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The Effect of Lower Body Compression Tights on the Running-Based Anaerobic Sprint Test in Young Male Basketball Players

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ABSTRACT

This study aims to assess the influence of lower body compression tights on performance in the Running-Based Anaerobic Sprint Test (RAST) in young male basketball players. Twenty male basketball players participated in the study (age = 16.5±0.5 years, height = 176.8±5.71 cm, weight = 68.5±8.98 kg, basketball experience = 2.35±0.49 years). Players performed the RAST, comprising 6 x 35 m sprints with 10-second intervals, wearing regular shorts or compression tights, with a one-week interval between conditions. Before each test, a 24-hour dietary record was used to calculate the total calorie intake and the percentage of calories from carbohydrates to account for dietary variations. The Hooper Index was used to assess fatigue levels before each test. The RAST, conducted using a Newtest Powertimer photocell (300 Series, Oulu, Finland), determined maximal power (Pmax), minimum power (Pmin), average power (AP), and fatigue index (FI). Perceived exertion after each RAST was assessed using the Borg Scale (20-point system). Paired-samples ttest results showed no statistically significant difference (p>0.05) between the means from the two test sessions. The study suggests that lower body compression tights did not significantly impact RAST performance in young basketball players. Considering the study design, applying it to more experienced players after familiarization sessions with compression tights may yield different results.

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INTRODUCTION

Basketball, a globally popular team sport played by men and women in over 200 countries, holds a significant position in athletics (Garcia et al., 2022; Scanlan et al., 2012). The popularity of basketball derives from high-intensity, short-term acyclic movements performed with the ball (dribbling, passing, shooting, etc.) and without the ball (jumping, sprinting, change of direction, agility, etc.; Gottlieb et al., 2021; Masanovic et al.,2018; Puente et al.,2016).

Gottlieb et al. (2021) stated that many movements in basketball last between six seconds and one minute. Therefore, basketball is marked by periods of intermittent activity, encompassing brief bursts of high intensity and more extended intervals of moderate intensity and recovery (Gottlieb et al., 2021; te Wierike et al., 2014).

Song et al. (2023) reported that basketball players perform an average of 105 high-intensity runs during a match, repeated every 21 seconds and lasting two - six seconds each. Puente et al. (2017) stated that basketball-specific movements, such as jumping and sprinting, are of great importance for scoring. Based on the explanations of Song et al. (2023), Puente et al. (2017), and Attene (2016), it is reported that repeated sprint ability (RSA) should be considered a critical component of physical fitness in team sports like basketball. As defined by Stojanovic et al. (2012, p.375), RSA refers to the capability of executing repeated sprints with minimal recovery. In simpler terms, it denotes the ability to achieve the best possible average sprint performance across a sequence of sprints, each separated by brief recovery periods. Mokou et al. (2016) and Castagna et al. (2008) suggest that the ability to repeat high intensity effort, including sprint and change of direction as in RSA, may be a major determinant of performance in basketball. Like other team sports, basketball players' RSA ability is improved through several training modalities, including maximal strength training, traditional sprint training, plyometric training, and complex training are mostly preferred by coaches (Borges et al., 2016; Buchheit et al., 2010; Ramirez-Campillo et al., 2021; Torres-Torrelo et al., 2018).

Though not current, some researchers suggest that the use of compression garments can increase performance and that compression garments can also be used for regeneration purposes (Driller et al., 2021; Franke et al., 2021; Hooper et al., 2015; Kraemer et al., 1996; Loturco et al., 2016). In one of the pioneering studies in this area, Kraemer et al. (1996) showed that volleyball players displayed improved capacity to maintain power output during a repeated jump test when utilizing compression tights instead of control garments (regular gym shorts). Nevertheless, the maximal jump power in the best attempt remained unaffected by compression. Duffield et al. (2007) reported that neither throwing nor repeated sprint performance was improved by a compression garment in cricket players. Higgins et al. (2009) also reported that compression garments did not affect 20 m sprints and countermovement jumps in netball players. Regarding the potential performance-enhancing effects of compression garments during training or competition, some researchers have suggested that wearing such garments could reduce muscle oscillation, enhance peripheral circulation and venous return, improve blood flow velocity, increase arterial perfusion, alleviate post-exercise muscle soreness, facilitate the clearance of blood lactate and creatine kinase (Davies et al., 2009; Driller et al., 2021; Franke et al., 2021; de Glanville & Hamlin, 2012;). Some of the benefits of power performance have been suggested to be due to improvements in proprioception (Kraemer et al., 1996). Born et al. (2013) asserted that compression garments might enhance proprioception, thereby potentially providing better feedback regarding limb movements' direction, acceleration, and velocity. Some authors argue that the effectiveness of wearing compression garments is more pronounced in endurance/aerobic-based performance or recovery compared to anaerobic and intermittent activities such as jumping, sprinting, agility, change of direction, etc. (Ballmann et al., 2019; Davies et al., 2009; de Glanville & Hamlin, 2012; Driller et al., 2021; Franke et al., 2021).

Therefore, this study aims to evaluate the effectiveness of compression tights on Running-Based Anaerobic Sprint Test (RAST) performance in young male basketball players. The study hypothesizes that the components of the RAST, including maximal power (Pmax), minimum power (Pmin), and average power (AP), will be more significant when the test is performed with compression tights.

METHODS

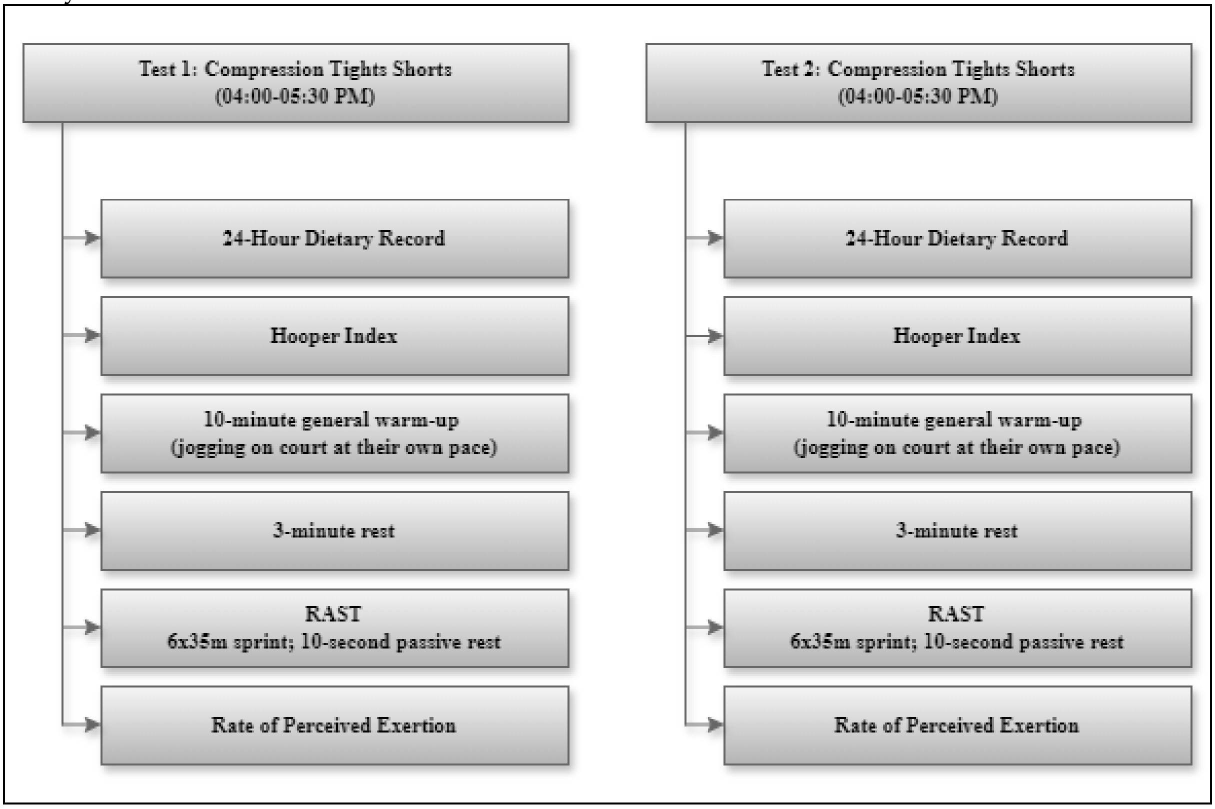
Participant

This study was conducted with the participation of 20 male basketball players who actively play basketball in four different clubs operating in amateur leagues in Istanbul. In sample selection, statistical power was determined using G*Power version 3.1.9.2. In the study by Ballmann et al. (2019), it was determined that the study could be performed with the participation of 20 athletes, considering the perceived rate of exertion scores (control = 7.9±0.6, lower body compression tights = 7.4±0.7; p=0.032), and the effect size d = 0.72 and significance α = 0.05 (statistical power = 0.85). However, considering there may be participant losses for various reasons, 20 people were included in the study. The criteria for inclusion in the study were determined as having at least two years of basketball experience, being between the ages of 16 and 18, having a license for the 2022-2023 basketball season, being healthy following the medical examination required to obtain a basketball license for the 2022-2023 basketball season, and not having an acute musculoskeletal system injury. Our study was approved by the Trakya University Scientific Research Ethics Committee on 12.07.2021 with the protocol number TÜTF-BAEK 2021/321. The study was conducted by the principles of the Declaration of Helsinki.

Procedure

The study was designed as a randomized crossover trial. Participants attended two test sessions between 16:00 and 17:30, one week apart, wearing either normal sports shorts or lower body compression tights. The sessions took place between October 13, 2023, and October 20, 2023, at the Beylerbeyi Sports Club Basketball Court and the Well Club Sports and Life Center Dudullu OSB Basketball Club Court.Before each test, 24-hour dietary record forms were collected from the participants, and their daily calorie intake and the percentage of total calories obtained from carbohydrates were calculated to exclude the effects of nutritional variables on the study results. Applying the Hooper Index before each test session made an attempt to eliminate different results that might be obtained from the two different test sessions due to fatigue in the athletes. Each test session began with a warm-up session consisting of 10 minutes of general warm-up (jogging) and 10 minutes of dynamic stretching, with the athletes performing at their own pace on the basketball court. After the warming-up, the athletes were given three minutes of passive rest before beginning the running-based anaerobic sprint test (RAST). The participants' repeated sprint performances were assessed with the RAST (6 x 35 m, 10 s rest). The RAST test was conducted on a wooden surface. Sprint times were measured with the Newtest Powertimer 300 device during this test. After each test session, the perceived exertion level was evaluated with the Borg Scale (20-point system). Basketball players using supplements (creatine, amino acids, etc.) were excluded from the study. Before each test session, the basketball players were given information on avoiding strenuous physical activities, maintaining regular sleep habits, not changing their eating habits throughout the study, and avoiding excessive caffeine intake 6 hours before the test.

Figure 1
Study Protocol



Body weight measurement

Volunteer athletes' body weight was measured using an electronic scale (Seca 769, Türkiye) while wearing shorts and a T-shirt and without shoes.

Height measurement

Volunteer athletes' height was measured with a mechanical height meter (Seca 769, Türkiye) without shoes, heels together, body upright, and paying attention to the Frankfort horizontal plane.

Assessment of 24-hour dietary intake

Before each test session, basketball players' 24-hour dietary intake was collected using a 24-hour dietary record form. The total calorie intake and the percentage of total calories obtained from carbohydrates were determined using the classical method with the support of a dietician.

Hooper Index

The Hooper index was used for basketball players before each RAST to exclude changes in performance that might result from fatigue. The Hooper index is a test that subjectively assesses athletes' sleep quality, stress levels, fatigue levels, and muscle pain on the day before a test. In evaluating the scale, each question is scored from 1 (very, very low, or good) to 7 (very, very high, or bad), and a high total score from the scale indicates that the athlete is tired (Haddad et al., 2013; Hooper et al., 1995).

Warm-up Session

Each test session began with a 10-minute general warm-up followed by 10 minutes of dynamic stretching exercises. The dynamic stretching session consisted of front kicks and hand reach, side kicks, back kicks, butt kicks, high knee skipping, and walking lunge movements. Each exercise was performed at a rhythm of 80-100 bpm, with 10-second intervals, in an area of 20 m. The tempo of the stretches was determined by an electronic metronome.

Compression Tights

In the study, Mediven Duomed Series CCL2 (Medi GmbH, Bayreuth, Germany) compression tights were utilized. These tights extend from the waist to the ankles and comprise 80% nylon and 20% spandex. They exert a pressure of approximately 15-20 mmHg at the ankle and 6-10 mmHg at the thigh (Ballmann et al., 2019; Şahin et al., 2022).

Figure 2
Appearance of a Compression Thight

Running-Based Anaerobic Sprint Test

The RAST consists of six maximal sprints of 35 m, separated by 10 seconds of passive rest (Zagatto et al., 2009). The RAST provides trainers and athletes with information about maximal (peak) power (Pmax), minimum power (Pmin), average power (AP), and fatigue index (FI) (Draper & Whyte, 1997). The RAST is regarded as an anaerobic power test suitable for sports branches that involve repeated sprints (Zagatto et al., 2009). Zacharogiannis et al. (2004) stated that the RAST can be used instead of the Wingate test to evaluate anaerobic performance in team sports such as basketball and that the RAST has high reliability (r = 0.90) (Balčiūnas et al., 2006). The components of the RAST, namely maximal power (Pmax), minimum power (Pmin), average power (AP), and fatigue index (FI), are determined after formulating the running times obtained after 35 m sprints (Balčiūnas et al., 2006), or automatically by the software of the test equipment used after using the photocell system, as in our study. This study determined 35m sprint times with a photocell (Newtest Powertimer 300-Series, Oulu, Finland) placed at the beginning and end of the 35m distance. The RAST components, Pmax, Pmin, AP, and FI, were calculated automatically using the latest Powertimer software.

As is known, peak power (PP) is defined as the greatest power achieved among the six efforts, mean power (MP) is defined as the average power among the six efforts, and minimum power (Pmin) is defined as the minimum power achieved among the six efforts (Zagatto et al., 2009). On the other hand, two formulas were used for the calculation of Power and FI, as represented below (Santosa et al., 2019; Zagatto et al., 2009).

(P = total body mass × distance2)/time3) and [FI (%) = ((PP – Pmin)/ PP) × 100].

Rate of Perceived Exertion

After the RAST, which was run with both compression tights and normal sports shorts, the degree of exertion perceived by the athletes was assessed with the Borg RPE Scale (6-20).

Borg scale

The degree of exertion perceived by participants is expressed as no exertion (6), extremely light (7-8), very light (9-10), light (11-12), somewhat hard (13-14), hard (15-16), very hard (17-18), extremely hard (19), and maximal exertion (20) (Williams, 2017).

Data Analysis

Statistical analysis of the data in our study was performed with IBM® SPSS® Windows Version 23.0 statistical software package (IBM® Corp., 2016, Armonk, NY). To understand whether the data were normally distributed, in the first step, the difference scores between the data sets obtained during the use of compression tights and normal tights were calculated for each variable. The Shapiro-Wilk test was used to test whether the data set, consisting of the difference scores calculated for the variables whose means were compared using the t-test for related samples, showed a normal distribution (Ak, 2008), and it was determined that all variables were normally distributed (p>0.05). Statistical analysis results are shown in the tables with mean and standard deviation values. To demonstrate the power of the statistical analysis, effect sizes for all relevant tests were included (Geen & Salkind, 2005; Morgan et al., 2004). The statistical significance level was set at p<0.05.

RESULTS

Participants' values for age (years), height (cm), body mass (kg), basketball experience (years) and weekly training frequency (hours/week) are shown in Table 1 with mean and standard deviation values (Table 1). Before each RAST, test performance was evaluated by collecting the Hooper Index and 24-hour dietary record to exclude deviations in test performance that might result from fatigue, total calories consumed, and amount of carbohydrates consumed. The Hooper Index score, the total calories consumed 24 hours ago, and the percentage of calories obtained from carbohydrates are shown in Table 2. Comparison of the arithmetic means of the RPE, Pmax, Pmin, AP and FI scores obtained after the RAST run with both compression tights and normal shorts is given in Table 3.

Table 1
Descriptive Statistics of Participants

Variables	Mean ± SD
Age (years)	16.5 ±0.51
Height (cm)	176.8 ±5.71
Body mass (kg)	68.5 ±8.98
Basketball Experience (years)	2.35 ±0.49
Training frequency (hours/week)	3.0 ±0

Note. SD: Standard Deviation

Following the t-test for related samples, which was performed to determine whether there was a difference between the arithmetic means of the Hooper Index scores, total calorie intake values, and calorie intake from carbohydrates values obtained on the day of the RAST run with compression tights and the RAST run with normal shorts, when the scores were compared no statistically significant difference was found in any parameter (p>0.05). This was interpreted asan indication that the participants' nutrition and general fatigue status did not have any statistically significant effect on the RAST (Table 2).

Table 2
Comparison of Mean Scores of Hooper Scale, Total Calorie Intake and Calorie Intake from Carbohydrate Variables Determined before the RAST Run in Compressive Tights and Normal Shorts

Variables and Tools	Mean ± SS (N=20)		Percentage difference between using compression tights and sports shorts (%∆)		
	Sport shorts	Compression tights	%∆ Mean ± SD	p	ES
Hooper Index	11.3 ± 2.77	11.8 ± 1.73	10.4 ± 30.5	0.504	0.15
Total calories (kcal)	2052.8 ± 701.0	2062.8 ± 648.2	7.31 ± 41.1	0.942	0.016
Calories from carbs (kcal)	897.0 ± 314.1	869.5 ± 286.4	5.71 ± 47.0	0.718	0.08

Note. ∆: Change; SD: Standard Deviation; ES: Effect Size for Related Samples t-test (d; 0.2 = small, 0.5 = medium, 0.8 = large effect size) p<0.05*

RPE, Pmax, Pmin, AP, and FI scores obtained after the RAST performed with both compression tights and normal shorts were not statistically different from each other (p>0.05).

Table 3
Comparison of Values Obtained after RAST Run with Compression Tights and Normal Shorts

Components of RAST	Mean ± SD (N=20)		Percentage difference between using compression tights and sports shorts (%∆)		
	Sports shorts	Compression tights	%∆ Mean ± SD	p	ES
RPE	16.1 ± 3.02	15.6 ± 2.96	- 2.42 ± 11.7	0.268	0.26
Pmax	637.0 ± 203.2	627.7 ± 220.3	- 2.12 ± 17.6	0.692	0.09
Pmin	279.0 ± 166.8	287.7 ± 174.6	110.5 ± 351.4	0.857	0.04
AP	437.3 ± 142.9	437.3 ± 169.5	2.73 ± 36.0	1.000	0.00
FI	8.19 ± 3.10	8.27 ± 3.63	16.3 ± 74.7	0.929	0.02

Note. ∆: Change; SD: Standard Deviation; ES: Effect Size for Related Samples t-test (d; 0.2 = small, 0.5 = medium, 0.8 = large effect size); RPE: Rate of perceived exertion; Pmax: Maximal power, Pmin: Minimum power, AP: Average power; FI: Fatigue index; p<0.05*

DISCUSSION

This study aimed to evaluate the effectiveness of compression tights on repeated sprint test performance in young basketball players through the RAST. The main finding of the study is that compression tights did not affect any of the performance parameters including maximal power (637.0± 20.3 Vs.627.7± 220.3, p>0.05), minimum power (279.0±,166.8 Vs. 287.7± 174.6, p>0.05) average power (437.3±,142.9 Vs.437.3 ±169.5, p>0.05) fatigue index

(8.19±,3.10 Vs. 8.27± 3.63, p>0.05) and RPE (16.1±.3.02 Vs. 15.6± 2.96, p>0.05). Based on this result, we can infer that the hypothesis of the study (that the components of the RAST, including maximal power (Pmax), minimum power (Pmin), and average power (AP), will be greater when the test is performed with compression tights) is rejected.

Our results are inconsistent with the study by Ballmann et al. (2019), who reported that mean power output (CON = 684.5 ± 146.3 watts, LBC = 738.8 ± 155.3 watts; p = 0.028; d = 0.35), anaerobic capacity (CON = 7.5 ± 1.3 watts/kg, LBC = 8.1 ± 1.4 watts/kg; p = 0.18; d = 0.45) and total work (CON = 20.533.3 ± 4392.2 joules, LBC = 22.165.4 ± 4661.3 joules; p = 0.027; d = 0.36) were higher when collegiate basketball players wore a lower body compression garment. Ballmann et al. (2019) also reported a lower RPE score (CON = 7.9 ± 0.6, LBC = 7.4 ± 0.7; p = 0.032; d = 0.72) with a lower-body compression garment compared to control after 2 x 30 second Wingate Anaerobic Tests (WAnTs). Doan et al. (2003) argued that wearing custom-fit compression shorts increased vertical jump performance (CON = 0.461 Vs., CGs = 0.485 m, p = 0.015) but not 60 m sprint performance. Doan et al. (2003) also speculated that custom-fit compression shorts may affect longer-distance sprinting than 60 m such as 100-400 m. In contrast with Doan et al. (2003), Faulkner et al. (2013) reported no significant differences in 400 m performance time, individual 100 m split times, heart rate, or blood lactate profiles between the control group and subjects who wore a lower limb compression garment.

In a separate study, Ali et al. (2011) found that the utilization of compression stockings of varying grades (GCS; low: 12-15 mmHg, medium: 18-21 mmHg, and high: 23-32 mmHg) did not affect 10 km running performance, mean heart rate, blood lactate profile, or perceptual scale scores (pain, comfort, tightness). However, low- and medium-grade GCS enhanced counter-movement jump performance (CMJ) after endurance exercise. Ali et al. (2011) also proposed that the rise in CMJ observed after wearing GCS could be attributed to improved proprioceptive mechanisms linked to jumping skills or a reduction in muscle oscillations that might result in muscle exhaustion or damage. Another investigation conducted by Loturco et al. (2016), aimed at evaluating the impact of compression garments on speed and jump performance among elite sprinters with visual impairment, revealed that jump squat (SJ) performance (placebo: = 39.49 ± 5.75 cm; compression = 41.19 ± 5.09 cm) was superior when participants wore compression garments compared to the control condition. However, no significant differences were observed in 20 m (placebo = 3.24 ± 0.20 s; compression: 3.27 ± 0.11 s) and 70 m sprinting performance (placebo = 9.12 ± 0.44 s; compression = 9.07 ± 0.39 s) between the compression and control conditions. The observed improvement in SJ performance among individuals with visual impairment when using compression garments could be attributed to these garments' beneficial effects on proprioceptive cues (Hooper et al., 2015; Kraemer et al., 1996).

Consistent with our study, Duffield et al. (2007) reported no significant differences in repeated sprint or throwing performance in cricket players wearing a compression garment. Another study by Duffield et al. (2010) reported no performance enhancement, including 20 m sprinting (Total sprint time = 35.2 ± 3.4 vs. 35.2 ± 3.0 s, $p = 0.70$) and bounding distance (total bound distance = 171.2 ± 14.0 vs. 172.1 ± 17.0 m, $p = 0.90$) performance between compression garment and control condition in trained team sport athletes, as in our research.

The divergent findings observed concerning the efficacy of compression apparel on athletic performance could be attributed to various factors, such as disparities in study methodologies, the fitness profiles of the participants, the properties of the compression garments, and the specific performance assessments employed in the studies, among other variables. The results of our study might be affected by our participants' age and training status. With regards to the age of athletes and the effectiveness of compression garments, Driller and Brophy-Williams (2016) reported that there was a significantly greater perceived benefit of compression garments ($p < 0.05$) in athletes under 20 years old compared to those over 20 years old. Regarding training status, Lee et al. (2023) reported positive effects of compression sportswear on endurance and functional motor performance (e.g., countermovement jump and visuomotor tasks) were observed in moderately trained adults, while no significant effects were observed in athletes. This result can be attributed to improvements in endurance and functional motor performance being greater for moderately trained adults due to the potential physiological and neuromuscular benefits from compression garments, compared to highly trained athletes who may already have competitive levels of neurophysiological functions. As can be seen, the majority of studies designed to test the effect of compression garments seem to be focused on endurance or aerobic-based activities (Ali et al., 2011; de Glanville & Hamlin, 2012; Franke et al., 2021; Hill et al., 2014; Hamlin et al., 2012). To the best of our knowledge, this is one of a few studies aiming to evaluate the effectiveness of compression garments on basketball players' performance, including jumping, sprinting, repeated sprint ability, etc. (Ballmann et al., 2019; Driller et al., 2021; Zamporri et al., 2018). Specifically, there is a lack of sufficient studies aboutto interpret the results pertaining to team sports thoroughly. In this context, a study by Driller et al. (2021) found that, although there were no significant interactions between trials for pre (wearing lower-body compression garments) to post (no lower-body compression garments - control) measures ($p>0.05$), compression garments were linked to slight improvements in lower-body power during two stair-climb tasks and slightly but significantly faster repeated-sprint times over 6 meters in the exercise circuit. However, Wong et al. (2020) found that upper-body (top) or full-body (top + bottom) compression garments significantly improved the accuracy of basketball free throws. The increase in free throw performance after wearing upper body or full body compression garments has been explained by reduced range of motion (ROM) of head flexion and lateral bending of the trunk and increased trunk stability. Otten et al. (2019) reported that zoned high-compression shorts decrease groin pain, increase pelvic stability, and improve performance on the Illinois Agility Test in soccer players with groin pain compared to normal sports clothes. A study by Ravier et al. (2018) argued that wearing full-leg length compression garments during handball-specific circuit exercises did not improve 15-meter sprint times, jump heights, and ground contact times compared to regular gym shorts. Duffield et al. (2008) found that wearing a compression garment did not affect the performance of male rugby players in simulated team-sport exercises, which involved high intermittent activities such as sprinting, peak power, and repeated sprint performance.

CONCLUSION

The research findings conclude that extended-length compression leggings worn on the lower limbs did not impact the performance of young basketball players in the Running-Based Anaerobic Sprint Test (RAST), including measures such as Pmax, Pmin, AP, and FI. Different results might be obtained from the same research design when a familiarization session is allocated to players.

PRACTICAL IMPLICATIONS

Although the results of our study failed to show any positive effects of using compression tights on repeated sprint test performance, there are also studies in the literature revealing positive effects of using compression tights on short-term, high-intensity activities such as jumping, changing direction, etc. Many researchers state that the use of compression tights is effective in increasing performance through regeneration. The results of this study reflect the average of a group, and therefore, compression tights should be used by athletes individually for increasing performance, regeneration, and reducing muscle pain and tension, and their effects on athletes' performance should be assessed individually.

Limitations

The study's major limitation is that we did not allocate a familiarization session for the players to facilitate adaptation to the repeated sprint test with compression tights. Players might have experienced discomfort when wearing compression tights during the RAST, potentially negatively affecting their performance. Another limitation is that players participated in two different test sessions; one with a long-length lower limb compression garment (hip to ankle) and the other without compression. Long-length tights (hip to ankle) without compression should have been used in the control instead of shorts.

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Authors' contribution

All authors carried out the research design together. The first and second authors were involved in the data collection. The third author took responsibility for the data analysis and interpretation of the data. The second author supervised and reviewed the original draft. All authors took responsibility for all writing process beginning from the manuscript preparation to approval of the final draft.

Declaration of conflict interest

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Ethical Committee

Our study was approved by the Trakya University Faculty of Medicine Scientific Research Ethics Committee on 12.07.2021 with the protocol number TÜTF-BAEK 2021/321.

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