

Effects of Fatigue on Competence and Emotional/Behavioural Problems in Youth: A Longitudinal Study

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Abstract

Background

Fatigue affects youth' mental health, academic performance and social skills. However, little is known about its long-term effects. This study examined how fatigue influences competence and emotional/behavioural problems in children and adolescents.

Methods

This prospective study included 4,575 students aged 6.0–15.5 years (48.5% boys) in Taiwan. Of them, 2,889 (63.1%) were followed up after 1 year. Parents completed the Child Behavior Checklist to report children's emotional/behavioural problems, activities, social and school competence and fatigue. Data were analysed with multiple linear regression and logistic regression models.

Results

At baseline, 19.5% of students experienced fatigue, with follow-up incidence of 10.44 per 100 person-years. Fatigue prevalence increased with age, and about one-fourth exhibited unstable trajectory. Fatigue negatively affected emotional/behavioural problems for both sexes, girls' school competence and boys' activity, social, school and total competence. It also had lasting effects on emotional/behavioural problems and social competence. Students with persistent or intermittent fatigue exhibited lower social and total competence than those without.

Conclusion

Fatigue prevalence increases with age, highlighting the concern for both sexes. It negatively affects social and total competence and emotional/behavioural problems concurrently and longitudinally. Therefore, addressing fatigue during childhood and adolescence is crucial for designing interventions to improve youth performance.

Introduction

Prevalence and influence of emotional and behavioural problems in youth

Emotional and behavioural problems are prevalent among children and adolescents, with prevalence ranging from 16.7% in China to 50% in southern New England (Yang et al., 2019; Ansary et al., 2017). These problems can persist from childhood to adolescence, affecting 30%–70% with ongoing internalising problems and about 20% with ongoing externalising problems (Ansary et al., 2017; Korhonen et al., 2014). Such problems affect social and school competence (Mundy et al., 2017) and increase the risk of developing mental illness (Philipp et al., 2018). They often appear in primary school, a critical period from early puberty to adolescence marked by significant physical, emotional, cognitive and social changes (Yang et al., 2019). In middle and high school, they are linked to poor academic outcomes and may continue into later adolescence (Ansary et al., 2017; Olivier et al., 2020). Studies examining the relationship between emotional and behavioural problems and competence in younger primary school children are limited. As children develop, their patterns of internalising and externalising problems can change because of changes in cognitive maturation, emotional regulation ability and communication skills (Korhonen et al., 2014). Furthermore,

sex differences appear in younger children (6–11 years), but not older groups (12–16 years) (Yang et al., 2019; Olivier et al., 2020). Longitudinal studies are needed to monitor these problems over time.

Characteristics and prevalence of fatigue in youth

Fatigue is common in children, affecting 15%–23% of girls and 13%–24% of boys (Luntamo et al., 2012). Children who experience fatigue often experience extreme tiredness or weakness, aches and pains, sleep disturbance and difficulty relaxing (Couvry-Duchesne et al., 2017; Lamers et al., 2013). Untreated fatigue can develop into chronic fatigue syndrome (CFS) (Collin et al., 2018; Gregorowski et al., 2019), characterised by overwhelming fatigue, somatic symptoms, sleep problems and cognitive impairments for at least 3 months in children (Bested & Marshall, 2015; Fukuda et al., 1994). Adolescents aged 10–19 years are at the highest risk of CFS (Parslow et al., 2018; Tollit et al., 2018). These symptoms can significantly affect children's school participation and performance, with up to 30%–50% of children with CFS reporting a decline in school and academic performance and < 50% of them attending school regularly (Tollit et al., 2018; Taylor et al., 2010)). Post-recovery, many children experience lower competence, physical functioning and general health status and lower school performance and social activities, although their emotional well-being often improves once fatigue resolves (Taylor et al., 2010).

Influence of fatigue on school children

Fatigue is often associated with CFS; however, many children experience it without meeting the CFS criteria (Jacobsen et al., 2017). Approximately one-fourth of schoolchildren experience weekly or daily headaches, more often in girls and older students (Jurišić, 2018). Headaches frequently co-occur with back pain, stomach pain, bad mood, nervousness, irritability and poor sleep quality, contributing to emotional and behavioural problems (Yang et al., 2019). Persistent stress and poor sleep quality in children are linked to suicidal ideation and attempts (Tseng et al., 2019; Chen & Kuo, 2020). Fatigue can hinder daily functioning, including school participation, social interactions and motivation, limiting involvement in family and peer activities (Crichton et al., 2015). Understanding fatigue in children without a specific clinical diagnosis is essential for promoting well-being.

Research gaps and purpose of the study

Numerous studies have demonstrated that children with emotional and behavioural problems are more likely to experience poor daily functioning and performance, although most research is limited by cross-sectional designs (Yang et al., 2019) and small sample sizes (Korhonen et al., 2014). Fatigue is common in youth and can negatively affect mental health and daily functioning in children even without a clinical diagnosis. However, its relationship with functioning and performance remains unclear and long-term effects are understudied. Therefore, we conducted a longitudinal study with a larger sample size to examine causal relationships among these factors. This study aims to 1) evaluate the prevalence of fatigue and emotional/behavioural problems by age and sex, and 2) examine the concurrent and longitudinal effects of fatigue on competence and emotional/behavioural problems in children and adolescents.

Patients and Methods

- Procedures

This prospective study investigated the mental health and behavioural problems of children and adolescents in Taiwan during a critical developmental stage. The baseline survey was conducted in 2011, followed by 2-year follow-up surveys. Participants were recruited from 27 elementary and 18 junior high schools in eight administrative areas of

northern and central Taiwan using a stratified cluster sampling approach. Students completed questionnaires on demographics, personality, eating habits, mental health and behavioural problems, sleep quality, family functioning and other factors based on their grade level. Furthermore, one parent of each student was invited to respond to complete questionnaires on their own personality, emotions and sleep quality and the children's mental health, sleep quality and behavioural problems. Student and parent data could be linked when available; however, some parents or students did not participate fully. Informed consent was obtained from all students and parents, and the study was approved by the Institutional Review Board of the conducting institute. All procedures were followed the ethical standards of the committee and with the Helsinki Declaration.

- Participants

We recruited 4,575 parents at baseline (T1) to report on their children's emotional/behavioural problems, with 2,889 (63.1%) participating in at least one follow-up wave (T2/T3). Some schools withdrew from the follow-up studies due to administrative concerns so that 1,686 (36.9%) participants did not participate in the follow-up waves. In total, 755 (16.5%) participants completed all three waves (i.e. T1, T2 and T3). Table 1 presents baseline demographic characteristics, measures of fatigue, competence and emotional/behavioural problems for participants and non-participants of the follow-up waves. At baseline, 2,219 (48.5%) were boys, with a mean age of 10.53 ± 2.33 years. The elementary school students were grouped into three age groups: 6–7.99 years (low grade), 8–9.99 years (middle grade) and 10–11.99 years (high grade) and junior high school students were grouped into two age groups: 12–12.99 years and ≥ 13 years.

Table 1
Demographic characteristics of the students at baseline (N = 4,575).

Variable	All (N = 4,575)		Follow-up (N = 2,889)		Without follow-up (N = 1,686)	
	N/mean $\pm$ SD	%/Range	N/mean $\pm$ SD	%/Range	N/mean $\pm$ SD	%/Range
Age (year) ^a	10.53 $\pm$ 2.33	(6.05–15.51)	10.54 $\pm$ 2.41	(6.31–14.64)	10.52 $\pm$ 2.18	(6.05–15.51)
Sex ^{b*}						
Boy	2,219	48.50	1,378	47.70	841	49.88
Girl	2031	44.39	1,347	46.63	684	40.57
Age group* (year)						
6.00–7.99	988	21.60	678	23.47	310	18.39
8.00–9.99	902	19.72	618	21.39	284	16.84
10.00–11.99	1,042	22.78	509	17.62	565	33.51
12.00–12.99	537	11.74	355	12.29	182	10.79
≥ 13	983	21.49	725	25.10	258	15.30
Fatigue	894	19.54	584	20.21	310	18.39
Competence						
Activity	5.12 $\pm$ 2.14	(0.00–10.00)	5.16 $\pm$ 2.11	(0.00–10.00)	5.04 $\pm$ 2.20	(0.00–10.00)
Social	6.20 $\pm$ 1.95	(0.00–12.00)	6.17 $\pm$ 1.94	(0.00–12.00)	6.27 $\pm$ 1.97	(0.00–11.33)
School*	4.87 $\pm$ 0.92	(0.00–6.00)	4.95 $\pm$ 0.83	(1.00–6.00)	4.69 $\pm$ 1.08	(0.00–6.00)
Total*	15.77 $\pm$ 4.39	(0.00–28.00)	16.07 $\pm$ 3.97	(0.00–28.00)	15.15 $\pm$ 5.12	(0.00–25.67)
Emotional/behavioural problems						
Anxious/depressed	592	12.94	383	13.26	209	12.40
Withdrawn	633	13.84	401	13.88	232	13.76
Somatic	464	10.14	304	10.52	160	9.49
Thought	244	5.33	151	5.23	93	5.52
Social	645	14.10	403	13.95	242	14.35
Note. ^a 91 (2.0%) participants did not indicate their age; ^b 325 (7.1%) participants did not indicate their sex.						
*significant difference between participants with and without follow-up data (p < 0.01).						

Variable	All (N = 4,575)		Follow-up (N = 2,889)		Without follow-up (N = 1,686)	
	N/mean $\pm$ SD	%/Range	N/mean $\pm$ SD	%/Range	N/mean $\pm$ SD	%/Range
Attention	705	15.40	439	15.20	266	15.78
Rule-breaking	376	8.22	231	8.00	145	8.60
Aggressive	582	12.72	366	12.67	216	12.81
Note. ^a 91 (2.0%) participants did not indicate their age; ^b 325 (7.1%) participants did not indicate their sex.						
*significant difference between participants with and without follow-up data ($p < 0.01$).						

- Measures

Child Behavior Checklist (CBCL)

The CBCL includes 20 items that assess competence and 118 items that assess emotional/behavioural problems over the past 6 months, completed by parents or guardians. The competence items comprise three dimensions: activity, social and school competence, with higher scores indicating better competence. Emotional/behavioural problem items are rated 0 to 2 (0 = not true, 1 = sometimes true or somewhat true and 2 = very true or often true) and grouped into eight narrow-band dimensions: anxious/depressed, withdrawn, somatic complaints, thought problems, social problems, attention problems, rule-breaking behaviours and aggressive behaviours. Raw scores were transformed into T-scores, with 60 or higher indicating a problem (Bassuk et al., 2014). Due to administrative concerns and time limits at schools in the northern cities, only 890 parents completed the competence scales during follow-up. The Chinese version of CBCL shows good internal consistency and test–retest reliability for assessing competence and emotional/behavioural problems among adolescents in Taiwan in previous studies (Chiu et al., 2014; Yang et al., 2000). In this study, confirmatory factor analysis revealed that all eight dimensions had good model fitting among the participants (CFI = 0.808–0.959, TLI = 0.961–0.990, RMSEA = 0.038–0.092, WRMR = 1.321–3.825).

Fatigue

No standard tool was available to measure fatigue in children, so we used prior research identifying fatigue symptoms, including extreme tiredness or weakness, aches and pains, sleep disturbance and difficulty relaxing (Couvry-Duchesne et al., 2017; Lamers et al., 2013). Based on these concepts, we selected five relevant questions from the parent-reported CBCL items: ‘overtired without good reason’ (somatic dimension), ‘headaches’ (somatic dimension), ‘sleeps less than most kids’ (thought dimension), ‘trouble sleeping’ (thought dimension) and ‘underactive, slow moving or lacks energy’ (withdrawn dimension). Confirmatory factor analysis has confirmed these five items measured fatigue well for our study sample (CFI = 0.957, TLI = 0.957, RMSEA = 0.069, WRMR = 1.691). A total score of ≥ 2 in the five items indicated fatigue.

Statistical analysis

We used the chi-square test and Student’s *t*-test to compare demographic characteristics and study variables between students with and without follow-up data. Fatigue prevalence was calculated by sex and age. Among students who participated in baseline and follow-up surveys, did not report fatigue at baseline and completed questionnaires at least

twice (T1–T2 subsets), the incidence of fatigue was calculated. Furthermore, the stability of fatigue status was categorised into three subgroups: persistent fatigue (fatigue at T1 and T2), sometimes fatigue (fatigue at either T1 or T2) and non-fatigue (not fatigue at T1 and T2, the reference group). For students with complete data at all three waves (N = 233), the trajectory of fatigue changes was examined over 2 years.

T1 data were used to examine the concurrent effect of fatigue on four competence scores and eight emotional/behavioural problem dimensions of the CBCL using multiple linear regression models and multivariate logistic regression models. Each model was stratified by sex, with age 10.00–11.99 years as the reference group. Most children in this age group started to enter puberty (Lee et al., 2017), and the age groups before or after this age period were close to pre-puberty or post-puberty. Fatigue items were removed from CBCL. Longitudinal effects were examined using fatigue at T1 and CBCL outcomes at T2. R^2 values were reported for the variance explained by linear regression models. Hosmer–Lemeshow chi-square test was used to indicate model fitting, and Nagelkerke R^2 was reported for the variance explained by logistic regression models. Data analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

- Prevalence, incidence and stability of fatigue

At baseline, 19.54% of students reported fatigue (Table 1). Figure 1 shows that the prevalence of fatigue increased with age in both sexes, with the oldest age group (28.4%–29.4%) reporting a prevalence 2–2.5 times higher than the youngest (11.9%–14.6%). This indicates that a significant proportion of students experienced some level of fatigue across age. Sex differences appeared only in the 8.00–9.99-year age group, where boys (24.7%) reported more fatigue than girls (12.9%, $p < 0.0001$). Among students without fatigue at baseline, the overall incidence rate of fatigue during follow-up was 10.44 per 100 person-years. Although boys had a slightly higher incidence rate than girls (11.84 vs. 9.16 per 100 person-years), the difference was insignificant (IRR = 1.29, $p = 0.08$). Furthermore, boys had a relatively stable fatigue incidence rate across age groups (10.18–13.75 per 100 person-years), while girls increased with age (6.86–14.86 per 100 person-years).

To better understand how fatigue changes over time, we analysed data from at least two waves and identified three groups: persistent fatigue (N = 169, 8.1%), sometimes fatigue (N = 412, 19.7%) and non-fatigue (N = 1,505, 72.1%) groups. For students who completed all three waves, we plotted the trajectory patterns of fatigue over time and found that 75.5% of students had a stable pattern (6.4% were fatigued and 69.1% were not fatigued), whereas 24.4% had an unstable fatigue pattern across three time points, as illustrated in Fig. 2.

- Fatigue and competence

Table 2 shows that at baseline, fatigue had a profound influence on boys' competence in all domains, whereas it negatively affected girls' school competence. Baseline fatigue had lasting effects on social competence at follow-up for both boys (beta = - 0.213, $p = 0.006$) and girls (beta = - 0.178, $p = 0.039$). Competence showed a reverse U-shape across age groups, with both younger and older students exhibiting lower competence in several domains compared with the reference group of 10.00–11.99 years. Those over 12 years old had lower competence in almost all domains, and the youngest had reduced social and total competence. Table 3 shows girls exhibited better school competence than boys (beta = 0.150, $p = 0.025$). Students with persistent fatigue (social: beta = - 0.782, $p = 0.006$; total: beta = - 1.314, $p = 0.025$) and sometimes fatigue (social: beta = - 0.397, $p = 0.037$; total: beta = - 0.786, $p = 0.042$) were linked to lower social and total competence than the non-fatigue group. Compared with the 10.00–11.99-year age group,

students aged ≥ 13 years had negative activity (beta = - 1.073, $p < 0.0001$), school (beta = - 0.837, $p < 0.0001$) and total competence (beta = - 2.779, $p < 0.0001$).

Table 2

Associations between fatigue and CBCL competence according to sex using multiple linear regression analysis.

		Concurrent (N = 4,575)				Longitudinal (N = 890) ^a			
	Beta	Activity	Social	School	Total	Activity	Social	School	Total
Boy	Fatigue	-0.164**	-0.144**	-0.076**	-0.379**	-0.059	-0.213**	-0.064	-0.321
	≥ 13 y/o	-0.316	-0.752**	-0.238**	-1.313**	-1.108**	0.387	-0.857**	-2.987**
	12.00– 12.99 y/o	-0.129	-0.527**	-0.199**	-0.697*	0.001	0.206	-0.156	-0.091
	10.00– 11.99 y/o	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	8.00– 9.99 y/o	0.081	-0.311	-0.052	-0.189	0.307	-0.074	-0.091	-0.140
	6.00– 7.99 y/o	-0.005	-0.706**	-0.030	-0.647*	0.009	-0.371	-0.081	-0.701
	R ²	0.020	0.032	0.034	0.037	0.038	0.027	0.079	0.060
Girl	Fatigue	-0.042	-0.032	-0.065**	-0.130	-0.094	-0.178*	0.006	-0.285
	≥ 13 y/o	-0.469**	-0.755**	-0.227**	-1.463**	-1.151**	0.045	-0.818**	-2.863**
	12.00– 12.99 y/o	-0.320	-0.669**	-0.197**	-1.167**	-0.502*	0.143	0.125	-0.200
	10.00– 11.99 y/o	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	8.00– 9.99 y/o	0.132	-0.318	-0.024	-0.157	0.080	-0.187	0.043	-0.152
	6.00– 7.99 y/o	-0.052	-0.584**	-0.046	-0.778*	-0.484	-0.834*	-0.070	-1.272
	R ²	0.014	0.023	0.038	0.028	0.048	0.031	0.128	0.073
* $p < 0.05$, ** $p < 0.01$									
^a Fatigue at baseline to predict the competence scales at follow-up waves.									

Table 3

Associations between fatigue groups during follow-up^a and CBCL competence at follow-ups using linear regression analysis (N = 890).

Beta	Activity	Social	School	Total
Persistent fatigue	-0.573	-0.782**	-0.235	-1.314*
Sometimes fatigue	-0.189	-0.397*	-0.073	-0.786*
Non-fatigue	Ref	Ref	Ref	Ref
≥ 13 y/o	-1.073**	0.221	-0.837**	-2.779**
12.00–12.99 y/o	-0.227	0.241	-0.025	-0.028
10.00–11.99 y/o	Ref	Ref	Ref	Ref
8.00–9.99 y/o	0.224	-0.106	-0.035	-0.083
6.00–7.99 y/o	-0.266	-0.523	-0.078	-0.992
Girl	0.076	-0.121	0.150*	0.256
Boy	Ref	Ref	Ref	Ref
R	0.043	0.026	0.103	0.068
* $p < 0.05$, ** $p < 0.01$				
^a Fatigue groups during follow-up were defined as persistent fatigue (fatigue at baseline and follow-up), sometimes fatigue (fatigue at either baseline or follow-up) and non-fatigue (non-fatigue at baseline and follow-up)				

- Fatigue and emotional/behavioural problems

Table 1 presents the prevalence of emotional/behavioural problems ranging from 5.33% (thought problems) to 15.40% (attention problems) at baseline. Fatigue had a significant negative effect on all emotional/behavioural problems for both boys (odds ratio [OR] = 1.84–2.48, $p < 0.01$) and girls (OR = 1.87–2.41, $p < 0.01$) at baseline and predicted higher risk at follow-up (OR = 1.34–1.55 for boys, OR = 1.44–1.73 for girls, $p < 0.01$), as shown in Fig. 3.

Younger boys had a higher risk of anxious/depressed (OR = 1.90–2.30, $p < 0.01$), social (OR = 1.69–1.87, $p < 0.01$), attention (OR = 1.99, $p < 0.01$), rule-breaking (OR = 2.14, $p < 0.01$) and aggressive (OR = 1.98–2.01, $p < 0.01$) problems than students aged 10.00–11.99 years. In contrast, older boys had a higher risk of withdrawn problems (OR = 1.60, $p < 0.05$) but fewer somatic complaints (OR = 0.35, $p < 0.01$) and social problems (OR = 0.62, $p < 0.05$). Older girls had lower risk of social problems (OR = 0.42–0.49, $p < 0.01$) and rule-breaking behaviour (OR = 0.29, $p < 0.05$), whereas younger girls had lower risk of withdrawn problems (OR = 0.55, $p < 0.05$).

Discussion

This study examined how fatigue affects competence and emotional/behavioural problems in children and adolescents concurrently and over time. Approximately one in five students reported fatigue, with prevalence rising from age 6 to 15 years, with an increase rate of 10.44 per 100 person-years. The longitudinal survey revealed that around one-quarter of students had a non-stable fatigue pattern, and 6.4%–8.1% experienced persistent fatigue. These findings are consistent with previous studies showing that fatigue is a common health complaint in children, with a prevalence of 13%–24% (Luntamo et al., 2012). Furthermore, our study revealed significant sex and age interactions in the prevalence of fatigue. In particular, an upwards trend was observed in fatigue prevalence with increasing age in

both sexes, reaching 28.4%–29.4% in the oldest group, about 2–2.5 times higher than the youngest group (11.9%–14.6%). Girls reported more fatigue complaints with increasing age, while boys' rate exhibited steadier after age 8. Furthermore, middle-grade boys showed a higher prevalence of fatigue than girls of the same age.

Fatigue during childhood has been linked to various emotional and behavioural problems that can negatively affect a child's academic performance and social functioning (Crichton et al., 2015). Although previous research has suggested that girls generally have higher activity levels, school performance and social competence (Yang et al., 2019), another study found no significant sex-related differences in either internalising or externalising problem trajectories. Instead, the study revealed that activity, school and social competence were associated with an individual's internalising or externalising problems (Korhonen et al., 2014). Our findings align with past research, showing fatigue is strongly tied to emotional/behavioural problems with boys and girls, both concurrently and longitudinally.

Our study demonstrated that pre-puberty boys were more likely to have internalising and externalising problems, including anxiety/depression, attention problems, social rule-breaking behaviours and aggressive problems. In contrast, post-puberty boys had a higher risk of withdrawn problems but a lower risk of somatic and social problems. Pre-puberty girls had a lower risk of withdrawn, while post-puberty girls had lower risks of social and rule-breaking problems. A previous study found that pre-puberty boys tend to have more behavioural problems than girls (Yang et al., 2019). Aggression problems were prevalent among both pre-puberty boys and girls; hyperactivity problems were higher among boys, whereas depression problems were higher among girls. In post-puberty adolescents, boys often had higher aggression, hyperactivity and social problems, whereas girls had more aggression and anxious–compulsive problems. These results support the notion that age affects an individual's behavioural problems, as highlighted in a previous study (Korhonen et al., 2014). Furthermore, the sex-related difference in behavioural problems appears to become more ambiguous as individuals transition from childhood to adolescence (Yang et al., 2019). Age-related patterns may stem from differences in cognitive maturity, emotional regulation and communication skills (Korhonen et al., 2014). However, unlike previous findings, our research did not show pre-puberty girls with a notably higher depression rate than males (25.8% vs. 1.7%) (Yang et al., 2019). Further research is needed; however, it can be concluded that emotional regulation skills are crucial for both sexes.

As expected, fatigue negatively affected the competence of children and adolescents and concurrently reduced activity, social, school and total competence in boys. Girls generally had better school competence than boys, but fatigue lowered it. Fatigue had a lasting effect on social competence for both sexes. Furthermore, fatigue that was sometimes or persistently present had a negative influence on the social and total competence. Our study revealed a reverse U-shaped pattern in competence performance across age groups, with pre-puberty and post-puberty youth exhibiting lower competence in several domains. This may be because these age groups often face new school environments and challenges, leading to nervousness and fatigue. A previous study found that adolescent students who are behaviourally and emotionally engaged in school are better able to cope with challenges, feel more competent and perform better academic tasks (Wang & Fredricks, 2014). Furthermore, behavioural and emotional engagement in school and youth behavioural problems have bidirectional associations over time. Students with lower behavioural and emotional engagement and more behavioural problems are more likely to be absent from school. Fatigue symptoms can negatively influence school participation, as several studies have shown a robust relationship between fatigue and low school attendance (Tollit et al., 2018; Taylor et al., 2010). Prolonged absence and missed peer and social activities may disrupt a child's learning, self-efficacy, sense of control and self-confidence (Taylor et al., 2010). Even after recovery, fatigue may delay school performance and physical and mental functioning (Taylor et al., 2010). The limitations and anxiety associated with many occupational performance areas are associated with decreased activity, school and social competence during adolescence.

- Implication

This study highlights a strong link between fatigue, emotional/behavioural problems and reduced competence in children and adolescents. Parents, schoolteachers and healthcare professionals should be vigilant and take necessary actions when children exhibit fatigue symptoms, such as daytime tiredness and pains, to prevent severe CFS and mental health, social and academic issues. Furthermore, schools and clinics should use a standardised procedure to evaluate fatigue. Interventions such as relaxation techniques, exercise programmes, cognitive behavioural treatment and medications can reduce fatigue and enhance sleep quality in children and adolescents (Solomon-Moore et al., 2019). Previous studies also showed regular exercise can effectively reduce fatigue and prevent physical and mental illnesses in children and adolescents (Solomon-Moore et al., 2019; Kuehn et al., 2023). An acceptance and commitment therapy programme was found to be effective for reducing fear-avoidance cognition and all-or-nothing thoughts and improving fatigue and quality of life in adult patients with chronic fatigue (Jacobsen et al., 2017). Cognitive behavioural therapy for insomnia (CBT-i) has also been validated as an effective treatment for improving sleep quality not only in adults but also in school-age children and adolescents (Dewald-Kaufmann et al., 2019). More research is needed to find better ways to support youth and help them fully engage in family, school and social life. Early intervention can bring long-term benefits for individuals and future generations (Hill et al., 2020).

- Limitations

This study has some limitations. First, relying on parent-reported data for fatigue, behavioural and emotional problems and competence may cause recall bias. Future research could use shorter recall periods, collect data prospectively and incorporate self or teacher reports to provide a more comprehensive picture. Children's self-reported experiences may differ from parents' or teachers' accounts, as some symptoms like pain, sleep problems or low energy may go unnoticed (Luntamo et al., 2012; Gold et al., 2009). Teacher reports can also give more insight into school and social functioning (Gold et al., 2009). While parent reports were valid for this study, adding self-reports could strengthen future findings. Second, the study did not examine other social factors that affect these outcomes, such as peer and teacher–student relationships (Wang et al., 2018). Finally, including school attendance could also improve accuracy, as fatigue may lead to missed classes (Tollit et al., 2018). Future work should explore how social environments interact with fatigue to better understand these connections.

Conclusion

In conclusion, fatigue is common among children and adolescents of both sexes and negatively impacts social and overall competence, as well as emotional and behavioural problems, both concurrently and longitudinally. Preventing and reducing fatigue is essential to enhance the school and social participation of young individuals.

Abbreviations

CFS
chronic fatigue syndrome
CBCL
Child Behavior Checklist

Declarations

Ethics Statement

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2013. All procedures involving human subjects were approved by the Institutional Review Board of National Taiwan University Hospital (No. 201202053RIC).

Consent Statement

Written informed consent was obtained from all students and their parents who participated in the study.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be considered a potential conflict of interest.

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Author Contribution

Y.L.C. contributed to the conception and design of the study, data curation, validation, analysis and drafting of the manuscript. Y.J.S. performed the analysis and provided critical review and editing. H.J.Y. contributed to methodology, secured funding and oversaw project administration. I.B.H. contributed to methodology and project administration. P.H.K. contributed to study conception and design, methodology, drafting of the manuscript, funding acquisition and project administration. All authors reviewed and approved the final manuscript.

Transparency Declaration

This manuscript is an honest, accurate and transparent account of the study being reported. No important aspects have been omitted, and any discrepancies from the planned study have been explained.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon request. These data are not publicly available due to privacy and ethical restrictions.

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Clinical trial number

Not applicable.

Ethics approval and consent to participate

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2013. All procedures involving human subjects were approved by the Institutional Review Board of National Taiwan University Hospital (No. 201202053RIC). Written informed consent was obtained from all students and their parents who participated in the study.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon request. These data are not publicly available due to privacy and ethical restrictions.

Competing Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be considered a potential conflict of interest.

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Authors' contributions

Y.L.C. contributed to the conception and design of the study, data curation, validation, analysis and drafting of the manuscript. Y.J.S. performed the analysis and provided critical review and editing. H.J.Y. contributed to methodology, secured funding and oversaw project administration. I.B.H. contributed to methodology and project administration. P.H.K. contributed to study conception and design, methodology, drafting of the manuscript, funding acquisition and project administration. All authors reviewed and approved the final manuscript.

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Figures

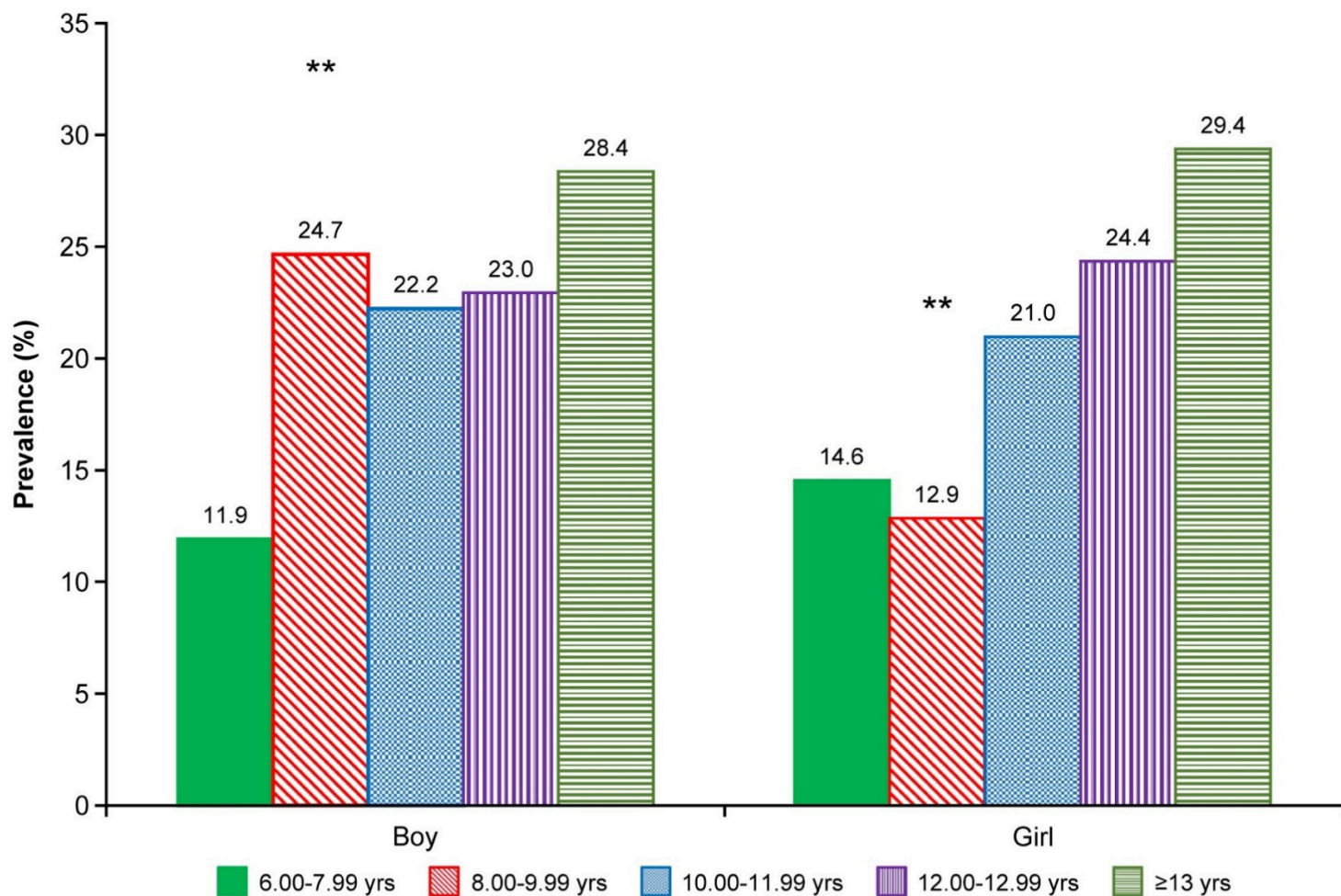


Figure 1

Prevalence of fatigue according to sex and age at baseline

Note: ** significant difference between boys and girls ($p < 0.0001$).

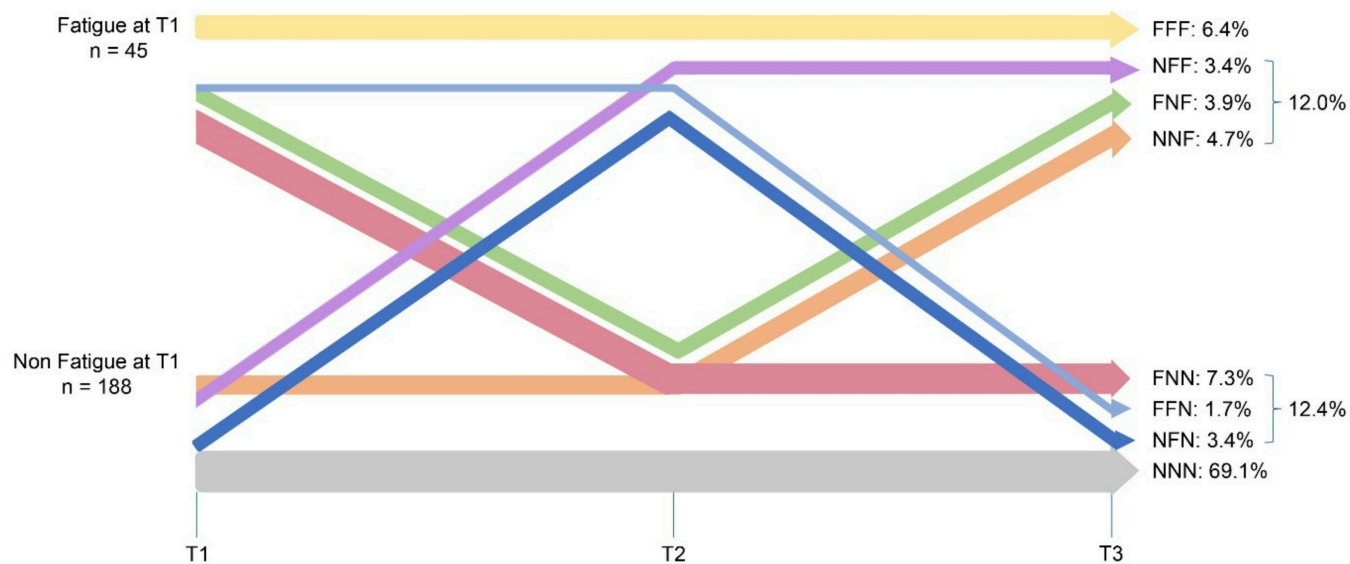


Figure 2
Trajectory of fatigue over time

Note: F means having fatigue at that time, N means non-fatigue at that time. Thus, FFF means fatigue at T1, T2 and T3; NFF means non-fatigue at T1 but having fatigue at T2 and T3, etc.

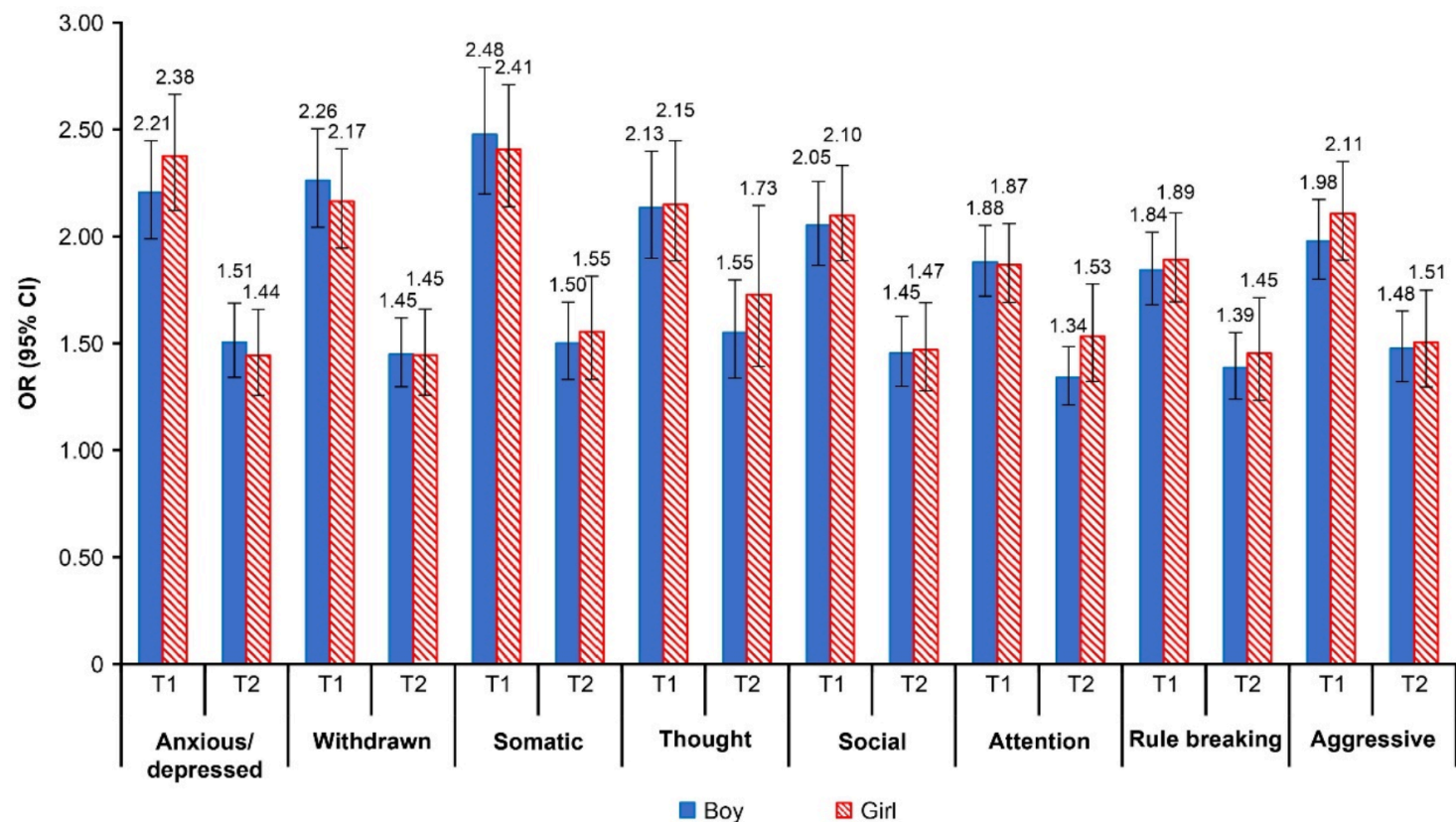


Figure 3

Associations between fatigue and CBCL emotional/behavioural problems according to sex using multivariate logistic regression analysis

Note: Fatigue at T1 had a significantly negative impact on all emotional/behavioural problems at T1 and T2 ($p < 0.01$). CBCL, Child Behavior Checklist.