



## Assessing Workload and Wellbeing Among Male School Athletes During a Two-Season Overlap Period

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### Abstract

The study's goal was to evaluate and track the physical abilities and seasonal workloads of male multisport athletes who struggle with converging sport seasons. Due to the increased training load, these obstacles may have an effect on their general well-being. The researchers monitored the internal workloads of 15 male students who participated in a variety of sports disciplines. Over the course of a 10-week period, they assessed their general preparation and fitness using self-reported questionnaires. Through the course of the monitoring period, statistical analysis revealed substantial variations in workloads and the ACWR (acute to chronic workload ratio) ( $p = 0.002$ ). Agility, vertical jump power, yo-yo intermittent recovery (Level 1), and predicted VO<sub>2</sub>max characteristics all showed significant changes ( $p 0.002$ ). The participants' relatively high wellbeing and ACWR values, however, show that they did not endure enough stress from the workloads to cause physiological changes that would improve their performance. It's probable that the athletes' workloads were reasonable enough to lower the risk of injury while still enhancing performance.

**Keywords:** Team Sport, Training Load Monitoring, Perceived Exertion Rate Throughout Sessions, And Youth Sports.

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## **A. Introduction**

School sports consist of different sports codes played during separate seasons throughout the year, and they have undergone a transformation towards greater competitiveness. In fact, professional team scouts often attend high school games with the intention of recruiting skilled players (DiFiori et al., 2014). As a result, the expectations for students participating in school sports have risen, with a more pronounced emphasis on competitiveness and a perceived "professional" standard. Consequently, in today's era of heightened specialization in high school sports, athletes are approaching their sports training with a professional mindset (Merkel, 2013).

Multisport student-athletes often face the challenge of managing overlapping competitive seasons, which coincide with the off-season and pre-season periods. Moreover, High school athletes participate in a variety of non-sports extracurricular activities both within and outside of the school setting (Eisenmann et al., 2020). These duties include obligations to one's family, academic obligations, and cultural obligations (Mann et al., 2016). As a result, young athletes experience physical, social, and emotional challenges as a result of the conflicting schedules of various sports. In general, athletes experience persistent fatigue due to prolonged and excessively

intense training (Gabbett, 2016). This fatigue has the potential to hinder performance and adaptations (Cunanan et al., 2018). In practical terms, it is crucial for the prescribed training regimen, including adequate recovery time, to dissipate fatigue, allowing for adaptation and ultimately leading to improved performance (Suchomel, Lamont, et al., 2016; Suchomel, Sato, et al., 2016).

To achieve desired adaptations, it is crucial for the training stimulus to be appropriately intense. Subjecting athletes to inadequate training loads, ineffective recovery strategies, or insufficient fatigue management can lead to overtraining and injuries. Therefore, in order to improve performance and reduce the risk of accidents, coaching specialists must build a consistent and balanced approach to specified training dosages. Because of this, it is crucial to evaluate the overall stresses of training workloads across all sports rather than concentrating only on specific sports codes (Bourdon et al., 2017; Gazzano & Gabbett, 2017).

Engaging in multiple sports codes simultaneously can be a disadvantage due to the significant time commitment involved, which restricts young athletes' opportunities to enhance their physical performance. Their demanding sports schedules keep them constantly engaged on

the field, limiting their ability to focus on improving their physical capabilities. Consequently, the workload that athletes experience throughout the sport seasons has a direct impact on their capacity to recover and adapt.

Participating in intense training has been associated with a higher risk of training injuries (Drew & Finch, 2016). Moreover, the physical challenges encountered by young athletes are heightened due to their maturation rate. This research aimed to analyze and observe the physical performance, overall health, and workload of athletes engaged in multiple overlapping sports seasons. The study had specific objectives, which included assessing the physical performance indicators at the start and end of each season, tracking the workloads and well-being during the overlapping sports seasons, and examining the influence of workload on both performance indicators and well-being.

## **B. Research Methodology**

### ***Participants***

Fifteen male school athletes (age:  $15.5 \pm 0.5$  years; stature:  $175.0 \pm 9.5$  cm; mass:  $66.0 \pm 13.2$  kg) participated in this observational and longitudinal study conducted over 10 weeks of overlapping sport seasons. Institutional ethics approval was obtained (REC-01-72-2019) and

signed informed and assent consent were secured from scholars and their parents prior to the commencement of the study.

A vertical leap test was conducted utilizing the Swift YARDSTICK II apparatus, produced by Deotome and situated in Wacol, Australia, to gauge each athlete's lower body strength. According to the 2017 study by Muehlbauer et al., the jump height was measured by computing the difference between the athlete's standing height and the vane's highest position during the leap. The highest jump out of three attempts made by the athlete was recorded. A one-minute rest interval was given to the athletes between each jump (Buckthorpe et al., 2012; Menzel et al., 2010).

### ***Upper body power***

To evaluate the explosiveness of the upper body limbs for each student, the seated medicine ball test was utilized, following the procedure described by Ti and Nair (2020). During the test, the students sat with their legs fully extended against a wall, ensuring their backs were also in contact with the wall. They pushed forward as far as they could while keeping their back in touch with the wall while holding a 2 kg medicine ball at their chest. The closest centimeter was used to gauge the distance between the wall and the ball's

landing spot. The students performed three attempts, and the highest score out of the three was recorded as their measure of upper body power (Ti & Nair, 2020).

Before the running tests, the scholars underwent a brief warm-up routine, which included light running, dynamic stretching exercises, and several run-throughs. The purpose of the warm-up was to prepare the participants for the running tests and to familiarize them with the testing procedure (W. B. Young & Pryor, 2007).

### **The Running Agility**

Using a planned agility run test created by the Australian Football League (AFL), the running agility of each student was evaluated. This test is frequently used to assess a person's ability to quickly alter their posture and direction (W. Young et al., 2011). During the test, participants had to use a set of slalom poles to navigate around five planned changes in direction (Buckthorpe et al., 2012). A Smart Speed Pro electronic timing device, produced by FusionSport in Coopers Plains, Australia, was used to facilitate the test. At the beginning and ending positions, respectively, were two sets of sensors, lights, and gates that made up the system.

### **The Running Speed And Acceleration**

The use of the 5 m and 20 m speed tests allowed for the evaluation of each student's running speed and acceleration. These tests measured the pupils' ability to accelerate from a standing posture to their top speed, as described in the Bishop et al. report from 2021. Two sets of the Speed Pro timing system were used during the testing, and they were placed at the 5 m and 20 m markers, respectively.

The trials began with the students standing upright and still, with their front foot aligned with the timing gate at the 0 m point. Following the instructions provided by the researcher, the students maneuvered through a series of slalom pole markers. Two maximal effort trials were conducted for each student, and the fastest time achieved was recorded (W. Young et al., 2011). To mitigate the impact of fatigue, a minimum rest period of 90 seconds was given to the students between each attempt (W. Young et al., 2011).

### ***Anaerobic capacity***

The objective of the 250-meter shuttle sprint test was to evaluate the athletes' anaerobic capacity, following the methodology described by Grobler et al. in 2017. The students were directed to sprint from the beginning line (0-meter mark) to the 10-meter mark and then return to the starting line. In this test, markers were

placed at 10-meter intervals. Each kid was asked to do 25 sprints in total, giving it their all while completing a cumulative distance of 250 meters without stopping. For analysis, the amount of time it took each student to finish the full exam was recorded (Grobler et al., 2017).

### ***Aerobic capacity***

Following the established procedure by Bangsbo et al. (2008), the Yo-Yo intermittent recovery test 1 was used to assess each student's ability to perform high-intensity aerobic activity. Based on how many levels and sublevels each student finished, the exam calculated and recorded the overall distance they traveled. A particular equation was used to determine each student's estimated VO<sub>2</sub>max (measured in milliliters per kilogram per minute) (Bangsbo et al., 2008).

### **Workloads and Acute: Chronic Workload Ratio**

The internal load refers to the physiological stress the body experiences as a result of the demands placed on it during high-intensity gameplay. These demands include specific metabolic requirements that are essential for optimal performance, contributing to the internal load (Halson, 2014). The physical strain placed on the body during training and competition, on

the other hand, is referred to as the external load and affects the internal load (Gazzano & Gabbett, 2017). A modified 1–10 rating of perceived exertion (RPE) scale based on Foster's work (1998) was used to measure felt effort in order to objectively evaluate the internal load. One (1) meant the session was thought to be "very easy," while ten (10) meant the session was thought to need "maximal effort" (Murray, 2017). The RPE of the session was multiplied by its length to get the internal load in Arbitrary Units (AU). The session's RPE was multiplied by the length of the session to calculate the workload. The cumulative load over a given week, typically spanning seven days, is known as the acute workload (Bowen et al., 2017; Hulin et al., 2014).

The rolling average model was used to determine the acute to chronic workload ratio (ACWR), which compares a four-week chronic load to a seven-day training load (Monday through Sunday) (Blanch & Gabbett, 2016; Hulin et al., 2014, 2016). The training effort in this study was tracked from weeks 4 to 10, and the workload ratio was calculated using the total training load throughout the first four weeks.

### ***Wellness***

In order to assess the effect of stresses, both sports- and non-sports-related, on the

participants' recovery processes, the participants were instructed to complete a wellbeing questionnaire (Gazzano & Gabbett, 2017). Eight questions made up the questionnaire, which evaluated a range of factors including sleep quality, exhaustion levels, soreness in the muscles, tension, motivation, and excitement for exercise, as well as health, mood, and study habits. A five-point Likert scale, from 1 ("awful") to 5 ("excellent"), was employed to collect comments. Following that, wellness scores were expressed as a percentage of the highest possible score out of 40.

### ***Statistical analyses***

The data gathered were analyzed using a variety of statistical techniques. The Shapiro-Wilk test was used to evaluate the data distribution. The mean and standard deviation were supplied for normally distributed data, whereas the median and interquartile range were shown for nonparametric data. To assess the sample's correctness, consistency, and precision, the standard error of measurement was computed. Paired t-tests were used to assess performance measures during the 10-week monitoring period and prior. The impacts of workloads, wellness, and ACWR (Acute:Chronic Workload Ratio) over time were also investigated using one-way

analysis of variance (ANOVA) with post hoc pairwise comparisons. The statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS 26 IBM), with a significance threshold of  $p < 0.05$ . Effect sizes were calculated using Cohen's  $d$ , and Hopkins' (2002) qualitative descriptors were used to describe them. These included trivial  $d$  (0-0.2), small  $d$  (0.2-0.6), moderate  $d$  (0.6-1.2), large  $d$  (1.2-2), very large  $d$  (2-4), nearly perfect  $d$  (4-infinity), and perfect  $d$  (difference in mean size of infinity).

## **C. Result and Discussion**

### **Result**

Table 1 displays the student performance information at the beginning and end of the 10-week monitoring period. Comparing the start and conclusion of the season did not reveal any differences that were statistically significant within the sample ( $p = 0.712$ ). The improvement of around 50 W was regarded as negligible, although there was a discernible rise in lower body power ( $p = 0.001$ ) (Table 1). The distance of the upper body power medicine ball toss did not alter significantly between the beginning and conclusion of the season ( $p = 0.649$ ).

The athletes showed a significant improvement in their AFL agility test times ( $p = 0.002$ ), with a large improvement of 1.1 seconds. However, there were no significant improvements in the sprint times

over 5 m ( $p = 0.099$ ) and 20 m ( $p = 0.507$ ) during the monitoring period.

Although there was a moderate improvement in anaerobic capacity following the 10-week season ( $d = 0.51$ ),

this improvement was not statistically significant ( $p = 0.233$ ). Trivial to small improvements were reported for aerobic capacity and Yo-Yo distance covered after the monitoring period ( $p = 0.001$ ).

**Table 1 Presents The Results Of Physical Performance Tests Conducted On 15 Male Students Before And After A 10-Week Study Period, Which Coincided With A Season Involving Multiple Sports Codes.**

Performance variables	Before	After	Effect size ( $d$ )	p	SEM
Vertical jump height (cm)	51.5 ± 8.6	52.4 ± 5.8	0.12	0.712	1.49
Vertical jump power (W)	4060 ± 893	4117 ± 582	0.08	0.001	149.23
Medicine ball throw distance (cm)	375 ± 89	364 ± 69	0.13	0.649	17.81
Agility (s)	10.0 ± 0.4	8.9 ± 0.9	1.58	0.002	0.22
5 m sprint time (s)	1.2 ± 0.1	1.3 ± 0.1	1.00	0.099	0.04
20 m sprint time (s)	3.5 ± 0.2	3.4 ± 0.2	0.50	0.507	0.06
250 m shuttle run(s)	80.1 ± 7.8	76.9 ± 4.4	0.51	0.233	1.13
Yo-Yo <sup>#</sup> level attained	14.1 ± 1.5	14.5 ± 1.0	0.31	0.001	0.26
Yo-Yo distance covered (m)	677 ± 352	712 ± 257	0.11	0.649	65.90
Estimated VO <sub>2</sub> max (ml/kg/min)	42.1 ± 3.0	42.4 ± 2.2	0.11	0.001	0.56

<sup>#</sup> median ± IQR

**Weekly Training Loads**

The average workload during the 10-week period was 2283 ± 390 AU. There was a significant variation in workloads across the weeks ( $p = 0.002$ ). In weeks 1, 2, and 3, there is a clear trend of rising effort. To be more precise, there was an increase in workload of 924 Arbitrary Units (AU) between weeks 1 and 2 ( $p = 0.048$ ), 1643 AU between weeks 1 and 3 ( $p = 0.0001$ ),

and 718 AU between weeks 2 and 3 ( $p = 0.0001$ ). The highest training workloads were seen in weeks 3 (3691 AU), 9, and 10 (3842 AU), with week 9 having the highest total burden. The lowest workloads were seen in weeks 1 (2048 AU), 2 (2973 AU), and 5 (3060 AU). After week 3, there was a progressive decrease in effort with occasional changes between weeks 4 and 8, albeit these differences were not statistically significant. Notably, there was

a significant difference between weeks 8 (3048 AU) and 9 (3842 AU) ( $p = 0.0001$ ),

followed by a slight decrease in workload in week 10 (3567 AU).

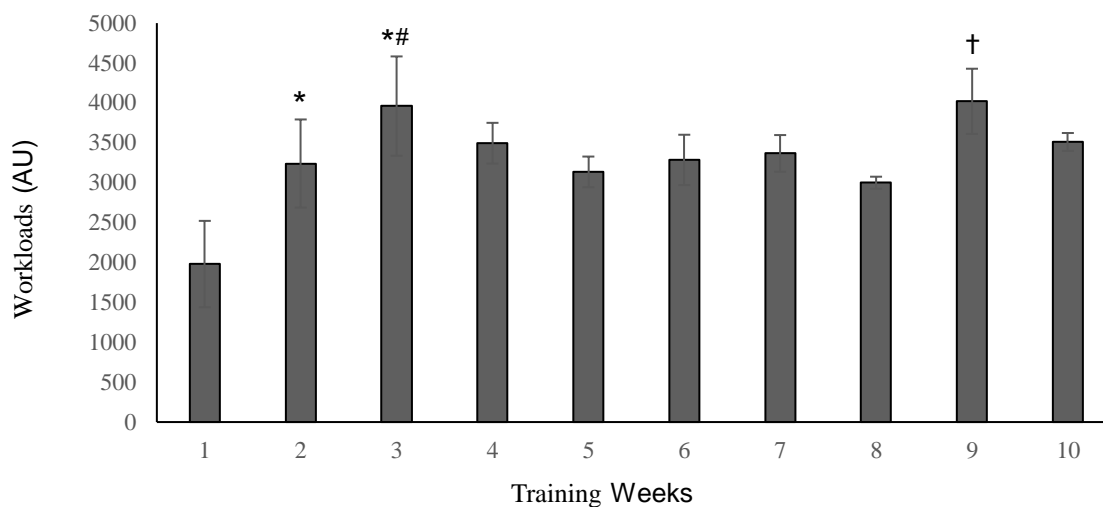


Figure 1 displays the weekly workloads of 15 athletes recorded over a 10-week period encompassing overlapping sporting codes. The asterisk (\*) indicates a significant difference compared to week 1 ( $p = 0.048$ ), the hashtag (#) indicates a significant difference compared to week 2 ( $p = 0.0001$ ), and the dagger symbol (†) indicates a difference compared to week 8 ( $p = 0.0001$ ).

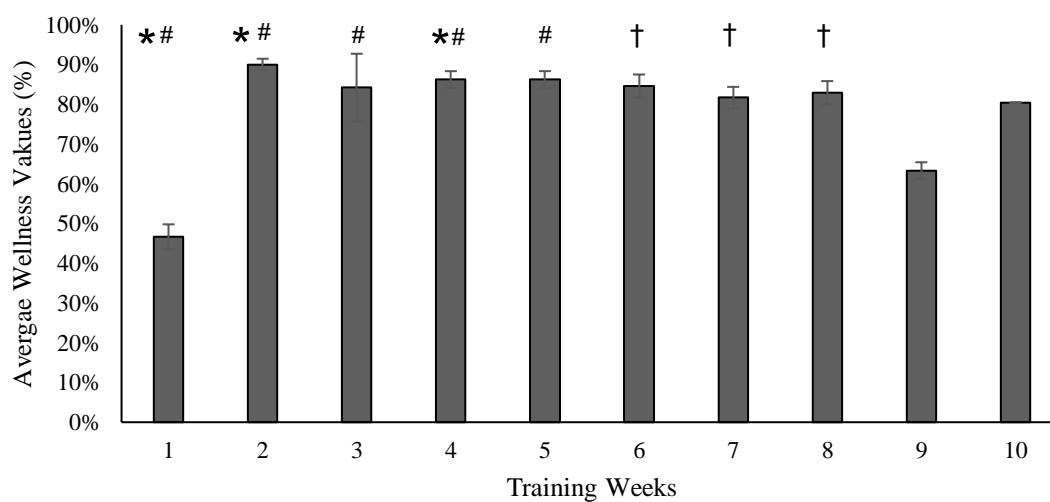


Figure 2 displays the wellness scores (%) reported by 15 athletes throughout 10 weeks of overlapping sporting codes. \* Indicates a significant difference from week 10, # indicates a significant difference from week 9, and † indicates a significant difference from weeks 1 and 2.



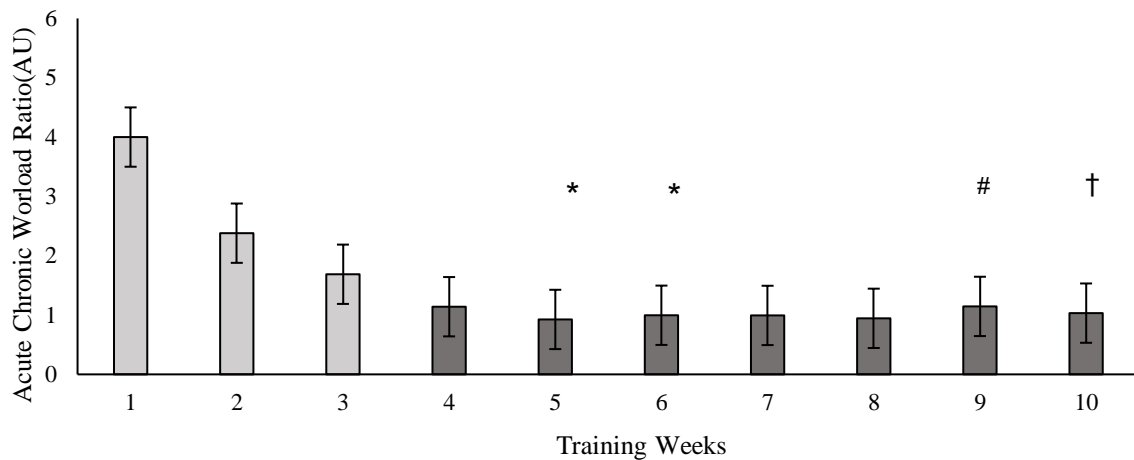


Figure 3: Acute: chronic workloads for 15 athletes tracked over 10 weeks of overlapping sporting codes. Only weeks 4–10 were analysed for chronic load.\* Significantly different from week 4 ( $p < 0.05$ ), # significantly different from weeks 6, 7 and 10  $p < 0.05$ , † significantly different from week 8 ( $p = 0.003$ )

### Wellness

The wellbeing ratings provided by the participants during the course of the 10-week trial are shown in Figure 2. Over the course of the 10 weeks, the group as a whole had an average wellbeing score of 78.2 3.0%. When compared to the total results for the 10 weeks, the wellness ratings were significantly low in the first week (46.4 1.9%). The average wellbeing score did, however, steadily rise starting in week 1. Both between week 1 and week 10 ( $p = 0.0001$ ) and between week 1 and week 9 ( $p = 0.0001$ ), there were appreciable differences in the wellness ratings. Similar to how week two's results were higher than

weeks nine and ten ( $p = 0.0001$ ), respectively. The greatest average scores were seen in weeks 2 (81.6% 0.7%), 3 (85.1% 5.0%), 4, 85% 5%, 5, 83.9% 10.9%, 7, and 8 (86% 1.4%), whereas weeks 1 and 9 had the lowest average scores ( $p = 0.0001$ ). Wellness and training load were also shown to be significantly correlated ( $r = -0.319$ ,  $p = 0.0001$ ).

### Acute: Chronic Workload

The ACWRs (Acute-to-Chronic Workload Ratios) computed throughout the 10-week observation period are shown in Figure 3. Since the workload buildup over the first four weeks was required to determine the chronic load, the data in Figure 3 only

includes weeks 4 to 10. For weeks 4 through 10, the average ACWR was 1.03 0.11 AU. Between weeks 4 and 5 there were changes in the ACWR (Figure 3;  $p = 0.0001$ ), but between weeks 6 and 7 there were no significant changes ( $p = 0.895$ ). Between weeks 8 and 10, there were significant variations ( $p = 0.003$ ). Furthermore, there were notable variations between weeks 6 and 9 ( $p = 0.0001$ ), weeks 7 and 9 ( $p = 0.0001$ ), and weeks 9 and 10 ( $p = 0.014$ ). It is significant to note that the data for weeks 1 through 3 were not analyzed in Figure 3 since they were not taken into account when determining the chronic load.

## **Discussion**

The study's major goal was to look at the effects of workload on high school athletes who compete in various sports during the same season. After a 10-week monitoring period, the majority of participants' performance measures did not, in general, show any appreciable improvements. The training burden increased steadily throughout the first three weeks but fluctuated between weeks four and ten. The computed ACWR remained mostly steady, suggesting that the entire sample had a low relative risk of harm. Self-reported wellbeing ratings were stable during the course of the 10-week study.

### ***Performance Parameters***

In the present study, the measurement of performance parameters was conducted to examine the changes or maintenance of these parameters over the 10-week period, although it was not the primary focus of the study. Considering the scholars' combined training workload, which includes academic and cultural commitments, there is a possibility of fatigue that can lead to overuse injuries and negatively impact the scholars' well-being, potentially resulting in burnout. Therefore, the performance parameters aimed to demonstrate the influence of workload on performance, particularly on the scholars' well-being.

The results regarding the performance parameters indicated slight improvements or insignificant changes. Specifically, the jump height showed a small effect size ( $d = 0.13$ ). However, when compared to other studies such as Till and Jones (2015), the jump height in our study ( $52.4 \pm 5.8$  cm) was higher than that of Junior rugby national players in the United Kingdom ( $43.4 \pm 6.4$  cm). Despite the higher jump height, the changes over the 10-week period were not statistically significant. Similar to lower body strength and power, upper body strength and power likewise had a negligible effect size ( $d = 0.13$ ), indicating no improvement. According to Till et al. (2016), these values were lower than those seen among teenage rugby league players from the United Kingdom

(580 cm). The acceleration ( $1.3 \pm 0.1$  m/s) and running speed did not significantly change between the 5 m and 20 m running intervals.

In contrast, the running agility in our study ( $8.9 \pm 0.9$  s,  $d = 1.58$ ) indicated a faster time compared to the Australian Institute of Sport AFL Academy elite junior players ( $9.08 \pm 0.35$  s) as reported by W. Young et al. (2011). Similarly, the anaerobic capacity (250m shuttle time) of our study sample showed improvement ( $76.9 \pm 4.4$  s,  $d = 0.51$ ) with a quicker time compared to South African youth aged 15-16 ( $81 \pm 6.4$  s). Additionally, there was a significant improvement in aerobic capacity as indicated by the estimated VO<sub>2</sub> max ( $p = 0.001$ ) and the achieved yo-yo level ( $p = 0.001$ ). Although the distance covered in the yo-yo test (m) did not show statistical significance, there was still an improvement in the covered distance ( $712.0 \pm 256.7$  m). However, it is important to note that the estimated VO<sub>2</sub> max (ml/kg/min) in our study was lower than that of adolescent national and regional junior rugby league players ( $48.7 \pm 5.2$  ml/kg/min and  $48 \pm 4.0$  ml/kg/min) respectively.

### ***Training Workloads and Wellness Scores***

In the present study, the focus was not solely on the performance parameters, but rather on assessing the effect of workload

on the well-being of scholars over a 10-week period. The combined workload, including academic and cultural commitments, may lead to fatigue and potentially result in overuse injuries and reduced wellness among scholars. Therefore, the performance parameters were measured to understand the impact of workload on performance and well-being.

The results of the performance parameters demonstrated minor improvements or negligible changes without statistical significance. For instance, the jump height showed a small effect size of  $d = 0.13$ , although our study recorded a higher jump height measurement ( $52.4 \pm 5.8$  cm) compared to Junior rugby national players ( $43.4 \pm 6.4$  cm) in the United Kingdom as reported by Till and Jones (2015). However, these changes in jump height over the 10-week period were not statistically significant. Similarly, the upper body strength and power displayed a small effect size of  $d = 0.13$ , indicating no improvement. Our findings were lower than those reported for young rugby league players in the United Kingdom (580 cm) according to Till et al. (2016). Running speed and acceleration ( $1.3 \pm 0.1$  m/s) did not exhibit significant differences in both the 5 m and 20 m running times.

In contrast, our study showed faster running agility ( $8.9 \pm 0.9$  s,  $d = 1.58$ ) compared to the Australian Institute of Sport AFL Academy elite junior players ( $9.08 \pm 0.35$  s) as reported by W. Young et al. (2011). Additionally, the anaerobic capacity (250m shuttle time) of our study sample improved ( $76.9 \pm 4.4$  s,  $d = 0.51$ ) and achieved a quicker time compared to South African youth aged 15-16 ( $81 \pm 6.4$  s). The estimated VO<sub>2</sub> max (ml/kg/min) and reached yo-yo level, which measure aerobic capacity, showed a considerable improvement ( $p = 0.001$ ). The distance traveled ( $712.0 \pm 256.7$  m) improved even if the Yo-yo distance covered (m) did not approach statistical significance. In contrast to teenage national and regional junior rugby league players, our sample's estimated VO<sub>2</sub> max (ml/kg/min) was lower ( $48.7 \pm 5.2$  ml/kg/min and  $48.4 \pm 4.0$  ml/kg/min, respectively).

### ***Effect of training workload on wellness***

The athletes in this study reported relatively low wellness levels, which can be attributed to the high workload they experienced. It is important to monitor athletes with low wellness and high workload as it indicates an increased risk of injury and overreaching, as noted by McFarland and Bird (2014). Previous studies by Ivarsson et al. (2017) have demonstrated a substantial correlation between high psycho-emotional stress and

the likelihood of injury as well as poor training results.

A wellness score of 65% is regarded as ordinary, and scores above 65% as desirable, according to McFarland and Bird (2014). The significant training stress encountered in the early preseason, when fitness levels are often low and athletes are exposed to higher-than-normal training stress, can thus be explained by the low wellness percentage observed in week 1 (46.39%). Additionally, the transition across academic years, with new academic, cultural, and sport programs, can contribute to elevated emotional, physical, and physiological stress levels, as mentioned by Fredricks (2012) and Kellmann (2010).

The study's participants had an average wellbeing score of  $78.2 \pm 3.0\%$ , which was generally considered to be good. The wellbeing score fell to 62.94% in week 9, falling short of the established criterion (McFarland & Bird, 2014). This reduction in wellness can be attributed to the increase in workload during weeks 8 and 9, which represented the highest spike in workload over the 10-week study period. It is noteworthy that despite the increase in workload, no injuries were reported during this period. This suggests a potential link between a decrease in wellness and an increase in workload (correlation coefficient  $R = -0.319$ ,  $p < 0.0001$ ),

although it should be noted that the absence of injuries during the week 8-9 period indicates the athletes' relative resilience. This finding aligns with Ahmun et al. (2019), who suggest that changes in wellness may not be directly tied to external workloads (Ahmun et al., 2019).

### ***Acute Chronic Workload Ratio***

A metric that contrasts the training load for the present week with the typical effort over a four-week period is the ACWR (Acute to Chronic effort Ratio). It is well known that a ratio between 0.8 to 1.30 is regarded as a "sweet spot" with a relatively low risk of damage and that an ACWR larger than 1.5 indicates a significant relative risk of harm. Ratios outside of this range point to under- or overtraining, which both increase the risk of injury. However, it's important to note that these numbers serve as general guidelines, and individual factors such as training experience, injury history, and participation level can influence an athlete's tolerance for workload and injury risk.

The 10-week ACWR ratios in our investigation pointed to a workload index with a low risk of harm. However, it is important to take into account how the ACWR may affect performance. According to Gabbett's (2016) suggested load-ratio range, the findings continuously

revealed low ACWR loads throughout the trial, indicating a low risk of harm. This indicates that the participants experienced minimal fatigue and performed effectively under competition and practice stress. Except for lower body power, agility, and anaerobic and aerobic capacity, the majority of physical performance indicators did not significantly increase as a result of the training load, it is important to note.

These findings suggest that the applied workload did not effectively enhance performance in our sample. Training effects typically result from specific conditioning factors, but the workload ratios in this study did not reflect a training response that would lead to performance improvements. It is crucial to establish a realistic training workload index that balances training and recovery while promoting performance improvement and reducing the risk of injury.

The ACWR, TL ratio, and TL in our study were relatively low, indicating that the sample was not undertraining or in a state of overreaching. The wellbeing data also showed promising outcomes with no stress or exhaustion symptoms. With a moderate training load for people of their age, the sample mostly remained in a maintenance phase. However, it's important to acknowledge that the study

only compared the sample to themselves, and comparing the results to a control group or a general population of non-sporting school scholars would provide a clearer perspective on the effects of training workload on performance.

In practice, applying the ACWR and the concept of the sweet spot may not directly apply to multi-code athletes. Limited research has investigated workload and ACWR in multi-code athletes, particularly school athletes, and most studies have examined these factors over multiple seasons rather than a 10-week observation period as in our study.

In order to validate or refute the current sweet spot training methodology, we anticipated that any accumulated pressures would be reflected in the wellness scores. These scores may be linked to life stresses, sports injuries, and performance results. However, defining an injury based solely on the ACWR is challenging as injuries can occur during competition due to various factors. Additionally, the ACWR is not consistent across studies, athlete groups, or levels of competition, making it difficult to draw concrete conclusions about injury risk based solely on this metric.

Overall, determining the best way to measure workload and predict injury occurrence is challenging due to different approaches to quantify training load and the complexity of injury risk factors.

Workload alone cannot fully explain all injuries, and further research is necessary to better understand the relationship between training load, injury risk, and performance outcomes.

#### **D. Conclusion**

In summary, coaches and performance practitioners need to monitor workloads comprehensively, considering both internal and external factors, in high school athletes. This allows them to prescribe appropriate training loads that support recovery and facilitate athletes' adaptation. During overlapping seasons, it is crucial to carefully monitor wellness as it tends to decline due to increased workloads. Academic programs can also contribute to reduced wellness due to mental and emotional stress. Therefore, measures should be taken to mitigate the potential negative consequences of workloads on performance.

The current study showed associations between workload, wellness, and performance, as evidenced by the results of performance parameters. Therefore, it is important to develop training programs that optimize the performance of young school athletes during overlapping sport seasons while taking into account cultural and academic commitments. Monitoring wellness scores proves highly valuable in detecting changes in training responses.

In practical terms, it is not feasible to directly apply the Acute:Chronic Workload Ratio (ACWR) to determine universal "sweet spots" due to variations among athletes in terms of competition level, training experience, and status. Additionally, different sports have distinct training requirements, resulting in diverse workload ratios. These ratios also fluctuate depending on the training season and components of the periodization program. Previous research has presented ACWR values as absolute ratios. Hence, caution should be exercised when using these values as they are valuable but not comprehensive in explaining injuries or burnout. The ACWR values may be arbitrary and primarily serve as estimates of injury risk.

It is recommended to assess individual athletes and specific sports to identify their specific "sweet spots." Overall, the study revealed workloads that were insufficient to elicit noticeable improvements in physical performance. Moreover, youth athletes involved in multiple sports effectively managed their workloads, indicating that their capacity to adapt to higher workloads may protect them from injury risks.

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#### **F. Conflict of Interest**

The authors declare no conflict of interests.

#### **References**

- Ahmun, R., McCaig, S., Tallent, J., Williams, S., & Gabbett, T. (2019). Association of Daily Workload, Wellness, and Injury and Illness During Tours in International Cricketers. *International Journal of Sports Physiology and Performance*, *14*(3), 369–377. <https://doi.org/10.1123/ijsp.2018-0315>
- Aloulou, A., Duforez, F., Léger, D., De Larochelambert, Q., & Nedelec, M. (2021). The Relationships Between Training Load, Type of Sport, and Sleep Among High-Level Adolescent Athletes. *International Journal of Sports Physiology and Performance*, *16*(6), 890–899. <https://doi.org/10.1123/ijsp.2020-0463>
- Bangsbo, J., Iaia, F. M., & Krstrup, P. (2008). The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine (Auckland, N.Z.)*, *38*(1), 37–51. <https://doi.org/10.2165/00007256->

- 200838010-00004
- Bishop, C., Brashill, C., Abbott, W., Read, P., Lake, J., & Turner, A. (2021). Jumping Asymmetries Are Associated With Speed, Change of Direction Speed, and Jump Performance in Elite Academy Soccer Players. *Journal of Strength and Conditioning Research*, 35(7), 1841–1847. <https://doi.org/10.1519/JSC.000000000000003058>
- Blanch, P., & Gabbett, T. J. (2016). Has the athlete trained enough to return to play safely? The acute:chronic workload ratio permits clinicians to quantify a player's risk of subsequent injury. *British Journal of Sports Medicine*, 50(8), 471–475. <https://doi.org/10.1136/bjsports-2015-095445>
- Bourdon, P. C., Cardinale, M., Murray, A., Gastin, P., Kellmann, M., Varley, M. C., Gabbett, T. J., Coutts, A. J., Burgess, D. J., Gregson, W., & Cable, N. T. (2017). Monitoring Athlete Training Loads: Consensus Statement. *International Journal of Sports Physiology and Performance*, 12(Suppl 2), S2161–S2170. <https://doi.org/10.1123/IJSP.2017-0208>
- Bowen, L., Gross, A. S., Gimpel, M., & Li, F.-X. (2017). Accumulated workloads and the acute:chronic workload ratio relate to injury risk in elite youth football players. *British Journal of Sports Medicine*, 51(5), 452–459. <https://doi.org/10.1136/bjsports-2015-095820>
- Buckthorpe, M., Morris, J., & Folland, J. P. (2012). Validity of vertical jump measurement devices. *Journal of Sports Sciences*, 30(1), 63–69. <https://doi.org/10.1080/02640414.2011.624539>
- Carey, D. L., Blanch, P., Ong, K.-L., Crossley, K. M., Crow, J., & Morris, M. E. (2017). Training loads and injury risk in Australian football-differing acute: chronic workload ratios influence match injury risk. *British Journal of Sports Medicine*, 51(16), 1215–1220. <https://doi.org/10.1136/bjsports-2016-096309>
- Cunanan, A. J., DeWeese, B. H., Wagle, J. P., Carroll, K. M., Sausaman, R., Hornsby, W. G. 3rd, Haff, G. G., Triplett, N. T., Pierce, K. C., & Stone, M. H. (2018). The General Adaptation Syndrome: A Foundation for the Concept of Periodization. *Sports Medicine (Auckland, N.Z.)*, 48(4), 787–797. <https://doi.org/10.1007/s40279-017-0855-3>
- DiFiori, J. P., Benjamin, H. J., Brenner, J. S., Gregory, A., Jayanthi, N., Landry,



- G. L., & Luke, A. (2014). Overuse injuries and burnout in youth sports: a position statement from the American Medical Society for Sports Medicine. *British Journal of Sports Medicine*, 48(4), 287–288. <https://doi.org/10.1136/bjsports-2013-093299>
- Drew, M. K., & Finch, C. F. (2016). The Relationship Between Training Load and Injury, Illness and Soreness: A Systematic and Literature Review. *Sports Medicine (Auckland, N.Z.)*, 46(6), 861–883. <https://doi.org/10.1007/s40279-015-0459-8>
- Eisenmann, J. C., Howard, R., & Moreno, T. (2020). LONG-TERM ATHLETIC DEVELOPMENT AS A FRAMEWORK TO INFLUENCE WELLNESS DURING CHILDHOOD AND ADOLESCENCE. *ACSM's Health & Fitness Journal*, 24(5). [https://journals.lww.com/acsm-healthfitness/Fulltext/2020/09000/LONG\\_TERM\\_ATHLETIC\\_DEVELOPMENT\\_AS\\_A\\_FRAMEWORK\\_TO.9.aspx](https://journals.lww.com/acsm-healthfitness/Fulltext/2020/09000/LONG_TERM_ATHLETIC_DEVELOPMENT_AS_A_FRAMEWORK_TO.9.aspx)
- Fredricks, J. A. (2012). Extracurricular participation and academic outcomes: testing the over-scheduling hypothesis. *Journal of Youth and Adolescence*, 41(3), 295–306. <https://doi.org/10.1007/s10964-011-9704-0>
- Gabbett, T. J. (2016). The training injury prevention paradox: should athletes be training smarter and harder? *British Journal of Sports Medicine*, 50(5), 273–280. <https://doi.org/10.1136/bjsports-2015-095788>
- Gazzano, F., & Gabbett, T. J. (2017). A practical guide to workload management and injury prevention in college and high school sports. *NSCA Coach*, 4(4), 30–34. <http://link.springer.com/10.1007/s40279-016-0529-6>
- Grobler, T. D., Shaw, B. S., & Coopoo, Y. (2017). Influence of physical fitness parameters on relative age effect on amateur secondary school rugby union players. *South African Journal for Research in Sport, Physical Education and Recreation*, 39(3), 29–39.
- Halson, S. L. (2014). Monitoring training load to understand fatigue in athletes. *Sports Medicine (Auckland, N.Z.)*, 44 Suppl 2(Suppl 2), S139-47. <https://doi.org/10.1007/s40279-014-0253-z>
- Hamlin, M. J., Wilkes, D., Elliot, C. A., Lizamore, C. A., & Kathiravel, Y.

- (2019). Monitoring Training Loads and Perceived Stress in Young Elite University Athletes. *Frontiers in Physiology*, 10, 34. <https://doi.org/10.3389/fphys.2019.00034>
- Hendricks, S., Till, K., Weaving, D., Powell, A., Kemp, S., Stokes, K., & Jones, B. (2019). Training, match and non-rugby activities in elite male youth rugby union players in England. *International Journal of Sports Science and Coaching*, 14(3), 336–343. <https://doi.org/10.1177/1747954119829289>
- Hulin, B. T., Gabbett, T. J., Blanch, P., Chapman, P., Bailey, D., & Orchard, J. W. (2014). Spikes in acute workload are associated with increased injury risk in elite cricket fast bowlers. *British Journal of Sports Medicine*, 48(8), 708–712. <https://doi.org/10.1136/bjsports-2013-092524>
- Hulin, B. T., Gabbett, T. J., Lawson, D. W., Caputi, P., & Sampson, J. A. (2016). The acute:chronic workload ratio predicts injury: high chronic workload may decrease injury risk in elite rugby league players. *British Journal of Sports Medicine*, 50(4), 231–236. <https://doi.org/10.1136/bjsports-2015-094817>
- Ivarsson, A., Johnson, U., Andersen, M. B., Tranaeus, U., Stenling, A., & Lindwall, M. (2017). Psychosocial Factors and Sport Injuries: Meta-analyses for Prediction and Prevention. *Sports Medicine (Auckland, N.Z.)*, 47(2), 353–365. <https://doi.org/10.1007/s40279-016-0578-x>
- Kellmann, M. (2010). Preventing overtraining in athletes in high-intensity sports and stress/recovery monitoring. *Scandinavian Journal of Medicine & Science in Sports*, 20 Suppl 2, 95–102. <https://doi.org/10.1111/j.1600-0838.2010.01192.x>
- Mann, J. B., Bryant, K. R., Johnstone, B., Ivey, P. A., & Sayers, S. P. (2016). Effect of Physical and Academic Stress on Illness and Injury in Division 1 College Football Players. *Journal of Strength and Conditioning Research*, 30(1), 20–25. <https://doi.org/10.1519/JSC.000000000000001055>
- McFarland, M., & Bird, S. P. (2014). A wellness monitoring tool for youth athletes. *Journal of Australian Strength and Conditioning*, 22(6), 22–26.
- Menzel, H.-J., Chagas, M. H., Szmuchrowski, L. A., Araujo, S. R., Campos, C. E., & Giannetti, M. R.

- (2010). Usefulness of the jump-and-reach test in assessment of vertical jump performance. *Perceptual and Motor Skills*, 110(1), 150–158. <https://doi.org/10.2466/PMS.110.1.150-158>
- Merkel, D. L. (2013). Youth sport: positive and negative impact on young athletes. *Open Access Journal of Sports Medicine*, 4, 151–160. <https://doi.org/10.2147/OAJSM.S33556>
- Muehlbauer, T., Pabst, J., Granacher, U., & Büsch, D. (2017). Validity of the Jump-and-Reach Test in Subelite Adolescent Handball Players. *Journal of Strength and Conditioning Research*, 31(5), 1282–1289. <https://doi.org/10.1519/JSC.000000000000001607>
- Palmer-Green, D., Fuller, C., Jaques, R., & Hunter, G. (2013). The Injury/Illness Performance Project (IIPP): A Novel Epidemiological Approach for Recording the Consequences of Sports Injuries and Illnesses. *Journal of Sports Medicine (Hindawi Publishing Corporation)*, 2013, 523974. <https://doi.org/10.1155/2013/523974>
- Phibbs, P. J., Roe, G., Jones, B., Read, D. B., Weakley, J., Darrall-Jones, J., & Till, K. (2017). Validity of Daily and Weekly Self-Reported Training Load Measures in Adolescent Athletes. *Journal of Strength and Conditioning Research*, 31(4), 1121–1126. <https://doi.org/10.1519/JSC.0000000000000001708>
- Sayers, E. W. (2012). Database resources of the National Center for Biotechnology Information. *Nucleic Acids Research*, 40. <https://doi.org/10.1093/nar/gkr1184>
- Suchomel, T. J., Lamont, H. S., & Moir, G. L. (2016). Understanding Vertical Jump Potentiation: A Deterministic Model. *Sports Medicine (Auckland, N.Z.)*, 46(6), 809–828. <https://doi.org/10.1007/s40279-015-0466-9>
- Suchomel, T. J., Sato, K., DeWeese, B. H., Ebben, W. P., & Stone, M. H. (2016). Potentiation Following Ballistic and Nonballistic Complexes: The Effect of Strength Level. *Journal of Strength and Conditioning Research*, 30(7), 1825–1833. <https://doi.org/10.1519/JSC.0000000000000001288>
- Ti, M., & Nair, A. C. (2020). The seated medicine ball throw as a test of upper body strength in undergraduate students. ~ 1 ~ *International Journal of Physiology*, 5(2), 1–04. [www.journalofsports.com](http://www.journalofsports.com)
- Till, K., Jones, B. L., Cogley, S., Morley,

- D., O'Hara, J., Chapman, C., Cooke, C., & Beggs, C. B. (2016). Identifying Talent in Youth Sport: A Novel Methodology Using Higher-Dimensional Analysis. *PloS One*, *11*(5), e0155047. <https://doi.org/10.1371/journal.pone.0155047>
- Warren, A., Williams, S., McCaig, S., & Trewartha, G. (2018). High acute:chronic workloads are associated with injury in England & Wales Cricket Board Development Programme fast bowlers. *Journal of Science and Medicine in Sport*, *21*(1), 40–45. <https://doi.org/10.1016/j.jsams.2017.07.009>
- Weakley, J. J. S., Till, K., Read, D. B., Roe, G. A. B., Darrall-Jones, J., Phibbs, P. J., & Jones, B. (2017). The effects of traditional, superset, and tri-set resistance training structures on perceived intensity and physiological responses. *European Journal of Applied Physiology*, *117*(9), 1877–1889. <https://doi.org/10.1007/s00421-017-3680-3>
- Young, W. B., & Pryor, L. (2007). Relationship between pre-season anthropometric and fitness measures and indicators of playing performance in elite junior Australian Rules football. *Journal of Science and Medicine in Sport*, *10*(2), 110–118. <https://doi.org/10.1016/j.jsams.2006.06.003>
- Young, W., Farrow, D., Pyne, D., McGregor, W., & Handke, T. (2011). Validity and reliability of agility tests in junior Australian football players. *Journal of Strength and Conditioning Research*, *25*(12), 3399–3403. <https://doi.org/10.1519/JSC.0b013e318215fa1c>