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The association of sleep with subjective wellbeing and performance in female athletes: A systematic review

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ABSTRACT

Sleep and athletic performance have been investigated in previous research, showing sleep to be important for cognitive function, mood, and recovery. Inferior sleep has been reported in female athletes compared to male athletes; however, no systematic reviews have examined the association of sleep with performance and subjective wellbeing in female athletes. Three electronic databases (SPORTDiscus, PubMed, and Web of Science) were searched with no date restrictions in June 2024. Studies contained primary data and examined any association between sleep and performance in female athletes over the age of 18 years, with their level of competition described. Performance and subjective wellbeing were categorised as sport-specific performance; cognitive performance; physical performance, readiness, and availability; and mood and subjective wellbeing. From 2565 records, 38 studies remained for review. Most studies examined physical performance, readiness, and availability, whereas cognitive performance was the least studied aspect of performance. The majority of studies included in this review supported the general conclusion that positive sleep outcomes were associated with positive performance and subjective wellbeing outcomes (89% of sport-specific performance; 50% of cognitive performance; 38% of physical performance, readiness, and availability; and 21% of mood and subjective wellbeing studies), while negative sleep outcomes were associated with negative performance and subjective wellbeing outcomes (50% of cognitive; 33% of physical, readiness, and availability; and 50% of mood and subjective wellbeing studies) in female athletes. Only 2 studies were of high-quality according to a modified version of the Newcastle-Ottawa Scale, indicating a lack of high-quality evidence in the reviewed literature. Lack of control for sleep, athletic population, and menstrual characteristics were particularly apparent. This review highlights lower sleep duration and/or quality being detrimental to sport-specific performance; cognitive performance; physical performance, readiness, and availability; and mood and subjective wellbeing of female athletes. However, more high-quality research is needed to describe sufficiently the relationship between sleep and performance in female athletes.

1. Introduction

Sleep is a fundamental aspect of human health, performance, and recovery (Consensus Conference Panel, 2015). The quantity, quality and timing of sleep obtained has implications on numerous physiological processes including immunity, hormone function, the cardiovascular system, and cognitive performance alongside psychological processes such as learning, mood, memory, and

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attention (Consensus Conference Panel, 2015). Sleep and its implications for performance are of particular importance to athletes, with quantity and quality of sleep being one of the most important factors in recovery and overall health among elite athletes (Vitale et al., 2019). Sleep and athletic performance have been linked, with total sleep deprivation for one night (30 hours awake) being associated with decreased average distance travelled by male recreational runners in a 30min treadmill test (Oliver et al., 2009), as well as lower average sprint times, decreased strength and muscle activation during isometric force testing, and reduced muscle glycogen concentrations in male athletes also (Skein et al., 2011). Studies have shown that obtaining less than 7 hours sleep is associated with decreases in cognitive performance in tests of memory, alertness, decision making and reaction time (Fullagar et al., 2015).

International experts have stated that the prevalence of sleep inadequacy is high among elite athletic populations who often experience disruptive training and competition schedules that may limit sleep opportunity (Walsh et al., 2021). Athletes obtaining less sleep than non-athletes have been reported in mixed-sex cohorts with Olympic athletes obtaining between 6.5 hours – 6.8 hours of sleep per night (Leeder et al., 2012), which is below the 7 hours – 9 hours of sleep recommended for adults (Hirshkowitz et al., 2015). When examining a range of sports with mixed cohorts, Sargent et al. (2014) also found that early morning training sessions reduced the total sleep time of athletes and increased pre-training fatigue levels. Sleep disturbances are common in athletic cohorts prior to competition, which could impact athletic performance (Gupta et al., 2017).

Female athletes may be at a greater risk of lower sleep quality and quantity than male athletes. Kawasaki et al. (2020) found that female athletes had significantly higher incidence of lower sleep quality (48.8% of females and 31.4% of males, $p < 0.001$) as measured by the Pittsburgh Sleep Quality Index (PSQI), and greater daytime sleepiness (54.3% of females and 43.0% of males, $p = 0.025$) as measured by the Epworth Sleepiness Scale (ESS), than male athletes. While in Australian Rules Football (Australian Football League [AFL] and Australian Football League Women's [AFLW]), AFLW (female) athletes had less total sleep time, and lower sleep efficiency than AFL (male) athletes when measured using wrist actigraphy (Roberts et al., 2021).

There is evidence to show that the menstrual cycle (MC) can have an impact on the sleep of non-athletic females (Baker & Driver, 2004), with self-reported disturbances during premenstrual and menstrual periods, as well as problems sleeping occurring in those with premenstrual syndrome or polycystic ovary syndrome (Baker & Lee, 2018). Greater menstrual abnormality was reported in female athletes with poor sleep quality than in those who had better sleep quality (Kawasaki et al., 2020), while sleep disturbances and changes in sleep quality were reported by 19.5% and 20.4% of recreational female athletes (Michelekaki et al., 2023). There has also been a strong positive association between scores on the Menstrual Symptom index (indicating severity of symptoms experienced) and both PSQI scores (indicating poor sleep quality) and the Athlete Sleep Behaviour Questionnaire (ASBQ; indicating poor sleep behavior; Kullik et al., 2024). This is indicative of a potential bidirectional relationship between sleep and MC characteristics. MC symptoms such as anxiety, cramps, headaches, and depression are associated with disturbed sleep (Van Reen & Kiesner, 2016). Body temperature changes associated with the MC can also have an influence on sleep. The normal decrease in body temperature while sleeping can be blunted during the luteal phase of the MC due to the thermogenic action of progesterone (Baker & Lee, 2018) which counteracts the hypothermic effect of melatonin during the night when temperature is supposed to fall (Manber & Armitage, 1999). Aside from physiological differences, there are also societal differences that may have an impact on the quantity and quality of sleep available to be obtained by female athletes. Teece et al. (2023) suggested that differences in sleep duration between male and female rugby union athletes may be caused by the impact of training schedules due to differences in professionalism. In female sports, salaries are often less than those of male athletes, leading female athletes to have to work in part-time jobs, which pushes training times to either early morning or late at night. In this study, female athletes also showed higher rates of using sleep medication and reported having more thoughts about both sport-related and non-sport-related matters while in bed when compared with male athletes (Teece et al., 2023). Sleep disruption that may be experienced by female athletes could leave them at an increased risk of detrimental impacts to their health and performance.

Although the impact of sleep on the athlete, and the habitual sleep of athletes in general has been studied, little is known about the impact of sleep on the performance of female athletes. With the known associations between sleep and female physiology, as well as the known prevalence of sleep disturbance and inadequacy in athletic populations, there is a need to further understand the sleep of female athletic populations and how it may or may not impact performance. There are no systematic reviews examining the association between sleep and performance in female athletes. Therefore, the aim of this study is to provide a systematic review of the existing literature examining the association between sleep and performance parameters in female athletes; namely, sport-specific performance; cognitive performance; physical performance, readiness, and availability; and mood and subjective wellbeing.

2. Methods

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) and registered with PROSPERO (CRD42022297974).

2.1. Search strategy and terms

Three electronic databases, SPORTDiscus, PubMed, and Web of Science were systematically searched with no date restrictions in June 2024. The sleep measurement search terms outlined with 'OR' were sleep, sleepiness, sleep loss, and sleep deprivation; the sex search terms outlined with 'OR' were female, and women; and the athletic population search terms outlined with 'OR' were athlete, athletic, elite, and sport; the performance parameter search terms outlined with 'OR' were performance, cognition, cognitive, mood, availability, and wellbeing. The performance parameter search terms were deemed to be suitable by the reviewers to encapsulate all aspects of sports performance under relatively broad performance parameters, to allow for the search strategy to capture as many studies as possible examining the association between sleep and any measure of performance in female athletes. The search term keywords were combined with 'AND' and searched in 'All Fields'. Reference lists of included articles were manually searched to ensure that all related texts were captured.

2.2. Eligibility criteria and selection process

The retrieved records' eligibility was assessed based on title and abstract to determine the relevance of the articles found in the initial search. Duplicate and irrelevant articles were excluded also based on title and abstract. Full-text articles were screened if information from title and abstract was unclear. Articles deemed eligible for full-text review were screened against the following inclusion criteria: (i) the study reported primary data and was published in a peer-reviewed journal as a full-text article in the English language; (ii) the study participants were described as elite or expert athletes or athletes competing at sub-elite (collegiate/national); (iii) the study examined sleep by use of polysomnography, actigraphy, sleep diaries and/or questionnaires; (iv) the study described the impact of sleep on performance from a cognitive, physical, wellbeing or skill-based perspective; and (v) the study included data for female athletes separately reported when study used mixed-sex cohorts. Studies were excluded if: (i) the participants were adolescents (< 18 years old); (ii) male and female results were not separated in the case of mixed-sex cohorts; (iii) no performance variable was investigated; (iv) the population was not athletic; (v) the study was in athletes who had sustained a concussion; (vi) here was the presence of a clinical condition which could have impacted sleep quality. The process of study selection following PRISMA guidelines is shown in Figure 1.

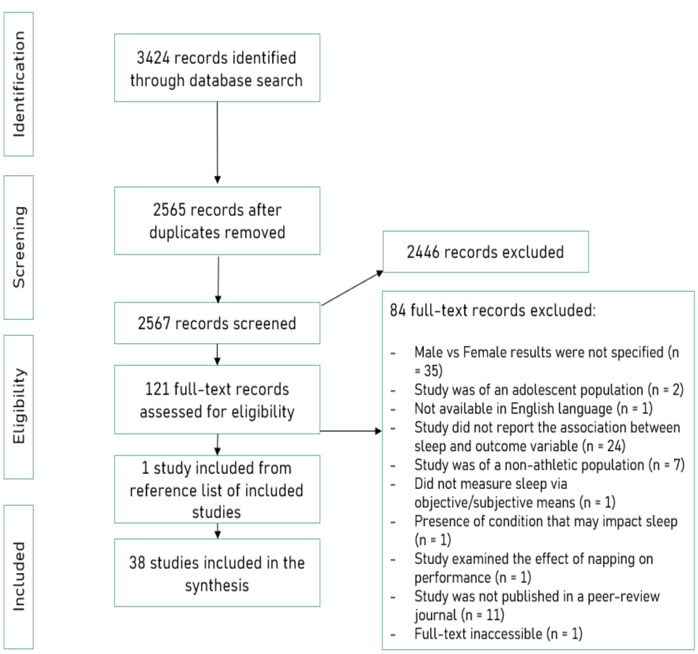

Figure 1: PRISMA Flow Diagram.

2.3. Data extraction and quality appraisal

The competitive level of athletes was examined using a modified taxonomy of Swann et al. (2015), presented in Table 1, in which participants are ranked on a continuum and categorised as semi-elite, competitive-elite, successful elite, and world-class elite to address the varying levels of competition reported in studies of athletic populations. With the application of the full taxonomy limited by participant description in the selected studies, a modified version of this tool was utilised, which has been used in previous systematic reviews of both mixed-sex athlete cohorts (Gupta et al., 2017) and female athlete sleep (Miles et al., 2022). Participants of the selected studies could be categorised as either competitive elite or semi-elite only. Competitive elite cohorts were those with a score greater than or equal to eight in the modified taxonomy. Semi-elite cohorts were those that obtained a score less than eight.

Quality of the studies was evaluated using the modified Newcastle-Ottawa Scale (NOS), a quality assessment instrument that has been previously used in studies of sleep in mixed-sex and female cohorts (Gupta et al., 2017; Miles et al., 2022). Breakdown of the scoring in the NOS is provided in Table 2. Quality of the selected studies was independently scored via the adapted NOS by two reviewers and checked for agreement. In the event of disagreement, the matter was discussed by the two reviewers, and if needed, a third reviewer was brought in for a consensus agreement.

2.4. Characterisation of included studies

The principal characteristics of the included studies are presented in Table 3. These include study design, duration, and performance measure. Performance measure was categorised as sport-specific performance; cognitive performance; physical performance, readiness, and availability; and mood and subjective wellbeing. The four performance categories mentioned were chosen as a method of incorporating all aspects of sports performance. Sport-specific performance incorporated any result relating to the athletes' performance in outcomes directly related to their sport (i.e., ranking, placing in competition, performance in statistics unique to their sport). Raysmith et al. (2019) stated that for athletes at the highest level of sport, performance at the key competitions is the 'outstanding measure for success'. Cognitive performance included any outcome measures that could be examined when measuring cognition, such as reaction time and decision making (Brito et al., 2022). Physical performance, readiness, and availability included any muscular performance (e.g., strength, power, speed) outcome, alongside any outcome which may inform the practitioner on the readiness and availability of the athlete (e.g., training load, fatigue, presence of illness). Mood and subjective wellbeing included any mood variable that may have been examined in athletic cohorts (i.e., stress, depression, tension, vigour, motivation, etc.).

Study cohorts were characterised by the percentage of female participants, age and competitive level quantified by the modified taxonomy of Swann et al. (2015). Whether or not a study reported or controlled for menstrual cycle phase was included in the study characterisation since phases of the menstrual cycle have been shown to have an impact on sleep (Van Reen & Kiesner, 2016).

Table 1: Modified competitive level taxonomy for selected studies.

	Within sport			Between sport		Statistics	
	A	B	C	D	E		
	Standard of performance	Success at level	Experience at level	Competitiveness in country	Global competitiveness of sport	Scores (out of 16)	Competitive elite (> 8)
Akazawa et al., 2019	1	NR	NR	1	4	2.5	0
Barreira et al., 2024	4	NR	NR	4	4	16	1
Benjamin et al., 2020	1	NR	NR	3	4	3.5	0
Coombes & Badenhorst, 2024	3	NR	NR	1	4	7.5	0
Costa et al., 2021	4	NR	NR	4	4	16	1
Costa et al., 2019	3	NR	NR	4	4	12	1
Crouch et al., 2021	1	NR	NR	1	1	1	0
Doeven et al., 2019	4	NR	NR	1	2	6	0
Dumortier et al., 2018	4	NR	NR	2	4	12	1
Fernandes et al., 2021	3	NR	NR	4	4	12	1
Foster et al., 2023	1	NR	NR	1	4	2.5	0
Grace et al., 2023	1	NR	NR	2	4	3	0
Haroldsdottir et al., 2021	1	NR	NR	1	4	2.5	0
Horgan et al., 2021	3	NR	NR	2	1	4.5	0
Juliff et al., 2018	3	NR	NR	2	1	4.5	0
Kawasaki et al., 2020	1	NR	NR	1	1	1	0
Kilic et al., 2021	3	NR	NR	3	4	10.5	1
Knufinke et al., 2018	4	NR	4	2	4	12	1
Koikawa et al., 2016	1	NR	NR	3	4	3.5	0
Long et al., 2024	1	NR	NR	2	4	3	0
Merrigan et al., 2024	1	2	NR	3	4	3.5	0
Mielgo-Ayuso et al., 2017	3	NR	NR	1	4	7.5	0
Moen et al., 2021	4	NR	NR	4	4	16	1
O’Donnell et al., 2018a	4	2	NR	3	1	8	0
Ressman et al., 2024	3	NR	NR	3	4	10.5	1
Reyner & Horne, 2013	1	NR	NR	2	4	8	0
Roberts et al., 2022	1	NR	2	1	1	1	0
Romyn et al., 2016	2	NR	NR	3	4	7	0
Roy et al., 2019	1	NR	NR	1	4	2.5	0
Sekiguchi et al., 2019	1	NR	NR	2	1	2	0
Senbel et al., 2022	1	NR	NR	4	4	4	0
Silva & Paiva, 2016	4	NR	4	1	3	8	0
Silva & Paiva, 2019a	4	NR	4	1	3	8	0
Silva & Paiva, 2019b	4	NR	4	1	3	8	0
Staunton et al., 2017	3	NR	NR	3	4	10.5	1
Taheri & Irandoust, 2020	1	NR	NR	3	3	3	0
Tsukahara et al., 2022	3	NR	NR	1	4	7.5	0
Ungureanu et al., 2021	3	NR	NR	2	4	9	1
Mean	2.39	NA	NA	2.18	3.29	6.83	11/38
SD	1.28	NA	NA	1.10	1.17	4.32	NA

Notes: Modified equation = {A × [(D + E)/2)]}; a score > 8 is judged to be a study that has recruited ‘competitive elite’ athletes (see Swann et al., 2015); NR, not reported; NA, not applicable; SD, standard deviation.

Table 2: Modified Newcastle-Ottawa Scale quality appraisal of selected studies.

	Selection[a]					Comparability[a]			Outcome[b]			Statistics			
	Representativeness of the sample	*n*	Non-respondents	Ascertainment of the exposure[b] (sleep)	Sub-total	Control for most important factor (sleep)	Control for other factors (competitive standard)	Sub-total	Assessment of outcome	Statistical test	Sub-total	Total (out of 10)	High (> 7)	Mod-high (5–7)	Low (< 5)
Akazawa et al., 2019	0	0	0	1	1	0	0	0	2	1	3	4	0	0	1
Barreira et al., 2024	1	0	0	1	2	0	0	0	2	1	3	5	0	1	0
Benjamin et al., 2020	1	1	1	1	4	0	0	0	1	1	2	6	0	1	0
Coombes & Badenhorst, 2024	1	0	1	1	3	0	0	0	1	1	2	5	0	1	0
Costa et al., 2021	1	0	1	1	3	0	0	0	2	1	3	6	0	1	0
Costa et al., 2019	0	1	0	1	2	0	0	0	2	1	3	4	0	1	0
Crouch et al., 2021	1	0	0	1	2	0	0	0	1	1	2	4	0	0	1
Doeven et al., 2019	1	0	1	2	4	0	0	0	1	1	2	6	0	1	0
Dumortier et al., 2018	0	0	0	2	2	1	0	1	1	1	2	5	0	1	0
Fernandes et al., 2021	0	0	0	0	0	0	0	0	1	1	2	2	0	0	1
Foster et al., 2023	1	1	1	1	4	0	0	0	1	1	2	6	0	1	0
Grace et al., 2023	1	1	1	0	3	0	0	0	1	1	2	5	0	1	0
Haroldsdottir et al., 2021	1	0	0	1	2	0	0	0	1	1	2	4	0	0	1
Horgan et al., 2021	1	1	1	1	4	0	0	0	1	1	2	6	0	1	0
Juliff et al., 2018	1	1	0	1	3	1	0	1	2	1	3	7	0	1	0
Kawasaki et al., 2020	0	1	1	1	3	0	0	0	1	1	2	5	0	1	0
Kilic et al., 2021	1	1	1	2	5	0	1	1	1	1	2	8	1	0	0
Knufinke et al., 2018	0	1	0	2	3	0	0	0	2	1	3	6	0	1	0
Koikawa et al., 2016	0	1	1	1	3	0	0	0	1	1	2	5	0	1	0
Long et al., 2024	0	1	0	1	2	0	0	0	1	1	2	4	0	0	1
Merrigan et al., 2024	1	0	0	2	3	0	0	0	2	1	3	6	0	1	0
Mielgo-Ayuso et al., 2017	1	1	0	2	4	0	0	0	1	1	2	6	0	1	0
Moen et al., 2021	0	0	1	2	3	0	0	0	2	1	3	6	0	1	0
O'Donnell et al., 2018a	1	0	0	2	3	1	0	1	2	1	3	7	0	1	0
Ressman et al., 2024	1	1	1	1	4	0	1	1	2	1	3	8	1	0	0
Reyner & Horne, 2013	0	0	0	2	2	1	0	1	2	1	3	6	0	1	0
Roberts et al., 2022	0	0	1	2	3	0	0	0	2	1	3	6	0	1	0
Romyn et al., 2016	0	0	0	2	2	0	0	0	2	1	3	5	0	1	0
Roy et al., 2019	0	0	1	0	1	0	0	0	1	1	2	3	0	0	1
Sekiguchi et al., 2019	1	0	0	2	3	0	0	0	2	1	3	6	0	1	0
Senbel et al., 2022	1	0	1	2	4	0	0	0	2	1	3	7	0	1	0
Silva & Paiva, 2016	0	1	0	1	2	0	0	0	1	1	2	4	0	0	1
Silva & Paiva, 2019a	0	1	0	1	2	0	0	0	1	1	3	4	0	0	1
Silva & Paiva, 2019b	0	1	0	1	2	0	0	0	2	1	3	5	0	1	0
Staunton et al., 2017	0	0	0	1	1	0	0	0	2	1	3	4	0	0	1
Taheri & Irandoust, 2020	0	0	1	1	2	0	0	0	2	1	3	5	0	1	0
Tsukahara et al., 2022	0	1	0	1	2	0	0	0	1	1	2	5	0	1	0
Ungureanu et al., 2021	0	0	0	1	1	0	0	0	1	1	2	3	0	0	1
Mean	0.47	0.45	0.42	1.26	2.61	0.11	0.05	0.16	1.47	1.00	2.50	5.24	2	26	10
SD	0.50	0.50	0.49	0.59	1.06	0.31	0.22	0.36	0.50	0.00	0.50	1.31	NA	NA	NA

Notes: [a]subscale items rated 0–1; [b]subscale items rated 0–2; NA, not applicable; SD, standard deviation; The NOS is scored by allocation of a point for each criterion that is met in each section of: 1. Selection (maximum 5 points); 2. Comparability (maximum 2 points); and 3. Outcome (maximum 3 points). Each section has sub-sections that can be worth either 1 or 2 points depending on the criterion being questioned. The total score out of a possible 10 points determines whether the study is of high (> 7), moderate (5–7) or low (< 5) quality.

Table 3: Characteristics of included studies.

	Sport	Female (*n*)	Female (%)	Female age (years)	Study design	Study duration	Performance measure	"Eliteness" of sample	Control for MC Phase/Regularity /HC use	Quality assessment score (adapted NOS 0–10)
Akazawa et al., 2019	Volleyball	12	100	20.0 ± 0.3	Cross-sectional	1 day	Cognitive	Semi	No	Low (4)
Barreira et al., 2024	Soccer	16	100	25.4 ± 3.6	Observational	7 days	Physical, readiness, and availability	Competitive	No	Moderate (5)
Benjamin et al., 2020	Soccer	120	52	20.0 ± 1.0	Observational	3 competitive seasons	Mood and subjective wellbeing	Semi	No	Moderate (6)
Coombes & Badenhorst, 2024	Soccer	22	100	20.8 ± 3.5	Cross-sectional	1 data collection session	Physical, readiness, and availability	Semi	Menstrual status recorded via LEAF-Q	Moderate (5)
Costa et al., 2021	Soccer	20	100	25.2 ± 3.1	Observational	9 days	Physical, readiness, and availability	Competitive	No	Moderate (6)
Costa et al., 2019	Soccer	34	100	20.6 ± 2.3	Observational	14 days	Physical, readiness, and availability	Competitive	No	Low (4)
Crouch et al., 2021	Lacrosse	27	100	18.7 ± 0.9	Observational	13 weeks	Physical, readiness, and availability	Semi	No	Low (4)
Doeven et al., 2019	Rugby (7s)	12	100	25.3 ± 4.1	Observational	7 days	Physical, readiness, and availability	Semi	No	Moderate (6)
Dumortier et al., 2018	Gymnastics	7	100	20.9 ± 2.8	Observational	14 weeks	Sport-specific	Competitive	No	Moderate (5)
Fernandes et al., 2021	Soccer	19	100	24.1 ± 2.7	Observational	10 weeks	Physical, readiness, and availability; mood and subjective wellbeing	Semi	No	Low (2)
Foster et al., 2023	Volleyball	67	100	NR	Observational	5 competitive seasons	Physical, readiness, and availability; mood and subjective wellbeing	Semi	No	Moderate (6)
Grace et al., 2023	Lacrosse	32	100	NR	Observational	1 competitive season	Sport-specific	Semi	No	Moderate (5)
Haroldsdottir et al., 2021	Volleyball	17	100	19.6 ± 1.0	Observational	9 months	Physical, readiness, and availability; mood and subjective wellbeing	Semi	No	Low (4)
Horgan et al., 2021	Netball	536	100	18.8 ± 4.6	Retrospective cohort	4 years	Physical, readiness, and availability	Semi	No	Moderate (6)
Juliff et al., 2018	Netball	42	100	19.2 ± 1.0	Observational	18 days	Sport-specific	Semi	No	Moderate (7)
Kawasaki et al., 2020	Multiple	215	51	19.0 ± 3.5; 20.3 ± 4.4	Cross-sectional	1 data collection session	Mood and subjective wellbeing	Semi	Yes	Moderate (5)
Kilic et al., 2021	Australian Football	132	36	22.8 ± 4.0	Cross-sectional	3 months	Physical, readiness, and availability; mood and subjective wellbeing	Competitive	No	High (8)
Knufinke et al., 2018	Multiple	56	57	NR	Observational	10 days	Physical, readiness, and availability	Competitive	No	Moderate (6)
Koikawa et al., 2016	Soccer	30	32	19.8 ± 1.2	Cross-sectional	1 day	Mood and subjective wellbeing	Semi	No	Moderate (5)

Continued

Long et al., 2024	Soccer	30	100	NR	Observational	1 competitive season	Physical, readiness, and availability; mood and subjective wellbeing	Semi	No	Low (4)
Merrigan et al., 2024	Ice Hockey	25	100	20.7 ± 1.6	Retrospective	1 competitive season	Physical, readiness, and availability	Semi	No	Moderate (6)
Mielgo-Ayuso et al., 2017	Volleyball	40	100	27.0 ± 4.0	Cross-sectional	1 day	Physical, readiness, and availability	Semi	Yes	Moderate (6)
Moen et al., 2021	Soccer	29	100	25.9 ± 4.1	Observational	124 days	Physical, readiness, and availability	Competitive	No	Moderate (6)
O'Donnell et al., 2018a	Netball	10	100	23.0 ± 6.0	Observational	7 days	Mood and subjective wellbeing	Semi	No	Moderate (7)
Ressman et al., 2024	Soccer	254	100	22 (No SD)	Cross-sectional	1 day	Physical, readiness, and availability	Competitive	No	High (8)
Reyner & Horne, 2013	Tennis	8	50	18–22 years	Experimental	4 days	Sport-specific	Semi	No	Moderate (6)
Roberts et al., 2022	Ultra-Marathon	18	50	38.0 ± 7.0	Observational	3 consecutive days	Physical, readiness, and availability; mood and subjective wellbeing	Semi	No	Moderate (6)
Romyn et al., 2016	Netball	8	100	19.6 ± 1.5	Observational	14 total days	Mood and subjective wellbeing	Semi	No	Moderate (5)
Roy et al., 2019	Volleyball	15	100	NR	Observational	54 days	Physical, readiness, and availability; mood and subjective wellbeing	Semi	No	Low (3)
Sekiguchi et al., 2019	Athletics	10	100	19.0 ± 1.0	Observational	12 weeks	Physical, readiness, and availability	Semi	No	Moderate (6)
Senbel et al. [53]	Basketball	16	100	NR	Observational	25 weeks	Sport-specific	Semi	No	Moderate (7)
Silva & Paiva, 2016	Gymnastics	67	100	18.7 ± 2.9	Cross-sectional	1 data collection session	Sport-specific	Semi	No	Low (4)
Silva & Paiva, 2019a	Gymnastics	67	100	18.7 ± 2.9	Cross-sectional	1 data collection session	Mood and subjective wellbeing	Semi	No	Moderate (5)
Silva & Paiva, 2019b	Gymnastics	67	100	18.7 ± 2.9	Cross-sectional	1 data collection session	Mood and subjective wellbeing; sport-specific	Semi	Identified delayed menarche and menstrual irregularities	Low (4)
Staunton et al., 2017	Basketball	17	100	NR	Observational	30 weeks (16 in one season, 14 in one season)	Sport-specific	Competitive	No	Low (4)
Taheri & Irandoust, 2020	Volleyball	21	100	23.6 ± 2.9	Experimental	2 days	Cognitive	Semi	No	Moderate (5)
Tshukahara et al., 2022	Athletics	77	100	NR	Cross-sectional	1 testing session	Sport-specific	Semi	No	Moderate (5)
Ungureanu et al., 2021	Volleyball	10	100	23.0 ± 4.0	Observational	16 weeks	Physical, readiness, and availability	Competitive	No	Low (3)

Notes: SD, standard deviation; HC, hormonal contraception; MC, menstrual cycle; NR, not reported.

3. Results

The database search returned 2565 records. Following a title and abstract screening, one hundred and twenty-one studies remained for full-text eligibility assessment. Following the application of inclusion and exclusion criteria, thirty-eight studies were included in the synthesis.

3.1. Quality appraisal

The quality of the selected studies was moderate to low, with twenty-six studies (68%) scoring between 5 – 7 (moderate quality) and ten studies (26%) scoring < 5 (low quality). Only two studies scored > 7 (high quality).

Due to many of the studies being observational in design, there was a lack of control for both sleep quality and/or quantity (only five studies included this control) and competitive standard (one study included this control). The full quality appraisal using the modified Newcastle-Ottawa Scale is presented in Table 2.

3.2. Characteristics of included studies

In the selected studies, thirty-one of the thirty-eight studies examined females exclusively, with the seven remaining studies containing mixed-sex sample with a mean of 46.9% female. The mean number of female athletes in the samples of included studies was $n = 58$ (range: 7 – 536).

Most studies were observational in design, with only two experimental studies included. Studies were conducted across fourteen different sports and two multi-sport cohorts, with soccer and volleyball being the most examined sports. Study durations varied, some studies were as short as one day in duration, while others spanned between three months and five competitive seasons.

Only two of the included studies reported menstrual cycle phase/regularity and/or hormonal contraceptive use, one study reported menstrual status, while one other study identified delayed menarche and menstrual irregularities. A full description of study characteristics is presented in Table 3.

3.3. Association between sleep and sport-specific performance

Results from included studies in this category of performance are presented in Table 4. In studies examining sport-specific performance, two studies recorded sleep through objective measures (wrist actigraphy) while the five remaining studies used subjective sleep measurement (Epworth Sleepiness Scale; Pittsburgh Sleep Quality Index; Sleep log/diary). The study durations ranged from one data collection session to two competitive seasons of monitoring. Five studies were of moderate quality with the remaining two studies being of low quality. Competitive level of the athletes in the studies sample was semi-elite in seven studies and competitive elite in two studies. The average sample size of the studies examining sleep and sport-specific performance was $n = 30$ (range: 7 – 67).

Performance outcomes measures included: coach ratings; championship/competition rankings; mean apparatus score (gymnastics); team win/loss record; serving accuracy (tennis); game statistics; injury reports; and competition scores (gymnastics). Associations between improved sleep indices and positive performance outcomes were moderate to strong in general. Superior competition ranking had significant associations with sleep duration ($r = -0.680$, $p < 0.01$; $r = 0.339$, $p = 0.005$) over both an 18-day monitoring period as well as cross-sectional data (Juliff et al., 2018; Silva & Paiva, 2016), while inferior competition ranking was associated with increased sleepiness (ESS score; $r = -0.454$, $p < 0.001$), and increased sleep disturbance (PSQI score; $r = -0.242$, $p = 0.042$; Silva & Paiva, 2016). The strongest association between sleep and sport-specific performance was found to be between increased total sleep time and mean apparatus score ($r = 0.771$) and world championship ranking ($r = -0.771$) in gymnasts over 14 weeks of data collection (Dumortier et al., 2017), however these associations were not significant.

3.4. Association between sleep and cognitive performance

Results from included studies in this category are also presented in Table 4. Cognitive performance was the least examined performance parameter in this review. In the two studies examining cognitive performance, two types of actigraphy were used to monitor sleep (mattress-based actigraphy; wrist actigraphy). The quality of these studies was moderate and low. Study duration was relatively short, having a one- and two-day testing period respectively. Average sample size was $n = 12$ with all the participants in the studies being female.

One study involved partial sleep deprivation to examine the impact of acute sleep loss on performance using the Vienna system test (Taheri & Irandoust, 2020), where participants slept for 3 hours the night before testing. This study saw significantly impaired reaction time ($p = 0.004$), accuracy rate ($p = 0.001$) median cognitive reaction ($p = 0.001$), median motor time ($p = 0.01$), processing speed ($p = 0.001$) and selective attention ($p = 0.001$) in a sleep deprivation group compared to a sleep deprivation group who completed an exercise bout upon waking before testing (both slept 3 hours). Reaction time (via Stroop task) during heavy exercise was found to improve in a superior sleep quality group ($p < 0.05$; Akazawa et al., 2019). Improved sleep efficiency was also associated with improved reaction time during heavy exercise compared to less strenuous exercise ($r = -0.680$, $p < 0.05$).

3.5. Association between sleep and physical performance, readiness, and availability

Results from included studies in this category can be found in Table 5. A total of twenty-one studies reported on the association between sleep and the physical performance, readiness, and availability of female athletes. Methods of objective sleep measurement included wrist actigraphy (Barreira et al., 2022; Costa et al., 2019; Costa et al., 2021; Knufinke et al., 2018; Roberts et al., 2022; Sekiguchi et al., 2019), a non-contact smart sleep monitor (Moen et al., 2021), a commercially available wearable (Merrigan et al., 2024) and partial polysomnography (Knufinke et al., 2018). Sleep was measured subjectively using wellness questionnaires (Costa et al., 2021; Crouch et al., 2021), Hooper Index (Fernandes et al., 2021; Roy et al., 2019; Ungureanu et al., 2021), sleep diaries (Barreira et al., 2022; Haroldsdottir et al., 2021; Horgan et al., 2021) and questionnaires

Table 4: Results from studies examining the association between sleep and sport-specific performance and cognitive performance in female athletes.

	Sleep Measurement	Performance Measurement	Results
Dumortier et al., 2018	Sleep log	Trainer rating; WC ranking; mean apparatus score	TST trended to association with ↑ gymnastics mean apparatus score ($r = 0.771$, $p = 0.072$) and gymnastics WC ranking ($r = -0.771$, $p = 0.072$).
Grace et al., 2023	Subjective wellness survey	Team win/loss record	60% of losses occurred with low sleep quality. 60% of wins occurred with high sleep quality. (Not significant: $p = 0.527$).
Juliff et al., 2018	Sleep diary; ESS; Wrist actigraphy	Finishing place in netball competition	↑ sleep duration associated with higher finishing place ($r = -0.68$, $p < 0.01$). Top 2 teams had ↑ TIB ($p < 0.001$), ↑ sleep duration ($p < 0.001$), ↑ subjective sleep rating ($p = 0.008$) compared to bottom 2 teams.
Reyner & Horne, 2013	Wrist actigraphy	Set target box within the tennis service area	Significant association between sleep condition (normal vs restricted) and number of hits inside the service box (F = 38.7, df:1,28; $p < 0.001$). Result the same for both men and women (no significant relative difference in effect of sleep reduction on serving accuracy).
Senbel et al., 2022	Wrist accelerometery	Game statistics; injury reports	Sleep need, sleep debt hours and weekly sleep duration were ranked in the top 10 features affecting game performance (5^{th}, 8^{th}, and 9^{th} respectively).
Silva & Paiva, 2016	ESS; PSQI; sleep/wake times	Overall performance ranking from published general competition results	↑ sleep duration associated with superior performance ranking ($r = 0.339$, $p = 0.005$). ↑ sleepiness (ESS score) associated with inferior performance ranking ($r = -0.454$, $p < 0.001$) ↑ sleep disturbance (PSQI score) associated with inferior performance ranking ($r = -0.242$, $p = 0.042$).
Silva & Paiva, 2019a	ESS; PSQI; sleep/wake times	Overall performance ranking from published general competition results	Lowest performances (OR = 1.25, 95% CI [0.76, 2.06]) and sleep duration <8h30m on weekdays (OR = 1.93, 95% CI [1.48, 2.50]) identified as risk factors for reduced sleep quality.
Staunton et al., 2017	Wrist actigraphy	Basketball Efficiency Statistic	Association between TST and basketball efficiency statistic for individual players ranged from moderate negative to strong positive; a significant association for one player only ($r = 0.60$, $p = 0.025$). No association between SE and basketball efficiency statistic.
Tsukahara et al., 2022	Customised training load and recovery questionnaire	IAAF competition scores	Number of sleep hours was not associated with IAAF score in the whole group or in the Japanese athlete sub-group. For American athlete sub-group, ↑ number of sleep hours per day associated with inferior performance ($r = -0.43$, $p < 0.05$).
Akazawa et al., 2019	Non-wearable, mattress-based actigraphy	Stroop test	In the difficult task RT was unchanged in lesser sleep quality group; RT improved in better sleep quality group during heavy exercise intensity ($p < 0.05$). ↑ SE associated with improved RT during heavy intensity exercise compared to light intensity exercise and rest ($r = -0.680$, $p < 0.05$).
Taheri & Irandoust, 2020	Wrist actigraphy; partial sleep deprivation group	Vienna system test: movement detection time; visual pursuit test, cognitrone test	Impaired RT ($p = 0.004$), accuracy rate ($p = 0.001$), median cognitive reaction ($p = 0.001$), median motor time ($p = 0.005$), processing speed ($p = 0.001$), and selective attention ($p = 0.001$) in those with PSD compared those with PSD with exercise upon waking before testing.

Notes: ESS = Epworth Sleepiness Scale; IAAF = International Association of Athletics Federation; IC = confidence interval; OR = odds ratio; PSD = partial sleep deprivation; PSQI = Pittsburgh Sleep Quality Index; RT = reaction time; SE = sleep efficiency; TST = total sleep time; WC = world championship.

Table 5: Results from studies examining the association between sleep and physical performance, readiness, and availability in female athletes.

	Sleep Measurement	Performance Measurement	Results
Barreira et al., 2024	Wrist actigraphy; Sleep diary	GPS; Subjective wellbeing	↑ perceived fatigue associated with ↓ TST and SE (r = -0.33, FDR-adjusted p = 0.04).
Coombes & Badenhorst, 2024	ASSQ	LEAF-Q	Significant difference in mean SDS between players at risk of LEA (7.8 ± 3.9AU) and players not at risk of LEA (5.4 ± 1.4AU) (p = 0.18). Those who had moderate and/or severe clinical sleep problems were 1.7 times more likely to be identified as being at risk of LEA. No significant relationship between SDS score and risk of LEA.
Costa et al., 2021	Wrist actigraphy; Hooper Index	s-RPE; GPS for running variables; total distance during matches and training	↑ sleep duration associated with ↓ training impulse (r = -0.25, p < 0.001), and ↓ s-RPE (r = -0.43, p < 0.001). ↑ sleep efficiency associated with ↓ training impulse (r = -0.20, p = 0.004); and ↓ s-RPE (r = -0.17, p = 0.02).
Costa et al., 2019	Wrist actigraphy	s-RPE; Training impulse	No association between training and match load parameters and TST, SE and lnRMSSD.
Crouch et al., 2021	Daily wellness scores	s-RPE; External training load variables (GPS)	↑ subjective sleep quality associated with ↑ distance covered (parameter estimate change = 303.8m, p = 0.019), ↑ high intensity distance (parameter estimate change = 64.2m, p = 0.015) and ↑ athlete load (parameter estimate change = 5.7AU, p = 0.015).
Doeven et al., 2019	Wellbeing questionnaire	s-RPE; questionnaire for fatigue and muscle soreness; Total Quality of Recovery scale of 6-20; training load via GPS; CMJ	No association between self-reported sleep quality and training load.
Fernandes et al., 2021	Hooper index	s-RPE; internal training load (CR-10 scale)	No association between sleep and stress, fatigue, DOMS, training monotony, training strain and ACWR.
Foster et al., 2023	Metrifit athlete monitoring application	Metrifit athlete monitoring application	↑ sleep quality associated with ↑ energy (r = 0.387, p < 0.001). ↑ sleep duration associated with ↑ energy (r = 0.218, p < 0.001). (Larger numbers on Likert scale indicate positive effect, hence positive correlation with stress).
Haroldsdottir et al., 2021	Likert scale 1-5 for sleep quality; subjective sleep duration	Injury onset; internal training load self-report	↑ sleep quality and duration associated with ↓ fatigue (r = 0.52, p < 0.001; r = 0.17, p < 0.001) and ↓ soreness (r = 0.22, p < 0.001; r = 0.07, p < 0.001). Sleep quality (OR = 0.49, p < 0.001) and prior night sleep duration (OR 0.69, p = 0.001) predicted in-season injury.
Horgan et al., 2021	AIS Athlete Management System: 1- Likert scale for sleep quality; TST to nearest half hour	Internal training load: s-RPE; monotony; strain; acute and chronic training load; ACWR. Injury and illness incidence	Sleep duration, fatigue and sleep quality explained 19.3% of the variance in risk for injury and illness. Significant effects for bidirectional changes in sleep duration (OR = 1.02 ± 0.04, p < 0.001; AR = 0.57 ± 0.11) and sleep quality (OR = 1.03 ± 0.09, p < 0.001; AR = 0.97 ± 0.18) in the 7-day period prior to an injury as well as bidirectional changes in sleep quality (OR = 1.00 ± 0.03, p < 0.01; AR = 0.94 ± 0.08) in the 28-day period prior to an injury event. Significant effects for - sleep duration (OR = 1.03 ± 0.03, p < 0.001; AR = 2.08 ± 0.84) and ¯ sleep quality (OR = 0.95 ± 0.12, p <0.001; AR = 1.89 ± 0.98) in the 7-day period prior to an illness event and for - sleep duration (OR = 1.01 ± 0.02, p < 0.001; AR = 1.70 ± 0.29) and for ¯ sleep quality (OR = 0.99 ± 0.04, p < 0.001; AR = 1.79 ± 0.17) in the 28-day period prior to an illness event. Significant effects were also found for the 7-day following an illness event for ¯ sleep duration (OR = 0.99 ± 0.03, p < 0.001; AR = 1.12 ± 0.25) and sleep quality (OR = 1.00 ± 0.05, p < 0.001; AR = 1.30 ± 0.02), as well as the 28-day period following an illness event for ¯ sleep duration (OR = 1.00 ± 0.01, p < 0.001; AR = 1.41 ± 0.27).

Continued

Kilic et al., 2021	Sleep disturbance via Athlete Sleep Screening Questionnaire	Injury incidence	Sleep disturbance associated with injury in previous 6 months (OR = 2.65; 95% CI [1.20, 5.85]).
Knufinke et al., 2018	Wrist actigraphy and wireless one-channel EEG sensor	Self-reported training load (1-10 scale)	Gender is a significant predictor of TIB (B = -13.12, CI [-22.55, -3.69], $p = 0.01$), TST (B = -15.34, CI [-24.10, -6.57], $p = 0.003$), and SE (B = -0.74, CI [-1.36, -0.12], $p = 0.02$) (B = small point estimate). No association between training load and sleep variables.
Long et al., 2024	Self-report via mobile app for duration and quality	GPS; self-reported wellness via mobile app (1-10 scale)	Significant interaction of day by sleep duration, indicating the effect of sleep duration on soreness differs depending on the day ($\beta = -0.0032$, $p = 0.040$). Sleep duration significantly predicted soreness ($\beta = 0.18$, $p = 0.010$). Day ($\beta = 0.0036$, $p < 0.001$), load ($\beta = -0.14$, $p = 0.004$), RPE ($\beta = 0.15$, $p = 0.002$), mental fatigue ($\beta = -0.15$, $p < 0.001$), and sleep quality ($\beta = 0.34$, $p < 0.001$) had a significant effect on sleep duration.
Merrigan et al., 2024	Consumer wearable (ring)	GPS monitoring system	↓ TRIMP(Intercept = 7.43 ± 0.09; Estimate = -0.13 ± 0.02), duration (I = 7.43 ± 0.10; E = -0.13 ± 0.02), total distance (I = 7.43 ± 0.10; E = -0.12 ± 0.02), time > 80% HRmax (I = 7.43 ± 0.09; E = -0.09 ± 0.02), time < 80% HRmax (I = 7.43 ± 0.10; E = -0.13 ± 0.02), and average HR(%) (I = 7.43 ± 0.10; E = -0.04 ± 0.02) were associated with ↓ sleep duration. There were also associations between all workload metrics and Sleep Score and Readiness Score.
Mielgo-Ayuso et al., 2017	Oviedo Sleep Questionnaire	Vertical jump; spike jump; 2x18m sprint (speed); 9-3-6-3-9m agility test; crunch test; overhead med ball throw	↓ OSQ score (better sleep) associated with ↑ vertical jump ($r = -0.32$, $p < 0.05$). ↓ OSQ score (better sleep) associated with ↑ spike jump ($r = -0.33$, $p < 0.05$). ↓ scores on sleep subscale of the OSQ (better sleep) associated with ↑ crunch test score ($r = -0.38$, $p < 0.05$). ↓ scores on insomnia subscale of the OSQ (better sleep) associated with ↑ vertical jump ($r = -0.37$, $p < 0.05$) and spike jump ($r = -0.36$, $p < 0.05$).
Moen et al., 2021	Actigraphy via Somnofy sleep monitor	Perceived fatigue on 1-10 scale via smartphone application	↑ in perceived fatigue associated with ↑ SWS (1.2 ± 0.6 min, $p = 0.007$) and ↓ TIB (3.6 ± 1.8 min, $p = 0.038$). ↑ REM sleep duration associated with ↓ perceived fatigue (0.21 ± 0.08 AU, $p = 0.008$). ↑ NREM respiration associated with ↑ perceived fatigue (0.27 ± 0.09 AU, $p = 0.002$).
Ressman et al., 2024	PSQI	SLS test	No significant association between PSQI score and SLS. 51% of poor sleepers (PSQI score ≥ 6) failed the SLS compared to 42% of good sleepers (PSQI score ≤ 5) on their non-dominant leg ($p = 0.18$). 71% of poor sleepers failed the SLS compared to 68% of good sleepers on their dominant leg ($p = 0.45$).
Roberts et al., 2022	Wrist actigraphy	Short recovery and stress scale	↑ sleep duration associated with ↑ recovery (b = 0.004 AU for every unit increase in sleep duration, $p = 0.048$).
Roy et al., 2019	Hooper Questionnaire	Internal training load and fatigue	↓ sleep quality associated with ↑ sRPE ($r = 0.098$, $p < 0.05$), ↑ HS ($r = 0.689$, $p < 0.01$), ↑ fatigue ($r = 0.390$, $p < 0.01$), ↑ muscle soreness ($r = 0.215$, $p < 0.01$).
Sekiguchi et al., 2019	Wrist actigraphy	RHR; HRV	↑ RHR associated with ↓ % time spent in light sleep ($r = -0.65$, $p < 0.05$), ↑ %SWS ($r = 0.55$, $p < 0.05$), ↑ %REM ($r = 0.20$, $p < 0.05$), ↓ sleep time spent in light sleep ($r = -0.47$, $p < 0.05$), ↑ SWS ($r = 0.54$, $p < 0.05$), ↑ REM ($r = 0.21$, $p < 0.05$), ↓ sleep consistency ($r = -0.41$, $p < 0.05$). ↑ HRV associated with ↑ % time spent in light sleep ($r = 0.54$, $p < 0.05$), ↓ %SWS ($r = -0.62$, $p < 0.05$), ↑ sleep time spent in light sleep ($r = 0.38$, $p < 0.05$), ↓ SWS ($r = -0.61$, $p < 0.05$).
Ungureanu et al., 2021	Hooper Index	sRPE; No. of jumps recorded via video	Sleep quality not associated with previous day sRPE or no. of jumps recorded in volleyball players.

Notes: ACWR = acute chronic workload ratio; AIS = Australian Institute of Sport; AR = absolute risk; ASSQ = Athlete Sleep Screening Questionnaire; AU = arbitrary unit; bpm = beats per minute; CI = confidence interval; CMJ = countermovement jump; CR-10 = category ratio-10; DOMS = delayed onset muscle soreness; E = estimate; EEG = electroencephalography; EMG = electromyography; EOG = electrooculography; ES = effect size; GPS = Global Positioning System; HR = heart rate; I = intercept; LEAF-Q = Low Energy Availability in Female Athletes Questionnaire; lnRMSSD = log-transformed root mean square of successive R-R intervals; NREM = non-rapid eye movement; OR = odds ratio; OSQ = Oviedo Sleep Questionnaire; PSQI = Pittsburgh Sleep Quality Index; RAT = Reactive Agility Test; REM = rapid eye movement; RPE = rate of perceived exertion; R-1 = from start line to the first gate; SDS = sleep difficulty score; SE = sleep efficiency; SLS = single leg squat; s-RPE = Session Rate of Perceived Exertion; SWS = slow wave sleep; TIB = time in bed; TST = total sleep time; YoYo IRT = YoYo Intermittent Recovery Test; b = beta value indicating the change in outcome variable for each one-unit increase in the predictor variable.

(Coombes & Badenhorst, 2024; Kilic et al., 2021; Mielgo-Ayuso et al., 2017; Ressman et al., 2024), analogue scales (Haroldsdottir et al., 2021; Horgan et al., 2021), and athlete monitoring applications (Foster et al., 2023; Long et al., 2024). Two of these studies were of high quality, seven were of low quality and fifteen were of moderate quality. Eight of the twenty-one studies contained a competitive-elite sample. The average sample size of these studies was $n = 66$ (range: 7 – 536).

Multiple studies examined the association between sleep indices and readiness to train/compete in female athletes. Increases in subjective fatigue were associated with decreases in total sleep time over a 7-day monitoring period ($r = -0.33$, FDR-adjusted $p = 0.04$) (Barreira et al., 2022) and increases in SWS (1.2 ± 0.6 min, $p = 0.007$), time in bed (3.6 ± 1.8 min, $p = 0.038$) and non-rapid eye movement (NREM) respiration (0.27 ± 0.09 AU, $p = 0.002$) over 124 observation days (Moen et al., 2021), while decreases in subjective fatigue were associated with increased rapid eye movement (REM) sleep duration (0.21 ± 0.08 AU, $p = 0.008$) (Moen et al., 2021), and increases in sleep quality and duration ($r = 0.52$, $p < 0.001$; $r = 0.17$, $p < 0.001$) over a 9-month period (Haroldsdottir et al., 2021). Increases in sleep quality and duration were also associated with increased energy ($r = 0.387$, $p < 0.001$; ($r = 0.218$, $p < 0.001$) (Foster et al., 2023) and decreased soreness (Haroldsdottir et al., 2021), with increased sleep duration also being associated with increased recovery (b = 0.004 AU for every unit increase in sleep duration, $p = 0.048$) (Roberts et al., 2022). Mean sleep difficulty scores via the Athlete Sleep Screening Questionnaire (ASSQ) in female athletes at risk of low energy availability (7.8 ± 3.9AU) were significantly higher than sleep difficulty scores in female athletes not at risk of low energy availability (5.4 ± 1.4AU) via the Low Energy Availability in Female Athletes Questionnaire (LEAF-Q) ($p = 0.018$) (Coombes & Badenhorst, 2024). There were also associations between decreased sleep quality and illness (Horgan et al., 2021) and injury (Haroldsdottir et al., 2021; Horgan et al., 2021; Kilic et al., 2021) in female athletes over 3 months, 9 months, and a full competitive season. There were clear associations observed between increased resting heart rate and decreases in percentage of time spent in light sleep ($r = -0.65$, $p < 0.05$), increases in percentage of time spent in slow wave sleep ($r = 0.55$, $p < 0.05$), increased percentage time spent in REM sleep ($r = 0.20$, $p < 0.05$), increased total slow wave sleep ($r = 0.54$, $p < 0.05$) and REM sleep ($r = 0.21$, $p < 0.05$), as well as decreased sleep consistency ($r = -0.41$, $p < 0.05$) over an 84-day period (Sekiguchi et al., 2019). Conversely, increases in heart rate variability (HRV) were associated with increases in percentage time spent in light sleep ($r = 0.54$, $p < 0.05$), and total time spent in light sleep ($r = 0.38$, $p < 0.05$), as well as decreases in percentage time spent in slow wave sleep ($r = -0.62$, $p < 0.05$) and total time spent in slow wave sleep ($r = -0.61$, $p < 0.05$) (Sekiguchi et al., 2019).

Sleep was associated with training intensity in female athletes. Increased sleep duration and sleep efficiency was associated with decreased training impulse ($r = -0.25$, $p < 0.001$; $r = -0.20$, $p = 0.004$), and decreased sleep quality was associated with session rating of perceived exertion (s-RPE) ($r = 0.098$, $p < 0.05$) over a 54-day period (Roy et al., 2019). Increased sleep duration and sleep efficiency was also associated with decreased s-RPE ($r = -0.43$, $p < 0.001$; ($r = -0.17$, $p = 0.02$) (Costa et al., 2021). Greater subjective sleep quality in female athletes was associated with greater distances covered (parameter estimate change = 303.8m, $p = 0.019$), greater high-intensity distance covered (parameter estimate change = 64.2m, $p = 0.015$), and athlete load (parameter estimate change = 5.7AU, $p = 0.015$) over a 13-week monitoring period (Crouch et al., 2021). RPE ($\beta = 0.15$, $p = 0.002$), load ($\beta = -0.14$, $p = 0.004$) and mental fatigue ($\beta = -0.15$, $p < 0.001$) all had a significant effect on sleep duration following a training session in female collegiate soccer athletes (Long et al., 2024). Increases in workload metrics (via GPS) were associated with decreases in sleep duration, Sleep Score and Readiness Score (via commercially available wearable), average HRV was negatively associated with increases in training impulse (TRIMP), time > 80% HRmax, and average HR (%) (Merrigan et al., 2024). Decreases in Oviedo Sleep Questionnaire (OSQ) scores were associated with increased vertical jump ($r = -0.32$, $p < 0.05$), spike jump ($r = -0.33$, $p < 0.05$), and crunch test score ($r = -0.38$, $p < 0.05$) (Mielgo-Ayuso et al., 2017). However, some studies found no association between sleep and physical performance outcomes in female athletes (Costa et al., 2019; Doeven et al., 2019; Fernandes et al., 2021; Knufinke et al., 2018; Ressman et al., 2024).

3.6. Association between sleep and mood and subjective wellbeing

Results from included studies in this category can be found in Table 6. In total, fourteen studies examined this association, with eight being of moderate quality, five of low quality, and one high quality study. One of the studies contained a competitive elite sample, with the remaining twelve studies containing semi-elite samples. The average sample size of these studies was $n = 110$ (range: 8 – 536). Five of the studies contained mixed-sex cohorts, while nine had all female cohorts. Sleep measurements used within this category included: sleep questionnaires (PSQI; ESS; ASSQ; Benjamin et al., 2020; Kawasaki et al., 2020; Silva & Paiva, 2019a; Silva & Paiva 2019b); Hooper Index/Questionnaire (Fernandes et al., 2021; Roy et al., 2019); subjective sleep quality (Foster et al., 2023; Haroldsdottir et al., 2021; Long et al., 2024); wrist actigraphy (O'Donnell et al., 2018a; Roberts et al., 2022; Romyn et al., 2016); and sleep diaries (Romyn et al., 2016).

Sleep duration and quality were significantly associated with stress in multiple studies ranging from 1 day of data collection to a full competitive season in duration, showing that improved sleep indices correlated with lower levels of stress (Foster et al., 2023; Haroldsdottir et al., 2021; Roy et al., 2019) as well as precompetitive stress (Silva & Paiva, 2019b) in female athletes. Increased PSQI scores were associated with increased tension; depression; anger; fatigue; confusion; and total mood disturbance over 3 competitive seasons of monitoring (Benjamin et al., 2020); as well as decreased physical functioning, general health perception, vitality, social functioning, and mental health, alongside increases in role limitations due to physical and emotional problems in a cross-sectional study (Kawasaki et al., 2020). However, one study found no association between sleep and mood variables over a 3-month period (Kilic et al., 2021).

4. Discussion

This systematic review targeted studies that examined the association between sleep and performance parameters in female athletes; namely, sport-specific performance; cognitive performance; physical performance, readiness, and availability;

Table 6: Results from studies examining the association between sleep and mood and subjective wellbeing in female athletes.

	Sleep Measurement	Performance Measurement	Results
Benjamin et al., 2020	PSQI	Profile of Mood States; Sports Anxiety Scale-2	↓ sleep quality associated with ↑ tension ($p < 0.001$), depression ($p < 0.001$), anger ($p < 0.001$), fatigue ($p < 0.001$), confusion ($p < 0.001$), total mood disturbance ($p < 0.001$); ↓ vigour ($p = 0.08$, not significant). Decreased sleep quality associated with greater tension and anger in females compared to males ($p = 0.040$, $p = 0.010$, respectively).
Fernandes et al., 2021	Hooper Index	Internal training load (CR-10 scale)	Moderate, non-significant association between ↑ sleep and ↑ stress ($r = 0.412$, $p > 0.05$).
Foster et al., 2023	Metrifit athlete monitoring application	Metrifit athlete monitoring application	↑ sleep quality associated with ↑ energy ($r = 0.387$, $p < 0.001$) and ↑ stress ($r = 0.255$, $p < 0.001$). ↑ sleep duration associated with ↑ energy ($r = 0.218$, $p < 0.001$) and ↑ stress ($r = 0.179$, $p < 0.001$). (Larger numbers on Likert scale indicate positive effect, hence positive correlation with stress).
Haroldsdottir et al., 2021	Likert scale 1-5 for sleep quality; sleep duration recorded via Metrifit app	Internal training load	↑ sleep quality and duration associated with ↓ stress ($r = 0.26$ and $r = 0.08$, $p < 0.001$) and mood ($r = 0.40$ and $r = 0.06$, $p < 0.001$).
Kawasaki et al., 2020	PSQI; ESS	Short form-8	↓ sleep quality associated with ↓ physical functioning, ↑ role limitations due to physical problems, ↓ general health perception, ↓ vitality, ↓ social functioning, ↑ role limitations due to emotional problems, and ↓ mental health.
Kilic et al., 2021	Athlete Sleep Screening Questionnaire	Athlete Psychological Strain Questionnaire (APSQ) and Kessler-10 (K-10); Anxiety - General Anxiety Disorder-7 (GAD-7); Depression - PHQ-9	No association between sleep disturbance and anxiety.
Koikawa et al., 2016	PSQI; ESS	Short form-8	Univariate analysis: low social functioning and mental health scores associated with female gender (OR = 2.92, $p = 0.020$; OR = 2.68, $p = 0.030$) and longer sleep duration (OR = 0.59, $p <= 0.020$; OR = 0.55, $p = 0.018$). Non-significant association with greater PSQI scores.
Long et al., 2024	Self-report via mobile app for duration and quality	GPS; self-reported wellness via mobile app (1-10 scale)	Mood and mental stress did not have a significant effect on sleep duration ($p > 0.05$).
O'Donnell et al., 2018a	Wrist actigraphy	Perceived stress	↓ sleep quality and duration following match compared night before game ($p < 0.05$).
Roberts et al., 2022	Wrist actigraphy	Short recovery and stress scale (SRSS)	Sleep duration ↓ for every unit increase in emotional balance for model 3 (b = -28.7 min, $p = 0.02$) and model 5 (b = -31.3 min, $p = 0.01$) and negative emotional state for model 3 (b = -25.4 min, $p < 0.001$) and model 5 (b = -20.7 min, $p < 0.001$). In model 9, WASO ↓ for every one unit increase in negative emotional state ($p = 0.049$) and ↑ for every unit increase in overall stress ($p = 0.02$).
Romyn et al., 2016	Wrist actigraphy; Sleep diary	Tension/anxiety subscale of the Profile of Mood States	↑ Perceived sleep quality associated with ↓ state anxiety ($r = -0.82$, $p < 0.05$)
Roy et al., 2019	Hooper Questionnaire	Internal training load and fatigue	↓ sleep quality associated with ↑ stress ($r = 0.383$, $p < 0.01$).
Silva & Paiva, 2019a	ESS; PSQI; bed and wake time of weekdays and weekend days	Sport Competition Anxiety Test form A (SCAT-A)	≥ 24 SCAT-A score (95%IC 1.27 to 2.95, $p = 0.004$) associated with abnormal daytime sleepiness. Reduced sleep duration observed in gymnasts with abnormal daytime sleepiness, reduced sleep quality and precompetitive anxiety, however no significant differences shown ($p > 0.05$).
Silva & Paiva, 2019b	ESS; PSQI; bed and wake time of weekdays and weekend days	Sport Competition Anxiety Test form A (SCAT-A)	↑ sleep disturbance associated with ↓ sleep quality ($p = 0.014$) and ↑ precompetitive stress ($p < 0.01$). ↓ sleep quality associated with ↑ precompetitive stress ($p = 0.010$).

Notes: APSQ = Athlete Psychological Strain Questionnaire; CSAI-2 = Competitive State Anxiety Inventory-2; GAD-7 = General Anxiety Disorder 7; IC = confidence interval; K-10 = Kessler-10; PCSP = Psychological Characteristics Related to Sport Performance; PHQ-9 = Patient Health Questionnaire 9; PHQ-15 = Patient Health Questionnaire 15; PSQI = Pittsburgh Sleep Quality Index; QOL = Quality of Life Questionnaire; SCAT = Sport Competition Anxiety Test; SCAT-A = Sport Competition Anxiety Test form - A; SF-8 = Short form-8; STAI = State-Trait Anxiety Inventory; WASO = wake after sleep onset; b = beta value indicating the change in outcome variable for each one-unit increase in the predictor variable.

and mood and subjective wellbeing. Thirty-eight studies met the inclusion criteria and were included in the review. Greater sleep quality and quantity was associated with improvements in a range of performance and subjective wellbeing outcomes examined in this review, with lesser sleep quality and quantity being associated with negative outcomes in both performance and subjective wellbeing outcomes. Making concentrated efforts to allow athletes to obtain more optimal sleep could be advantageous in aiding athletes to achieve their desired performance outcomes.

Quality assessment of the included studies found that many of the studies were of moderate quality (71%), with the remaining studies being of low quality (26%) apart from one high quality study. Studies were not excluded from this review based on quality rating or study design, to allow for maximal number of studies examining the association between sleep and female athletes to be included. Studies were of moderate and low quality largely due to some studies not monitoring sleep objectively alongside subjective measurement, as well as lack of control for both sleep and level of competition of the participants, resulting in lower scores on the modified NOS. These findings show a need for more high-quality research to be conducted in this area. Gupta et al. (2017) also reported on the limited quality of the majority investigating sleep in elite athletes, finding the quality of studies examining characteristics of sleep among elite athletes was low in 62% of studies. Similarly, Miles et al. (2022) reported 82% of studies examining the sleep of female athletes were of moderate study quality.

Methodological guidelines have been outlined in recent publications to improve research in sport and exercise science with female participants (Elliott-Sale et al., 2021); for example, recording hormonal contraceptive use or whether the participants were naturally and regularly menstruating or amenorrhoeic. Three of the studies in this review examined aspects of the menstrual cycle (MC) including regularity, phase and hormonal contraceptive use, as well as delayed menarche. Symptoms of the MC such as mood changes and anxiety could be related to sleep disruption or loss in exercising females (Bruinvels et al., 2021). There have also been reported alterations to sleep architecture with the cyclic fluctuations of oestrogen and progesterone throughout the MC, as well as sleep disturbances related to fluctuating body temperature as a result of the menstrual cycle (Baker & Lee, 2018). Future studies should consider the MC phases and symptoms, hormonal contraceptive use and other factors related to the MC.

Classification of competition level showed that 74% of the studies were conducted using semi-elite cohorts, with the remaining studies using competitive elite cohorts. This is a lower level of competition than in studies reviewed by Gupta et al. (2017), where 54% of the studies were judged to have recruited competitive elite athletes. This could be due to the inclusion of male participants in these studies. Inclusion of male athletes in sleep and performance research could allow for larger sample sizes given that there may be increased opportunity to recruit professional athletes in a wide range of sports to participate. Future research in sleep and performance of female athletes should be conducted in high-level (competitive elite) cohorts if possible. Further research in this area will allow practitioners to better understand the associations between sleep and performance in elite female athletic cohorts and will inform evidence-based sleep intervention. Studies found varying associations between sleep, performance, and subjective wellbeing. Percentages of studies in each category showing various associations can be found outlined through this section of the review.

4.1. Association between sleep and sport-specific performance

Eight out of the nine (89%) studies investigating sleep and sport-specific performance found that improved sleep indices were associated with improved or superior sport-specific performance outcomes for female athletes. While one study found contrasting findings showing that number of sleep hours per day was negatively associated with performance. The most examined performance outcome was in competition scores and rankings for both team and individual sports. Four of the studies in this area examined sleep objectively through wrist actigraphy; however, only one of these four studies also employed sleep diaries. Sleep diaries are useful for both the subjective measure of sleep from the participant but also to confirm approximate sleep and wake times, as well as if naps take place. Other sleep measurements included wellness surveys, as well as validated sleep questionnaires in the ESS and PSQI.

Six studies showed that sleep duration and quality had a positive effect on the performance of the athletes (Dumortier et al., 2018; Grace et al., 2023; Juliff et al., 2018; Reyner & Horne, 2013; Silva & Paiva, 2016; Staunton et al., 2017), with one finding that lower performances were often associated with poor sleep quality (Silva & Paiva, 2019b). Juliff et al. (2018) found that top performing teams in netball competition had higher sleep duration, time in bed and subjective sleep rating than those who were placed at the bottom of the competition rankings. Netball athletes have been reported to obtain more sleep on the night before a game compared to the night of a game (O'Donnell et al., 2018b). This could be an attempt by athletes to obtain more sleep before competition, but care needs to be taken to ensure athletes obtain adequate sleep to elicit sufficient recovery from competition, which may be of particular importance at major international tournaments where competition schedules can be condensed. Senbel et al. (2022) identified that sleep need, sleep debt hours and weekly sleep duration were ranked in the top ten features affecting performance in collegiate basketball players, with positive correlations for each variable and player efficiency. However, Tsukahara et al. (2022) reported that number of sleep hours per day was associated with lower International Association of Athletics Federation (IAAF) scores in track and field athletes. This contrasting finding, with increased sleep hours associated with decreased performance, provides rationale for further research in female athletic cohorts' sleep and sport-specific performance. It should be noted that within applied research of elite athletic cohorts, confounding variables (e.g. nutrition, injury, travel) are common and could have an impact on the performance of an athlete in competition.

Collectively, the evidence demonstrates that sleep has a clear positive association with improved sport-specific performance outcomes in female athletes. This shows that sleep not only can have an impact on the key performance indicators associated with sporting performance, but differences in sleep duration and quality can have a direct impact on actual competition outcomes and scores for athletes.

4.2. Association between sleep and cognitive performance

Only two studies in this review examined the relationship between sleep and cognitive performance. One of the studies showed a positive association between sleep and performance outcomes, with the other showing that negative sleep outcomes are associated with negative performance outcomes. Akazawa et al. (2019) examined the impacts of sleep quality on cognitive performance, finding that reaction time in the Stroop Test was faster in the better sleep quality group during high-intensity exercise compared to the lesser sleep quality group. Taheri and Irandoust (2020) utilised interventions in the form of partial sleep deprivation (athletes slept for 3h), finding performance measures to be impaired in the sleep deprivation group but not in the group that completed exercise prior to the cognitive assessment on the morning post-sleep deprivation. Both studies showed the positive effect of increased sleep quality and duration on performance. The results from Taheri and Irandoust (2020) are similar to previous findings showing acute physical exercise improves cognitive performance in a mixed-sex cohort of college-aged students (Chang et al., 2014). This provides evidence that exercise can be a combatant to the negative effects of sleep loss on athletic populations. In a review of sleep hygiene and optimal recovery in athletes, Vitale et al. (2019) concluded that focus should be placed on obtaining more sleep rather than prioritising training time, however the findings of Taheri and Irandoust (2020) may offer a possible alternative if optimal sleep durations cannot be achieved due to circumstances often faced in elite sport, such as travel and competition/training schedule.

4.3. Association between sleep and physical performance, readiness, and availability

An interesting finding in relation to female athlete sleep is that although females have been shown to have objectively better sleep quality (less time awake during the night and higher sleep efficiency) than their male counterparts (Leeder et al., 2012), they report worse sleep quality when measured subjectively (Schaal et al., 2011). These findings are in line with the reported paradox in female sleep, where females tend to report inferior subjective sleep compared to males, while obtaining superior objective sleep (Hrozanova et al., 2021). For this reason, this review was not confined to just objective measures of sleep and included subjective measures also.

Only one study in this systematic review was rated as high quality using the adapted NOS used in the quality appraisal of studies examining this aspect of performance (Kilic et al., 2021). This study examined injury in the previous six months and sleep disturbances, finding that the two were associated with one another. However, all other studies of sleep and the association with physical performance, readiness, and availability were of moderate or low quality.

Of the twenty-one studies in this category, eight (38%) found positive associations between sleep improved sleep and performance, seven (33%) found negative associations between impaired sleep and performance, while six (29%) found no association between sleep outcomes and performance. When investigating the relationship between sleep and readiness and availability, this review found varying effects of sleep relating to external and internal training load variables (e.g., total distance covered, training impulse, s-RPE, fatigue). Perceived fatigue in female athletes was associated with less sleep, particularly less REM sleep hours (Moen et al., 2021) as well as lower total sleep time and sleep efficiency (Barreira et al., 2022). Fatigue was increased with decreases in sleep quality (Roy et al., 2019), which was also associated with increases in s-RPE, and muscle soreness. Workload metrics such as TRIMP, total distance, training duration, and time spent in HR of greater than and less than 80% of max HR, were all associated with lesser sleep duration (Merrigan et al., 2024). Care must be taken when managing the objective and subjective workload of athletes when attempting to achieve more optimal sleep. Both perceived fatigue and increases in workload metrics have been shown to have a significant impact on the following night's sleep (Long et al., 2024; Merrigan et al., 2024). This could be of particular importance when preparing for competition or attempting to both train and compete at a high level in a condensed competition schedule.

Poorer sleep quality was identified as a predictor of illness both seven and twenty-eight days prior to an illness event by Horgan et al. (2021), which is similar to findings in male athletes where poorer sleep quality and less sleep duration was associated with greater odds of illness in both the short term and long term (Fitzgerald et al., 2019). It was also reported that athletes at risk of low energy availability (LEA) had significantly higher sleep difficulty scores via the ASSQ than those who were not at risk of LEA (Coombes et al., 2024). Increasing sleep opportunity in female athletic cohorts could lead to decreases in perceived fatigue and improvements of the athlete’s feeling of readiness to compete or train on any given day. This also may lead to improvements in availability and decrease time missed through illness. The importance of sleep for optimal readiness and performance provides rationale for good sleep hygiene strategies in this cohort. Improved sleep hygiene through education seminars has been shown to increase time in bed and therefore sleep opportunity in professional rugby league athletes, by eliciting earlier sleep times and later wake times (Caia et al., 2018). Driller et al. (2019) found that sleep efficiency, sleep latency, sleep onset variance were improved from pre- to post-intervention of sleep education sessions in male cricket athletes, while O’Donnell et al. (2017) reported a significant increase in total sleep time in elite female athletes following a one-hour sleep hygiene education session.

Mielgo-Ayuso et al. (2017) examined the impact of sleep on jump performance, measuring sleep through the OSQ to determine the impact of sleep on vertical and spike jump performance. This study identified a positive influence of sleep on jump performance in the form of vertical and spike jump score improvements. In a study of male cyclists, Mah et al. (2019) found that maximal vertical jump decreased following sleep restriction. Athletes’ sleep was decreased from 7 hours to 4 hours, with significant detrimental effects being shown for both maximal vertical jump as well as slower psychomotor vigilance task response time. With these results linking sleep and jumping performance in athletes, those competing in sport where jump performance is a key performance indicator should take measures to attempt to optimise athlete sleep.

In other research of sleep and physical performance, it has also been shown in male cycling time trials that performance is hindered in those who had their sleep restricted compared to performance with normal sleep and compared to those who have had extended sleep (Roberts et al., 2019), with performance deteriorating as the number of days of sleep restriction increased. Performance in this study was unaffected by one night of sleep restriction but began to deteriorate over subsequent days. This is an indication of the problems faced by athletes who experience sleep loss on a consistent basis. These athletes may be more at risk of negative implications on their performance over time than those who experience only one night of disturbed sleep. This finding should encourage the analysis of sleep and performance over a more prolonged period.

4.4. Association between sleep and mood and subjective wellbeing

Psychological mood and subjective wellbeing of athletes is important for training and competition, with emotions experienced before and during sports competition influencing sports performance (Lane et al., 2012). The selected studies in this review that examine the relationship between sleep and subjective wellbeing in female athletes support the conclusion that disrupted sleep or less sleep is correlated with greater mood disturbances in stress, anger, depression, confusion, and tension. Three of the studies (21%) found that positive sleep outcomes were associated with positive mood and subjective wellbeing outcomes while seven studies (50%) found negative sleep outcomes to be associated with negative mood and subjective wellbeing outcomes. Two studies (14.5%) found no association between sleep and mood and subjective wellbeing variables, while two studies (14.5%) found contrasting findings indicating that increases in sleep outcomes were associated with negative mood and subjective wellbeing outcomes. This finding supports the current literature surrounding sleep quality and mood. In a mixed cohort, confusion, fatigue, and tension have been shown to be detrimental to sleep quality, while vigour has been shown to reduce the likelihood of poor sleep (Andrade et al., 2019). All mood and subjective wellbeing variables were measured subjectively. In the case of stress, there is opportunity for objective measurement through a method such as examining salivary cortisol (Bozovic et al., 2013), which may yield different results to that of perceived stress in athletes.

Subjective wellbeing and sleep can impact each other, in that less sleep can increase the severity of negative mood variables (such as confusion, tension, fatigue), and these variables can have a negative impact on sleep. An example of this is increased pre-competition stress in athletes, especially before and during important competitions. Silva and Paiva (2016) found that increased sleep disturbance was associated with increases in precompetitive stress, which is similar to previous findings in elite male and female German athletes (Erlacher et al., 2011). Negative mood variables such as fatigue and tension were both significantly negatively correlated with pre-competitive sleep quality and total sleep time in a mixed cohort of athletes (Lastella et al., 2014).

4.5. Limitations

The present review did not exclude studies based on methodological quality, allowing for studies that scored low in quality appraisal to be included in the review. This was deemed a necessary limitation, as the research examining the sleep and performance of female athletes and athletes in general is relatively scarce and generally low in quality. Excluding studies based on quality would have left very few studies remaining to be included in this review. The aim of this systematic review was to review all the evidence and literature that met the inclusion criteria and was not limited to only high-quality research. This review included only articles published in the English language in peer-reviewed journals.

Conclusion

Relatively few studies have reported the effects of sleep on performance in female athletes. The studies included in this review support the conclusion that lower sleep duration and quality are associated with negative performance and subjective wellbeing outcomes in female athletes, while greater sleep duration and quality are associated with positive performance and subjective wellbeing outcomes. Superior sleep duration and quality has repeatedly been reported to be associated with superior performance in female athletes from various sports, with associations shown with sport-specific performance; cognitive performance; physical performance, readiness and availability; and mood and subjective wellbeing. Some of the strongest associations between sleep and outcome variables were with respect to finishing place in competition or competition ranking, and the association of decreased sleep with increased levels of fatigue. Given the association of sleep with subjective wellbeing and performance, efforts should be made by both athletes and their support staff to optimise sleep where possible. Optimal sleep hygiene practices and planning of training times to allow for maximal sleep opportunity could be of benefit in this regard.

However, within the included studies there is a lack of methodological consistency, where studies examine both sleep and performance parameters through a variety of methods. Collectively, there is very limited high-quality research in sleep and performance in female athletes. An emerging theme from this review is the lack of consideration of the MC in studies examining the sleep and performance of female athletes, with only three included studies doing so. Future research of the sleep and performance of female athletes, and any research including female athletes, should include the monitoring of the MC, MC symptoms, and/or hormonal contraception use to improve methodological quality of the research.

Conflict of Interest

The authors declare no conflict of interests.

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