2024, Retos, 61, 868-877

Effects of Bulgarian bag training on bio-motor fitness, physiological, haematological, and performance in young adult male Kabaddi players

Efectos del entrenamiento con bolsa búlgara sobre la aptitud biomotora, fisiológica, hematológica y el rendimiento en jugadores varones adultos jóvenes de Kabaddi

*Nithin B S, *Ram Mohan Singh, **Dilpreet Kaur, ***Yuni Astuti, ***Ahmad Chaeroni, *Masilamani Elayaraja, ****Bekir Erhan Orhan, *****Yashwant Singh, **Basavaraj Kumasi, ******Ethiraj Balaji, *******Edi Setiawan, ********Hemantajit Gogoi, *********Karuppasamy Govindasamy

*Pondicherry University (India), **Sri Balaji University (India), ***Universitas Negeri Padang (Indonesia), ****Istanbul Aydın University (Turkiye), *****Sports University of Haryana (India), ******C.B.M. College (India), *******Universitas Negeri Surabaya (Indonesia), ********Rajiv Gandhi University (India), *********SRM Institute of Science and Technology (India)

Abstract. Kabaddi demands high bio-motor fitness and physiological robustness in players. The Bulgarian Bag, known for its dynamic training potential, offers multi-planar movements to enhance strength, endurance, and coordination. However, its impact on Kabaddi players still needs to be explored. To assess the effects of Bulgarian Bag training (BBT) on bio-motor fitness, physiological, hematological, and performance measures in young adult Kabaddi players. A total of 30 participants were randomly assigned to either the BBT Group (BBTG) (n = 15; age = 20.73 ± 1.83 years; weight = 72.56 ± 7.27 kg; height = 175.20 ± 6.03 cm) or the active Control Group (CG) (n = 15; age = 20.80 ± 1.69 years; weight = 71.86 ± 4.75 kg; height = 171.46 ± 6.06 cm). The training intervention lasted 12 weeks and was conducted during the in-season period. All outcome parameters tests were conducted before and after the intervention, including agility (AG), explosive strength (ES), shoulder strength (SS), muscular strength (MS), resting heart rate (RHR), VO2max, red blood cells (RBC), white blood cells (WBC), hemoglobin (HG), and playing ability (PA). The ANCOVA analysis revealed significant between-group differences in all physical fitness measures at post-test. Specifically, the BBTG showed significant improvements in AG, ES, SS, MS, RHR, VO2Max, RBC, WBC, HG, and PA (d = 0.75 to 3.28; Δ0.50% to 16.37%). Moreover, the BBTG group significantly reduced resting heart rate (d = 0.75; Δ-3.31%). In contrast, no significant changes were reported in the Control Group (CG) between pre- and post-tests (d = 0.00 to 0.78; Δ-0.08% to 4.59%). Integrating BBTG into the training program of young adult male Kabaddi players yielded beneficial effects across multiple parameters of bio-motor fitness, physiological, hematological, and playing ability. The findings reveal the potential of BBTG as a valuable training method for enhancing Kabaddi performance and overall athletic conditioning.

Keywords: Kabaddi Player, Bulgarian bag training, bio motor, physiological, haematological

Resumen. El Kabaddi exige una alta aptitud bio-motora y una gran robustez fisiológica en los jugadores. La bolsa búlgara, conocida por su potencial de entrenamiento dinámico, ofrece movimientos multi-planares que mejoran la fuerza, la resistencia y la coordinación. Sin embargo, su impacto en los jugadores de Kabaddi aún necesita ser explorado. Para evaluar los efectos del entrenamiento con bolsa búlgara (BBT) en las medidas de aptitud bio-motora, fisiológicas, hematológicas y de rendimiento en jugadores jóvenes adultos masculinos de Kabaddi, un total de 30 participantes fueron asignados aleatoriamente al grupo BBT (BBTG) (n = 15; edad = 20.73 ± 1.83 años; peso = 72.56 ± 7.27 kg; altura = 175.20 ± 6.03 cm) o al grupo de control activo (CG) (n = 15; edad = 20.80 ± 1.69 años; peso = 71.86 ± 4.75 kg; altura = 171.46 ± 6.06 cm). La intervención de entrenamiento duró 12 semanas y se realizó durante el período de temporada. Todas las pruebas de parámetros de resultado se realizaron antes y después de la intervención, incluyendo agility (AG), explosive strength (ES), shoulder strength (SS), muscular strength (MS), resting heart rate (RHR), VO2max, red blood cells (RBC), white blood cells (WBC), hemoglobin (HG) y playing ability (PA). El análisis ANCOVA reveló diferencias significativas entre los grupos en todas las medidas de aptitud física en el post-test. Específicamente, el BBTG mostró mejoras significativas en AG, ES, SS, MS, RHR, VO2max, RBC, WBC, HG y PA (d = 0.75 a 3.28; Δ0.50% a 16.37%). Además, el grupo BBTG redujo significativamente la resting heart rate (d = 0.75; Δ-3.31%). En cambio, no se reportaron cambios significativos en el grupo de control (CG) entre las pruebas pre y post (d = 0.00 a 0.78; Δ-0.08% a 4.59%). La integración del BBTG en el programa de entrenamiento de jugadores jóvenes adultos masculinos de Kabaddi produjo efectos beneficiosos en múltiples parámetros de aptitud bio-motora, fisiológicos, hematológicos y en la playing ability. Los hallazgos revelan el potencial del BBTG como un método de entrenamiento valioso para mejorar el rendimiento en Kabaddi y la condición atlética general.

Palabras clave. Kabaddi Player, entrenamiento con bolsa búlgara, biomotor, fisiológico, hematológico

Fecha recepción: 24-07-24. Fecha de aceptación: 19-09-24
Yuni Astuti
yuniastuti@fik.unp.ac.id

Introduction

The Bulgarian Bag, a unique exercise equipment invented by Ivan Ivanov, has garnered attention from researchers in sports science due to its potential for enhancing athletes' performance in various aspects of fitness through dynamic movements (Maki et al., 2021). Studies have shown that incorporating Bulgarian Bag exercises into training programs can improve upper body strength among wrestlers (Maki et al., 2021). Research has also investigated the kinematics and kinetics of Bulgarian Bag-overloaded sprint training and found that it increases the maximal velocity in young athletes (Duca et al., 2020). Furthermore, by utilizing the Bulgarian Bag, athletes can engage in dynamic movements that target multiple muscle groups simultaneously, improving overall performance (Maki et al.,

2021). Combined with exercises like the Bulgarian squat, unconventional methods like vibration, suspension, and unstable surfaces have increased muscle activity (Aguilera-Castells et al., 2019). The equipment's crescent moon shape and sand-filled design allow various exercises that challenge athletes in ways that traditional equipment could not do (Duca et al., 2020; Maki et al., 2021). This unique shape lets users easily grip the bag in various positions, facilitating movements like swings, squats, lunges, and twists that simultaneously engage multiple muscle groups. The unique design and dynamic nature allow athletes to engage in functional movements that mimic real-life activities, improving their performance across various sports disciplines (Maki et al., 2021). It is a novel approach and a promising tool for enhancing athletes' strength, power, endurance, and flexibility. Open for collaboration

Kabaddi, a sport from Southeast Asea, requires strength, speed, agility, and endurance to excel (Gunasekar & Balamurugan, 2021; Jumareng et al., 2023, 2023; Ram et al., 2022; Ram & Singh, 2021). Past research dedicated considerable attention to investigating the impact of traditional training methods on the performance of Kabaddi players and found a positive impact on strength, conditioning, and skill development (Gunasekar & Balamurugan, 2021; Subradeepan, 2017; Utama et al., 2022). Even though the effects of traditional training methods have been extensively investigated, exploring unconventional methods like Bulgarian Bag training (BBT) for Kabaddi players remains an area that has yet to be thoroughly investigated. While traditional training methods are essential for athletic development, exploring innovative tools like the Bulgarian Bag can provide new opportunities to enhance athletes' capabilities in sports like Kabaddi, revealing coaches and trainers to tailor training programs for achieving the unique demands of Kabaddi players, ultimately contributing to improved performance and overall athletic success.

Studies in other sports have shown that BBT can improve strength, power, and agility (Aguilera-Castells et al., 2019; Duca et al., 2020; Maki et al., 2021). However, whether these benefits would translate to Kabaddi players needs to be clarified. Additionally, there is limited research on how BBT might affect athletes' blood parameters, which can be important for performance. So, our study aims to fill these gaps by investigating how BBT affects bio-motor fitness, physiological measures, blood markers, and performance in young male Kabaddi players.

Materials & methods

Participants

This investigation involved thirty (n = 30) participants of young adult male kabaddi athletes having an average age of 20.73 ± 1.83 among the BBT group (BBTG) and 20.80 ± 1.69 for the Control Group (CG). The participants were recruited from Pondicherry University. Before initiating the study, we calculated the necessary sample size for the agility speed test among the intervention and control groups. Criteria were set, including a type 1 error rate of 0.05 and a statistical accuracy of 80 per cent. The expected effect size, denoted by Cohen's d (0.96), was calculated using a similar procedure used by (Borah et al., 2024). The findings suggested that a group consisting of 12 participants at a minimum would be sufficient for the sample.

Consequently, the needed number of participants was set at 24. In preparation for potential participant's attrition, 30 male kabaddi athletes were assigned randomized to either the BBTG (n = 15; age = 20.73 ± 1.83 years; Weight = 72.56 ± 7.27 kg; Height = 175.20 ± 6.03 cm) or the active Control Group (CG) (n = 15; age = 20.80 ± 1.69 years; Weight = 71.86 ± 4.75 kg; Height = 171.46 ± 6.06 cm). All participants were categorized as collegiate-level players with a background of systematic kabaddi training amounting to 4.0 ± 1.2 years and having 3 to 5 weekly training sessions. It was verified that all participants exhibited a state of optimal physical well-being, devoid of any notable musculoskeletal ailments throughout the six months before the commencement of the study. The research investigation excluded individuals who did not attend over eighty per cent of the training sessions or two consecutive sessions. The anthropometric details for both groups can be found in Table 2. The current research followed the latest edition of guidelines, and the procedure complies with the ethical standards approved for research in sports and exercise science (Harriss et al., 2017). Before commencing experimental testing, the protocol received approval. All of the subjects or their legal guardians gave their written consent, and the Institutional Ethics Committee gave their ethical approval. (Human Studies) at Pondicherry University (HEC/PU/2023/07/07-08-2023).

Study Design

We utilized a research design with two groups and repeated measures to explore the outcomes of a 12-week program with three sessions per week training using Bulgarian Bag on measures of bio-motor fitness, physiological parameters, hematological markers, and playing ability in young adult male kabaddi players. The performance of BBTG was compared to that of a CG, who adhered to their standard kabaddi-specific training routine during the same in-season period (September to October). The participants were randomly assigned to either the BBTG or the CG using an online randomization tool, following CONSORT guidelines (Schulz et al., 2010). The experimental group took part in three training sessions per week. The BBTG engaged in 60-minute sessions on Monday, Wednesday, and Friday throughout the 12 weeks. These BBTG sessions were supervised by the team's fitness trainer, who was aware of the group allocation.

Participants in the treatment group, following the BBT component, merged with those in the CG to finish the remaining section of their standard kabaddi-specific training routine. To ensure participants were well-acquainted with the tests and exercises used in the study, three orientation

sessions were conducted two weeks prior to the initial evaluation. Moreover, the researchers provided verbal cues and demonstrations during the intervention to maintain the proper technique. The assessments conducted before and following the training program included a comprehensive series of evaluations, including Agility (AG), Explosive Strength (ES), Shoulder Strength (SS), Muscular Strength (MS), Resting Heart Rate (RHR), VO2 Max, Red Blood Cells (RBC), White Blood Cells (WBC), Hemoglobin (HG), and Playing Ability (PA). Consistency was maintained as the same assessors performed all test measurements. A qualified biochemistry lab technician carried out haematological blood measurements. The evaluators were aware of the participant's allotted group. All assessments were carried out within two days.

After the concluding session, evaluations were conducted within two days in stable environmental conditions in the early hours, between 7:30 am and 9:30 am. (26.5–31.7°C, 3.1 wind speed). In the three weeks leading up to the start of the research, the participants partook in bi-weekly sessions involving exercises using their body weight. These exercises focused on various upper and lower limbs and the core muscles, using their body weight. This preparatory phase aimed to prepare participants for the forthcoming BBTG program. To maintain transparency and fairness, we generated the allocation sequence utilizing the specified online resource (https://www.sealedenvelope.com/simple-randomiser/v1/lists). This sequence remained concealed until interventions were assigned, minimizing any potential bias. Participants were enrolled sequentially based on meeting inclusion criteria, and we tried to achieve a double-masked design when possible. Additionally, we carefully monitored and documented the randomization process to enhance transparency and reproducibility.

Outcome Measures

Agility

The T-test of agility, designed to measure speed with directional changes, was administered according to the protocol explained by Pauole K. et al. (2000). Participants started with both feet behind the starting line and cone A and sprinted forward to cone B, touching its base with their right hand. Without crossing their feet and facing forward, they shuffled left to cone C, touching its base with their left hand, then shuffled right to cone D, touching its base with their right hand. They then shuffled back to cone B and touched its base before running backwards as quickly as possible to return to cone A. Any participant who crossed their feet failed to touch the cone bases or did not face forward while moving, had to redo the test. Each participant performed three trials, with a two-minute rest between each, and the best of the final two trials was recorded for analysis. In our study, the T-test for agility demonstrated an Intra-class Correlation Coefficient (ICC) of 0.83, with a 95% confidence interval (Cl) ranging from 0.33 to 0.88 (Table 3).

Explosive Strength

The standing broad jump test was conducted on a hard surface employing the standing long jump test following the protocol explained by Bianco et al. (2015). Participants stood with their heels on the starting line and feet parallel. After receiving instructions from the investigator, they were required to jump as far as possible horizontally. No specific instructions were given regarding the movement of their legs or arms, allowing participants to use their chosen depth countermovement and arm swing. They had to land with both feet together and stop without moving forward. The distance was measured in centimetres from the starting line to the heel closest to the starting line, and the best of the three trials was used for the final analysis. There was a five-minute rest between the two trials. The ICC for the standing long jump test was reported as 0.95, and its 95% CI ranged from 0.72 to 0.96 (Table 3).

Shoulder Strength

The procedure mentioned by Kollath et al. (1991) for pull-up test was employed to assess shoulder strength. Participants used a pronated grip to grasp the bar and performed pull-up repetitions hanging from the bar. At the signal, the participants bent their elbows, pulling their bodies up until their chin was above the bar, then returned to the starting hanging position without resting. This exercise was repeated as many times as possible without rest. The result was the number of complete pull-ups performed in 60 seconds, where the chin must pass over the bar each time. Three trials were conducted, with a three-minute rest period between each. The best trial was chosen for analysis. The ICC for the pull-up test and its 95% CI were reported as 0.92, ranging from 0.52 to 0.94 (Table 3).

Muscular Strength

A back and leg dynamometer was used to measure lower body muscle strength. We followed the procedure explained by Harding et al. (2017). Each participant participated in two testing sessions spaced one week apart. At the beginning of each session, participants performed a warm-up consisting of five repetitions of bilateral knees-to-chest exercise in a supine position with a 5-second hold, followed by five prone press-ups. The dynamometer's chain was adjusted so the handlebar was parallel to and level with each participant's tibial tuberosities. Participants were instructed to grasp the handlebar at the distal palmar crease with their elbows extended and forearms pronated. Before data collection, participants practised using submaximal contractions in each test position three times. After these practice contractions, participants rested for 1 minute before assuming the testing position. Three trials were conducted, with a two-minute rest period between each. Participants stood upright with their knees and hips flexed, maintaining lumbar lordosis, and pulled towards the ceiling primarily using their leg muscles. While executing the test, at the beginning, the participants stood with their knees extended and hips flexed, maintaining lumbar lordosis, and pulled towards the ceiling using their back muscles.

Furthermore, the participants stood upright with their knees extended and their spines hyper-flexed, pulling towards the ceiling using their back muscles. The best trial was chosen for the final analysis. The ICC for the strength test (kg), along with its 95% CI, was reported as 0.94 and ranged from 0.58 to 0.95 (Table 3).

Resting Heart Rate

Resting heart rate (the number of heartbeats per minute) was measured ten minutes after waking from sleep while participants were still lying in a supine position in bed using a stethoscope. The stethoscope's ICC (number of beats in one minute), along with its 95% confidence interval (CI), was reported as 0.91, ranging from 0.54 to 0.93.

VO2 Max

The Queens College step test was employed to measure maximal oxygen uptake following the procedure by Shete et al. (2014). Before the test, participants warmed up for 5-7 minutes with brisk walking and lower limb muscle stretching. The test utilized a 16¼-inch wooden stepping bench, a metronome, and a stopwatch. The metronome, set at 96 beats per minute (24 complete steps per minute), controlled the stepping cadence. After a brief demonstration and practice period, participants began the step test. They continuously performed each stepping cycle to a four-step cadence (up-up-down-down) for 3 minutes. Upon completing the test, participants remained standing while their pulse rate was measured at the carotid or radial artery for 15 seconds, from the 5th to the 20th second of the recovery period. This 15-second recovery heart rate was then converted to beats per minute by multiplying by 4. Three trials were conducted, with a ten-minute rest period between each. The best trial was chosen for the final analysis. The ICC for the Queens College step test (No of beats in one minute), along with its 95% CI, was reported as 0.94, ranging from 0.67 to 0.95 (Table 3).

Blood Test

Venous blood samples were collected from the antecubital vein using standard clinical procedures with EDTA as an anticoagulant. Blood collection co-occurs each day (6:30 am) for consistency. Participants fasted for 8 hours and avoided coffee or other stimulants for 24 hours prior to sampling. A portion of the fresh blood was used for hematological analysis, including WBC, RBC, and HG measurements using a Celltac α MEK-6318K hematological analyzer (Nihon Kohden Europe GmbH, Rosbach, Germany). The remaining blood (approximately 10 mL) was centrifuged immediately at 3000× g for 10 minutes to separate the plasma. Plasma osmolality was measured with a Model 3300 micro osmometer (Advanced Instruments Inc., Norwood, MA, USA), and the remaining plasma aliquots were quickly frozen and stored at −80°C for later biochemical analysis (Kaur et al., 2022).

Playing Ability

A structured evaluation procedure was followed to assess the participants' Kabaddi playing ability. The assessment was conducted by three experts in the game of Kabaddi and focused on five key performance categories. Each category was scored out of 10 points, with the total assessment carrying a maximum of 50 marks. The categories evaluated were an offence, defence, successful release from a catch or struggle, quick movement/reaction, and team cohesion. The final score for each player was the average of the scores given by the three experts. The ICC for the kabaddi playing ability (No of beats in one minute), along with its 95% CI, was reported as 0.83, ranging from 0.23 to 0.83 (Table 3).

Training Intervention

A familiarisation session was held two weeks before the 12-week BBT program. This introductory session introduces participants to the following program's exercises, equipment, and training procedures. For 12 weeks, BBTG followed a structured BBT program (Table 1). During the first one to four weeks, participants practised the exercises listed in Table 1 with six to eight repetitions for three sets. They took 30-to-40-second breaks between each exercise and two minutes between each set. In weeks 5–8, the program ramped the intensity with 7–9 repetitions while keeping the set and rest lengths the same. The ninth and tenth weeks were more advanced, requiring 10 to -12 repetitions each set. Participants returned to a slightly lower rep range of 6 to 8 reps in the last 11 to 12 weeks but followed the established set and rest procedures. In the last two weeks, the training load had been purposely lowered to enhance adaptation and limit fatigue, aligning with the reversibility principle. For the preparation of the training program, we followed Bompa & Haff (2009) and Enes (2024)

Table 1.
Training Intervention 12 weeks BBT

Weeks	Exercises	Reps/sets	Recovery	Progression
I & II	1. Bulgarian Bag Spain arm throw 2. Backkick with the Bulgarian bag 3. Left & right cover bag throw 4. Basic foot moment with the bag 5. Bag swing and catch 6. Alternative side toe touch with the Bulgarian bag 7. Bulgarian bag with an alternative lateral hand touch	6 to 8 Reps 3 Sets	30 to 40 sec between exercises 2 min rest between sets	Addition of repetition after a Week (2 weeks)
III & IV	1. Bulgarian Bag ankle hold 2. Bulgarian bag military press 3. Side-to-side bag drags 4. Bag hold on the leg & centre line crossing 5. Left & right cover sideward move with bag push	6 to 8 Reps 3 Sets	30 to 40 sec between exercises 2 min rest between sets	Addition of repetition after a Week (2 weeks)

	6. Straight arm side-to-side swing 7. Sideward move with bag push			
V & VI	1. Zig Zag duck walk 2. Bulgarian bag lifting in blocking position 3. Bulgarian bag Swing Squat 4. Bag rotations 5. Bulgarian bag tuck jump 6. Hand touch & turning with the bag 7. High knees with a bag	7 to 9 Reps 3 Sets	30 to 40 sec between exercises 2 min rest between sets	Addition of repetition after a week(2 weeks)
VII &VIII	1. Bulgarian bag with a side-to-side hand touch 2. Bulgarian bag vertical jumps 3. Bulgarian bag Spain arm throw 4. Broad jump with the bag 5. Left & right cover bag throw 6. Shoulder push with bag run 7. Sideward moves in a squat position with a bag	7 to 9 Reps 3 Sets	30 to 40 sec between exercises 2 min rest between sets	Addition of repetition after a week (2 weeks)
IX & X	1. Zig Zag hope 2. Bag swing and catch 3. 360-degree jump duck turning with the bag 4. Straight arm side-to-side swing 5. Forward move duck jump with bag 6. Shoulder block with a bag	10 to 12 Reps 3 Sets	30 to 40 sec between exercises 2 min rest between sets	Addition of repetition after a Week (2 weeks)
XI & XII	1. Back kick with the Bulgarian bag 2. Left & right cover bag throw 3. Basic foot moment with a bag 4. Bulgarian bag military press 5. Side-to-side drag 6. Bulgarian bag Spain arm throw 7. Forward move duck jump with bag	6 to 8 reps 3 Sets	30 to 40 sec between exercises 2 min rest between sets	Training load reduced based on the principle of reversibility (2 weeks)

Data Analysis

The evaluation of data normality commenced with the Shapiro-Wilk test. Following this initial step, the Analysis of Covariance (ANCOVA) was employed to explore the training program's effectiveness, with baseline measurements included as covariates for a nuanced analysis. Subsequently, we employed Cohen's d to quantify effect sizes, converting partial eta-squared values derived from ANCOVA results. Further analysis involved examining performance changes within the same group from before to after the intervention, utilizing paired sample t-tests. Effect sizes emerging from these tests were classified according to Cohen's criteria into small ($0.00 \leq d \leq 0.49$), medium ($0.50 \leq d \leq 0.79$), or large ($d \geq 0.80$) categories, facilitating a clear understanding of the training's impact. The reliability of these measures over time was confirmed through the ICC, specifically using a 3,1 model, ensuring the consistency of our findings. For a comprehensive overview, mean values and standard deviations were compiled for initial assessments, while adjustments were made to present means and standard deviations for the concluding assessments. The significance level was maintained at $p \leq 0.05$ throughout the study to ensure scientific rigour. All statistical analyses were meticulously performed to uphold this standard.

Results

All athletes effectively participated in over 90% of the training sessions, ensuring full engagement in the final assessments. Table 3 provides detailed explanations of the data reported in this section. Substantial variance among the groups was recognized in age, height, weight, and experience in the field, as indicated in Table 2. No significant differences at the baseline were noted between the groups ($p>0.05$) regarding bio-motor fitness, physiological, haematological, and playing ability measures.

There existed an important and considerable disparity between the two groups at the post-test across various parameters. Particularly, there were significant differences observed between groups in AG ($p<0.001$; effect size = 2.54), ES ($p = 0.004$; effect size = 1.21), SS ($p <0.001$; effect size = 1.93), MS ($p <0.001$; effect size = 2.28), RHR ($p = 0.017$; effect size = 0.97), VO2Max ($p <0.001$; effect size = 1.77), RBC ($p = 0.024$; effect size = 0.92), WBC ($p = 0.014$; effect size = 1.01), HG ($p <0.001$; effect size = 2.15), and PA ($p <0.001$; effect size = 3.28) evaluations. In particular, the group undergoing BB training demonstrated significantly larger improvements from pre to post-training in various parameters such as AG (Δ -1.34%; d =1.08), ES (Δ 10.73%; d =1.26), SS (Δ 19.04%; d =1.29), MS (Δ 9.13%; d =1.34), RHR (Δ -3.31%; d =0.75), VO_2Max (Δ 16.37%; d =1.63), RBC (Δ 9.97%; d =0.88), WBC (Δ 9.67%; d =0.50), HG (Δ 9.58%; d =1.78) and PA (Δ 8.39%; d =2.13) tests. These findings highlight the significant positive impact of BB training on a diverse set of fitness, physiological and performance metrics within the study.

Conversely, the CG exhibited no significant differences in the range of parameters between the pre-and post-test.Specifically, there were no significant alterations observed for AG (Δ 4.59%; d =0.78), ES (Δ 0.40%; d =0.03), SS (Δ -4.32%; d =0.64), MS (Δ 0.66%; d =0.08), RHR (Δ -0.10%; d =0.02),VO_2Max (Δ 1.92%; d =0.15), RBC (Δ 0.13%; d =0.01), WBC (Δ 0.09%; d =0.00), HG (Δ -0.08%; d =0.01) and PA (Δ -0.82%; d =0.20) tests. These results indicate that the control group did not experience significant improvements across these parameters during the study period.

Table 2.
Demographic information of BBTG and CG

	BBTG	CG	*p*-value
Years	20.73 ± 1.83	20.80 ± 1.69	0.836
Weight (kg)	72.56 ± 7.27	71.86 ± 4.75	0.140
Height (cm)	175.20 ± 6.03	171.46 ± 6.06	0.438

Table 3.
Intra-class correlation coefficient (ICC) and their 95% confidence interval (CI)

Factors	ICC	95% CI
Agility (s)	0.83	0.33 to 0.88
Explosive Strength (cm)	0.95	0.72 to 0.96
Shoulder Strength (Nm)	0.92	0.52 to 0.94
Muscular Strength (kg)	0.94	0.58 to 0.95
Resting Heart Rate (bpm)	0.91	0.54 to 0.93
VO2 Max (ml/kg/min)	0.94	0.67 to 0.95
Red Blood Cells (mm)	0.88	0.43 to 0.91
White Blood Cells (mm)	0.97	0.81 to 0.98
Hemoglobin (ml)	0.95	0.74 to 0.96
Playing Ability (p)	0.83	0.23 to 0.83

Table 4.
Pre and post-test performances of BBTG as well as CG in bio-motor fitness, physiological, haematological and playing ability in young adult male kabaddi players following 12 weeks of BBT

	Pre				Post				
	BBTG	CG			BBTG	CG			
	M ± SD	M ± SD	Diff (95% CI)	*Independent sample t-test* *p*-value	M ± SD	M ± SD	Diff (95% CI)	*Independent sample t-test* *p*	-value p-value
AG	9.89 ± 0.25	10.10 ± 0.35	-0.20 (-0.43 to 0.02)	0.077	9.76 ± 0.18	10.57 ± 0.4	-0.81 (-1.04 to -0.57)	<0.001	<0.001 (2.54)
ES	2.28 ± 0.12	2.32 ± 0.22	-0.03 (-0.17 to 0.09)	0.568	2.51 ± 0.13	2.33 ± 0.22	0.18 (0.04 to 0.32)	0.013	0.004 (1.21)
SS	11.20 ± 1.89	12.33 ± 1.79	-1.13 (-2.51 to 0.24)	0.104	13.33 ± 2.31	11.80 ± 1.20	1.53 (0.15 to 2.91)	0.031	<0.001 (1.93)
MS	60.96 ± 3.24	60.2 ± 3.54	0.76 (-1.77 to 3.30)	0.542	66.53 ± 2.8	60.6 ± 2.52	5.93 (3.93 to 7.93)	<0.001	<0.001 (2.28)
RHR	66.26 ± 2.65	66.06 ± 2.8	0.20 (-1.65 to 2.05)	0.827	64.06 ± 1.86	66 ± 2.42	-1.93 (-3.55 to -0.31)	0.021	0.017 (0.97)
VO2Max	37.86 ± 2.74	38.06 ± 2.98	-0.20 (-2.34 to 1.94)	0.850	44.06 ± 3.03	38.8 ± 3.09	5.26 (2.97 to 7.56)	<0.001	<0.001 (1.77)
RBC	4.92 ± 0.47	5.05 ± 0.5	-0.12 (-0.49 to 0.24)	0.488	5.41 ± 0.34	5.05 ± 0.46	0.35 (0.05 to 0.66)	0.024	0.024 (0.92)
WBC	7433.66 ± 1529.91	7386.66 ± 1628.26	47.00 (-1134.68 to 1228.68)	0.936	8152.66 ± 469.65	7393.66 ± 1026.27	759 (162.06 to 1355.93)	0.015	0.014 (1.01)
HG	14.85 ± 0.7	14.87 ± 0.68	-0.02 (-0.53 to 0.49)	0.938	16.27 ± 0.56	14.86 ± 0.78	1.41 (0.90 to 1.92)	<0.001	<0.001 (2.15)
PA	38.14 ± 1.71	38.14 ± 1.47	0.00 (-1.19 to 1.20)	0.995	41.35 ± 1.24	37.83 ± 1.24	3.52 (2.59 to 4.45)	<0.001	0.001 (3.28)

Discussion

The results of this study demonstrate that the BBTG exhibited significant improvement across multiple parameters of bio-motor fitness, physiological, hematological, and playing ability compared to the CG following the intervention. Notably, there were no significant differences between the groups at baseline across all measured variables, indicating that the groups were comparable before the intervention.

At baseline, the AG scores between BBTG and CG were not significantly different ($p = 0.077$). However, post-intervention, the BBTG group showed a significant improvement in agility compared to the CG group ($p < 0.001$), with a mean difference of -0.81 seconds (95% CI: -1.04 to -0.57) and a large effect size (Cohen's $d = 2.54$). This suggests that the training program implemented in the BBTG group effectively enhanced agility. The BBT has acquired popularity for its capacity to improve agility in male kabaddi players during a set training period. The dynamic and functional motions done with the Bulgarian bag are similar to the agility needs of Kabaddi, such as rapid direction changes, lunging, and twisting. These motions put the neuromuscular system to the test, enhancing coordination, balance, and proprioception, all of which are necessary for agile performance on the kabaddi court (Caglayan & Ozbar, 2017). Male kabaddi players' ability to respond swiftly and efficiently to opponents' movements and execute nimble manoeuvres during matches improved significantly after constantly engaging in Bulgarian bag exercises emphasizing agility (Antony et al., 2015). BBT's versatility makes it an effective tool for improving the agility required for success in fast-paced and dynamic sports such as Kabaddi.

The ES did not differ significantly between groups at baseline ($p = 0.568$). After the intervention, the BBTG demonstrated a significant increase in ES compared to the CG ($p = 0.013$), with a mean difference of 0.18 (95% CI: 0.04 to 0.32) and an effect size of 1.21. This improvement is indicative of the intervention's effectiveness in enhancing muscular power. The Bulgarian bag's unusual design allows for various dynamic and explosive exercises targeting numerous muscle groups simultaneously. Swings, snatches, and throws involve rapid and forceful movement, which is necessary to develop explosive strength. Kabaddi players who regularly incorporate these explosive motions into their training regimen might increase their ability to generate short bursts of power during tackles, raids, and defensive manoeuvres throughout the game (Liao et al., 2022).

In addition to explosive strength, BBT includes exercises that target shoulder strength development. The shoulder is an important joint in Kabaddi because it allows players to execute powerful throws, tackles, and blocks. Our study revealed that while there was no significant difference at baseline ($p = 0.104$), the BBTG showed a significant improvement in SS post-intervention compared to the CG ($p = 0.031$). The mean difference was 1.53 units (95% CI: 0.15 to 2.91), with an effect size of 1.93, highlighting the training's impact on improving shoulder strength components. Bulgarian bag exercises' rotational and pushing actions effectively target the deltoids, rotator cuff muscles, and stabilizing muscles surrounding the shoulder joint (Schoenfeld, 2017). Male kabaddi players experienced a significant gain in shoulder strength over time, allowing them to perform these important moves with more power

and control. The complete nature of BBT helps male kabaddi players improve their muscular power (Maki et al., 2021). Bulgarian bag workouts improve overall body strength development by working many muscular groups simultaneously. This balanced strength is essential for kabaddi players to retain endurance during a game and outperform opponents in physical clashes (Tarabrina et al., 2020). Kabaddi players improved their physical capabilities and performance by incorporating this versatile training tool into their conditioning regimen and adhering to a structured program designed to target strength-based specific areas.

There was no significant difference in RHR at baseline ($p = 0.827$). Post-intervention, the BBTG exhibited a significantly lower RHR than the CG ($p = 0.021$), with a mean difference of -1.93 beats per minute (95% CI: -3.55 to -0.31) and an effect size of 0.97. A lower RHR indicates improved cardiovascular efficiency, suggesting positive adaptations from the training program. A study by Shandryhos and Shandryhos (2024) found that systematic BBT regimens positively impact physiological factors such as resting heart rate in kabaddi players. Initially created for professional athletes to improve muscular endurance and explosive strength, the Bulgarian bag provides a dynamic and functional approach to strength training that increases cardiovascular fitness and resting heart rate (Petrov et al., 2014). The benefits of Bulgarian bag workouts on power and strength in kabaddi players have been studied, and the results reveal that a well-structured BBT program significantly increases physical ability. The study underlines the need for good planning and exercise programming to get the most out of BBT, increasing athletes' physical strength and performance levels (AMANY, 2017). The Bulgarian bag's multifunction enables comprehensive training that targets many muscle groups, resulting in long-term improvements in cardiovascular fitness and resting heart rate. BBT programs also dramatically improved the VO2 max of male kabaddi players. Results revealed that VO_2Max values were similar at baseline ($p = 0.850$). After the intervention, the BBTG group showed a significant increase in VO_2Max compared to the CG group ($p < 0.001$), with a mean difference of 5.26 ml/kg/min (95% CI: 2.97 to 7.56) and an effect size of 1.77. This improvement reflects enhanced aerobic capacity resulting from the intervention. Balasingh and Reeves studied male kabaddi players and discovered that 12 weeks of interval and circuit training with the Bulgarian bag resulted in a considerable rise in the players' VO2 max (Balasingh & Reeves, 2018). This study demonstrates the benefits of planned BBT for improving athletes' cardiovascular fitness and endurance capacity. El-Deeb evaluated the impact of Bulgarian bag exercises on basketball pivot players' physical characteristics and performance levels. The study indicated that BBT improved particular physical indicators and increased athletes' performance levels (El-Deeb, 2017). This implies that Bulgarian bag workouts' dynamic and adaptable character might significantly increase athletes' physical abilities, particularly cardiovascular fitness, which is critical for increasing VO2 max (Brezze & Kumar, 2023). Vairavasundaram and Palanisamy (2015) investigated the impact of BBT on specific physical variables among handball players. Their findings suggested that Bulgarian bag exercises contributed to better muscle capacity and skill level, which is essential for improving overall athletic performance (Vairavasundaram & Palanisamy, 2015).

Research investigations have shed light on the potential benefits of the BBT programs in dramatically boosting RBC, WBC, and HG levels in male kabaddi players. Our study also revealed the BBTG had a significantly higher RBC count ($p = 0.024$) with an effect size of 0.92, a significant increase ($p = 0.015$) in WBC and HG levels were significantly higher in the BBTG group ($p < 0.001$), with an effect size of 2.15. This may indicate improved oxygen-carrying capacity, enhancement in immune function or a response to training stress, or improved oxygen transport capacity. Sivakumar and Arumugam (2019) evaluated the effects of BBT on core and shoulder strength in soccer players (Arumugam Sivakumar 2019). The results showed that a six-week BBT program significantly improved core and shoulder strength. This implies that systematic training with the Bulgarian bag resulted in good physiological changes in athletes, including increased blood parameters such as RBC, WBC, and hemoglobin levels. Overall physical fitness gains from BBT indirectly contribute to improving RBC, WBC, and hemoglobin levels among male kabaddi players.

Furthermore, the result revealed that the BBTG had significantly higher PA scores following the intervention than the CG ($p < 0.001$), with a substantial effect size of 3.28. This suggests that the intervention improved specific fitness components and overall kabaddi playing ability. According to studies, Bulgarian bag workouts successfully develop the core, shoulders, arms, legs, and rotational muscles, resulting in increased muscular endurance and strength across numerous muscle groups (Abdel-Ghany & Al-Sayed, 2023; Ahmed Abd Alrhman Alagory, 2022). Bulgarian bag workouts test athletes in several planes of motion, improving coordination, balance, joint mobility, and grip strength (Azab, 2019). This holistic training strategy perfectly suits the multiple demands of Kabaddi, a sport that requires both aerobic and anaerobic strength. Male kabaddi players who engaged in regular BBT for several months saw considerable improvements in their agility, speed, strength, power and overall physical performance (Hajji & Aldimkhi, 2022). The information from study papers supports the idea that a 12-week BBT program significantly improved male kabaddi players' overall playing ability and skill level. By adopting this unique training regimen into the athlete's routine, kabaddi competitors saw significant improvements in their physical abilities, translating into improved court performance.

Strength and Limitation

One of the primary strengths of this study is the use of a structured BBT program specifically tailored to enhance the physical fitness and performance metrics relevant to male

kabaddi players. The study's comprehensive approach, incorporating a variety of bio-motor, physiological, haematological, and playing ability measures, provides a holistic understanding of the impacts of BBT. The significant improvements observed in agility, explosive strength, shoulder strength, muscular strength, resting heart rate, VO2 max, RBC, WBC, haemoglobin levels, and playing ability reveal the effectiveness of this training modality. Additionally, including a control group allows for a robust comparison, further validating the results.

Despite these strengths, the study has several limitations. Firstly, the sample size was relatively small, which may limit the generalizability of the findings. Future studies should include a larger, more diverse cohort to confirm these results. Secondly, the study duration was limited to 12 weeks. While significant improvements were noted, a more extended study period could provide insights into the long-term benefits and sustainability of the training effects. Additionally, the study focused exclusively on male kabaddi players; thus, the findings may not directly apply to female athletes or individuals participating in different sports. Lastly, the study did not account for potential dietary variations among participants, which could influence some physiological measures.

Practical Application

The findings of this study have practical applications for coaches and sports trainers working with kabaddi players and other athletes in similar high-intensity, dynamic sports. Implementing BBT into regular conditioning programs can significantly improve key performance metrics. The versatility of Bulgarian bag exercises makes them suitable for enhancing multiple aspects of physical fitness, including agility, strength, and cardiovascular health. Coaches should consider incorporating these exercises into their training regimens to optimize athlete performance and reduce injury risk. Furthermore, the study highlights the importance of structured and well-planned training programs to achieve specific fitness goals.

Conclusion

In conclusion, BBT is an effective method for enhancing male kabaddi players' physical fitness and performance. The significant improvements in various bio-motor, physiological, haematological, and playing ability measures demonstrate the comprehensive benefits of this training approach. While the study's limitations should be addressed in future research, the findings provide valuable insights into applying BBT in sports conditioning. By incorporating such training regimens, coaches and athletes can achieve significant advancements in physical capabilities, ultimately leading to better performance in competitive settings.

References

Abdel-Ghany, S. M. M., & Al-Sayed, H. N. Y. (2023). The Effect of The Bulgarian Bag on Osoto Gari Skill Performance Level in Judo. *Journal of Theories and Applications of Physical Education Sport Sciences*, *9*(1), 45–60.

Aguilera-Castells, J., Buscà, B., Morales, J., Solana-Tramunt, M., Fort-Vanmeerhaeghe, A., Rey-Abella, F., Bantulà, J., & Peña, J. (2019). Muscle activity of Bulgarian squat. Effects of additional vibration, suspension and unstable surface. *PLOS ONE*, *14*(8), e0221710. https://doi.org/10.1371/journal.pone.0221710

Ahmed Abd Alrhman Alagory, M. (2022). The effect of torso stability exercises using the aqua bag and the Bulgarian bag on some physical, skill and mechanical variables of handball players. *The Scientific Journal of Physical Education and Sports Sciences*, *46*(1), 233–253.

Amany, F. (2017). Effects of Bulgarian Bag Exercises on Power and Shot Speed for Handball Players. *Ovidius University Annals, Series Physical Education & Sport/Science, Movement & Health*, *17*(2). https://analefefs.ro/anale-fefs/2017/i2/pe-autori/AMANY%20Fathy.pdf

Antony, B., Maheswri, M. U., & Palanisamy, A. (2015). Impact of battle rope and Bulgarian bag high intensity interval training protocol on selected strength and physiological variables among school level athletes. *International Journal of Applied Research*, *1*(8), 403–406.

Arumugam, S., & Sivakumar, R. (2019). A Study on the Upshot of Bulgarian Bag Training on Core Strength and Shoulder Strength among Soccer Players. *Journal of Emerging Technologies and Innovative Research (JETIR)*, *6*(10).

Azab, M. (2019). Effects of Battle Rope Exercises on Power and Leaping Ability in Rhythmic Gymnasticsfor Female College Students. *Ovidius University Annals, Series Physical Education & Sport/Science, Movement & Health*, *19*. https://www.analefefs.ro/anale-fefs/2019/i2suplement/pe-autori/MANAL_AZAB.PDF

Balasingh, S., & Reeves, D. J. (2018). *Effect of interval and circuit training on Vo2 max of kabaddi players*. *3*(2), 186–187.

Bianco, A., Jemni, M., Thomas, E., Patti, A., Paoli, A., Roque, J., Palma, A., Mammina, C., & Tabacchi, G. (2015). A systematic review to determine reliability and usefulness of the field-based test batteries for the assessment of physical fitness in adolescents – The ASSO Project. *International Journal of Occupational Medicine and Environmental Health*, *28*. https://doi.org/10.13075/ijomeh.1896.00393

Bompa, T. O., & Haff, G. G. (2009). *Periodization Theoryand Methodology of Training*. Human Kinetics.

Borah, P., Hussain, I., Gogoi, L., Karuppasamy, G., Sarkar, S., Elayaraja, M., Ethiraj, B., & Gogoi, H. (2024). Effect of Mat Pilates Training Program on Functional Fitness in Older Adults. *Pedagogy of Physical Culture and Sports*, *28*(1), 16–25. http://dx.doi.org/10.15561/26649837.2024.0102

Brezze, M. R., & Kumar, M. S. (2023). Effect Of Cluster Training And Tabata Training On Speed Muscular

Strength And Vital Capacity Among Men Kabaddi Players. *Korean Journal of Physiology and Pharmacology*, *27*(2), 123–126.

Caglayan, A., & Ozbar, N. (2017). The Examination of The Effects of Functional Training Program Applied on Instable Ground on Anaerobic Capacities of Elite Martial Arts Athletes. *European Journal of Education Studies*. http://oapub.org/edu/index.php/ejes/article/view/1322

Duca, M., Trecroci, A., Perri, E., Formenti, D., & Alberti, G. (2020). Kinematics and Kinetics of Bulgarian-Bag-Overloaded Sprints in Young Athletes. *Life*, *10*(11). https://doi.org/10.3390/life10110282

El-Deeb, H. A.-A. (2017). Effect of bulgarian bag exercises on certain physical variables and performance level of pivot players in basketball. *Sci Mov Health*, 311–316.

Enes, A. S., Bruno; Oneda, Gustavo; Leonel, Danilo Fonseca; Bernardo, Mauro F. ;. Macedo, Ana Carolina G. ;. Alves, Ragami Chaves; De Souza, Eduardo Oliveira; Souza-Junior, Tácito P. (2024). Effects of Different Weekly Set Volumes on Strength and Perceptual Responses in Athletes. *International Journal of Sports Medicine*, *45*(09), 690–697. https://doi.org/10.1055/a-2312-5103

Gunasekar, T., & Balamurugan, S. (2021). Effects of Plyometric Training on Selected Motor Components in Semi-Professional Kabaddi Players – A Randomised Control Study. *Indian Journal of Physiotherapy & Occupational Therapy - An International Journal*, *15*(3), 184–192. https://doi.org/10.37506/ijpot.v15i3.16181

Hajji, S., & Aldimkhi, B. (2022). Effect of bulgarian bag exercises on anticipation and certain physical variables for kuwaiti sabre fencers. *Ovidius University Annals, Series Physical Education & Sport/Science, Movement & Health*, *22*(2). https://www.analefefs.ro/en/analefefs/2022/i2/pe-autori/15.%20SALMAN%20Hajji%20,%20BADEER%20Aldimkhi.pdf

Harding, A. T., Weeks, B. K., Horan, S. A., Little, A., Watson, S. L., & Beck, B. R. (2017). Validity and test–retest reliability of a novel simple back extensor muscle strength test. *SAGE Open Medicine*, *5*, 205031211668884. https://doi.org/10.1177/2050312116688842

Harriss, D. J., Macsween, A., & Atkinson, G. (2017). Standards for Ethics in Sport and Exercise Science Research: 2018 Update. *International Journal of Sports Medicine*, *38*(14), 1126–1131. https://doi.org/10.1055/s-0043-124001

Jumareng, H., Ram, J., Karuppasamy, G., Gogoi, H., Borah, P., Elayaraja, M., Setiawan, E., & Gogoi, L. (2023). Notational Analysis of Pro Kabaddi League in the Perspective of the Teams? Achievement. *Revista Iberoamericana de Psicologia Del Ejercicio y El Deporte*, *18*, 607–611.

Kaur, D., Malik, A., Govindasamy, K., Ks, S., Anand, M., Suresh, C., Anitha, J. B., Pramanik, M., Achouri, I., Boughanmi, H., & Chandrasekar, S. J. A. (2022). Comparative Analysis of Mean Platelet Volume Among female Volleyball, Rugby Players and Yoga Practitioners. *Health, Sport, Rehabilitation*, *8*(3). https://doi.org/10.34142/HSR.2022.08.03.04

Kollath, J. A., Safrit, M. J., Zhu, W., & Gao, L.-G. (1991). Measurement Errors in Modified Pull-Ups Testing. *Research Quarterly for Exercise and Sport*, *62*(4), 432–435. https://doi.org/10.1080/02701367.1991.10607545

Liao, K.-F., Nassis, G., Bishop, C., Yang, W., Bian, C., & Li, Y.-M. (2022). Effects of unilateral vs. bilateral resistance training interventions on measures of strength, jump, linear and change of direction speed: A systematic review and meta-analysis. *Biology of Sport*, *39*(3), 485–497. https://doi.org/10.5114/biolsport.2022.107024

Maki, M. T., Berliana, B., Nurjaya, D. R., & Novian, G. (2021). Increasing Upper Body Strength of Wrestling Athletes through Bulgarian Bag Exercise. *ACTIVE: Journal of Physical Education, Sport, Health and Recreation*, *10*(2), 71–76.

Pauole, K., K. Madole, J. Garhammer, M. Lacourse, & R. Rozenek. (2000). Reliability and validity of the t-test as a measure of agility, leg power, and leg speed in college-aged men and women. *Journal of Strength and Conditioning Research*, *14*(4), 443–450.

Petrov, L. A., Bozhilov, G., Alexandrova, A. V., Mugandani, S. C., & Djarova, T. G. (2014). Salivary alpha-amylase, heart rate and heart-rate variability in response to an experimental model of competitive stress in volleyball players science. *African Journal for Physical Health Education, Recreation and Dance*, *20*(21), 308–322.

Ram, J., & Singh, J. (2021). Relationship of Selected Anthropometric and Linear Kinematical Variables with the Performance of Toe-Touch Skill in Kabaddi. *Teorìâ Ta Metodika Fìzičnogo Vihovannâ*, *21*, 304–309. https://doi.org/10.17309/tmfv.2021.4.03

Ram, J., Singh, J., Singh, B., Gogoi, H., & Rather, N. M. (2022). Relationship of Selected Physical and Angular Kinematical Variables with the Performance of Toe-Touch Skill in Kabaddi. *Теорія Та Методика Фізичного Виховання*, *22*(4), 516–521. https://doi.org/10.17309/tmfv.2022.4.09

Schoenfeld, M. L. (2017). Increasing Strength and Power With Gada, Indian Clubs, Bulgarian Bags, and Other Tools of Concentric Strength. *Strength & Conditioning Journal*, *39*(1), 48–56.

Schulz, K. F., Altman, D. G., Moher, D., & CONSORT Group. (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomized trials. *Annals of Internal Medicine*, *152*(11), 726–732. https://doi.org/10.7326/0003-4819-152-11-201006010-00232

Shandryhos, V. I., & Shandryhos, H. A. (2024). *The Use of "Bulgarian Bag" In Physical Training Of Wrestlers*. http://dspace.tnpu.edu.ua/bitstream/123456789/32235/1/Shandryhos.pdf

Shete, A. N., Bute, S. S., & Deshmukh, P. R. (2014). A Study

of VO2 Max and Body Fat Percentage in Female Athletes. *Journal of Clinical and Diagnostic Research: JCDR*, *8*(12), BC01-03. https://doi.org/10.7860/JCDR/2014/10896.5329

Subradeepan, A. (2017). Effect of Continuous Running on Endurance of Men Kabaddi Players. *InternaüonalJourna1 of Research -GRANTHAALAYAH*, *5*(5 (SE)), 7–10. https://doi.org/10.29121/granthaalayah.v5.i5(SE).2017.1959

Tarabrina, N.Y., Kraev, Y.V., & Tikhonov, A.I. (2020). Physiological substantiation and practical implementation of methods of development of strength-building component of endurance training for wrestlers. *Theory and Practice of Physical Culture*, *2*, 3–3.

Utama, M. B. R., Sugiharto, S., Hidayah, T., Mukarromah, S. B., & Sutoro, S. (2022). Circuit training using elastic band: Can it improve the direction-changing agility of Kabaddi athletes? *SPORT TK-Revista EuroAmericana de Ciencias Del Deporte*, *11*, 21. https://doi.org/10.6018/sportk.522601

Vairavasundaram, C., & Palanisamy, A. (2015). Effect of Bulgarian Bag Training on Selected Physical Variables Among Handball Players. *Indian Journal of Applied Research*, *5*(3).

Datos de los/as autores/as y traductor/a:

Nithin B S	nithinbernad1@gmail.com	Autor/a
Ram Mohan Singh	dr.rammohansingh@gmail.com	Autor/a
Dilpreet Kaur	dilpreet.kaur2818@gmail.com	Autor/a
Yuni Astuti	yuniastuti@fik.unp.ac.id	Autor/a
Ahmad Chaeroni	ahmad.chaeroni@fik.unp.ac.id	Autor/a
Masilamani Elayaraja	elaya.cricket@gmail.com	Autor/a
Bekir Erhan Orhan	bekirerhanorhan@aydin.edu.tr	Autor/a
Yashwant Singh	yashwantbangerwa@live.com	Autor/a
Basavaraj Kumasi	basavaraj.kumasi@sbup.edu.in	Autor/a
Ethiraj Balaji	balajiethirajcbe@gmail.com	Autor/a
Edi Setiawan	edisetiawanmpd@gmail.com	Autor/a
Hemantajit Gogoi	gogoihemantajit@gmail.com	Autor/a
Karuppasamy Govindasamy	gowthamadnivog@gmail.com	Autor/a
Bekir Erhan ORHAN	bekirerhanorhan@aydin.edu.tr	Traductor/a