

# The Relationships Between Sport Specialization, Sleep, and Quality of Life in Female Youth Volleyball Athletes

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**Background:** Although sport specialization may be associated with stress and burnout among youth athletes, the relationship with quality of life (QOL) remains unknown. The purpose of this study was to evaluate the relationship between sport specialization, sleep, and QOL in female youth athletes.

**Hypothesis:** Higher levels of specialization are associated with increased daytime sleepiness and worse QOL.

**Study Design:** Cross-sectional study.

**Level of Evidence:** Level 4.

**Methods:** Female high school volleyball players completed preseason surveys to determine sport specialization (low, moderate, high), injury history, QOL, sleep duration, and daytime sleepiness. QOL and sleep variables were compared across specialization groups. Multivariable linear regression models were developed to evaluate the associations between sleepiness, QOL, specialization, grade in school, and injury history.

**Results:** Of 1482 participants, 591 (40%), 436 (29%), and 455 (31%) were categorized as low, moderate, and high specialization, respectively. Highly specialized athletes demonstrated worse QOL (median 91.3 [interquartile range 86-96]) than low (92.4 [88-97],  $P = 0.05$ ) and moderate (93.5 [88-99],  $P = 0.05$ ) specialization groups and greater daytime sleepiness (11 [7-15]) than low (10 [6-14],  $P < 0.001$ ) and moderate (10 [6-14],  $P < 0.001$ ) specialization groups. In the multivariable model, QOL was negatively associated with prior injury occurrence ( $\beta = -1.1 \pm 0.5$ ,  $P = 0.02$ ), but not grade in school ( $\beta = -0.08 \pm 0.2$ ,  $P = 0.71$ ) or specialization (moderate:  $\beta = 0.08 \pm 0.5$ ,  $P = 0.88$ ; high:  $\beta = -0.70 \pm 0.5$ ,  $P = 0.18$ ). Daytime sleepiness increased with high specialization ( $\beta = 1.12 \pm 0.3$ ,  $P < 0.001$ ) and grade ( $\beta = 0.76 \pm 0.1$ ,  $P < 0.001$ ), but not prior injury ( $\beta = 0.51 \pm 0.3$ ,  $P = 0.10$ ).

**Conclusion:** Highly specialized female volleyball athletes demonstrate decreased QOL, perhaps because of higher rates of prior injury. Specialization is also associated with increased daytime sleepiness.

**Clinical Relevance:** Sport participation patterns and injury may have implications for QOL in youth athletes.

**Keywords:** quality of life; sleep; sleepiness; adolescent

No universally accepted definition currently exists for sports specialization. It has been conventionally defined as year-round intensive participation in a single sport at the exclusion of others.<sup>15</sup> Although several guidelines and policy statements have suggested that athletes who choose to specialize in a single sport at an early age may be at risk of increased stress, overtraining, and burnout, there remains minimal primary evidence to support this proposed relationship.<sup>15,15,23</sup> Relationships between sport specialization

and health outcomes are likely sport specific, but the majority of research has been conducted on larger groups of athletes from multiple different sports.<sup>18,19,29</sup> Volleyball represents a rapidly growing sport for girls.<sup>24</sup> No prior research has been conducted regarding sport specialization specifically within this group.

Quality of life (QOL) is increasingly recognized as an important primary health endpoint (Centers for Disease Control and Prevention, Healthy People 2020), and athletes are no

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exception. While athletes generally have higher health-related QOL than nonathletes, there are a number of potential risk factors that can threaten QOL among athletes in particular.<sup>11,33,34</sup> Prior research has suggested that injury negatively affects QOL in athletes, and severe injuries may even result in the development of symptomatology consistent with posttraumatic stress disorder.<sup>11,26,35</sup> Athletic identification may exacerbate the psychological impacts of injury and may directly influence QOL through increased stress and anxiety associated with competition.<sup>26</sup> Specialization may negatively influence QOL among adolescent athletes through these or other mechanisms. There are no prior studies that have evaluated the relative risk of mental health disorders, such as anxiety or depression, after serious injuries in adolescent athletes, and this represents an important area of future research.

Proper sleep is vital to optimal academic and athletic performance, yet athletes have consistently demonstrated insufficient sleep and impairments in sleep quality.<sup>3,4,32,41</sup> Poor sleep has also been shown to negatively impact a number of health outcomes in athletes.<sup>3,6,41,43</sup> Youth athletes may be at even greater risk for sleep problems given their competing sources of academic, social, and athletic stress, as well as the need for adequate sleep to promote normal growth and development.<sup>8,16,17,44</sup> Previous research has identified an association between specialization and subjective well-being measures such as stress, mood, and fatigue among adolescent soccer athletes.<sup>42</sup> Similarly, increased daytime sleepiness among highly specialized athletes has been observed in a sample of athletes from multiple sports.<sup>30</sup> However, we are aware of no prior research that has specifically evaluated this among female volleyball athletes.

The influence of sport specialization on QOL and sleep may be confounded by several factors. Specialized athletes have been found to demonstrate increased rates of certain types of injuries, and injuries, in turn, have been found to influence both QOL and sleep.<sup>10,35</sup> In addition, specialization rates and sleep needs vary with age. Age, however, may be associated with a number of factors that could influence QOL. It is unknown whether the relationships between specialization, QOL, and sleep are independent of the influence of prior injury or age. The purpose of this study was to evaluate the independent relationships between sport specialization, QOL, and sleep in female high school volleyball athletes, while adjusting for the influence of prior injury and age.

## METHODS

### Study Design

Data were collected at 79 Wisconsin high schools immediately before the fall volleyball season. This represented 26 large (>800 students), 29 medium (400-800 students), and 24 small (<400 students) schools, of which 70 were publicly funded and 9 were private. To be included in the study, schools had to employ a certified athletic trainer and have an interscholastic volleyball program. Informed written consent was obtained

from adult athletes ( $\geq 18$  years old), while informed written assent was obtained from minor athletes in addition to informed written consent from the parent or guardian. All procedures performed in this study were approved by the institutional review board of the University of Wisconsin–Madison.

### Participants

Recruiting occurred at preseason girls' volleyball team meetings where potential participants and their parents or guardians were provided detailed information about the study and procedures. Participants were excluded if they had a current injury that would restrict them from team activities on the first day of practice. Otherwise, all female students who committed to trying out for their interscholastic volleyball team were eligible for enrollment (grades 9-12, age range 14-18 years).

### Questionnaire

All participants completed a questionnaire regarding typical sleep duration, sport specialization, injury history, the adolescent version of the Pediatric Quality of Life Inventory (PedsQL GCS, Version 4.0), and the Pediatric Daytime Sleepiness Scale (PDSS). Participants were asked to report the average duration of sleep they achieved each weeknight and weekend night, respectively, during the prior week (in 1-hour increments from <4 to >8). Participants were asked to report details of any prior sport-related injury, including the date of the injury, the body part involved, and the type of injury sustained. Based on their responses, participants were grouped based on whether they had sustained a prior injury in the past 12 months or not. The adolescent version of the PedsQL is a valid and reliable, 23-item instrument that consists of emotional-functioning (5 items), social-functioning (5 items), physical-functioning (8 items), and school-functioning (5 items) subscales.<sup>37,38</sup> Each item is rated on a 5-point Likert-type scale, reverse scored and transformed to a 0 to 100 scale (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0) such that higher subscale and summary scores represent better QOL. Social-functioning, emotional-functioning, and physical-functioning subscale items are averaged to yield a psychosocial summary score and a total score is generated by averaging all the items. The PedsQL has been utilized extensively in children with chronic diseases<sup>36,39</sup> and among youth and collegiate athletes.<sup>10,11,20,35</sup> A minimal clinically important difference (MCID) in the PedsQL has been reported to be around 4.5 in healthy children and children with chronic diseases.<sup>9,37</sup> No prior research has attempted to establish an MCID in adolescent athletes, and no prior research in children has established an MCID for the PedsQL subscales or psychosocial functioning score. Given that athletes consistently score higher in QOL than their nonathlete counterparts,<sup>11</sup> it is unclear whether the MCID for the PedsQL total score can be applied to athletic populations.

The PDSS is a valid instrument that consists of 8 items on a 5-point Likert-type scale (from 0 to 4) that are summed to yield a total score ranging from 0 to 32, with higher values indicating more daytime sleepiness.<sup>7</sup> The PDSS has been previously

utilized in a wide range of pediatric populations, including young athletes.<sup>7,21,25,27,30</sup> No MCID has been published for the PDSS, but a cut-point of 15 has been suggested to be predicted of negative outcomes associated with daytime sleepiness.<sup>21</sup>

Sport specialization in volleyball was determined using a common 3-point scale with modification to identify sport specialization in volleyball only.<sup>2,12,19,28</sup> Degree of specialization was classified based on the answers to 3 questions: (1) Have you quit another sport to focus on volleyball? (2) Do you consider volleyball to be more important than your other sports? (3) Do you train more than 8 months a year in volleyball? Participants responded with either “yes” or “no” to each question, which was scored as 1 or 0 points, respectively. Scores for each question were summed to determine the classification of specialization for each participant as low (0-1), moderate (2), or high (3).

### Statistical Analysis

Data were initially evaluated for normality using descriptive statistics and histogram analysis. Chi-square tests were performed to compare the rates of specialization across the different grades and the rate of prior injury between specialization groups. PedsQL scores, PDSS scores, and sleep duration were compared between participants with and without a prior injury using Wilcoxon rank sum tests. The same variables were compared across specialization groups and grades using Kruskal-Wallis tests and post hoc pairwise Wilcoxon rank sum tests, and adjusted for multiple comparisons using the Holm method. Comparisons between groups were represented visually as violin plots, representing the median and interquartile range as a box-and-whisker plot, overlaid on a kernel density estimation to represent the distribution of the data around the median. Wider sections of the plot represent a higher probability of a given value, while thinner sections represent a lower probability. Separate multivariable linear regression models were developed to evaluate the association between specialization (low, moderate, high) and QOL (total PedsQL score), as well as the association between specialization and daytime sleepiness (total PDSS score), while adjusting for grade and prior injury. Significance level was determined a priori at the 0.05 level and all tests were 2-tailed. All statistical analyses were performed in R.<sup>31</sup>

## RESULTS

Baseline survey data were collected from 1482 participants, of whom 591 (40%), 436 (29%), and 455 (31%) were categorized as low, moderate, and high specialization, respectively. Specialization rates increased with increasing grade (Figure 1). A total of 423 (29%) participants reported a prior injury. The most common injury location was ankle (176, 42%) followed by foot (66, 16%), knee (59, 14%), wrist/hand (40, 9%), back (23, 5%), lower leg (16, 4%), shoulder (15, 4%), pelvis/hip (13, 3%), upper leg (7, 2%), arm/elbow (5, 1%), and other (3, 1%). The

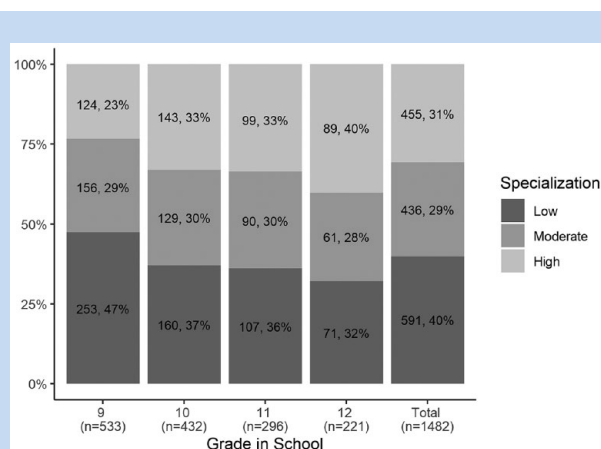


Figure 1. Specialization rates by grade in school among female high school volleyball athletes.

most common types of injury were sprain/strain (245, 58%), fracture (95, 23%), tendinopathy (35, 8%), contusion (20, 5%), and dislocation/subluxation (10, 2%).

The proportion of participants who reported a prior injury increased with specialization level (low: 21%; moderate: 31%; high: 36%,  $P < 0.001$ ). Highly specialized athletes demonstrated lower total QOL and increased daytime sleepiness, but no significant differences were noted with regard to weekend or weekday sleep duration (Figure 2, Table 1). Sleep duration decreased and daytime sleepiness increased with grade, but no differences were noted between grades with respect to QOL (Figure 3). Participants who reported an injury in the past 12 months reported lower QOL and increased daytime sleepiness compared with those without an injury, but no significant differences were noted with regard to sleep duration (Figure 4). In the multivariable model, history of an injury in the past 12 months was a predictor of worse QOL, while sport specialization and grade were not. Conversely, high sport specialization and higher grade were associated with higher (worse) daytime sleepiness, while moderate sport specialization and prior injury were not (Table 2).

## DISCUSSION

Although sport specialization is often suggested as a cause of increased stress and burnout among athletes, there is a paucity of research regarding the sport-specific relationships between specialization and QOL in young athletes. Our research found that highly specialized, female high school volleyball athletes demonstrate decreased QOL, driven primarily by lower ratings of physical QOL, as the remainder of the QOL subscales appeared very similar between the specialization groups. While sport participation and physical activity have been consistently shown to improve QOL among athletes,<sup>11,33,34</sup> the reason why focusing specifically on a single sport would be associated with reduced QOL remains incompletely understood. It is also unclear whether these differences are clinically meaningful.

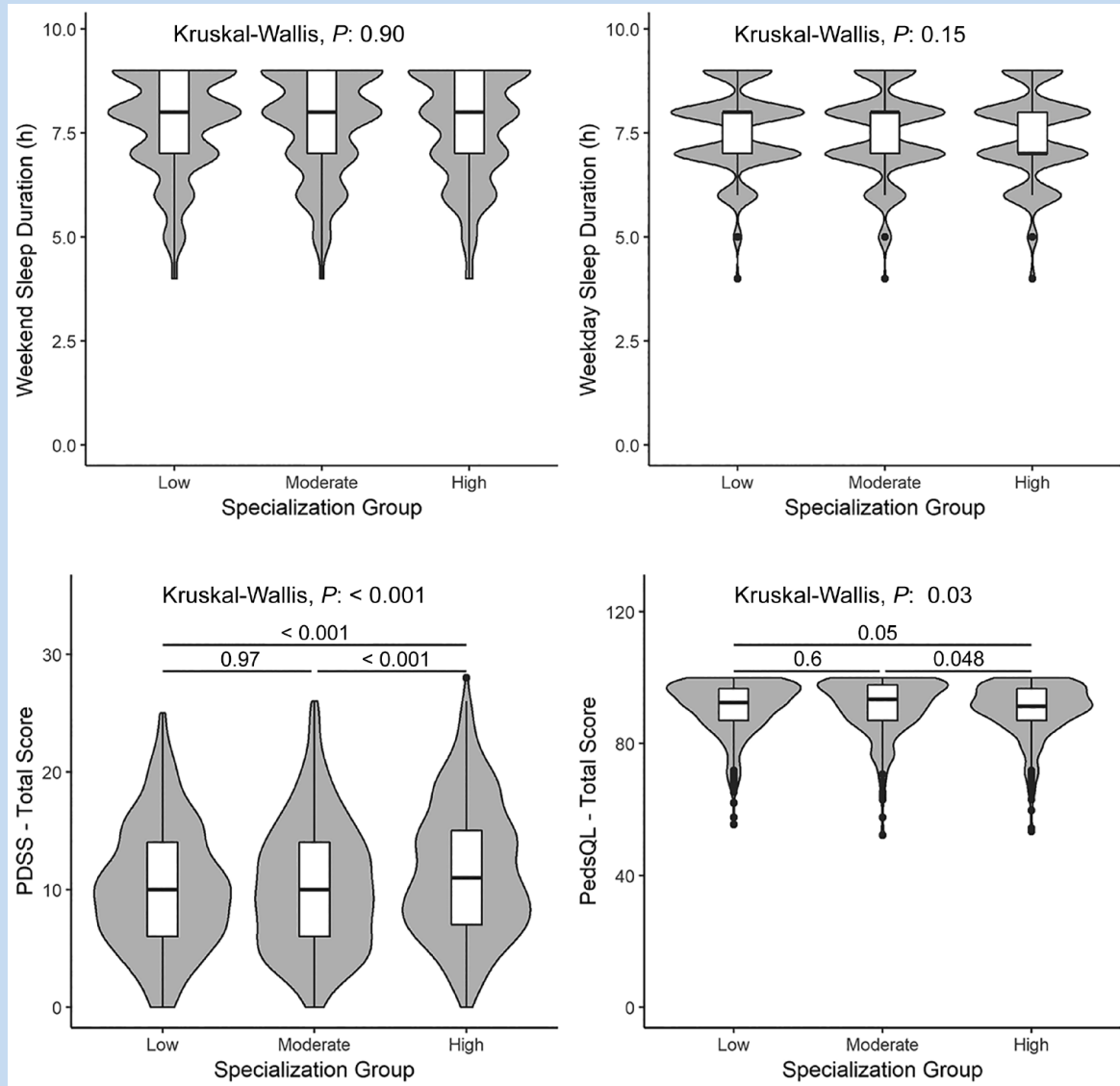


Figure 2. Quality of life, daytime sleepiness, and sleep duration by sport specialization among female high school volleyball athletes. Data shown as violin plots representing the median, interquartile range, and kernel density distribution of the data, with significance levels from Kruskal-Wallis and post hoc pairwise Wilcoxon rank sum tests, if indicated. Wider sections of the violin plots represent a higher probability of a given value, while thinner sections represent a lower probability. PDSS, Pediatric Daytime Sleepiness Scale; PedsQL, Pediatric Quality of Life.

They fall below the published MCID for the PedsQL total score, but there is no published MCID for adolescent athletes, and it has been suggested that they may represent a unique population with regard to QOL.<sup>14</sup>

Our highly specialized athletes were more likely to report a prior injury, and after adjusting for grade and prior injury, the difference in total QOL between the specialization groups was no longer significant. Injury history has been found to impact QOL even after physical recovery,<sup>11,20,35</sup> suggesting that the increased injury rates reported by our specialized athletes may be responsible for the differences in QOL. Although we cannot confirm this from the available data, it is possible that

specialized athletes have greater year-round training loads that result in higher levels of soreness or non-time loss injuries that exerted a negative effect on their preseason physical QOL. It is unknown whether this could translate into an increased risk of injury during the subsequent season, but this remains an important area of future research.

Specialization was also associated with worse daytime sleepiness but not sleep duration. This relationship persisted in the multivariable model and is similar to the findings of a prior cross-sectional study of youth athletes from a variety of different sports, which found that highly specialized athletes demonstrated higher (worse) scores on the PDSS than those

Table 1. Quality of life, daytime sleepiness, and sleep duration by sport specialization among female high school volleyball athletes

Variable	Low (n = 591), Median ± IQR	Moderate (n = 436), Median ± IQR	High (n = 455), Median ± IQR
PedsQL			
Physical function	93.8 ± 16	93.8 ± 16	90.6 ± 12 <sup>a,b</sup>
Emotional function	90 ± 25	90 ± 20	90 ± 25
Social function	100 ± 10	100 ± 10	100 ± 10
School function	95 ± 10	95 ± 10	95 ± 10
Psychosocial summary	93.3 ± 10	93.3 ± 10	93.3 ± 8.3
Total score	92.4 ± 9.8	93.5 ± 11	91.3 ± 9.8 <sup>b,c</sup>
PDSS total sleep score	10 ± 8	10 ± 8	11 ± 8 <sup>a,b</sup>
Weekday sleep duration, h	8 ± 1	8 ± 1	7 ± 1
Weekend sleep duration, h	8 ± 2	8 ± 2	8 ± 2

IQR, interquartile range; PDSS, Pediatric Daytime Sleepiness Scale; PedsQL, Pediatric Quality of Life.

<sup>a</sup>*P* < 0.05 compared with low specialization.

<sup>b</sup>*P* < 0.05 compared with moderate specialization.

<sup>c</sup>*P* = 0.05 compared with low specialization.

categorized as low specialization.<sup>30</sup> It is also consistent with prior research among adolescent female soccer players that demonstrated decreased sleep quality over the course of a season among single sport athletes compared with multisport athletes, but no significant differences in sleep duration.<sup>42</sup> While it is not possible to determine whether the relationship between sport specialization and sleepiness is causal from the available evidence, it does seem to suggest that specialized athletes are at increased risk of poor sleep and daytime sleepiness, and the present study demonstrates that these findings are reproducible in a large sample of female youth volleyball athletes. Further research into the underlying mechanism behind this relationship and its existence in other specific populations may help guide recommendations and interventions in a sport-specific manner.

Athletes who reported an injury within the past 12 months also reported worse overall QOL. This is similar to previous research that identified decreased total QOL among currently injured adolescents, as well as worse physical functioning, pain, and social functioning.<sup>35</sup> In otherwise healthy collegiate athletes, those with any history of prior knee injury reported lower QOL than those without a prior knee injury, even though all had recovered and returned to sport.<sup>13</sup> Our results similarly suggest that the effects of an injury on QOL in adolescent athletes extend beyond the recovery period, as we found decreased QOL among a large sample of athletes with an injury within the past 12 months, all of whom were recovered and preparing to start their sport season. In addition, injury may impact QOL beyond physical complaints by interfering with normal social

interactions around sport participation and threatening an adolescent's identity as an athlete.<sup>35</sup> Together these influences may negatively affect athletes beyond recovery from the injury itself.

We also found that although our previously injured athletes were no longer restricted by their injury, they continued to report increased daytime sleepiness compared with their uninjured counterparts. This is consistent with a prior study of athletes from multiple sports that found increased daytime sleepiness among those that reported an injury in the prior 12 months.<sup>30</sup> Although we are aware of no direct evidence to support this, it seems reasonable to speculate that the stress, anxiety, and social changes after an injury that potentially impact QOL could also undermine sleep and result in increased daytime sleepiness. While these interactions have only been partially explored, they could increase the risk of subsequent injury, as insufficient sleep has been found to be related to injury risk in youth athletes.<sup>22,40</sup>

This study has several limitations. This cross-sectional study relied on self-report of injuries from volleyball and other activities, and it is possible that adolescent athletes may not fully recall all their injuries. To minimize this recall bias, we limited the time frame of injury reporting to within the past 12 months. We did not include a measure of prior injury severity, which could also theoretically influence QOL, even after return to sport. In addition, we did not ask participants to report the context of their injury, and thus we cannot determine whether the relationship between specialization and injury is specifically

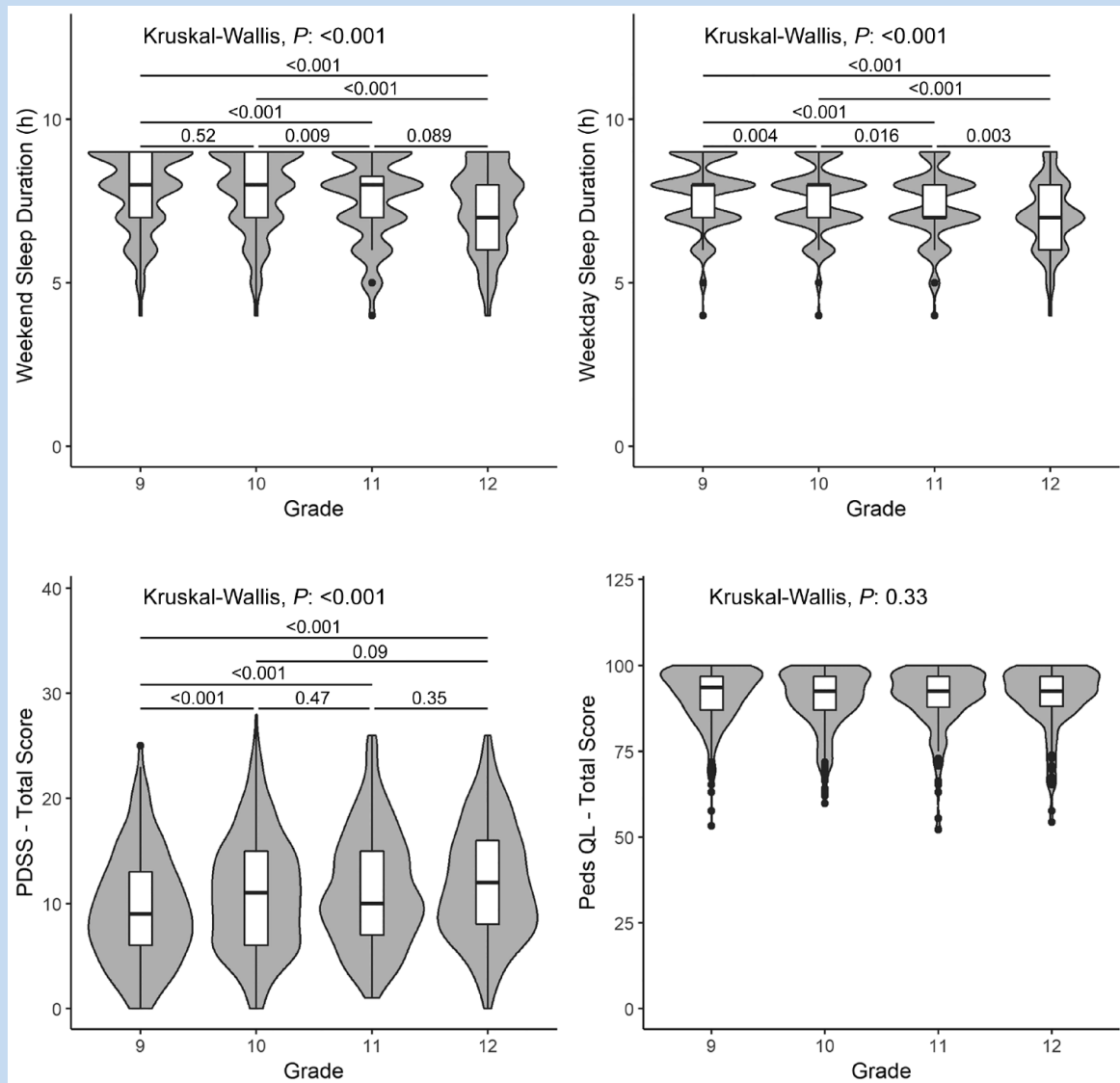


Figure 3. Quality of life, daytime sleepiness, and sleep duration by grade among female high school volleyball athletes. Data shown as violin plots representing the median, interquartile range, and kernel density distribution of the data, with significance levels from Kruskal-Wallis and post hoc pairwise Wilcoxon rank sum tests, if indicated. Wider sections of the violin plots represent a higher probability of a given value, while thinner sections represent a lower probability. PDSS, Pediatric Daytime Sleepiness Scale; PedsQL, Pediatric Quality of Life.

because of injuries obtained during volleyball. It is possible that the proximity of the prior injury to the time of the QOL survey could also influence the relationship between injury and QOL, but we were not able to evaluate this relationship. Importantly, the causality of any relationships identified from this study cannot be proven and any suggestion that they may exist must be speculative. Sleep and QOL measures were obtained preseason before the start of school and may therefore be different than those identified in-season after school starts. Last, this study included only adolescent female volleyball athletes from a single geographic state and therefore may not be generalizable to other populations.

In conclusion, we found that higher levels of sport specialization among high school female volleyball athletes is associated with decreases in QOL and increases in daytime sleepiness. History of a previous injury was also associated with decreased QOL, and after including both specialization and injury history into our multivariable model, specialization was no longer significantly associated with QOL. This suggests that the negative association between specialization and QOL is actually because of the higher rates of previous injury among specialized athletes. Sleepiness and sleep duration worsened with increasing grade in school, but specialization was still associated with increased daytime sleepiness even after

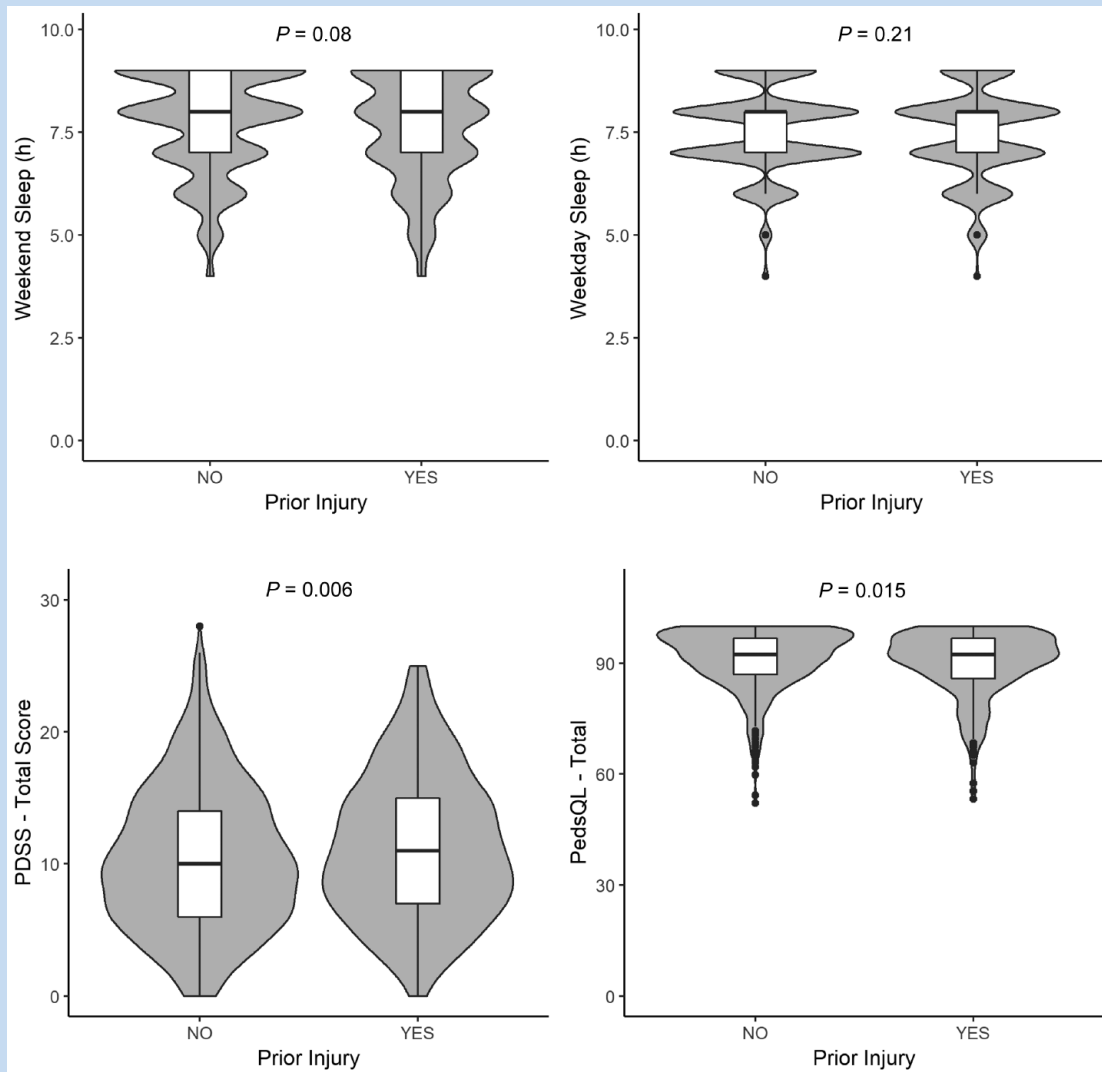


Figure 4. Quality of life, daytime sleepiness, and sleep duration by prior injury among female high school volleyball athletes. Data shown as violin plots representing the median, interquartile range, and kernel density distribution of the data, with significance levels from Kruskal-Wallis and post hoc pairwise Wilcoxon rank sum tests, if indicated. Wider sections of the violin plots represent a higher probability of a given value, while thinner sections represent a lower probability. PDSS, Pediatric Daytime Sleepiness Scale; PedsQL, Pediatric Quality of Life.

Table 2. Multivariable models to predict quality of life and daytime sleepiness among female high school volleyball athletes

	PedsQL—Total Score			PDSS—Total Score		
	Estimate	SE	P	Estimate	SE	P
Specialization: Moderate	0.08	0.52	0.88	-0.10	0.34	0.76
Specialization: High	-0.70	0.52	0.18	1.12	0.34	<0.001
Grade	-0.08	0.20	0.71	0.76	0.13	<0.001
Prior injury (yes)	-1.11	0.48	0.02	0.51	0.31	0.10

PDSS, Pediatric Daytime Sleepiness Scale; PedsQL, Pediatric Quality of Life.

adjusting for grade and previous injury history. Despite the known benefits of sport participation and physical activity, specialized athletes appear to be at risk for impaired sleep and may be at increased risk of impaired QOL due more to the increased risk of prior injury associated with specialization. Further research is needed to better define the mechanisms behind these relationships, as well as the efficacy of interventions to improve QOL after injury among adolescent athletes.

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