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Training Load and Injury Incidence of Under-19, Under-21 and enior Netball Players

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Abstract

Research demonstrated links between training load, performance adaptation and injury risk in sport. In netball, monitoring and optimising training load is essential to support player welfare and reduce injuries. The aim was to determine the training loads (session rating of perceived exertion X session duration) and injury incidence of under-19 (u/19), under-21 (u/21) and senior elite netball players in the Free State Province, South Africa. A descriptive cohort research was conducted. Weekly training monitoring and injury questionnaires were used. Thirty-six netball players (12 per age group) that participated in a competitive season were eligible. Data were collected over 12 consecutive weeks. In week 7, the University Sport South Africa (USSA) netball tournament took place, week 8 was university holidays and week 12 the National Netball Championships. Data for weeks 1–6 and 9–11 represented normal training weeks. Descriptive statistics were calculated per player, age group, and position. Significant differences in training load were found between age groups, with senior players recording notably lower loads than u/19 and u/21 players. No significant differences were observed between playing positions. Injured u/19 players consistently had higher training loads than their uninjured peers. Most injuries, predominantly ligamentous, occurred during matches. Age-related disparities in training load highlight the need for tailored workload strategies. Understanding position-specific and age-specific demands can aid coaches and strength and conditioning staff in optimising training loads to reduce injury risk and enhance performance.

Keywords: Training Load; Netball Injuries; Playing Positions; Session Rating of Perceived Exertion; Srpe; Session Duration

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A. Introduction

Netball is a court sport characterised by high intensity intermittent movement involving quick and rapid change of direction, multiple accelerations and decelerations, and explosive jumps, at the same time also landing and stopping abruptly due to the unique rules of netball restricting movement with the ball (Bardzinski et al., 2021). Netball is the one of the most popular women's sports (Whitehead et al., 2021) and a popular sport in South Africa, played at various skill and age levels. High physical demands during either training or match play increase the risk of players sustaining an injury (Botha et al., 2020). Furthermore, training load, overuse injuries, increased risk of injuries and illness have become a growing concern over the last decade (Bruce et al., 2022; Drew & Finch, 2016; Graham et al., 2020; Impellizzeri et al., 2019; Schwellnus et al., 2016; Vanrenterghem et al., 2017). Therefore, practicians, conditioning coaches and sport scientists monitor athletes' training loads for various reasons, including managing fatigue, identifying risk of injury, and periodisation training (Bardzinski et al, 2021; Bourdon et al., 2017; Bruce et al., 2022; Sands et al., 2017). However, the way training load is measured and how players respond to the imposed training stimulus, can vary significantly between different teams and between different sporting codes (Fox et al., 2018).

Bardzinski et al. (2021) and Bruce et al. (2022) explained that two common classifications of training load are "internal and external load measures." External training load is a measure of the load specific to the training undertaken and includes measures such as distance, for example, total distance or distance within specific speed ranges, accelerations and decelerations. Internal loads reflect the "actual psycho-physiological response by the athlete elicited by the external training load and includes measures related to heart rate (e.g., heart rate variability, heart rate reserve) and the product of session rating perceived exertion (sRPE) and duration (sRPE-TL [training load])" (Bardzinski et al., 2021; Williams et al., 2017). Although technical innovations focussed on monitoring training loads have provided valuable assessment tools to assist in determining optimal training conditions, these are not always available to sub-elite players due to the cost of these products (Brooks et al., 2016).

Chandler et al. (2014) mentioned that RPE scores alone may not be sufficiently sensitive to evaluate small changes in intensity and volume in netball. However, Brooks et al. (2016) found that adding a time element to the sRPE, significant positive correlations were found between player load and sRPE. Therefore, Brooks et al. (2016) concluded that the use of an sRPE measure provides a valid and reliable alternative for coaches and support staff who wish to monitor training and competition loads in a sub-elite netball population. Bardzinski et al. (2021) and Burgess (2017) agreed that sRPE is easy to implement, inexpensive (free) and non-invasive. Furthermore, research indicated that there are differences between the training loads experienced by different teams within the same competition (Bruce et al., 2022; McLaren et al., 2018). Several reasons could contribute to those differences, including different coaches and support staff, with varied priorities on training components and diverse training schedules. Pre-season training load was significantly higher than in-season during competitions (Bradzinski et al., 2022). These comparisons of training load in different phases of competitions are important as it allows for the identification of "under- or over-loading" which can influence the effectiveness of training programmes (Robertson et al., 2017).

Assessing player load differences between positions, matches, training sessions and level of play is important

because of the distinguishing characteristics of player load placed on players in specific positions (Bailey et al., 2017; Young et al., 2016). During competition, essential physical qualities include speed, strength, power, agility, and aerobic and anaerobic endurance. It is crucial to monitor and analyse athletic and functional capabilities for the long-term development process. This aids in managing fatigue, providing adequate preparation of the player for competition, identifying injury risk and determining player readiness (Bruce et al., 2022; Young et al., 2016). Simpson et al. (2020) recommended the combination of internal and external workloads when monitoring elite netball athletes, and proposed the use of sRPE and change of direction (CoD) as the ideal combination.

Previous studies on training load provided information about typical training load in a variety of sports and explored relationships between training load and other factors that affect performance, such as adaptations to training and the risk of injury (Bardzinski et al., 2021; Bruce et al., 2022; Drew & Finch, 2016; Graham et al., 2020; Impellizzeri et al., 2019; Schwellnus et al., 2016; Vanrenterghem et al., 2017). However, Impellizzeri et al. (2019) stated that training workload is a key factor influencing sports injury risk, and it can be manipulated to reduce injury risk.

Whitehead et al. (2021) mentioned that further investigation of training load and training practices of netball across the range of playing standards and age-groups is needed. Simpson et al. (2020) concluded that although considerable research has investigated the injury risks associated with netball (Attenborough et al., 2015; Downs et al., 2022), limited research has examined the physiological demands of netball at various playing levels and in different age groups. Therefore, we explored the extent to which training load varies between teams of different ages. An understanding of these variations is required to accurately quantify the typical range of training loads in different ages in sport. Collectively, this information may assist coaches in determining effective and safe training loads for teams of different ages.

Physical performance is affected by technical, tactical, physiological and psychological factors in netball, with most research done on the technical and physical components of exercise (Bailey et al., 2017; Chandler et al., 2014; Thomas et al., 2016). Player position and court restrictions further affect specific activity profiles of each player (Bailey et al., 2017; Graham et al., 2020), and the needs of individualised programs and players' capabilities are prominent (Davidson & Trewartha, 2008). To optimise the development of essential fitness attributes in each sport, training must be specific and focus on the internal and external demands required during competition (Simpson et al., 2020; Wood et al., 2022).

Limited data are available on training load and the association with netball injuries in South Africa (Bruce et al., 2022; Langeveld et al., 2012; Pillay & Frantz, 2012; Sinclair et al., 2020). The available studies have indicated that the most frequently injured joints in netball are the ankle and knee, of ligamentous or musculoskeletal anatomical origin (Botha et al., 2020; Mullally et al., 2023; Pillay & Frantz, 2012; Sinclair et al; 2020). Janse van Rensburg et al. (2022) reported in a study of 1 357 female netball players 13–19 years of age from 49 schools in South Africa that most injuries occurred to the ankle (29%) and foot (15%). Previous studies investigated possible risk factors for injury, such as hypermobility of joints and somatotyping (Ferreira & Spamer, 2010; Sinclair et al., 2021), insufficient warm-up before the game (Pillay & Frantz, 2012), poor landing techniques, fast rotational movements and contact with other players (Mullally et al., 2023). Coetzee et al. (2014) highlighted the playing surface as an important risk factor, indicating that cement surfaces were

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associated with 80% of knee injuries, opposed to 20% on synthetic surfaces.

The aim of the current study was to determine the training loads and incidence of injuries recorded during the preseason, practice and match play (competition) for one season in three different age categories (under-19 [u/19], under-21 [u/21] and senior netball players) in the [removed to ensure blind review] ([removed to ensure blind review]) Province, South Africa. In addition to the different age groups, the study aimed to establish differences in training load and incidence of injuries according to players' positions, namely goal attack (GA), wing attack (WA), goal defence (GD), goal shooter (GS), centre (C), wing defence (WD) and goalkeeper (GK).

B. Methods

Study design

A descriptive cohort study was conducted to determine the training load and incidence of injuries among u/19, u/21 and senior netball players in the [removed to ensure blind review] Province, South Africa. The total study population consisted of 36 players (u/19, u/21 and senior; n=12 each). All participants (players) in the teams completed the weekly training monitoring questionnaire as well as the injury questionnaire (Coetzee et al., 2014). Data were collected over 12 consecutive weeks, where the University Sport South Africa (USSA) netball tournament took place in week 7, university holidays were in week 8, and the National Netball Championships in week 12. Therefore, weeks 1–6 and 9–11 represented "normal" training weeks.

Training load questionnaire

The training load questionnaire collected data on the number of training sessions regarding various exercise components that included core, biomechanical (jump and landing techniques), stretching (flexibility), proprioception and balance (neuromuscular control), strength and conditioning (S&C), technical and tactical. The average duration in minutes of each session and the rate of perceived exertion (sRPE) after the session were expressed by the player (Brooks et al., 2016). The total load was calculated for each participant per week according to total sessions, total average duration, and the rate of perceived exertion by players week (Brooks et al., 2016). The sRPE method uses a time-adjusted version of the Borg CR-10 RPE scale (0–10, representing rest [no exertion] to maximal exertion) (Foster et al., 2001).

Specifically, the duration of the activity (measured in minutes) is multiplied by the athlete's self-assessed RPE score, to generate an sRPE value for the session (Gallo et al., 2015). An sRPE score was obtained for each training session being separated into two distinct periods, S&C and skills training. Brooks et al. (2016) reported significant positive correlations between player load and sRPE for S&C (r=0.77) and weekly total (r=0.87) in sub-elite netball players. The strong correlations between sRPE and player load indicated that sRPE was an effective measure of S&C, skills, total training sessions and match loads in sub-elite female netball players and across a diverse range of athletes (Brooks et al., 2016; Fuller et al., 2007).

Injury questionnaire

Injury data were collected using a structured injury questionnaire designed to capture the nature and characteristics of injuries sustained during the study period. The questionnaire was adapted from the consensus statement on injury definitions in rugby union (Eijwoudt et al., 2023) and modified for application in netball (Langeveld et al., 2012). For the purpose of this study, an injury was defined as "any physical complaint sustained by a player during or following a netball game or practice that required medical treatment, and which resulted in either time loss or performance restriction" (Fuller et al., 2007: 178).

All injuries were diagnosed by a

qualified medical doctor. Data collection occurred on a weekly basis, during which players from participating teams were approached collectively to ascertain whether any injuries had been sustained in the preceding week and to confirm the medical diagnosis. A trained research assistant helped injured players to complete the injury questionnaire. If players participated in multiple playing positions, the position recorded corresponded to the role the player occupied at the time the injury occurred. Injury data were categorised according to several factors, including the time when the injury occurred (match play, preseason, or practice), type (acute/traumatic, overuse, or re-injury), mechanism (including contact with another player), anatomical location, type of injury and playing position.

Statistical analysis

In keeping with the nature of the study, the statistical analysis was largely descriptive. In the first analysis step, training load data for each participant, training load variable, and study week were averaged. The resulting weekly data (averages) were then summarised descriptively by the mean, standard deviation (SD), minimum (min), median and maximum (max). These statistics were calculated for all players in the sample, by age group (u/19, u/21 and senior players), and by playing position. Potential differences between the age groups and playing positions, respectively, were tested using a mixed model repeated measures (MMRM) analysis fitting age group, playing position and study week as fixed effects, and a Toeplitz covariance structure for the repeated measurements within each subject.

From these MMRM analyses, the F-tests and associated p-values for age group and playing position were determined. Because of the relatively large number of training load variables reported and the resulting multiplicity issues, these p-values should be interpreted from a descriptive perspective. Furthermore, for the u/19 age group, descriptive statistics for training load data were calculated by injury status (yes/no), and by injury type (muscle strain/ligament/other injury); here, no inferential statistics were calculated because of the small number of players with an injury in the reporting period. Data analysis was performed using SAS Version 9.4, in particular SAS procedure MIXED (SAS Institute Inc.; Cary, NC, USA).

Ethical considerations

The study received ethics approval from the Health Sciences Research Ethics Committee (HSREC) of the University of [removed to ensure blind review] (reference number [removed to ensure blind review]). In addition, permission to conduct the research was obtained from the South African Netball Association, [removed to ensure blind review] Netball, and the respective team coaches. All participating players who provided voluntary informed consent were included in the study.

C. Result and Discussion

Result

Training load

The training load data for the whole sample, by age group and by playing position are summarised in Table 1. Table 2 presents a summary of training load data by injury status and by injury type for the u/19 age group. In this study, significant differences in training load ($p<0.05$) between age groups were found regarding core, plyometric, proprioception, strength and technical sessions (Table 1), largely due to senior players experiencing notably lower mean and median loads than u/19 and u/21 players. In contrast, no statistically significant differences between playing positions were found.

Injuries

As shown in Table 2, only four injuries were reported in the tournament in the u/19 group, mostly ligamentous and muscle strains. No injuries were reported in the u/21 and senior group of players.

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Regarding the comparison of u/19 players with and without injury (Table 2), injured players had higher training loads for all training load variables. Most injuries occurred during matches.

Table 1. Training data of elite netball players by age group and playing position, with values presented as arbitrary units (AU).

sRPE-TL	Statistic	Team				Player position								
		Senior (n=12)	u/21 (n=12)	u/19 (n=11)	F-test (df=2, 26)	GS (n=5)	GA (n=4)	WA (n=5)	C (n=6)	WD (n=5)	GD (n=5)	GK (n=5)	F-test (df=6, 26)	All (n=35)
Core	Mean	98.3	1 279	353.8	F=11.09; p=0.0003	224.4	97.2	448.2	1 004	950.6	902.4	276.1	F=1.23; p=0.3211	583.6
	SD	5.64	960.9	371.1		153.4	4.2	758.5	881.2	1 021	1 176	304.9		781.2
	Min	87.2	200	15		105.6	92.2	16.7	92.2	96.7	15	96.7		15
	Median	99.7	1 305	165.5		200	97.4	124.4	900	591.8	90	165.5		165.5
	Max	106.1	2 716	1 080		480	101.7	1 800	2 234	2 716	2 520	816		2 716
Plyometric	Mean	80.1	374.5	385.9	F=6.30; p=0.064	298.3	372.6	273.7	327.1	323.2	202.6	151.5	F=1.10; p=0.3915	277.1
	SD	4.66	203	392.9		337	591.6	276.5	258.3	225.4	192.7	101.3		282.2
	Min	75	109.1	14.4		59	76.1	14.4	75.6	75	23.3	81.7		14.4
	Median	78.9	381.8	324		87.8	77.2	203.6	265.9	384.5	90	105.9		109.1
	Max	87.8	840	1 260		840	1 260	708.9	675	600	420	324		1 260
Proprioception	Mean	82.3	269.2	224.8	F=5.55; p=0.099	167.2	161.2	123.4	324.2	229.6	199.2	100.6	F=1.42; p=0.2463	191.2
	SD	6.02	144.9	207.2		115.9	166.5	136.9	220.1	174.4	172.9	47.71		161.7
	Min	73.9	18.3	10		80.6	76.7	10	85.6	18.3	65.6	55.5		10
	Median	80.6	349.1	180		109.1	78.6	84.4	314.8	280	81.8	82.8		95.6
	Max	95.6	430.9	600		360	410.9	360	600	430.9	414.5	180		600
Strength	Mean	84.9	656.3	627.5	F=10.29; p=0.005	349.8	448.2	359.5	711.7	536.7	299.2	401.6	F=1.30; p=0.2939	451.3
	SD	9.68	272.6	613.4		346.5	726.8	292.2	641.7	531.6	266.8	350.6		454.9
	Min	73.9	281.4	5		83.9	73.9	5	80	74.4	80.9	80.6		5
	Median	82.2	604.1	347.7		123.6	90.3	538.9	579.7	347.7	131.1	324		324
	Max	105.6	1 440	1 680		768.2	1 538	602.7	1 680	1 440	630	872.7		1 680

National Championship, USSA netball tournament and university holiday weeks were without training and therefore excluded from the study. One u/19 player was excluded from the study as no training data were available.

p-value calculated from the F-test of three-way analysis of variance (ANOVA) with the factors age group, playing position and training week. df, degrees of freedom; SD, standard deviation; Min, minimum; Max, maximum; GS, goal shooter; GA, goal attack; WA, wing attack; C, center; WD, wing defence; GD, goal defence; GK, goal keeper; sRPE-TL, session rating of perceived exertion X duration of session; USSA, University Sport South Africa.

Table 2. Continued.

sRPE-TL	Statistic	Team				Player position								
		Senior (n=12)	u/21 (n=12)	u/19 (n=11)	F-test (df=2, 26)	GS (n=5)	GA (n=4)	WA (n=5)	C (n=6)	WD (n=5)	GD (n=5)	GK (n=5)	F-test (df=6, 26)	All (n=35)
Technical	Mean	354.8	1748	367.7	F=11.88; p=0.0002	455	294.7	689.3	1 268	1 519	1 236	198.9	F=1.66; p=0.1709	836.6
	SD	44.33	1 156	510.2		290.4	200.8	1234	1 005	975.5	1 477	134.9		977.6
	Min	269.4	180	0		227.3	0	0	320.6	337.2	0	0		0
	Median	362.5	2 090	120		377.2	367.5	180	1 140	1 145	366.7	180		366.7
	Max	443.9	2 990	1 440		960	443.9	2 880	2 990	2 542	2 880	365		2 990
Physical	Mean	995.7	1 517	920.9	F=1.81; p=0.1842	675.9	1 117	999.8	2081	1 397	1 029	563.4	F=1.69; p=0.1642	1151
	SD	93.51	1 117	1 181		383.1	151.7	1 118	1 425	366	1 087	400.4		943.4
	Min	888.2	320	10		210	924.4	10	600	900	22.2	174.5		10
	Median	985.6	1 295	600		600	1 124	853.3	1 958	1 349	741.8	336		924.4
	Max	1 147	3 040	4 050		1 093	1 293	2 880	4 050	1 839	2 880	1 062		4 050
Matches	Mean	644.4	506.8	969.6	F=2.04; p=0.1508	413.5	859.1	597.8	1 000	1 036	490	471.3	F=0.93; p=0.4931	699.4
	SD	154	180.3	1 161		173.2	518.2	330	979.8	1 302	174.6	202.8		672.6
	Min	600	54.5	136.4		240	600	288.9	600	54.5	200	136.4		54.5
	Median	600	600	420		327.3	600	600	600	600	600	600		600
	Max	1 133	600	3 327		600	1 636	1 133	3 000	3 327	600	600		3 327

National Championship, USSA netball tournament and university holiday weeks were without training and therefore excluded from the study. One u/19 player was excluded from the study as no training data were available. sRPE-TL, session rate of perceived exertion multiply duration of session; df, degrees of freedom; SD, standard deviation; Min, minimum; Max, maximum; USSA, University Sport South Africa.

Table 2. Training data of elite netball players by injury and type in u/19 netball players, with values presented as arbitrary units (AU).

sRPE-TL	Statistic	Injury			Injury Type		
		No (n=7)	Yes (n=4)	All (n=11)	Muscle strain	Ligament (n=2)	Other injury

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					(n=1)		(n=1)
Core	Mean	344.8	369.8	353.8	95.5	629.1	124.4
	SD	426.1	309	371.1		128.6	
	Min	15	95.5	15		538.2	
	Median	165.5	331.3	165.5			
	Max	1 080	720	1 080		720	
Plyometric	Mean	173.8	757.1	385.9	1 260	529.8	708.9
	SD	214.9	365.5	392.9		205.4	
	Min	14.4	384.5	14.4		384.5	
	Median	90	691.9	324			
	Max	600	1 260	1 260		675	
Proprioception	Mean	169.1	322.2	224.8	410.9	410	57.8
	SD	201.2	205.8	207.2		183.8	
	Min	10	57.8	10		280	57.8
	Median	81.8	345.5	180			57.8

Table 2. Continued.

sRPE-TL	Statistic	Injury			Injury Type		
		No (n=7)	Yes (n=4)	All (n=11)	Muscle strain (n=1)	Ligament (n=2)	Other injury (n=1)
Technical	Mean	222.1	622.5	367.7	0	1 245	0
	SD	308	736.2	510.2		275.8	
	Min	0	0	0	0	1 050	0
	Median	120	525	120	0		0
	Max	840	1 440	1 440	0	1 440	0
Physical	Mean	299.2	2 009	920.9	1 293	2 945	853.3
	SD	280.4	1419	1 181		1 563	
	Min	10	853.3	10		1 839	
	Median	210	1 566	600			
	Max	741.8	4 050	4 050		4 050	
Matches	Mean	333.6	2 083	969.6	1 636	3 164	366.7
	SD	163	1 358	1 161		231.4	
	Min	136.4	366.7	136.4		3 000	
	Median	288.9	2 318	420			
	Max	600	3 327	3 327		3 327	

National Championship, USSA netball tournament and university holiday weeks were without training and therefore excluded from the study. One u/19 player was excluded from the study as no training data were available. sRPE-TL, session rate of perceived exertion multiply duration of session; df, degrees of freedom; SD, standard deviation; Min, minimum; Max, maximum; USSA, University Sport South Africa.

Discussion

Training load

The professional nature of sport is driving team personnel to find innovative methods to gain a competitive edge and improve athletes' and team performance (Bardzinski et al., 2021). Sands et al. (2017) stated in this regard that one way to assist in improving performance is monitoring the training loads and ensuring players are "ready" for competition and peak at the right times. Workloads in team sports tend to increase as the competition level increases (Beard et al., 2019; Cormack et al., 2014; Downs et al., 2022; Ferioli et al., 2018; Herman et al., 2006; McMillan, 2004). However, it is still unclear if differences in external biomechanical workloads (player load per minute) exist between different age groups during netball competitions. Practitioners need this information to prepare scientifically for competition throughout their periodised season (Ferioli et al., 2018).

Therefore, the objective of this study was to determine the training load of various training components and matches and the epidemiology of injuries in u/19, u/21 and senior [removed to ensure blind review] netball players for one consecutive season over 12 weeks, including injuries sustained during practice and preseason training. This study identified differences in training load between the different age groups. Differences in training load were anticipated and explainable, However, some results were unexpected and might have important practical implications for coaches and players. It is also important to note that the varied nature of the current findings and previous research suggests that practitioners differ in their approach to training load prescription. Future research should explore the relationship between changes in training load and individual and team performance (Bruce et al., 2022).

In this study, the u/21 netball players had a higher median value for all training sessions and matches compared to the u/19 and senior netball players (Table 1). This finding could be attributed to the fact that most u/21 players play for both the University of [removed to ensure blind review] first team and national league during the season. Bardzinski et al. (2021) highlighted that clubs that have training partners or players who train across multiple teams, may experiencing higher training loads when training for multiple teams.

In the current study, the senior netball team had fewer gym sessions (73.9 arbitrary units [AU] in the in-season competition phase sRPE) than the u/19 and u/21 teams, although the number of technical (222.1 AU), physical (299.2 AU) and match sessions (333.6 AU) were higher than those of the u/19 team but lower than the u/21 team's values (Table 1). This was in line with Bardzinski et al., (2021) who also reported that the session type with the lowest load were conditioning sessions (240.13 AU in-season sRPE) in elite netball players. However, Chandler et al. (2014) found the opposite, namely that traditional conditioning sessions incurred higher loads than matches. It is important to note that variation in session duration is also a contributor to differences in load within and between studies (Bardzinski et al., 2021). Furthermore, netball players also use other training modalities to build their aerobic fitness, such as applied court sessions and/or weight sessions.

Bardzinski et al. (2021) reported higher sRPE match loads (482.42 AU) in elite netball players versus our senior netball players (333.6 AU), but also lower than our u/21s (2 083 AU) and u/19 (969.6 AU). Bruce et al. (2022) reported similar average training loads of eight teams in an elite netball competition during 2017 and 2018 ranging between 435 and 500 sRPE per training session. They concluded that the competition trend was for higher training loads in pre-season than in-season

and higher training loads in 2017 compared to 2018 (Bruce et al., 2022).

Herman et al. (2006) highlighted the fact that using sRPE-TL is not without limitations. Consequently, Bruce et al. (2022) recommended to include both objective and subjective measures of load (e.g., cost of devices, teams using the same hardware). The current study used sRPE-TL as a measure of session load and the three age groups might have completed different numbers of sessions within a week, thus the overall training load between teams might be vastly different. However, the current study is unique with the inclusion of comparisons between the differences in training load and incidence of injuries in u/19, u/21 and senior [removed to ensure blind review] netball players.

Injuries

An objective of this study was to establish comparisons between the differences in training load and the incidence of injuries in u/19, u/21 and senior [removed to ensure blind review] netball players. To compare the findings with relevant literature (Botha et al., 2020; Ellapen et al., 2015; Langeveld et al., 2012; Partner et al., 2018; Pillay & Frantz, 2012), it is important to be aware of the methodology for determining the incidence of injuries. However, our findings can be compared with relevant research in netball in South Africa (Botha et al., 2020; Coetzee et al., 2014; Langeveld et al., 2012; McManus et al., 2006; Pillay & Frantz, 2012).

Only four injuries were sustained among the u/19 players during the twelve-week monitoring period. Regarding the comparison of u/19 players with and without injury (Table 2), injured players had higher training loads for all training load variables. However, an investigation of injured versus uninjured elite adolescent netball players did not indicate a causative relationship between heavier training loads and a risk of overuse injuries (Drew & Finch., 2016). A trend towards greater variability in training programs for injured players was observed. In this regard, it must be noted that the u/19 provincial team brings together talented athletes from the university's second netball team and promising players from surrounding towns. While team selection takes place three weeks before competition, this structure encourages players to take personal responsibility for maintaining their baseline fitness and conditioning in preparation for the season.

The most prevalent types of injuries were ligament and muscle strains (Table2). Published investigations did not always report on the type of injury, only the anatomical structures (Coetzee et al., 2014; Ellapen et al., 2015; McManus et al., 2006). However, our finding was in agreement with the results reported from a number of other studies (Botha et al., 2020; Langeveld et al., 2012; Sinclair et al., 2020). McManus et al. (2006) highlighted the fact that injuries can be attributed to several factors, such as incorrect landing, slipping, tripping and direct trauma. Botha et al. (2020) also mentioned that increased levels of competitiveness can increase physical demands and load on the body, in particular on an immature skeletal structure.

The current study quantified training load using sRPE, which is a subjective measure. Further research should aim to include both subjective and objective measures to assess training load. We report data for only one season phase (e.g., competition phase), and therefore, no data on how load changes over time were generated.

D. Conclusion

In this study, the training load and incidence of injuries in u/19, u/21 and senior netball players in competitive tournaments were determined. Understanding a player's more recent

training loads could ensure appropriate loading (e.g., building or decreasing loads within an acceptable range) to enhance performance and reduce the risk of injury. It is important to note that injured players had higher training loads for all the training load variables.

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F. Conflict of Interest

The authors declare that this research was conducted following the Declaration of Helsinki and ethical approval was obtained from the Health Sciences Research Ethics Committee (HSREC).

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