COMPARATIVE EFFICACY OF BODYWEIGHT AND FREE WEIGHTS TRAINING ON SHOOTING STRENGTH IN ROLLER HOCKEY

EFICACIA COMPARATIVA DEL ENTRENAMIENTO CON PESO EN HOCKEY SOBRE PATINES

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Abstract

This study evaluated the impact of an 8-week training program on two groups of players, one performing free weights training and the other bodyweight training. The sample consisted of 14 athletes with a mean age of 22.6 years. Assessments of shooting strength were conducted before and after the program, measuring shot speed, acceleration, and strength. The free weights training included exercises with dumbbells and barbells, while the bodyweight training included squats, push-ups, and planks. Sessions occurred twice a week, with gradual progress in the number of sets and repetitions. Statistical analyses were performed using GraphPad Prism software, with significance set at $p<0.05$. Data distribution was tested using the Shapiro-Wilk test, and comparisons between pre- and post-intervention assessments were made with paired t-tests. Results showed significant improvements in shot speed, acceleration, and strength in the free weights training group, while the bodyweight training group showed no significant changes. It was concluded that free weights training is more effective for improving shooting strength in roller hockey players.

Keywords: Free weights training, bodyweight training, strength, hockey, athletes.

Resumen

Este estudio evaluó el impacto de un programa de entrenamiento de 8 semanas en dos grupos de jugadores, uno que realizó entrenamiento con pesas libres y el otro entrenamiento con peso corporal. La muestra consistió en 14 atletas con una edad media de 22,6 años. Se realizaron evaluaciones de la fuerza de tiro antes y después del programa, midiendo la velocidad, la aceleración y la fuerza del tiro. El entrenamiento con pesas libres incluyó ejercicios con mancuernas y barras, mientras que el entrenamiento con peso corporal incluyó sentadillas, flexiones y planchas. Las sesiones se realizaron dos veces por semana, con un progreso gradual en el número de series y repeticiones. Los análisis estadísticos se realizaron utilizando el software GraphPad Prism, con una significancia establecida en p < 0,05. La distribución de los datos se probó utilizando la prueba de Shapiro-Wilk, y las comparaciones entre las evaluaciones previas y posteriores a la intervención se realizaron con pruebas t pareadas. Los resultados mostraron mejoras significativas en la velocidad, la aceleración y la fuerza del tiro en el grupo de entrenamiento con pesas libres, mientras que el grupo de entrenamiento con peso corporal no mostró cambios significativos. Se concluyó que el entrenamiento con pesas libres es más eficaz para mejorar la fuerza de tiro en jugadores de hockey sobre patines.

Palabras clave: Entrenamiento con pesas libres, entrenamiento con peso corporal, fuerza, hockey, atletas.

Introduction

The importance of shooting strength in hockey cannot be understated, as it significantly influences game performance, including the speed and accuracy of shots, and overall player effectiveness. Research has shown that shooting is a critical skill in both ice hockey and roller hockey, directly impacting match results and player performance (Novak et al., 2022). Specifically, the speed and strength of the player, as well as the level of maximum strength achieved, influence shooting in hockey (Ferreira et al., 2019).

Research in basketball, a sport with similarities to roller hockey, has shown that long-distance shooting has a significant impact on game dynamics, creating more space for players closer to the basket due to the higher accuracy of long-range shooters (García et al., 2013). Additionally, studies in basketball have highlighted the relationship between upper and lower body strength and shooting performance, emphasizing the importance of strength in discriminating winning from losing game outcomes (Cabarkapa et al., 2022). Furthermore, the role of neuromuscular control and postural stability in basketball shooting has been emphasized, indicating the importance of improving postural control for higher shooting levels (Zemková & Zapletalová, 2022).

Strength training in sports, including high-intensity team sports like ice hockey and rugby, has been a subject of extensive research. Studies have highlighted the importance of neuromuscular training and motor control in youth athletes, emphasizing the need for targeted training programs to enhance motor control of movement among young athletes (Williams et al., 2021). In ice hockey, the importance of shooting and passing as integral components of players' skill sets has been recognized, with these skills being prioritized in the early phases of players' journey to excellence (Huard Pelletier et al., 2021). Moreover, the significance of joint angle-specific hip strength for skating performance in ice hockey athletes underscores the importance of specific strength requirements for optimal performance in hockey-related activities (Secomb et al., 2021). Similarly, in roller hockey, agility has been identified as a crucial factor, with its relation to changes of direction being comparable to the conditions required among roller hockey players (Ferreira et al., 2019). The impact of strength training on shooting performance has been studied in various sports, including basketball and field hockey. Research has shown that rapid strength and shooting training applied to professional basketball players can significantly affect shooting percentage levels, highlighting the importance of combining shooting and strength training for improved performance (Savas et al., 2018). Similarly, specific strength training of the flick in field hockey through over-weighted balls has been shown to have effects on technical execution, emphasizing the potential benefits of targeted strength training for shooting skills (Pérez et al., 2005). In summary, shooting strength is a crucial determinant of game performance in roller hockey and ice hockey, influencing the speed and accuracy of shots, and overall player effectiveness. The findings from basketball and field hockey studies provide valuable insights into the importance of strength, agility, and neuromuscular control for shooting performance, highlighting the need for targeted strength training to enhance shooting skills in hockey.

Systematic reviews have been conducted to summarize the literature on concurrent training in team sports, providing insights into the effects of combined aerobic and anaerobic training on strength and jump performance measures in team sports (Seipp et al., 2023). Furthermore, a systematic review and meta-analysis have examined the effects of strength and conditioning interventions on sprinting performance in team sport athletes, providing valuable insights into the impact of strength training on sprinting performance (Murphy et al., 2023). Moreover, research has delved into the specific training approaches in sports such as ice hockey, with a longitudinal study monitoring ice hockey player with collective and individual training during pre-season preparation, shedding light on the relationship between training approach and physical performance in ice hockey players (Čerňanová et al., 2018). Additionally, studies have investigated the effects of contrast training programs on jump performance in rugby union players during a competition phase, providing valuable insights into the impact of specific training programs on athletic performance in team sports (Argus et al., 2012).

Despite studies on strength training in various sports, such as ice hockey and rugby, there are significant gaps in the literature regarding roller hockey. Few studies specifically address roller hockey players, highlighting the need to investigate how strength training impacts their performance. Additionally, it is essential to examine the effectiveness of different training modalities, such as bodyweight training versus free weights training, in improving athletic performance for roller hockey players. Therefore, this study aims to evaluate and compare the effects of bodyweight training and free weights training on the shooting strength of roller hockey players.

Materials and Methods

Participants

The sample consisted of 14 individuals, with a mean age of 22.6 ± 4.2 years, height of 175.5 ± 6.0 cm, body mass of 75.0 ± 7.9 kg, and body fat percentage of 15.5 ± 3.9%. All participants were athletes from a nationally renowned Portuguese roller hockey club, known for its tradition and importance in the development of young talents in the sport. Before participating in the study, all individuals were thoroughly informed about the procedures and were provided with a Free and Informed Consent Form (TCLE) to sign. This process included a detailed discussion of the potential risks and benefits of the research, ensuring that participants had the autonomy to decide whether to take part and the right to withdraw from the study at any time.

Study Design

The individuals were divided into two groups: a bodyweight (n=6) training group and a free weights (n=8) training group. The study duration was set at 8 weeks, based on several factors. Firstly, previous research suggests that significant improvements in strength and power can be observed within this period when appropriate training interventions are applied (Ferreira et al., 2019; Leong et al., 2014; Novak et al., 2022). Additionally, an 8-week duration provides sufficient time to implement structured training programs, monitor progress, and observe measurable changes in strength and throwing performance among participants (Cotter, 2022; Lagrange, 2022; Zhang & Zhang, 2022). This duration also balances the need to capture significant adaptations to the training interventions while minimizing potential dropouts or compliance issues that may arise in a longer study (Cotter, 2022). Furthermore, an 8-week period aligns with the typical duration of training blocks in athletic preparation and is practical for implementation within the schedules of roller hockey players and competitive seasons (Zhang & Zhang, 2022).

Training Protocols

The bodyweight training program included squats, lunges, push-ups, planks, and bodyweight rows. Participants performed these exercises twice a week for 8 weeks. The program started with 2 sets of 10 to 12 repetitions for each exercise in the first week, gradually progressing to 3 sets of 12 to 15 repetitions by the end of the 8-week period. The frequency and duration of the program were based on evidence from previous study (Cadore et al., 2010), which demonstrated significant improvements in strength and endurance with similar frequency and duration of bodyweight training. Additionally, proper attention was given to warm-up and cool-down. Table 1 provides a detailed description of the bodyweight training protocol.

Table 1
Description Bodyweight Training Program

Day 1	Sets	Reps
Squats	3	10 to 12
Push-ups	3	8 to 10
Planks	2	20 to 30 seconds
Day 2	**Sets**	**Reps**
Lunges	3	8 to 10 (each leg)
bw. Rows	3	10 to 12
Planks	2	30 to 40 seconds

The free weights training program involved exercises using dumbbells and barbells to target major muscle groups. Participants performed exercises such as squats, deadlifts, bench presses, overhead presses, and rows. The program was conducted twice a week for 8 weeks. It began with 2 sets of 8 to 10 repetitions for each exercise in the first week and progressed to 3 sets of 10 to 12 repetitions by the end of the 8-week period. Table 2 provides a detailed description of the free weights training protocol.

Table 2
Description Free Weights Training Program

Day 1	Sets	Reps
Barbell Squats	3	8 to 10
Bench Presses	3	8 to 10
Dumbbell rows	3	10 to 12
Day 2	**Sets**	**Reps**
Deadlifts	3	6 to 8
Overhead presses	3	8 to 10
Barbell Rows	3	10 to 12

The progression plan was based on the literature (Ho et al., 2012), which demonstrated improvements in cardiovascular risk factors and body composition with a similar duration and progression of resistance exercise. The loads were determined by the subject's perceived rate of exertion (i.e., 7/10), ensuring that quality repetitions were maintained. Additionally, proper attention was given to warm-up and cool-down exercises.

Measurement of Shooting Strength

The assessment of shooting strength involved the use of video analysis to determine the speed of the shot. Participants were filmed while performing a shot from a pre-established distance of nine meters, which is the distance from the penalty spot to the end board. The first step involved calculating the average velocity of the ball during the shot. This was achieved by analyzing the time taken for the ball to travel a set distance, which was predetermined and consistent for all shots (9 m). The velocity was determined by dividing this distance by the time recorded.

The next step was to estimate the acceleration of the ball. Acceleration was calculated as the change in velocity over time, assuming initial velocity of zero m/s and reached the calculated velocity within the recorded time frame. Finally, to calculate the average strength exerted during the shot, Newton's second law of motion (Strength = mass x acceleration) was applied. The mass of the ball is 155 grams. By multiplying this mass by the calculated acceleration, the average strength exerted in the shot was determined, providing a quantifiable measure of shooting strength.

Baseline and Follow-Up Assessments

The baseline assessment was conducted at the start of the 8-week training program, during which participants' anthropometric measurements were recorded using a stadiometer and bioimpedance analysis. In addition, each participant executed a shot from a predetermined distance, and these actions were captured on video for analysis. The videos were then examined to ascertain the speed of each shot. A follow-up assessment was carried out at the conclusion of the 8-week program, replicating the initial measurements and analyses. These two evaluation points were compared using JASP software to determine any variations in shooting strength that occurred throughout the training program. All training for this study was undertaken at a similar time of day with subjects instructed to maintain their normal dietary intake before and after each workout. We did not control for nutrition, or hydration levels, but subjects were told not to make any changes in the above during the intervention. No injuries were reported as part of the training intervention.

Statistical Analysis

The data are presented as mean ± standard deviation (SD). The Shapiro-Wilk test was used to assess normality. To compare between a cup match and a league match, paired Student's t-tests were employed. All statistical analyses were conducted using GraphPad Prism 6.0 software. The significance level was set at 5% ($p \leq 0.05$).

Results

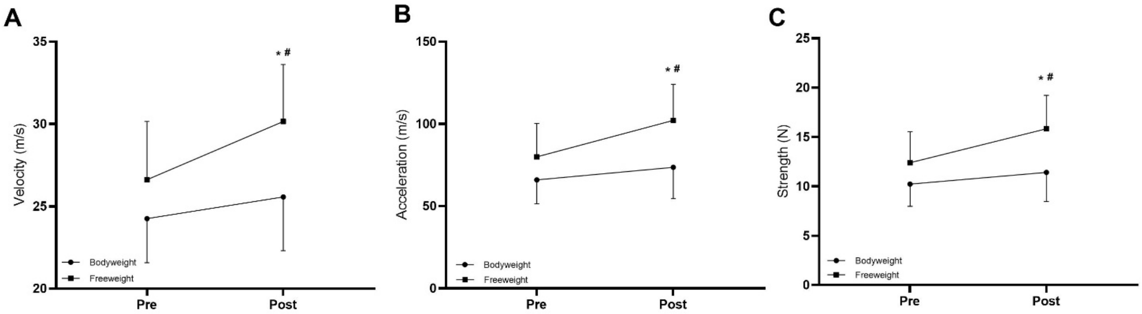
Table 3 presents the characterization data of the sample and its respective groups. The average age of the participants was 22.6 ± 4.2 years. Specifically, the Body Weight group had an average age of 23.2 ± 5.5 years, while the Free Weights group had an average age of 22.3 ± 3.3 years. The overall average height of the participants was 175.5 ± 6.0 cm. The Body Weight group had an average height of 171.67 ± 4.3 cm, compared to an average height of 178.3 ± 5.7 cm in the Free Weights group. In terms of body mass, the participants had an average weight of 75.0 ± 7.9 kg. The Body Weight group had an average weight of 72.0 ± 7.3 kg, while the Free Weights group had an average weight of 77.2 ± 8.0 kg. Finally, the average body fat percentage was 15.5 ± 3.9%. In the Body Weight group, the average was 17.2 ± 3.5%, whereas in the Free Weights group, the average was 14.2 ± 3.9%.

Table 3
Characterization Data of the Sample and its Respective Groups

Parameters	All subjects (n = 14)	Bodyweight (n = 6)	Free Weight (n = 8)
Age(y)	22.6 ± 4.2	23.2 ± 5.5	22.3 ± 3.3
Height (cm)	175.5 ± 6.0	171.67 ± 4.3	178.3 ± 5.7
Body mass (KG)	75.0 ± 7.9	72.0 ± 7.3	77.2 ± 8.0
Body fat (%)	15.5 ± 3.9	17.2 ± 3.5	14.2 ± 3.9

Figure 1 illustrates the variables analyzed at pre- and post-intervention stages for the Bodyweight and Free weight training groups. The main results indicated that, in the Bodyweight group, there were no significant changes in velocity, acceleration, or strength between the pre- and post-intervention assessments. Conversely, the Free weight group experienced significant improvements in velocity (<0.0001), acceleration (<0.0001), and strength (<0.0001) from pre- to post-intervention. Comparisons between the groups revealed no significant differences in the analyzed variables before the intervention. However, post-intervention, the Free weight group showed significant increases in velocity (0.027), acceleration (0.026), and strength (0.026) compared to the Bodyweight group.

Figure 1
Comparison of Performance Variables pre- and Post-intervention in Bodyweight and Free Weight Training Groups



*P<0.05 vs. Pré; #P<0.05 vs. Post Bodyweight.

Discussion

The present study aimed to compare the effects of 8 weeks of a bodyweight training program versus a free weights training program on the shooting strength of roller hockey players. The main results indicated that free weights training was effective in significantly increasing the speed, acceleration, and shooting strength of the athletes, while bodyweight training did not show significant improvements in these parameters. These findings suggest that free weights training may be a more effective approach for enhancing shooting performance in roller hockey players.

Roller hockey is a sport that requires high technical skill, strength, agility, and power (Rodríguez, 1991; Stastny et al., 2018). In this context, shooting strength is particularly important as it directly influences the effectiveness of shots, impacting the outcomes of matches. Given the importance of shooting strength, various training methods have been employed to enhance this skill, including bodyweight training and free weights training.

Bodyweight training is widely recognized for its benefits in improving general fitness and muscular endurance, offering an accessible option that can be performed with little to no equipment (Baechle & Earle, 2019; Thompson, 2018). However, the results of this study indicate that while bodyweight training may contribute to overall physical conditioning, it may not be sufficiently effective for increasing strength in specific skills, such as shooting in roller hockey. This limitation is associated with the lack of progressive overload, a crucial element for developing maximum strength and muscular power (Scantlebury et al., 2018). Although the study did not find statistically significant differences in shooting strength within the free weights training group over the 8 weeks, there was a trend of increasing performance parameters. This trend suggests that a longer training period could reveal more pronounced improvements.

On the other hand, free weights training proved to be significantly more effective in improving shooting strength among roller hockey players. This method allows for progressive overload, which is essential for promoting muscle adaptations and continuous strength gains (Teixeira et al., 2021; Teixeira et al., 2022). Additionally, the ability to target specific muscle groups and adjust the load as needed highlights free weights training as a powerful tool for developing specific athletic skills. The results of this study are consistent with existing literature, which points to the superiority of free weights training in improving strength and muscular power, essential components for optimized performance in roller hockey (Teixeira et al., 2021; Teixeira et al., 2022).

Finally, this study presents some limitations that should be considered when interpreting the results, such as the short duration of the intervention, the small sample size, and the absence of a control group. For future research, it would be ideal to extend the duration of training interventions, incorporate nutritional strategies that optimize strength gains, and include a control group. These measures could provide a more robust and detailed analysis of the effects of different training modalities on the performance of roller hockey players.

Conclusions

We conclude that free weights training, conducted over 8 weeks, is more effective in improving the speed, acceleration, and shooting strength of roller hockey players compared to bodyweight training.

Ethics Committee Statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee: Instituto Superior de Ciências Educativas do Douro (registration code 31142, date September 2020).

Conflict of Interest Statement

Authors must declare no conflicts of interest.

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Authors' Contribution

Conceptualization E.P & P.R; Methodology E.P & P.A.; Software E.P; Validation E.P & P.R; Formal Analysis E.P & P.R; Investigation E.P; Data Curation P.R.; Writing – Original Draft E.P., L.B.L., J.E.T. & P.F.; Writing – Review & Editing L.B.L. & P.F; Visualization E.P & P.R.; Supervision PF and P.R.; Project Administration E.P & P.R. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author (pedromiguel.forte@iscedouro.pt).

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