultural differences in children's sleep patterns. Further studies are needed to investigate factors that may result in cultural differences associated with children's sleep.

5. Conclusion

This study conducted cross-cultural comparison of sleep duration and disturbances of TD children and autistic children in the UK and Korea. Cultural differences associated with sleep duration were found in both TD and ASD groups, showing TD and autistic children in the UK had earlier bedtime, earlier getting up time, longer time in bed, longer assumed sleep time and longer actual sleep time than TD and autistic children in Korea. Cultural differences associated with parent-reported children's sleep disturbances were found in both TD and ASD groups, however some results were not supported from actigraphy data. Parent-reported children's sleep was mostly related to objectively measured and self-reported children's sleep if sleep behaviour in question is observable. Taken together, these findings suggest a cultural influence on sleep duration and disturbances in both TD children and autistic children and future studies should combine the use of parent reports with objective measures or children's reports to supplement one another.

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Mina Jeon: Conceptualization, Methodology, Project administration, Formal analysis, Writing – original draft. **Michelle Neoh Jin Yee:** Formal analysis, Writing – original draft, Writing – review & editing, review &editing. **Gianluca Esposito:** Formal analysis, Writing – review & editing. **Elizabeth Halstead:** Supervision, Conceptualization, Methodology, Formal analysis, Writing – review & editing. **Arvin Haghighatfard:** Writing – review & editing. **Dagmara Dimitriou:** Supervision, Conceptualization, Methodology, Formal analysis, Writing – review & editing, All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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