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Predicting sleep-linked mental health in youth with visual impairments: a multidimensional approach

Abstract

Youth with visual impairments face heightened vulnerability to health disparities, yet limited research has examined the interplay of physical competence, psychosocial factors, and sleep-related mental health in this population. This study investigated associations among perceived motor competence, physical performance, health-related quality of life (HRQoL), and mental health–related sleep disruption (MHSD) in youth with visual impairments. Thirty-seven participants (M = 13.59 years; SD = 2.80; Female = 51%) were recruited from a sports camp for youth with visual impairments. Spearman's rank-order correlations revealed significant associations between perceived motor competence and MHSD ($\rho = -.46$, $p = .005$), as well as between MHSD and HRQoL and weekday sleep. A multiple linear regression model accounted for 42% of the variance in MHSD ($p = .006$), with HRQoL ($\beta = -.48$), perceived motor competence ($\beta = -.40$), and physical performance (Supine-to-Stand; STS Max; $\beta = -.38$) emerging as significant predictors. These findings support the link from physical competence to health outcomes and underscore the importance of addressing both perceived and actual movement skill in mitigating mental health risks. Given the low-incidence nature of visual impairment, this study provides rare and valuable insight, advocating for inclusive, developmentally sensitive interventions that target movement functional capacity and overall well-being.

Keywords: Health-related quality of life, sensory impairment, youth development, perceived motor competence, sleep quality, physical competence

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Introduction

Sleep is fundamental to cognitive, emotional, and physical balance, yet no singular prescription proves universally applicable across the spectrum of individual differences. Although general recommendations for sleep tend to suggest sleep duration, the actual need is determined by an intricate interplay of biological, behavioral, and environmental influences which range from age and lifestyle to genetic predispositions.[1] Equally important is the quality of sleep, defined not merely by its duration, but by its restorative potency upon awakening. For pediatric populations, the attainment of high-quality, uninterrupted sleep that synchronizes with developmental demands is especially imperative.[2]

A myriad of factors have the potential to disturb this delicate equilibrium between sleep and developmental demands. For example, environmental variables such as inconsistent bedtime routines, caregiver practices, and familial stress contribute substantially to the dysregulation of sleep patterns. Emotional disturbances, including anxiety and relational discord, further exacerbate sleep disruptions and delay sleep onset in youth.[3] The American Academy of Sleep Medicine advises that children aged eight to 12 years secure between nine and 12 hours of sleep and that adolescents aged 13 to 18 years obtain eight to ten hours per day.[4] Nonetheless, many youth fall short of these targets as over half of middle school students and almost three quarters of high school students consistently fail to meet these benchmarks on school nights.[5] Moreover, a comprehensive meta-analysis covering 20 countries and over 670,000 participants has documented a persistent decline in average sleep duration over the past century.[6]

The consequences of insufficient sleep are profound. Cognitive performance, academic achievement, and neurological development (including mental health) are all compromised when sleep is inadequate or of poor quality.[2,5] In the long term, chronic sleep deprivation is implicated in the pathogenesis of obesity, type 2 diabetes, and behavioral disorders.[7] Although population-level guidelines serve as a valuable framework, effective sleep strategies must ultimately be personalized to accommodate individual health profiles and lifestyles.[1] The mental health implications of insufficient sleep are particularly pressing during childhood and adolescence, a period marked by rapid brain development and emotional maturation.[8] Poor sleep quality has been strongly associated with increased symptoms of anxiety, depression, emotional dysregulation, and impulsivity.[9] These effects are especially pronounced in populations already facing elevated psychosocial or sensory challenges, such as youth with visual impairments.

Children with visual impairments confront unique physiological challenges, as their diminished capacity to perceive light cues can disrupt circadian synchronization. Thus, visual impairments often result in difficulties initiating sleep, fragmented sleep episodes, and heightened daytime somnolence.[10] Disruption of these circadian processes often results in a constellation of adverse effects, including pervasive fatigue, impaired concentration, mood instability, and irregular nocturnal behaviors such as sleepwalking, snoring, or frequent awakenings.[2] Conversely, optimal sleep quality underpins both mental well-being and physical recuperation. At the heart of sleep regulation lies the circadian rhythm, a sophisticated internal timing system governed by the hypothalamus and finely attuned to environmental cues, most notably light.[11] These endogenous rhythms, which naturally extend slightly beyond 24 hours, are continually recalibrated by exogenous factors such as meal timing, physical activity, and stress, with light playing a preeminent role.[12] As dusk approaches, a cascade of physiological changes ensues; melatonin secretion increases while core body temperature declines, thus facilitating sleep. Conversely, the advent of daylight suppresses melatonin production and activates arousal pathways.[13]

A robust interrelationship exists between physical activity and sleep quality, particularly among adolescents and young adults.[14] Furthermore, diminished cardiovascular endurance and lower muscular strength are associated with a heightened propensity for sleep disturbances.[15,16] Regular engagement in moderate to vigorous physical activity not only promotes expedited sleep onset but also enhances sleep continuity and overall restorative efficacy, thereby bolstering recovery and energy equilibrium.[17] Additionally, movement function and one's perceptions of their own movement capabilities historically predicts physical activity behavior.[18] Given that physical activity impacts sleep, and that sleep impacts mental health,[19] it is important to explore how movement function and one's perception of their movement ability directly impact the sleep quality and subsequent mental health among those with visual impairments.[20] Furthermore, physical activity, movement function, and self-perceptions also are putative factors often predicting health-related quality of life (HRQoL). HRQoL is another strong predictor of actual health and must be included in any study incorporating mental, physical, and cognitive factors.[20] The Supine-to-Stand (STS) measure can serve both as a functional performance indicator and a developmentally relevant proxy for physical capacity, particularly among youth with visual impairments.[21] The ability to efficiently transition from lying to standing is foundational to independence in daily life. Delays or difficulties in this transition may signal broader issues with mobility, physical confidence, or functional motor competence, all of which are central to well-being.

Unfortunately, research concerning pediatric sleep patterns within this population remains nascent, with prevailing studies relying largely on adult data and anecdotal evidence, which may not fully capture the developmental complexities at play.[10,22] A recent scoping review by Flynn and colleagues reveals a significant research gap regarding the relationship between physical activity and sleep in youth with visual impairments. The limited evidence suggests that youth with visual impairments consistently fall short of meeting established sleep and physical activity guidelines.[23–26] Moreover, preliminary intervention studies, such as one employing an ice-skating program, indicate potential benefits for sleep outcomes, though methodological limitations like the absence of control groups[27] temper the strength of these causal inferences. Collectively, these findings underscore the urgent need for more rigorous and comprehensive research to better understand and address the unique challenges faced by this vulnerable population. Moreover, the intersection of sleep quality and physical activity in youth with visual impairments represents an urgent research gap, warranting further systematic and developmentally sensitive investigation.

Therefore, the purposes of this study were to examine associations among putative factors regarding the sleep quality of youth with visual impairments including those which predicted mental health problems associated with sleep. We aim to explore the factors, including BMI, physical activity levels, and sleep habits, that best predict mental health symptoms related to sleep.

Materials and methods

Participants

Participants were recruited from a summer sports camp for youth with visual impairment. Inclusion criteria included any child who fit the criteria of attending the sports camp. The sample included 37 youth with VI (Males =18, Females = 19) ranging from 9 and 19 years with a mean age of 13.59 years (SD = 2.80 years). The participants' heights ranged from 122 cm to 180 cm with a mean height of 151.2 cm (SD = 13.6). Weights ranged from 22.91 kg to 100.45 kg with a mean of 56.21 kg (SD = 20.7). Thus, mean Body Mass Index (BMI) was 24.30 kg/m2 with a standard deviation of 8.00 kg/m2. The level of visual impairment varied from 1 (Blind) – 4 (highest vision field and acuity) with a mean level of 2.7 based upon the United States Association of Blind Athletes classification system. Eight of the participants were classified as B1 (of the eight, six had congenital visual impairment), three were B2, 18 were B3, and eight B4. Most of the participants were White (n = 21), five participants were Asian, four were Black, three were multiracial/ethnicity and three participants were Hispanic/Latinx. Thirty-one of the participants were returning campers, seven of the participants were new to camp, and one did not report. All participants except for two attended a public school, one attended a school for the blind, and another attended a private school. See Tables 1 and 2 for more demographic information.

Table 1 Frequency of VI diagnoses and other diagnoses

VI diagnosis	Frequency	Other diagnoses	Frequency
Optic nerve hypoplasia	5	Developmental delay (including ID)	9
Albinism (w/ or w/o nystagmus, photophobia)	3	ADHD (with/without additional conditions)	5
Retinopathy of prematurity	3	Deafblindness	2
Glaucoma (alone or combined with other conditions)	3	Anxiety/Obsessive-compulsive disorder	2
Coloboma (including with ROP)	2	Autism spectrum disorder	1
Brain tumor; OGT; Neurofibromatosis I	2	Cancer (neuroblastoma)	1
Optic nerve atrophy	2	Gasteroparesis; Thickened corpus callosum	1
Detached retina	2	Seizure disorder; Cerebral palsy (R-sided)	1
Nystagmus (w/ associated conditions)	4	Racesmean deficiency (metabolic disorder)	1
Microphthalmia / Bilateral microphthalmia	2	OFCG-gene mutation	1
Familial exudative vitreoretinopathy	2	Petala ulta	2
Leber congenital amaurosis	1	Specific learning disability (mentioned separately from ID in some cases)	4
Best disease and a hemorrhage	1	NA (No additional diagnoses reported)	19
Cortical visual impairment	1		
Retinal dystrophy	1		
Cone rod dystrophy	1		
Stargardt disease	1		
Retinitis pigmentosa	1		
Peters plus syndrome	1		
Microcornea; Opaque cornea	1		
Unknown	1		

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Table 2 Participant demographics

Demographic variable	Category	Frequency (n)
Sex	Girl	18
	Boy	19
Race	American Indian/Alaska Native	0
	Asian	5
	Black	6
	Native Hawaiian/Pacific Islander	0
	White	22
	Other/Multiracial	4
Ethnicity	Hispanic/Latinx	3
	Not Hispanic/Latinx	33
School Type	Public	34
	Private	1
	Home School	0
	School for the Blind	1
Geographic Region	Urban	5
	Suburban	23
	Rural	8

Instrumentation

The children's sleep habits questionnaire (CSHQ)

The Children's Sleep Habits Questionnaire[28] is a parental report that includes 55 questions that examine parental beliefs about their child's sleep habits. The questionnaire is broken into five sections. The first 13 questions refer to a child's bedtime, including an approximation of the child's bedtime, if the child goes to bed at the same time every night, and if the child is afraid of sleeping alone (amount of sleep time during the week and weekend are estimated from this section). Section two includes 19 questions that look at the child's sleep behavior, with questions asking if the child sleeps the right amount, sleepwalks, reports pain during sleep, and awakens during the night screaming, sweating, and inconsolable. Within the next four questions, section three, parents are asked about their child's waking habits during the night, with questions asking if the child wakes once during the night, and if the child returns to sleep without help after waking. In section four, parents complete nine questions about their child's morning waking habits. Examples of questions include a child waking up by him/herself, a child waking up in a negative mood, and a child taking a long time to become alert in the morning. Section five concludes with 10 questions regarding daytime sleepiness. For each of the 55 items, the parent answers regarding whether the behavior happens "rarely" (1 time), "sometimes" (2-4 times), or "usually" (5-7 times) or "not a problem". The CSHQ is scored according to established protocols, yielding a total sleep disturbance score, with higher values reflecting more problematic sleep behaviors. Sleep wake problems scores can range from 0 to 4 with larger scores indicating more problems. Mental health, including mental health sleep scores - sleep disturbances, range from 0 to 6 with higher scores indicating more anxiety. Chronotype indicating morningness versus eveningness range from 0 to 4 with higher scores indicating a later chronotype. Social jet lag refers to the number of hours sleeping extra on the weekends. Sleep onset latency indicates the total time to fall asleep, 5 to 15 minutes is ideal, over 30 minutes is a critical concern. Sleep need refers to the amount of sleep an individual needs to feel successful. Sleepiness scores range from 0 to 4 with lower numbers indicating being less sleepy. The psychometric properties include good internal consistency (α =.68 -.78), good stability via test-retest reliability (r =.62 -.79) and other indicators of content and construct validity across a wide-variety of contexts and cultures.[28]

Rapid assessment of physical activity (RAPA)

Participants also completed a short nine question instrument on their physical activity participation, The Rapid Assessment of Physical Activity (RAPA) is a ten item self-report / recall of past physical activity behavior across two sections. In section one, participants provide a binary (yes/no) answer where the highest frequency of physical activity behavior (1-7) becomes the score. Next, the same scoring structure occurs for strength and weight training/flexibility where the highest outcome becomes the score (1-3). Both scales are combined and participants can score between 1-10 points. The RAPA holds good test-retest reliability ICC =.94 and concurrent validity with other self-report assessments like the International Physical Activity Questionnaire.[29]

Supine-to-stand assessment

The Supine-to-Stand (STS) assessment is a functional motor task used to evaluate an individual's ability to transition from lying on their back (supine) to a standing position as quickly as possible.[30] The STS serves as a valuable indicator of motor function and independence across the lifespan. STS time showed weak to moderate negative correlations (r = −.28 to −.64) with motor competence product measures across all age groups, supporting its validity and reliability as an indicator of MC from childhood through young adulthood.[21] The purpose of the assessment is to assess coordination, strength, balance and motor planning involved in rising from the floor. The measurement is quantitative, time to stand where faster is better. Each participant completes five attempts and the maximal effort (e.g., fastest time) is used for scoring (STS Max). The STS has stout psychometric properties with excellent test-retest reliability (ICC =.95), concurrent validity with other measures of function, and good feasibility.[21]

Test of perceived physical competence (TPPC)

The Test of Perceived Physical Competence for Youths with Visual Impairments[31] assesses self-perceptions of physical competence among youths aged 9 to 19 years with visual impairments. Adapted from Harter's 1985 Perceived Physical Competence subscale, the TPPC is administered using a fully auditory format to ensure accessibility. Each of the six items are read aloud, and participants respond by selecting the statement that best describes them, followed by indicating whether it is "sort of true" or "really true," using a structured four-point Likert scale. Researchers follow a standardized script to maintain consistency. The instrument demonstrates excellent internal consistency (McDonald's $\omega = 0.987$), with confirmatory factor analysis supporting a unidimensional structure (CFI = 0.95, SRMR = 0.053). Divergent validity was established through a moderate correlation (Spearman's $\rho = 0.469$) with the Self-Perception Profile for Children/Adolescents.[32]

Vision-QL (HRQoL)

VISION-QL is an instrument to evaluate health related quality-of-life (HRQoL) in individuals with visual impairments.[33] This instrument was adapted from the Impact of Hearing Impairment on Children Survey[34] for populations with visual impairment and was validated for face and content validity. VISION-QL includes a total of 63 questions organized into the following subcomponents: educational implications, social integration, psycho-social well-being, speech, language and communication, family relationships, and general functioning. Assessment response options can range

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from 1 (completely disagree) to 4 (completely agree) and scores are calculated for each of the 7 subcomponents.

Procedures

The local institutional review board approved all procedures. Participant assent and parental consent was obtained from all participants and their legal guardians. Participants were assessed at the summer sports camp for youth with visual impairments. At registration, parents completed a demographic survey. Parents/guardians completed the demographic survey including questions on their child's age, sex, gender, and visual impairment. Parents/guardians also completed the CSHQ. Participants completed the TPPC and the RAPA with one of the researchers. The surveys were read to the participants and repeated if requested by the participant. Participants performed the STS assessment with a mat on the ground following all procedures as outlined within Cattuzzo et al.[30]

Data analyses

To examine aim one or the associations among our primary variables of interest, a Spearman's rank-order correlation was conducted using IBM SPSS Statistics (Version 29.01). This nonparametric test was chosen due to the ordinal nature of some of the data (e.g., TPPC, RAPA, and the sleep scales). Prior to analysis, data were screened for missing values and outliers. The assumption of a monotonic relationship between variables was verified through visual inspection of scatterplots of the ranked data. Spearman's rho (ρ) was then calculated to determine the strength and direction of the association. An alpha level of.05 was used to assess statistical significance in two-tailed tests. Correlation coefficients were interpreted as small if between 0.10 and 0.29, moderate if between 0.30 and 0.49, and large if between 0.50 and above.[35]

To address aim two or which factors predicted mental health as a result of no sleep, we conducted a linear multiple regression using IBM SPSS Statistics (Version 29.01). The independent variables were entered simultaneously using the enter method (e.g., VI class, BMI, RAPA, HRQoL, STS max, TPPC, Sleep time during the week, Sleep time during the weekend). All variables were screened for missing data, outliers, and assumptions of linearity, independence, homoscedasticity, multicollinearity, and normality of residuals. Linearity was evaluated through scatterplots, independence of residuals was tested using the Durbin-Watson statistic, homoscedasticity was examined via residual plots, multicollinearity was assessed using variance inflation factors (VIF), and normality of residuals was checked using histograms and normal probability plots. All statistical tests were two-tailed with an alpha level of.05.

Results

Results for aim one or the associations among our variables of interest reveal that the strongest association occurred between TPPC and Mental Health – Sleep Disturbance (MHSD) (ρ = -.46, p =.005). Other significant associations include MHSD and HRQoL (ρ = -.31, p <.10), BMI and Sleep during the week (ρ = -.33, p <.10), and others (See Table 3). These associations are above and beyond degree of vision. Results for aim two, or the multiple linear regression predicting MHSD indicate that three factors significantly predicted our outcome, while five were non-significant. As a collective, these eight factors accounted for 42% of the variance in mental health-no sleep (F = 3.76, p =.006, adjR2 =.42) with HRQoL (β = -.48, p =.004), TPPC (β = -.40, p =.021), and STS Max (β = -.38, p =.040) being the significant factors. All other factors were above p =.10.

Table 3 Spearman correlation matrix for variables of interest

	Sleep week	Sleep weekend	Mental health no sleep	VI class	BMI	STS max	TPPC	RAPA	HRQoL
Sleep week	1								
Sleep weekend	.46**	1							
Mental health no sleep	-.35**	-.13	1						
VI class	.01	.13	-.14	1					
BMI	-.33*	-.10	.14	.20	1				
STS max	-.09	-.07	.08	-.23	.44**	1			
TPPC	.15	-.08	-.46**	-.14	-.19	-.08	1		
RAPA	.20	-.15	-.10	.35**	-.04	-.25	.29*	1	
HRQoL	.07	.01	-.31*	.25	.009	-.15	-.07	-.14	1

*p < .10, **p < .05

Discussion

The present study explored the relationships among physical, psychosocial, and health-related variables contributing to mental health disturbances linked to sleep among youth with visual impairments. Drawing on a robust analytic approach, we employed Spearman's rank-order correlations to examine bivariate associations among our primary variables of interest and conducted a multiple linear regression analysis to identify significant predictors of MHSD. These analyses were designed to address a key gap in the literature by applying developmentally and methodologically sensitive techniques to an understudied population. Consistent with our hypotheses, perceived motor competence emerged as a central variable in relation to mental health-related sleep difficulties. Spearman's correlation analysis indicated a moderate negative association between perceived motor competence and sleep, suggesting that youth who perceived themselves as less competent in motor tasks reported greater mental health symptoms associated with sleep disturbances. This finding extends upon the developmental importance of perceived motor competence[36] and underscores the multidimensional effects of self-efficacy on physical activity and physical activity behavior in youth with disabilities.[37,38]

Moderate associations, such as those between MHSD and HRQoL, and BMI and weekday sleep, highlight the complexities of health and behavior influencing sleep and mental health outcomes. These results provide evidence of robust associations that extend beyond the degree of visual impairment, pointing to the importance of perceived and objective health factors in understanding risk for poor sleep-related mental health. To further clarify these relationships, a

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multiple linear regression analysis was conducted with eight predictor variables. This model accounted for 42% of the variance in MHSD, with three variables reaching statistical significance: HRQoL, PMC, and STS. These findings offer critical insight into both psychosocial (VISIONS-QL, TPPC) and physical performance (STS) predictors of MHSD, suggesting an interplay between subjective experiences and functional capacity that warrants targeted, multimodal interventions.

PMC and HRQoL stand out as two of the most critical psychosocial constructs in our findings, and their significance offers powerful insight into the experiences of youth with visual impairments. These findings align with competency-based motivation theories, where perceptions of competence drive engagement and resilience[39] and a conceptual model (the developmental trajectories model) which proposes a dynamic and reciprocal relationship between actual motor competences, perceived motor competence, physical activity, and health-related outcomes over time. In youth with visual impairments, who may face environmental or social barriers to physical participation,[40] this perception becomes especially consequential. A diminished sense of perceived motor competence may lead to a withdrawal in participation in physical activity,[41] and a reinforcing cycle of lower self-esteem and according to this data, sleep disturbance. Furthermore, HRQoL's predictive value underscores the developmental trajectories model's emphasis on long-term health-related outcomes. Poor motor competence, both perceived and actual, may limit opportunities for inclusion, participation, and wellness, ultimately degrading HRQoL and exacerbating sleep disturbances and mental health risks.

STS was a statistically significant predictor of MHSD, indicating that lower physical capacity was independently associated with greater psychological sleep-related distress. This strengthens the argument for including objective physical assessments in interventions aimed at improving sleep and mental health. When examined alongside perceived motor competence and HRQoL, the STS measure added a third dimension, actual physical performance, offering a richer, multidimensional picture of the youth's capacities and risks. During adolescence, gains in strength, coordination, and autonomy are developmentally expected.[42–44] STS performance may help identify youths whose developmental trajectories are being disrupted, not necessarily by vision loss per se, but by reduced physical activity access or social inclusion. Notably, five other predictors did not reach significance ($p > .10$), but their theoretical relevance and potential interaction effects should not be discounted in future research.

Strengths and limitations

This study contributes novel insights into the psychosocial and functional correlates of sleep-related mental health in youth with visual impairments, a population and topic that remains significantly underrepresented in the empirical literature. Several strengths and limitations warrant consideration. A key strength of this study is its multidimensional approach, integrating performance-based measures (e.g., STS), self-perceptions of motor competence (e.g., TPPC), and health-related quality of life (e.g., VISIONS-QL). These measures allowed for a more comprehensive understanding of how functional and psychological domains converge to influence sleep-related mental health. Rigorous data screening and assumption testing (e.g., linearity, independence, homoscedasticity, multicollinearity, and normality of residuals) affirmed the validity of the regression model. Additionally, the recruitment setting, a summer sports camp designed for youth with visual impairments, provided access to a population that is typically difficult to reach. The camp setting reflects a naturalistic environment in which physical activity, and socialization are emphasized, thus enhancing ecological validity.[45,46]

While there are many strengths of this study, it is not without limitations. The relatively small sample size restricts statistical power and generalizability. Importantly, the low incidence of visual impairment in the general population poses an inherent challenge in securing large, representative samples. This limitation is not unique to this study but is a persistent barrier in disability-related research.[47] The fact that data were obtained from such a specialized and underrepresented group should be viewed as a notable achievement, even as it underscores the need for future multi-site or longitudinal collaborations.

The recruitment context, an adaptive sports camp, may have introduced selection bias, as youth who attend such programs may differ in physical literacy, parental support, and social motivation compared to peers who do not participate in structured physical activity environments.[48] Furthermore, the reliance on self-report instruments may introduce biases, particularly among younger respondents.[49] Complementary approaches such as actigraphy, caregiver reports, or observational data could strengthen future investigations.

Conclusion

Collectively, the findings point to a need for holistic, developmentally informed, and interdisciplinary approaches to promote sleep health and physical and emotional well-being in youth with visual impairments. Integrating components that bolster motor competence, improve health-related quality of life, and enhance physical performance may yield cascading benefits not only for sleep-related mental health but also for daily functioning and overall development. This work contributes to a growing body of evidence supporting inclusive, adaptive, and preventive programming tailored to the nuanced needs of this vulnerable population.[50–53]

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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