The frequency and intensity of representative and non-representative late adolescent team-sport athletes' training schedules

Running title: Representative and non-representative youth athlete training loads

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Abstract

This study aimed to identify and compare the training frequency and intensity (via session rating of perceived exertion load (sRPE load)) of representative and non-representative late adolescent athletes. Thirty-six team sport athletes completed a web-based questionnaire daily over an 8-month period, reporting their training/match activities from the previous day. Athletes were categorised as representative (academy/county/international) or non-representative (club/school) depending on the highest level of their sport they participated. Mean weekly frequencies and sRPE load of different training/match activities were quantified for each athlete across five school terms. Mann-Whitney U tests established the significance of differences and effect sizes between playing standards for mean weekly frequencies and mean sRPE load. Within-athlete weekly sRPE loads were highly variable for both playing standards however representative level athletes participated in significantly more activity outside of school compared to non-representative athletes during November to December (effect size; *0.43* – club technical training; *0.36* – club matches), January to February (effect size; *0.78* – club technical training; *0.75* – club matches) and February to March (effect size; *0.63* – club technical training; *0.44* – club matches). Therefore, club and school coaches must ensure that all elements of representative athletes training schedules are coordinated and flexible to promote positive adaptions to training such as skill & physical development and prevent maladaptive responses such as overuse injury and non-functional overreaching. A cooperative and malleable training schedule between club/school coaches and the athlete will allow the athlete to perform on multiple fronts whilst also being able to meet the demands of additional stressors such as schoolwork.

Key Words: Training Load, Sport, Periodization, Overtraining

INTRODUCTION

Youth athletes engage in various sporting activities, due to either long-term sporting career ambitions as a professional athlete, short-term enjoyment or compulsory structured activities within schools (18,31). Athletes identified with potential for long-term career progression within a sport most often engage in structured talent development sporting programmes outside of their school environments (12,24). More recently, there has been an increased prevalence of sports schools which incorporate sports training into the education curriculum (13). School sport scholarships are becoming an integral part of the elite sports performance strategy in the United Kingdom, with Ofsted stating 15% of current British athletes received a sports scholarship (22). Consequently, given the concurrent talent development systems and sports participation within and outside of schools, it is important to understand the different sporting activities completed by youth athletes to ensure optimal concurrent school and club sporting programs (26,27).

Frequent exposure to sport specific practise can enhance the technical skills of team sport athletes (7). Previous research has shown athletes who engaged in more sport specific practice reached a higher playing standard (7). Similarly, adolescent rugby union players within a representative academy undertake a greater volume of training than lower standard school level players (23). Despite this, a “more is better” approach to training may be detrimental to development in the absence of adequate recovery and greater diversification may be beneficial (18). Greater diversification in late adolescence followed by increased training in early adulthood has been shown to differentiate between elite and near elite athletes demonstrating the optimal career path is not only dependent on the amount of training hours but also when they occur (20).

Repeated exposure to sporting activities from multiple sessions, inside and outside of school can contribute to non-functional overreaching or overuse injury if inadequately prescribed (5,16). Therefore, practitioners must consider the entirety of the youth athletes training schedule as well as the intensity and duration of different training sessions and

matches rather than exclusively investigating the volume of training to further understand the training stress experienced by athletes (15).

The overall load of training or a match, can be quantified via the session-rating of perceived exertion load (sRPE load) by multiplying the intensity (measured by a modified Borg category ratio-10 (CR-10) scale) of an activity by the duration to the nearest minute (8). Establishing the sRPE load of an activity is an important consideration for school sport athletes, given the complex nature of their training schedules (17). It is likely that the loads experienced by athletes via different training/match activities vary throughout the year, given differences in competition schedules and the 'seasonal' nature of sports. Whilst the intensity of training will vary throughout the year depending on the coaches' periodization structure (11), matches may also vary with sRPE load increasing as the skill level of the opponent and perceived importance of the fixture increases (1) (21). Although the importance of monitoring a late adolescent athlete's participation in sporting activities is clear, the multiple sources of training and matches, the different forms of training activities (technical/resistance training), exposure to a range of practitioners as well as variations in training intensity and duration exacerbates the complexity and difficulty of this process. Late adolescent athlete practitioners must balance training and competition with the required recovery and should understand all sporting activities that late adolescent athletes participate in across the week.

Despite the previously ascertained benefits of sports training alongside the consequences of inadequate training prescription, to the authors knowledge, no study to date has explored the training schedules of school sport scholarship athletes of different playing standards. Therefore, the aim of the present study was to identify and compare the weekly frequency and mean load (sRPE load) of different sporting activities undertaken by representative and non-representative late adolescent athletes and identify the variation in sRPE load across the academic year.

METHOD

Experimental approach to the problem

The study used a prospective longitudinal research design to establish the mean weekly frequencies and mean loads (sRPE load) of sporting activities which comprise the overall sporting schedule of late adolescent athletes across the academic year. Data were collected over an eight-month period from 7th September to 27th May. All participants were familiarised with the web-based questionnaire design (Google Forms, Google, CA, USA) used to obtain sRPE load during the previous academic year. The web-based questionnaire required participants to provide a measure of intensity via a modified Borg category ratio-10 (CR-10) (9) scale and a session duration to the nearest minute for any training/match activity completed the previous day.

Subjects

Thirty-six adolescent athletes including 18 (11 female, 7 male) representative (academy, county or international) athletes (age 17.6 ± 0.7 years, height 174.0 ± 9.1 cm, body mass 75.2 ± 15.5 kg) and 18 (7 female, 11 male) non-representative (club or school) athletes (age 17.3 ± 0.8 years, height 171.4 ± 7.4 cm, body mass 67.0 ± 10.4 kg) were recruited from an independent school in the United Kingdom. All athletes participated in one of the following school sports; soccer, rugby, netball or field hockey. Coaches, players and parents provided informed written consent prior to participation. Ethics approval was granted by the university's ethics committee.

Procedures

Prior to the commencement of the study, participants were asked to fill in a questionnaire detailing every level of their sport that they currently participated in before being grouped based on their playing standard (representative or non-representative).

All participants were asked to fill in a freely available and previously validated (25,29) web based questionnaire on a daily basis throughout the entire study period detailing any training/competition they had completed in the previous 24 hours. Whilst the questionnaire has been previously validated for single session recall of training duration and intensity, it must be considered that it is currently unknown how the presence of multiple sessions within a 24-hour window influences the accuracy of individual session recall. Participants were instructed to complete the questionnaire using a suitable device (e.g. mobile phone, electronic tablet, computer) in isolation to avoid external influence on selection.

The questionnaire allowed participants to choose from the following sporting activities; 'club-match', 'club-technical training session', 'club-resistance training, 'school-match', 'school-technical training session', 'school-resistance training'. After selecting the appropriate training/match activity, participants were required to report the duration of the training session or match to the nearest minute before specifying the intensity of the session by selecting the appropriate text descriptor on a modified Borg category ratio-10 (CR-10) scale (9). The session duration was then multiplied by the intensity rating corresponding to the selected text descriptor on the CR-10 scale to provide a sRPE load value in arbitrary units (AU).

Data were filtered on a daily basis by the research team to detect any potential participant errors which may have occurred during the completion of the questionnaire. Should a potential error arise, the corresponding participant was asked to clarify their questionnaire response with the data subsequently left unchanged, modified or discarded. Responses had to be collected within 24 hours (assessed via the time-stamp associated with the response available on the web-based questionnaire), any responses outside of this period were deemed invalid and discarded (29). Following the completion of the data collection period, questionnaire responses were separated based on playing standard for analysis. Data were separated into academic terms and only full training weeks (i.e., Monday to Sunday) were considered for analysis of training/match frequency. Participants were required to have completed full training weeks for at least 50% of the possible weeks available for a specific term, other than term 5 where participants were required to have completed a minimum of 4

full training weeks. Table 1 shows the number of full training weeks collected for representative and non-representative athletes for each term. Table 2 displays the number of sessions collected during each term for each training/match activity for representative and non-representative athletes respectively.

Statistical analyses

Participants were grouped into playing standard with mean weekly frequencies and mean sRPE loads of each training/match activity calculated for each participant during each time point. Variability in weekly training loads for representative/non-representative athletes was calculated by establishing a coefficient of variation (CV) for each athlete at each term. The mean CV and CV range was then calculated for each playing standard. A Shapiro-Wilks test was conducted to assess data distribution. As the data did not fit a normal distribution, Mann-Whitney U tests were conducted to establish significant differences between playing standards for mean weekly frequency and mean sRPE loads for each training/match activity. Prior to Mann-Whitney U tests, a Levene's median-based homogeneity of variance test was performed on the data to ensure the assumptions of the Mann-Whitney U test were met. Alpha levels were set at the 95% level of statistical significance. To calculate effect sizes, the Z score obtained from the Mann-Whitney U test was divided by the square root of the number of participants. The magnitude of the effect was classified per the following thresholds; r= 0.20-0.49 *small*, 0.50-0.79 *moderate*, >0.80 *large*. Statistical analyses were carried out using the SPSS statistical analysis software for mac (version 24.0, SPSS Inc., Chicago, IL, USA).

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RESULTS

Figure 1 displays the mean (± SD) weekly frequency and mean sRPE loads for each club and school training/match activity for both representative and non-representative athletes across each of the school terms. Table 3 displays the Mann-Whitney U score, effect size and statistical significance of differences between representative and non-representative athletes for mean weekly frequency and mean sRPE loads for school and club training/matches during each term. Table 4 displays the coefficient of variation of weekly training loads for representative/non-representative athletes across each term.

Term 1

A *moderate* significant difference was found between playing standards for school match frequency (sessions per week) (mean ± SD) (representative 0.5 ± 0.3; non-representative 0.8 ± 0.2). *Small* non-significant differences were found for club match (representative 0.6 ± 0.4; non-representative 0.4 ± 0.4) & club technical training frequency (representative 0.5 ± 0.5; non-representative 0.4 ± 0.3). Differences in school resistance training frequency did not significantly differ between playing standards with the effect size <0.20. There was a *small* non-significant difference in mean sRPE load for club technical training (AU) (representative 337 ± 98; non-representative 166 ± 119). Differences in mean sRPE load for school technical/resistance training and school/club match play were not significant and effect sizes were <0.20.

Term 2

Small significant differences for club technical training (representative 1 ± 1; non-representative 0.4 ± 0.3) and club match frequency (representative 0.8 ± 0.6; non-representative 0.3 ± 0.3) were found between playing standards. School technical/resistance training and match play did not significantly differ between playing standards with effect sizes

<.20. Differences for all club/school training/match activities did not significantly differ between playing standards with effect sizes <0.20.

Term 3

Moderate significant differences were found for club match (representative 1.3 ± 0.3; non-representative 0.4 ± 0.4) and club technical training frequency (representative 1.3 ± 0.6; non-representative 0.3 ± 0.2), whilst differences in school technical training frequency between playing standards were *small* but not significant (representative 2.1 ± 1.4; non-representative 2.6 ± 1.1). Differences for school match and resistance training frequency were not significant with effect sizes <0.20. A *small* non-significant difference in mean sRPE load was found for club technical training (representative 346 ± 115; non-representative 270 ± 96). Differences in school technical/resistance training and school/club match play were not significant with effect sizes <0.20.

Term 4

There were *moderate* and *small* significant differences for club technical training (representative 1.2 ± 1.0; non-representative 0.1 ± 0.1) and club matches (representative 0.8 ± 0.4; non-representative 0.3 ± 0.2) respectively. There was a *small* non-significant difference in school resistance training (representative 2.2 ± 0.2; non-representative 1.7 ± 0.8). No significant differences were found for school technical training and match play with effect sizes <0.20. There were *small* non-significant differences in mean sRPE load for club (representative 393 ± 193; non-representative 373 ± 14) and school technical training (representative 255 ± 109; non-representative 219 ± 111). Differences for school/club match play and school resistance training were not significant with effect sizes <0.20.

Term 5

A *moderate* significant difference was found between playing standards for club technical training frequency (representative 0.7 ± 0.5; non-representative 0.2 ± 0.1). Additionally, *small* non-significant differences were found for club match play (representative 0.6 ± 0.5; non-representative 0.2 ± 0.2) and school technical training frequency (representative 1.6 ± 0.8; non-representative 1.9 ± 0.8). The difference for school resistance training frequency was not significant with an effect size <0.20. *Small* non-significant differences were found for school technical training (representative 189 ± 95; non-representative 210 ± 103) and club match (representative 370 ± 124; non-representative 301 ± 59) mean sRPE load. There was a *moderate* non-significant difference for club technical training mean sRPE load (representative 357 ± 135; non-representative 276 ± 250) whilst the difference in mean sRPE load for school resistance training was not significant with the effect size <0.20.

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DISCUSSION

The study provides novel information identifying and comparing the mean weekly frequency and load of different sporting activities which comprise representative and non-representative late adolescent athletes sporting schedules. The main finding of the study is that players of a higher standard participate in more frequent training and matches outside of school than their non-representative counterparts however the sRPE load of these activities do not significantly differ between playing standards. As such, practitioners working with representative youth athletes should be cognizant of the athlete's training/match schedule, to plan and adjust the sporting activities that they participate inside of school, and vice versa.

The frequency of club training/match activities were similar between playing standards during term 1 (September-October), likely due to academy, county or international team training not commencing until later in the term. However, from November to March (terms 2, 3 & 4), there were *small* to *moderate* differences between playing standards as representative athletes participated in significantly more club training and matches than non-representative athletes. Literature has shown a greater exposure to practice enhances skill development (7,32) as well as differentiating between playing standards in team sport athletes (7). Alongside the increased frequency of training, representative players will likely experience a higher standard of coaching. Previous research has suggested a differentiation between recreational and elite level coaches with elite level coaches often not coaching at recreational levels (6). Furthermore, high level organizations such as sporting academies require coaches to possess higher level qualifications and coaching licenses with coach education an essential prerequisite for elite level coaches (6). Therefore, the increased frequency of training undertaken by representative athletes in the presence of qualified coaches may facilitate their sporting development, widening the difference in skill level between playing standards.

Conversely, whilst increased training may enhance skill development, excess training and match exposure without the presence of adequate recovery may predispose the athlete to a maladaptive training response (5,16). Whilst no significant differences were found between playing standards for mean sRPE loads of each training/match activity, representative club training/matches had a higher sRPE load than school training/matches throughout the entire school year, reiterating the findings of previous research in elite youth rugby union (24,28). Therefore, the increased frequency of more demanding club training/matches may expose athletes competing at a high standard to a greater accumulation of fatigue, particularly throughout November to March.

The time commitments required by simultaneous educational and sporting pursuits is another key contributor in the accumulation of fatigue (4). Whilst fatigue can impair sporting performance, of equal importance is the negative impact it may have on athlete education. Student-athletes reported fatigue, induced through sporting commitments as a key stressor,

hampering ability to focus during class as well as restricting the athletes time to complete assignments (4). The difficulty in balancing school and sporting commitments can lead to athletes prioritizing education or sport with success in one venture coming at the expense of the other (3,19). Student athletes who prioritize education and reduce sporting commitments sacrifice the aforementioned benefits of increased sports training, jeopardizing future sporting attainment. On the other hand, prioritizing sports training at the expense of education may limit future study opportunities, holding implications for athletes future careers, with career uncertainty leaving athletes vulnerable to anxiety (14). Therefore,
future research quantifying late adolescent training loads should record periods of high academic stress (e.g. exam periods/coursework deadlines) to establish the influence of academic stress on sRPE load and subsequent fatigue.

Periods of frequent and/or intensified training are required to promote physical adaption and develop the technical and tactical skills of the athlete whilst the sporting calendar dictates athletes may be required to play multiple matches per week. During periods of increased training/match frequency, school and club coaches must work together and provide flexibility within their program to ensure athletes are provided with sufficient time to complete schoolwork and dissipate fatigue. Failure to run sporting programs cooperatively may not only impair the performance from a sporting context but also harm the athlete from an educational and social standpoint (4). Therefore, all coaches working with student athletes should collaborate with each other, academic staff and the athlete to gain an understanding of the athlete's academic load and build a developmental pathway allowing the athlete to cope with the demands of both sports training and school.

The importance of collaboration is highlighted by the large variability in weekly training load identified for both representative/non-representative athletes across all 5 terms (table 4). The large CV's for both playing standards are consistent with previous research (26) which demonstrated highly variable (CV=37%) within-athlete weekly training loads in late adolescent rugby union players. Weekly fluctuations in sRPE load are expected coinciding with the coach's periodized program however increases <10% have been suggested to minimize injury

risk, highlighting the need to reduce the substantial within-athlete variability. Whilst the need to reduce weekly load variability is clear, it is a complex task and must be considered on an individual level. Unique athlete characteristics such as fatigue and fitness (10) influence internal response, meaning perceptions of session intensity may vary throughout a squad despite individuals participating in the same training session. Furthermore, previous research has demonstrated a discord between the coaches intended/perceived sRPE load and the athletes perceived sRPE load (2,30) emphasising the importance of monitoring athlete sRPE load on an individual basis to account for within squad variations. Therefore, by monitoring individual responses to training and matches, practitioners can reflect on an athlete sRPE load and modify training weeks accordingly to reduce the variability in weekly load and provide recovery for athletes with a higher than intended sRPE load or additional training for athletes with a lower than intended sRPE load.

This study provides important information to club and school coaches alike regarding the frequency and mean load of training/match activities which comprise representative and non-representative sports schedules. However, as participant numbers were limited to 18 representative and 18 non-representative athletes, differences in training/match frequency and mean load could not be assessed between sports and is therefore a suggestion for future research.

PRACTICAL APPLICATIONS

Despite mean sRPE load for school and club training/matches not significantly differing between playing standards, within-athlete weekly sRPE load is highly variable for representative/non-representative athletes. Furthermore, the increased frequency of training occurring outside of school increases the training load of representative athletes in comparison to their non-representative counterparts. Therefore, whilst particularly important for coaches working with representative athletes, it is necessary for coaches of all playing standards to set up communication channels with the athlete and various stakeholders to monitor the highly variable weekly training loads. Communication channels will allow

collaboration between stakeholders, the athlete and/or the athletes parents, and in turn, allow coaches to plan and structure training around more/less demanding periods of training, competition and academia. Additionally, coaches should obtain sRPE load on an individual basis within a 24-hour window to assess athlete response to training and ensure the athletes sRPE load is in-keeping with the training plan. If necessary, the coach may adapt the training program to restrict/increase training load and promote positive adaptions to training such as skill and physical development whilst avoiding maladaptive responses such as overuse injury and non-functional overreaching.

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Table 1; The amount of full training weeks collected for representative and non-representative athletes for each term with mean ± SD for each athlete

Representative	**Term 1** ***(6 weeks)***	**Term 2** ***(6 weeks)***	**Term 3** ***(4 weeks)***	**Term 4** ***(4 weeks)***	**Term 5** ***(7 weeks)***
Total training weeks (All athletes combined)	53	75	41	35	69
Training weeks per athlete	3 ± 2	4 ± 2	2 ± 2	2 ± 2	4 ± 3
Non-Representative					
Total training weeks (All athletes combined)	47	68	34	28	51
Training weeks per athlete	3 ± 2	4 ± 2	2 ± 2	2 ± 2	3 ± 3

Table 2; The total number of sessions (mean ± SD sessions per athlete) collected during each term for each training/match activity

	Term	Club Match	Club Technical Sessions	Club Resistance Training	School Match	School Technical Sessions	School Resistance Training
Representative (n=18)	**1** *(6 weeks)*	41 (2 ± 3)	36 (2 ± 3)	12 (1 ± 1)	41 (2 ± 1)	226 (13 ± 7)	139 (8 ± 3)
	2 *(6 weeks)*	72 (4 ± 3)	103 (6 ± 5)	26 (1 ± 2)	59 (3 ± 1)	240 (13 ± 6)	188 (10 ± 4)
	3 *(4 weeks)*	62 (3 ± 3)	66 (4 ± 4)	21 (1 ± 2)	52 (3 ± 2)	129 (7 ± 5)	80 (4 ± 4)
	4 *(4 weeks)*	35 (2 ± 2)	48 (3 ± 3)	13 (1 ± 2)	17 (1 ± 1)	137 (8 ± 5)	106 (6 ± 3)
	5 *(7 weeks)*	53 (3 ± 3)	66 (4 ± 4)	24 (1 ± 2)	0 (0)	153 (9 ± 6)	209 (12 ± 7)
Non-Representative (n=18)	**1** *(6 weeks)*	27 (1 ± 2)	17 (1 ± 2)		58 (3 ± 2)	229 (11 ± 7)	120 (6 ± 4)
	2 *(6 weeks)*	34 (2 ± 3)	43 (2 ± 3)		76 (4 ± 3)	262 (13 ± 7)	203 (10 ± 4)
	3 *(4 weeks)*	26 (1 ± 2)	22 (1 ± 2)		43 (2 ± 2)	151 (7 ± 6)	82 (4 ± 3)
	4 *(4 weeks)*	14 (1 ± 1)	10 (1 ± 1)		21 (1 ± 1)	142 (7 ± 5)	94 (5 ± 3)
	5 *(7 weeks)*	18 (1 ± 2)	13 (1 ± 1)		0 (0)	159 (8 ± 6)	175 (8 ± 6)

Table 3; The Mann-Whitney U score, effect size and statistical significance of differences in school and club training/match mean weekly frequency and mean sRPE load between representative and non-representative athletes during each term

		Term 1		Term 2		Term 3		Term 4		Term 5	
		Frequency	Mean Load	Frequency	Mean Load	Frequency	Mean Load	Frequency	Mean Load	Frequency	Mean Load
School technical training	*Mann-Whitney U*	62.0	168.0	102.0	162.0	38	136.0	38.0	96.0	39.5	96.5
	Effect Size	0.10	0.01	0.16	0.04	0.31	0.00	0.12	0.24	0.22	0.23
	Significance	p = 0.54	p = 0.93	p = 0.36	p = 0.78	p = 0.15	p = 0.87	p = 0.53	p = 0.22	p = 0.28	p = 0.48
School resistance	*Mann-Whitney U*	59.5	139.5	125.5	123.0	58.5	123.0	28.0	117.0	58.0	152.0
	Effect Size	0.18	0.16	0.03	0.16	0.02	0.03	0.35	0.12	0.03	0.06
	Significance	p = 0.38	p = 0.34	p = 0.99	p = 0.32	p = 0.92	p = 0.91	p = 0.12	p = 0.46	p = 0.90	p = 0.97
School match	*Mann-Whitney U*	27.0	124.5	105.5	160.0	47.5	96.0	37.5	57.0	N/A	N/A
	Effect Size	0.55	0.12	0.14	0.11	0.18	0.02	0.18	0.11	N/A	N/A
	Significance	p = 0.01*	p = 0.49	p = 0.43	p = 0.95	p = 0.40	p = 0.79	p = 0.41	p = 0.42	N/A	N/A
Club technical training	*Mann-Whitney U*	54.5	13.0	64.0	54.0	6.5	36.0	13.5	9.0	21.0	0.14
	Effect Size	0.26	0.43	0.43	0.03	0.78	0.24	0.63	0.42	0.56	56
	Significance	p = 0.21	p = 0.25	p = 0.02*	p = 0.89	p < 0.01*	p = 0.38	p = 0.01*	p = 0.12	p = 0.01*	p = 0.48
Club match	*Mann-Whitney U*	51.5	64.5	73.5	45.0	7.5	62.0	23.0	30.0	34.0	23.0
	Effect Size	0.27	0.08	0.36	0.15	0.75	0.04	0.44	0.07	0.38	0.28
	Significance	p = 0.19	p = 0.69	p = 0.04*	p = 0.46	p < 0.01*	p = 0.68	p = 0.05*	p = 0.85	p = 0.08	p = 0.19

*Denotes a statistically significant difference

Table 4; The coefficient of variation (mean CV%; CV range) of weekly training loads for representative/non-representative athletes across each term

Playing standard	Term 1	Term 2	Term 3	Term 4	Term 5
Representative	36; 7-79	27; 16-62	30; 11-59	29; 13-52	31; 3-61
Non-representative	36; 19-65	29; 12-70	35; 10-64	30; 7-51	33; 12-78

FIGURE CAPTIONS

Figure 1; Mean (± SD) of weekly frequency & sRPE load for club & school training/matches for representative and non-representative athletes across terms 1, 2, 3, 4 & 5

A = term 1, B= term 2, C= term 3, D= term 4, E= term 5