Physical fitness improvements of 8-week light vs. heavy tyre flip training in young adults

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ABSTRACT: This study compared the effects of eight-week tyre flipping training intervention using light and heavy tyres on physical fitness performance. Twenty-nine young physically active males were divided into light (n = 15) and heavy (n = 14) tyre flipping groups evenly according to body weight and height. Body-to-tyre weight ratios were 0.61 ± 0.06 for the light tyre (LTTG) and 1.51 ± 0.16 for the heavy tyre training (HTTG) groups. Fitness parameters were measured before and after the intervention. One-way ANCOVA analysis indicated no significant between-group differences when pre-test values were controlled. Both groups demonstrated within-group improvements in 6RM bench press (ES: 0.98 in LTTG and 1.10 in HTTG), intermittent endurance (ES: 0.45 in LTTG and 0.66 in HTTG), five horizontal jumps (ES: 0.35 in LTTG and 0.26 in HTTG), and agility (ES: 0.34 in LTTG and 0.41 in HTTG). Both groups improved tyre flipping efficiency, through decreasing average set duration and work-rest ratios in the first six training sessions, and reached a plateau starting from the 7th training session. This study provides the first empirical evidence for coaches to justify usage of tyre flip training and the timing to progressive overload for a population with limited weight training and no tyre flip training experience.

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INTRODUCTION

Strongman exercises and equipment have gained increasing popularity with strength and conditioning (S&C) coaches due to being versatile and inexpensive [1, 2, 3]. Winwood et al. [4] surveyed 220 S&C coaches on their professional practice, in which 193 reported using strongman implements, with the most commonly used equipment being tyres, sleds, ropes, kettlebells, sandbags and farmer's walk bars. Justifications for using strongman equipment were for anaerobic and metabolic conditioning, and strength, power and muscular endurance development. Literature suggests that strongman training also increases muscular hypertrophy [4, 5], creates high caloric expenditure [6], provides an unstable and awkward resistance [2, 7], and increased adherence to training programmes [3].

It has been suggested that strongman exercises can be more functional compared to traditional gym-based resistance and power exercises, as they mimic natural sporting and human movements, incorporating both unilateral and horizontal actions [7]. The tyre flip (TF) is a unique exercise requiring rapid triple extension to perform a vertico-horizontal movement, while anteroposterior forces are applied to the body [7]. According to the force-vector theory performing exercises that combine both vertical and horizontal force production such as the tyre flip may be more beneficial than completing only vertically orientated exercises such as Olympic Weightlifting, particularly for developing sporting movements such as acceleration [8, 9].

To perform the TF technique an athlete is required to flip a flat lying tyre end to end for a specific distance or number of repetitions [7]. Referring to the Winwood et al. [4] survey, 98 respondents stated that they used the TF exercise to train their athletes, with the main reasons being to develop endurance, metabolic conditioning, strength, and power. Interestingly, 78% of coaches wanted the TF performed using an explosive drive from low down into rapid triple extension, where prescribed weights were approximately x1 bodyweight for speed, x2 bodyweight for power and x3 bodyweight for strength [4]. S&C coaches also reported using a broad range of repetitions (7.2 ± 4.6), distances (18 ± 7.6 m), durations (63.4 ± 46.1 s), sets (4 ± 2), loads (151.1 ± 74.6 kg, or 63.6 ± 21.2% 1RM), and inter-set rest periods (107 ± 58 s) for TF exercise. Although S&C coaches manipulate many parameters of the TF exercise to obtain a desired outcome, there is no empirical research to date showing the effects of TF training or outcomes of using different tyre weights.

A number of studies have researched the effects of strongman training on: muscle activation [2]; hormonal changes [5]; acute physiological responses [10]; relationships between strength, anthropometrics and strongman performance [11]; injury epidemiology [12]; and comparison of strongman vs. traditional resistance training on muscular function and performance [4]. However, to the authors' knowledge, only Keogh et al. [7] have solely focused on TF; they assessed the biomechanics, acute physiological stressors, and temporal components of the exercise. However, these cross-sectional (i.e., acute) physiological results cannot accurately reflect the longitudinal training effects solely from TF.

Considering the lack of research and limited evidence of the physiological and performance benefits of TF training, this study aimed to assess the effects of an eight-week TF training intervention using light and heavy tyres on physical fitness. The results of this study can provide an S&C coach's evidence for justifying the use of TF training and prescribing lighter or heavier tyre loads.

MATERIALS AND METHODS

Experimental Approach to the Problem

An eight-week TF training intervention was conducted to examine physical fitness changes in participants, who were grouped into a light tyre training group (LTTG) (n = 15, age = 20.64 ± 1.60 years, body weight = 69.79 ± 7.66 kg, height = 179.91 ± 5.52 cm) or heavy tyre training group (HTTG) (n = 14, age = 20.53 ± 1.77 years, weight = 70.72 ± 7.14 kg, height = 178.09 ± 4.55 cm) evenly according to body weight and height. Body to tyre weight ratios were 0.61 ± 0.06 for the LTTG (tyre weight = 43 kg, diameter = 98.2 cm, thickness = 23.0 cm) and 1.51 ± 0.16 for the HTTG (tyre weight = 104 kg, diameter = 131.5 cm, thickness = 51.5 cm) group. TF training sessions were conducted twice per week, with 72-hour recovery between sessions. Before and after the eight-week intervention, participants conducted pre- and post-tests to assess physical fitness, conducted during the same time of day to minimize the circadian effects. Participants were instructed not to participate in any form of high intensity exercise during the studied period.

Participants

Twenty-nine young physically active males volunteered for this study. They had limited weight training and no TF experience, no history of cardiovascular disease or injuries within 3 months prior to the study. Participants conducted a standardized whole body dynamic warm up prior to all TF training, and static stretching after each training session. Training sessions for both groups consisted of 4 sets of 6 TFs with five minutes' rest between sets, twice a week. Verbal encouragement and technique correction were provided during training. Time used by each participant to complete one set was measured by stopwatch and recorded for analysis. TF techniques were standardised by instructing participants to complete the TF as quickly as possible, using the following techniques. LTTG: 1) squat down behind the tyre with arms fully extended, using a supinated grip to hook underneath the tyre, 2) perform rapid triple extension through the ankle, knee and hip joints while pushing the tyre up and forward, completing the lift in one movement. Heavy tyre training group (HTTG): 1) kneel behind the tyre and rest the chin and deltoids on it, 2) use a supinated grip to hook underneath the tyre with arms fully extended, 3) dorsiflex ankles while coming onto the balls of the feet and raising the knees off the ground, 4) perform rapid triple extension through the ankle, knee and hip joints then step in towards the tyre, 5) flex the hip and strike the tyre with the quadriceps of the lead leg and flip hands to a pronated grip, 6) continue to move into the tyre and push over to complete the flip [1]. Ethical approval was obtained from the University Human Ethics Committee, and all participants provided written informed consent before the study commenced.

Procedures

Height, body weight and body composition were examined using height and weight measuring scales and a bioelectrical impedance analyser (Inbody 370, Inbody, Korea). Following familiarisation of procedures, participants completed physical fitness tests over two days during both pre- and post-test. Day 1: explosive power (five horizontal jump test), strength (handgrip test and 6RM bench press), and intermittent endurance (Yo-Yo intermittent endurance test-level 1). Day 2: agility (T-test), speed (20 m sprint) and speed endurance (six 20 m repeated sprints).

During the handgrip strength test, participants held an electronic handgrip dynamometer (WCS-100, Shanghai Yi Lian Medicine Ltd, China) in the right hand, with the handle adjusted to hand size to optimise handgrip. While standing erect with hands beside but not touching the torso, participants squeezed the dynamometer to perform a 5-second maximum isometric effort. The highest handgrip strength reading was taken from two trials.

The bench press test protocol was adopted from Wong et al. [13], with two warm-up sets of 8 repetitions at 65%-75% of participants' perceived maximum bench press loads prescribed. Two-kilogram increments were added until participants failed to complete 6 repetitions with proper technique, in no more than 6 total sets. A five-minute rest was provided between trials.

The five horizontal jump test required participants to perform five consecutive alternating strides with feet together at the start of the first stride and landing of the final stride [14]. A three-minute rest was provided between trials and the average value of the two best results was taken from three trials.

The Yo-Yo Intermittent Endurance Test (Level 1) required participants to perform two repeated 20-metre runs back and forth at progressively increased speeds controlled by audio bleeps from a tape recorder, with a maximum distance of 4320 m. The maximum distance covered was recorded as the test result [15].

Using a 10 x 10 m course in the agility T-test [16], participants' times were recorded by timing gates (Brower Timing System, Brower, USA) placed at the start and finish line. Participants started with the front foot 30 cm behind the start line, and then ran forward to the centre cone, sidestepped right 5 m to the right cone, sidestepped left 10 m to the left cone, sidestepped right 5 m back to the centre cone, and then ran backwards over the finishing line. A three-minute rest was provided between trials and the fastest time of three trials was taken.

To assess sprint performance, participants were instructed to perform a 25-metre sprint from a standing start. Timing gates were positioned 0.4 m apart at 0 m, 10 m, and 20 m distance from the starting point. Participants started with the front foot 30 cm behind the start line and were instructed to sprint the to the 25 m marker to ensure they did not decelerate through the timing gate positioned at 20 m. A three-minute rest was provided between trials and the fastest time (to the nearest 0.01 s) was taken from 3 trials.

To assess repeated sprint ability (RSA) participants were instructed to perform six 20-meter repeated sprints. Timing gates were positioned 0.4 m apart at 0 m and 20 m. Each sprint was separated with 25-second active recovery, used to return to the starting line, and a 5-second reminder was given before the next sprint. All sprint times were recorded [17].

Statistical Analyses

Descriptive statistics (mean ± standard deviation) were calculated for all anthropometric and dependent variables. Within-group differences between the LTTG and HTTG for pre- and post-test measures were analysed using the paired sample t-test, percentage change, and 95% confidence interval of mean differences. Within-group differences were determined using effect size (Cohen's *d*). Effect size

TABLE 1. Descriptive statistics of anthropometric measures for Heavy and Light Tyre groups.

	Light Tire Group (Pre-test)	Light Tire Group (Post-test)	Heavy Tire Group (Pre-test)	Heavy Tire Group (Post-test)	Between-group comparison (ANCOVA)
Height (cm)	178.09 ± 4.55	177.99 ± 4.58	179.91 ± 5.52	179.77 ± 5.47	F = 0.01, p = 0.92
Body weight (kg)	70.72 ± 7.14	70.72 ± 7.21	69.79 ± 7.66	70.77 ± 7.46	F = 2.50, p = 0.13
Body fat Mass (kg)	12.07 ± 3.55	12.13 ± 3.80	11.17 ± 5.10	11.51 ± 4.91	F = 0.17, p = 0.69
Percent body fat (%)	16.78 ± 3.75	16.96 ± 4.31	15.51 ± 5.65	15.89 ± 5.63	F = 0.05, p = 0.82
Muscle mass (kg)	55.66 ± 4.73	55.29 ± 5.10	55.46 ± 4.01	56.02 ± 4.31	F = 3.81, p = 0.06

Note: Data expressed as mean ± SD, [a] Significant difference at $p < 0.05$.

TABLE 2. Comparisons of pre- and post-test results of Light Tyre group.

	Pre-test	Post-test	Percentage change [± post-pre/ pre]*100	95%CI of mean difference	Pre vs. post effect size
Hand grip strength ± kg	48.33 ± 6.15	47.73 ± 5.06	-0.51 ± 10.86	-3.32; 2.12	-0.13
6RM bench press (kg)	50.36 ± 6.85	54.29 ± 8.96 [a]	7.67 ± 7.87	1.61; 6.24	0.98***
Five horizontal jump test (m)	12.28 ± 0.71	12.40 ± 0.80	1.01 ± 2.81	-0.08; 0.32	0.35*
YYIET-level 1 (m)	2328.57 ± 641.19	2577.14 ± 725.06	10.6 ± 23.8	-67.34; 564.48	0.45*
Agility T-test (s)	10.22 ± 0.54	10.09 ± 0.45	-1.18 ± 4.07	-0.37; 0.11	0.34*
20-m sprint time (s)					
0 to 10m	1.81 ± 0.06	1.81 ± 0.05	0.07 ± 3.32	-0.03; 0.03	0
10 to 20m	1.29 ± 0.05	1.30 ± 0.06	1.17 ± 3.11	-0.01; 0.04	-0.24*
0 to 20m	3.10 ± 0.08	3.11 ± 0.08	0.51 ± 2.25	-0.03; 0.06	-0.15
Repeated-sprint ability					
fastest time (s)	3.16 ± 0.12	3.14 ± 0.08	-0.41 ± 2.40	-0.06; 0.03	0.26*
average time (s)	3.25 ± 0.13	3.23 ± 0.09	-0.54 ± 2.33	-0.07; 0.03	0.25*
total time (s)	19.50 ± 0.79	19.38 ± 0.54	-0.54 ± 2.33	-0.40; 0.17	0.24*
%decrement	2.97 ± 1.18	2.84 ± 1.24	-0.32 ± 38.63	-0.90; 0.63	0.10

Note: Data expressed as mean ± SD, * = small effect; ** = moderate effect; *** = large effect; [a] Significant difference between pre- and post-test at $p < 0.05$.

values of 0-0.19, 0.20-0.49, 0.50-0.79 and 0.8 and above represented trivial, small, medium and large differences, respectively [18]. Between-group comparisons were analysed using one-way ANCOVA with pre-test data being the covariates. Statistical significance was set at $p < 0.05$ and calculations were carried out using SPSS software (IBM SPSS Statistics 25 for Windows, Armonk, NY: IBM Corp.).

RESULTS

Descriptive statistics for pre- and post-eight weeks of TF training for both groups are presented in Table 1. The results indicated that no significant differences were observed between groups for body height, body weight, body fat mass, percentage of body fat, and muscle mass.

Participants from both groups improved their ability to perform the TF exercise, indicated by a decreased average time to complete each set of training and average work-rest ratios (Figure 1a and Figure 1b). The LTTG in the first training session took on average 15.6 ± 4.8 s to complete each set with a work-rest ratio of 1:19, plateauing after the 7th session to 10.2 ± 1.4 s and 1:29. The HTTG in the first training session took on average 28.3 ± 5.5 s to complete each set with a work-rest ratio of 1:11, plateauing after the 7th training session to 17.6 ± 2.1 s and 1:17.

After eight weeks of light TF training, a significant and large within-group improvement was observed in 6RM bench press (ES: 0.98, $p < 0.05$, Table 2), a small improvement in intermittent endurance (ES: 0.45, $p > 0.05$), five horizontal jumps (ES: 0.35, $p > 0.05$), agility (ES: 0.34, $p > 0.05$) and fastest (ES: 0.26, $p > 0.05$), average (ES: 0.25, $p > 0.05$), and total time (ES: 0.24, $p > 0.05$) for repeated sprint ability (RSA). A small negative effect was found on 10-20 m sprint time (ES: -0.24, $p > 0.05$).

After eight weeks of heavy tyre training, a significant and large within-group improvement was observed in 6RM bench press (ES: 1.10, $p < 0.05$, Table 3), a significant and moderate improvement in intermittent endurance (ES: 0.66, $p < 0.05$), small improvement in agility (ES: 0.41, $p > 0.05$), five horizontal jumps (ES: 0.26, $p > 0.05$) and 10-20 m sprint time (ES: 0.21, $p > 0.05$).

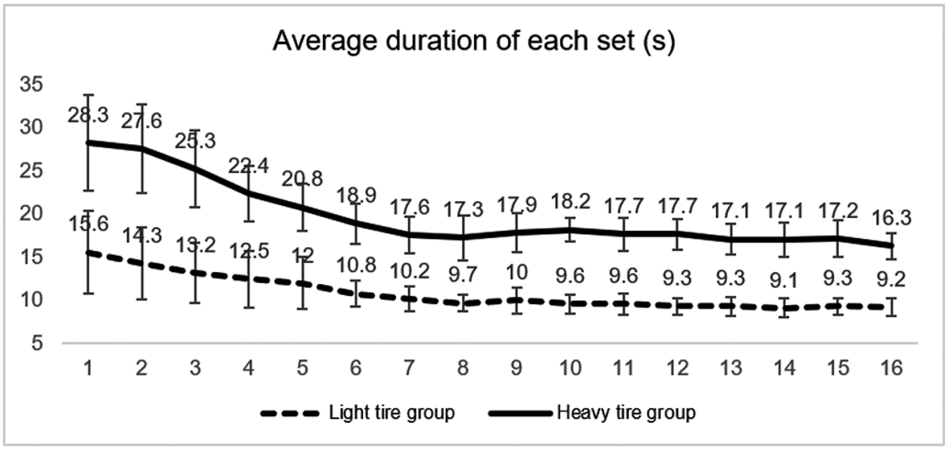

FIG. 1a. Actual duration of each training set across the 16 training sessions.

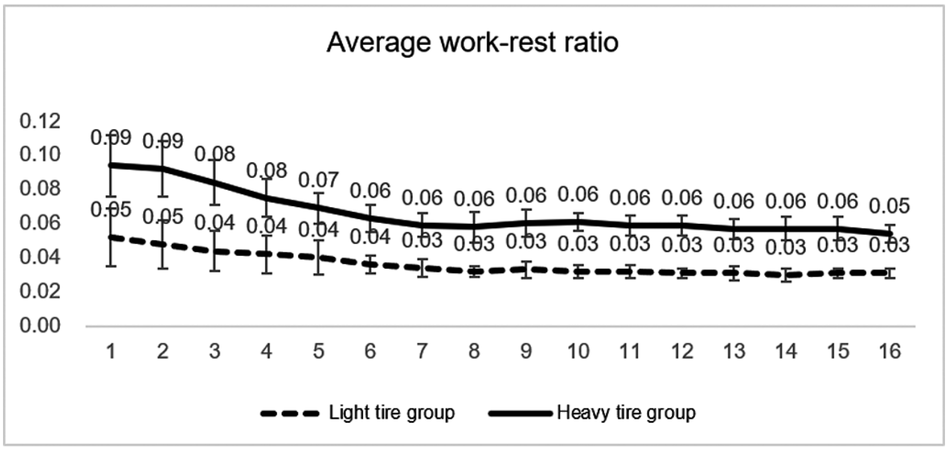

FIG. 1b. Actual work-to-rest ratio of each set across the 16 training sessions.

TABLE 3. Comparisons of pre- and post-test results of Heavy Tyre group.

	Pre-test	Post-test	Percentage change [± post-pre)/ pre]*100	95%CI of mean difference	Pre vs. post effect size
Hand grip strength ± kg)	50.07 ± 5.42	50.04 ± 6.87	-0.10 ± 9.18	-2.49; 2.42	-0.01
6RM bench press (kg)	48.17 ± 8.99	53.67 ± 7.49 [a]	13.13 ± 13.08	2.72; 8.28	1.10***
Five horizontal jump test (m)	12.48 ± 0.92	12.59 ± 1.09	0.84 ± 3.45	-0.12; 0.34	0.26*
YYIET-level 1 (m)	2421.33 ± 569.89	2744.00 ± 713.43 [a]	15.0 ± 20.1	52.35; 592.99	0.66**
Agility T-test (s)	10.16 ± 0.40	10.02 ± 0.46	-1.37 ± 3.27	-0.33; 0.04	0.41*
20-m sprint time (s)					
0 to 10m	1.80 ± 0.09	1.81 ± 0.08	0.26 ± 3.26	-0.03; 0.04	-0.17
10 to 20m	1.30 ± 0.06	1.29 ± 0.06	-0.67 ± 3.74	-0.04; 0.02	0.21*
0 to 20m	3.10 ± 0.13	3.10 ± 0.12	-0.14 ± 2.73	-0.05; 0.04	0
Repeated-sprint ability					
fastest time (s)	3.14 ± 0.14	3.15 ± 0.14	0.23 ± 2.40	-0.03; 0.05	-0.14
average time (s)	3.23 ± 0.12	3.23 ± 0.14	-0.04 ± 1.67	-0.03; 0.03	0
total time (s)	19.38 ± 0.74	19.37 ± 0.84	-0.04 ± 1.67	-0.19; 0.18	0.03
%decrement	2.92 ± 1.64	2.65 ± 1.10	9.39 ± 55.46	-1.22; 0.68	0.16

Note: Data expressed as mean ± SD* = small effect; ** = moderate effect; *** = large effect; [a] Significant difference between pre- and post-test at $p < 0.05$.

TABLE 4. Between-group comparison (Light vs. Heavy Tyre groups) with pre-test values being controlled.

	Between-group comparison	Partial Eta Squared
Hand grip strength (kg)	F = 0.39, p = 0.54	0.02
6RM bench press (kg)	F = 0.57, p = 0.46	0.02
Five horizontal jump test (m)	F = 0.03, p = 0.87	0.00
YYIET-level 1 (m)	F = 0.21, p = 0.65	0.01
Agility T-test (s)	F = 0.06, p = 0.81	0.00
20-m sprint time (s)		
0 to 10m	F = 0.01, p = 0.93	0.00
10 to 20m	F = 1.79, p = 0.19	0.06
0 to 20m	F = 0.50, p = 0.49	0.02
Repeated-sprint ability		
fastest time (s)	F = 0.43, p = 0.52	0.02
average time (s)	F = 0.31, p = 0.59	0.01
total time (s)	F = 0.35, p = 0.56	0.01
%decrement	F = 0.17, p = 0.68	0.01

[a] Significant difference at $p < 0.05$.

Results of between-group comparison using one-way ANCOVA are presented in Table 4, where no significant between-group differences were observed for all variables measured after controlling pre-test values.

DISCUSSION

The aim of this study was to compare the effects of an eight-week TF training intervention using light and heavy tyres. To the best of the author's knowledge, this is the first study comparing the longitudinal training effects of light and heavy TF. The results showed no between-group differences among the parameters measured for participants with no prior TF and limited weight training experience.

Participants in this study had limited weight training and no TF experience. Relevant research indicates that participants with no previous training experience often demonstrate accelerated progress and larger inter-subject variability in training responses [19]. This was corroborated by this study, because at the start of the intervention participants took longer to complete each set of TF, and larger standard deviations (SD) and work-rest ratios were observed (Figure 1a and 1b). The reduction in average set duration and work-rest ratios may indicate that participants had neurological and physiological adaptations, while also improving TF efficiency. Literature suggests that short sets with longer rest intervals, as in the LTTG, allows participants to fully restore energy and produce greater muscle power as in the five horizontal jump test, whereas shorter rest intervals as in the HTTG would be of more benefit to develop participants' muscular endurance as in the intermittent endurance test [20]. Therefore, it is important for coaches to observe plateaus in work and rest durations, to apply progressive overload, through increasing work durations or decreasing rest periods to obtain a specific training stimulus.

The present study found no between-group differences and both groups significantly improved upper body strength after eight weeks of TF training, irrespective of tyre weight. This is consistent with a systematic review and meta-analysis of movement velocity in dynamic resistance training, showing that both fast and moderate-slow resistance training can produce similar gains in dynamic muscular strength, regardless of training age and status, which is possibly achieved through different mechanisms, being morphological and neurological adaptations [21]. Performing repetitions at slower movement velocities can produce superior morphological adaptations compared to faster movements, through increased muscular tension and metabolic stress, which are important factors for increasing muscle fibre cross sectional area [22]. On the other hand, performing repetitions at faster movement velocities can produce superior neurological adaptations, through increased muscle activation, motor unit recruitment and firing frequency [23]. In this study, the HTTG showed a superior within-group improvement in 6RM bench press compared to the LTTG (13.13% vs 7.67%), demonstrating a greater increase in maximal strength, which is supported by changes in pre- and post-test muscle mass, where the HTTG increased from 55.46 kg to 56.02 kg, and the LTTG decreased from 55.66 kg to 55.29 kg. Therefore, the TF movement performed with light and heavy tyres, at respectively faster and slower velocities, provided large improvements in upper body strength, but may derive from different mechanisms.

The present study found no between-group difference in intermittent endurance after eight weeks of TF training. However, the HTTG showed medium positive effects compared to small positive effects of LTTG for intermittent endurance. Research suggests that strength training using submaximal to near maximal loads improves running economy and running endurance performance [24]. Most notably, non-strength trained athletes as in this study considerably benefitted from strength training incorporating explosive and reactive elements (e.g. TF), which can improve maximal force, power and reactive strength, attributes associated with improved endurance performance [25]. Furthermore, conducting multi-joint strength training incorporating the lower and upper body can significantly improve Yo-Yo IR1 performance compared to sports training only [26]. Utilising multi-joint dynamic exercises such as the TF that requires high levels of whole-body muscle activation, particularly the core and lower limbs [7], has shown a strong relationship with developing acceleration, stride length and maximum velocity [27]. In terms of percentage change, the superior within-group improvements from the HTTG (15% vs 10.6%) is possibly explained by the higher training load (tyre weight) and training volume (set duration), which may have improved participants' ability to sustain increased levels of repeated high-intensity aerobic workload.

No between-group differences in five horizontal jump performance were observed after eight weeks of TF training. Both light and heavy tyre training demonstrated small positive effects. Research suggests that training whether at high velocity close to maximum power loads or low velocity close to repetition maximum loads can lead to similar increases in high-velocity muscular strength and intramuscular coordination, when the intention to move against the external resistance during training is as fast as possible and in the given direction of intended movement (e.g. vertical/horizontal) [6, 28, 29], which may explain similar improvement between groups in this study. The LTTG improved plyometric performance, which may be due to the weight and dimensions of the tyre, enabling participants to flip the tyre in one quick movement, improving their ability to produce as much force in the shortest possible time period [27]. Furthermore, the technique used and movement specificity of the LTTG more closely mimicked the five horizontal jump test, moving from a squatting position into one continuous fully extended vertical/horizontal movement. By contrast, the weight of the HTTG required participants to perform the movement in stages by flexing the hip and striking the tyre with the quadriceps, then continuing to step forward into the tyre to push it over.

No between-group differences in RSA performance were observed after eight weeks of TF training. However, only LTTG showed small positive within-group improvements for RSA average, fastest and total times. RSA performance is closely related to muscle power [30], in which the LTTG demonstrated greater within-group improvements in five horizontal jump test performance, a valid determinant of lower body power [14]. As mentioned above, the development of lower body power may have derived from the LTTG's more powerful TF technique, shorter set duration and potentially superior neurological adaptations to training. Interestingly, both groups demonstrated similar improvements for agility T-test performance. Traditional measures of agility (total time) may not indicate what component of agility has been performed well, as it requires acceleration, deceleration, change of direction and re-acceleration, and each component could be accounted for independently to provide a more informative assessment of agility performance [31]. The LTTG's greater improvements in RSA but not agility may be because agility has the additional components of deceleration and change of direction. Literature suggests a strong relationship between lower body strength, particularly eccentric strength, and the ability to decelerate from accelerations and sprinting [32]. The LTTG flipped the tyre in one continuous motion, whereas the HTTG performed a knee strike to change hands into a pronated grip; during this phase eccentric forces were exerted on the lower limbs, possibly developing lower body eccentric strength. To test this speculation, it would be interesting for future research to assess whether there is any difference in the groups' ability to accelerate, decelerate, change direction and re-accelerate.

Due to no progressive overload being prescribed to participants in this study, it may have diminished the potential training effects of TF. The Winwood et al. [33] survey showed that S&C coaches prescribed tyre weights based on the purpose of the activity, being; x1 bodyweight for speed, x2 bodyweight for power and x3 bodyweight for strength. However, in this study only two tyre weights were selected, being x0.61 bodyweight for the light tyre and x1.51 bodyweight for the heavy tyre. In order to prescribe heavier loads, training age and ability of participants must be considered.

Specifically, training with a light tyre had similar training effects as training with a heavy tyre in upper body strength, agility, and horizontal explosive power. Although light tyre training had superior within-group training effects on RSA, and heavy tyre training had superior within-group training effects on intermittent endurance, no significant between-group differences were observed when pre-test values of both groups were controlled.

Future research could assess the effects of a tyre with modifiable weights in order to meet the progressive overload needs of each participant, and the effects of TF training on different populations (e.g. athletes or those with TF experience). On the other hand, continuing from McGill's research on muscle activity [2], it would be interesting to measure muscle activity of other sites of the body, to provide a deeper understanding of the magnitude of muscle activity when conducting the TF exercise with different tyre weights at different velocities. It is advised that, due to participants having limited weight training and no TF training experience in this study, using the results with other populations (e.g. athletes) should be done with caution.

CONCLUSIONS

This study provides practitioners with the first evidence for justifying the inclusion of TF in their training programme. The results demonstrated that eight weeks of TF training improved 6RM bench press (large effect), intermittent endurance (small to medium effects), five horizontal jumps (small effect) and agility (small effect), regardless of using light or heavy tyres. S&C coaches may consider using the TF to improve such physical fitness parameters or to supplement traditional training methods. Furthermore, both groups in this study improved their TF efficiency, through decreasing average set durations and work-rest ratios in the first six training sessions and plateaued from the 7th training session. This may be a method to observe and provide informed decisions for S&C coaches to apply individualised progressive overload for participants.

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Conflict of interest

The authors report no conflict of interest.

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