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The Impact of Exercise Order on Velocity Performance in the Bench Press and the Squat: A Comparative Study

Rogério Martins Pereira [1,2], Diogo Luís Marques [1,2], Ana Ruivo Alves [1,2], Daniel Almeida Marinho [1,2], Pedro Pombo Neves [1,2], António José Silva [2,3,*] and Henrique Pereira Neiva [1,2,*]

[1] Department of Sport Sciences, University of Beira Interior, Convento de Santo António, 6200-001 Covilhã, Portugal; rogerio.pereira@ubi.pt (R.M.P.); diogo.marques@ubi.pt (D.L.M.); asra@ubi.pt (A.R.A.); marinho.d@gmail.com (D.A.M.); pedroneves93@hotmail.com (P.P.N.)
[2] Research Center in Sports Sciences, Health Sciences and Human Development (CIDESD), Convento de Santo António, 6200-001 Covilhã, Portugal
[3] Department of Sport Sciences, University of Trás-os-Montes and Alto Douro (UTAD), 5000-801 Vila Real, Portugal
* Correspondence: ajsilva@utad.pt (A.J.S.); hpn@ubi.pt (H.P.N.)

Abstract: We analyzed the influence of exercise order using the bench press and squat as the first or second exercise of the session on velocity performance. Ten male trained individuals (20.9 ± 0.7 years) randomly performed two protocols of three sets of six repetitions at 80% of their one-repetition maximum with different exercise sequences: the bench press followed by the squat (BP + S) and the squat followed by the bench press (S + BP). A linear velocity transducer attached to the Smith machine barbell measured the mean propulsive velocity (MPV), peak velocity (PV), and time to peak velocity. Additionally, blood lactate and heart rate were measured. Regarding the bench press, differences were found in the MPV in the first (BP + S: 0.50 ± 0.07 $m{\cdot}s^{-1}$ vs. S + BP: 0.42 ± 0.08 $m{\cdot}s^{-1}$; $p = 0.03$, g = 0.72) and second sets (0.50 ± 0.06 $m{\cdot}s^{-1}$ vs. 0.42 ± 0.07 $m{\cdot}s^{-1}$; $p = 0.03$, g = 0.73), and in the PV in the second set (0.74 ± 0.09 $m{\cdot}s^{-1}$ vs. 0.63 ± 0.09 $m{\cdot}s^{-1}$; $p = 0.02$, g = 0.86). Regarding the squat, although the S + BP sequence tended to show higher velocities, no significant differences were found between protocols. These results showed that squatting first decreased subsequent bench press velocity performance. On the other hand, squat velocity performance was not impaired when preceded by the bench press.

Keywords: strength; mechanical variables; exercise sequence; monitoring; performance

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1. Introduction

Programming resistance training requires a solid understanding of the acute variables involved in training, their manipulation, and their combination to achieve the intended results [1,2]. Training volume, load or intensity, exercise selection, frequency, rest periods between sets and exercises, movement velocity, and exercise order are critical acute variables that strength and conditioning coaches and researchers must consider when designing and monitoring resistance training programs [1,2].

Regarding exercise order, research indicates that it is advised to prioritize larger muscle groups and multiple-joint exercises, such as the squat and bench press, at the beginning of a resistance training session [3,4]. Exercises performed last are intimately associated with decreased performance, regardless of the muscle mass recruited within a training session [3,4]. Furthermore, subjects tend to achieve greater strength and hypertrophy gains in exercises and muscle groups involved in the first exercise of the resistance training session [1,3,4]. These findings suggest that resistance exercises that best address the subject's needs and goals should be prioritized first within a training session. without disregarding other acute variables and training principles [1,3,4].

In order to obtain a deeper insight into the responsiveness to different resistance exercise orders, Neves et al. [5] monitored mechanical power in the bench press and squat. In a crossover design, subjects randomly performed two resistance training sessions with three sets of six repetitions at 80% of their one-repetition maximum (1 RM) using the bench press followed by the squat (condition 1) and the squat followed by the bench press (condition 2). The data showed that squatting before the bench press decreased mechanical performance in the latter exercise. Conversely, no decreases in squat mechanical performance were observed when performing the bench press first. A possible explanation for these results may be related to the greater cardiovascular, metabolic, and neuromuscular demands required by the squat compared to the bench press [5,6].

Despite these novel findings, to our knowledge, there is no research regarding the effects of exercise order on squat and bench press velocity performance. From a strength and conditioning coach and researcher perspective, it is essential to analyze whether squatting first in the session affects bench press velocity performance and vice versa to refine the design of resistance training sessions according to the individual targets.

Regarding velocity variables to assess and monitor strength performance, research indicates that the mean propulsive velocity (MPV) is critical when programming and monitoring resistance training [7]. The MPV only considers the propulsive phase of the lift (i.e., the portion of the concentric phase in which the barbell acceleration is higher than gravity) and avoids underestimating the strength potential when lifting low and moderate relative loads with maximal intended velocities [7,8]. Alongside the MPV, the peak velocity (PV) and time to peak velocity (TPV) assume great relevance in monitoring and testing sport-specific movements performed with maximal intended velocities, such as throws, sprints, and jumps [9–13]. Furthermore, researchers have also shown that the PV can be used to monitor short- and long-term squat and bench press performance [14–16].

Given the relevance of the MPV, PV, and TPV in monitoring resistance training, it is essential to analyze their response pattern to different exercise orders using the most commonly performed strength exercises, the squat and bench press. Therefore, based on these premises, we aimed to analyze the influence of exercise order using the bench press and squat as the first or second exercise of the session on the MPV, PV, and TPV. In addition, we compared the blood lactate and heart rate responses between protocols to understand the metabolic and hemodynamic demands of both exercises when performed in different sequences. We hypothesized that performing the squat first would decrease subsequent bench press velocity performance, while no squat velocity decreases would occur when performing the bench press first. In addition, we expected to observe higher blood lactate and heart rate levels when performing the bench press followed by the squat exercise.

2. Materials and Methods

2.1. Study Design

In a crossover study design, ten male sports science students performed four sessions interspersed with 48 h of rest. We familiarized the participants with the testing procedures and training sessions in the first session, while in the second session, we implemented the progressive loading test in the bench press and squat. In the third and fourth sessions, the participants randomly performed the resistance training protocols using the bench press and squat with different exercise orders: the bench press followed by the squat (BP + S) and the squat followed by the bench press (S + BP). We measured the MPV, PV, and TPV of each repetition performed in both protocols and blood lactate and heart rate before and after the protocols. Two strength and conditioning coaches and researchers supervised all sessions. Figure 1 illustrates the study design.

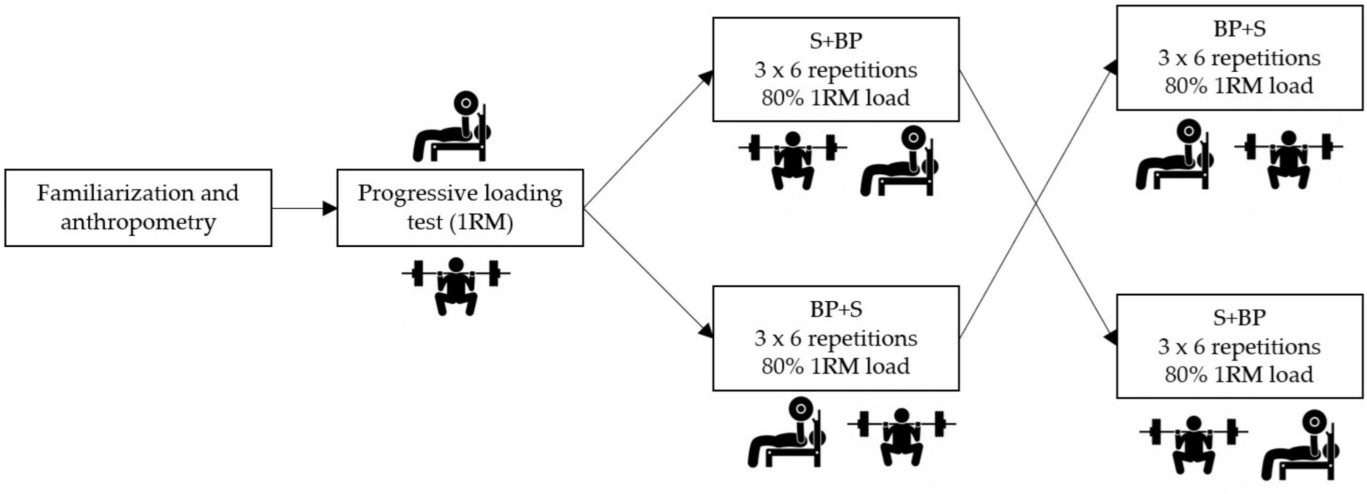

Figure 1. Study design. 1 RM = 1-repetition maximum. BP + S = bench press followed by squat; S + BP = squat followed by bench press. Each stage corresponds to one session.

2.2. Participants

Based on previous similar outcomes [4,17], a priori analysis suggested that a minimum sample size of 11 participants was needed to observe a 0.04 m·s^{-1} change in movement velocity, with an alpha = 0.05 and statistical power = 0.80 [18]. A drop-out rate of 10% was also considered. The inclusion criteria for participation were male individuals aged 18 years or over, consistently engaging in resistance training in the last six months and performing the squat and bench press in their training routines, able to complete the experimental procedures, and having no clinical conditions that could risk their health during the performance of exercises. All subjects were informed about the experimental procedures and provided informed consent to participate in the study. The University of Beira Interior Ethics Committee approved the study (CE-UBI-Pj-2021-018), which follows the recommendations of the Declaration of Helsinki. Of the 16 participants who provided consent, 2 were excluded for not meeting the inclusion criteria, and therefore, 14 were randomly divided into the two sequences, specifically S + BP (n = 7) or BP + S (n = 7). Throughout the data collection process, two participants of each sequence were excluded (lost to follow-up or dropped out without a specific reason). Thus, 10 male sports science students remained for the final analysis (Figure 2). Table 1 presents the characteristics of the participants at baseline.

Table 1. Participants' characteristics at baseline (n = 10).

Variable	Mean ± SD
Age (years)	20.9 ± 0.7
Height (cm)	175.7 ± 9.7
Body mass (kg)	73.9 ± 7.3
1 RM bench press (kg)	77.0 ± 18.3
Bench press relative strength	1.0 ± 0.2
1 RM squat (kg)	91.0 ± 16.3
Squat relative strength	1.2 ± 0.3

1 RM = one-repetition maximum load.

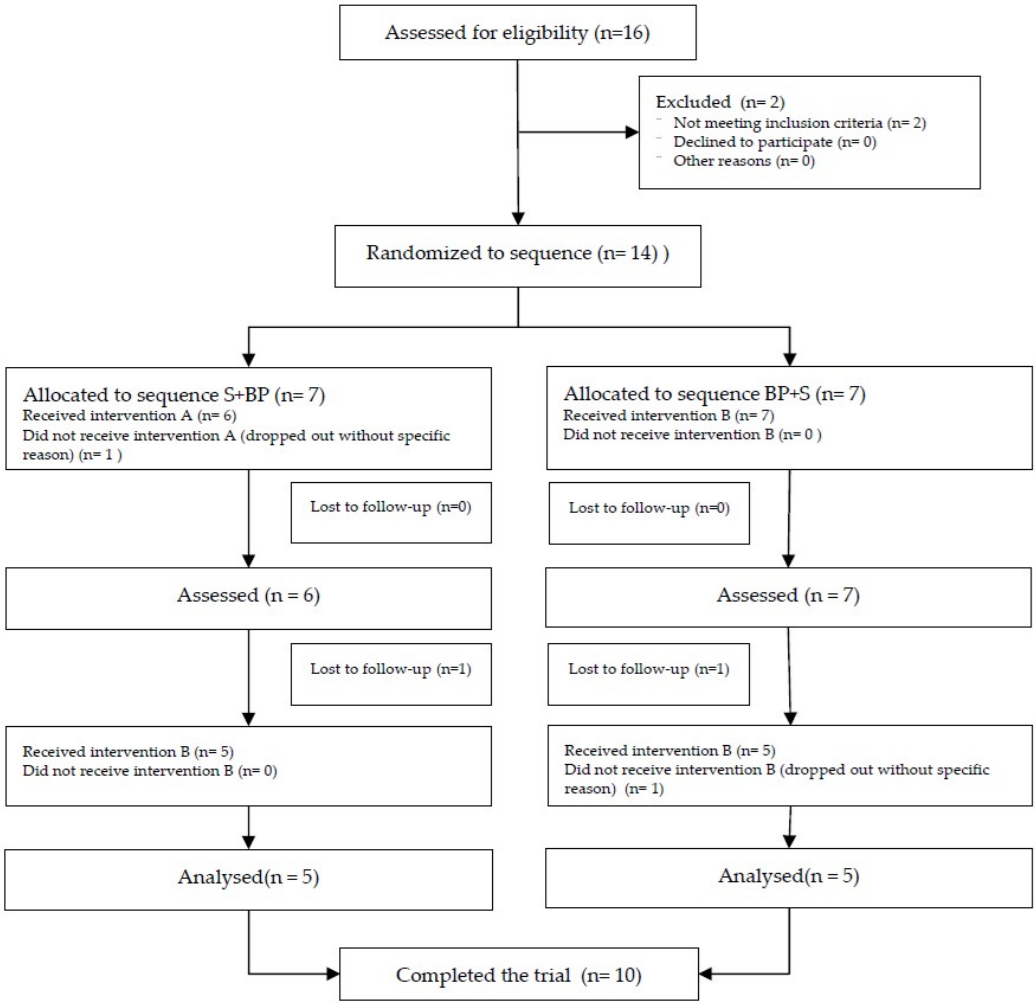

Figure 2. Study flow diagram. BP + S = bench press followed by squat; S + BP = squat followed by bench press.

2.3. Procedures

2.3.1. Familiarization Session

In the first session, we measured each subject's height and body mass (Seca Instruments, Ltd., Hamburg, Germany) and gave instructions regarding the specific execution techniques in the bench press and squat following procedures described elsewhere [7,19]. We also identified the correct position for each subject, which was then used during testing and training protocols.

2.3.2. Progressive Loading Test in the Bench Press and Squat

In the second session, we implemented the progressive loading test in the bench press and squat following the procedures described elsewhere [7,19]. Moreover, the reliability and validity of assessments have been already reported [8,20,21]. Both exercises were performed using a Smith machine (Multipower Fitness Line, Perola, Murcia, Spain) with a linear velocity transducer (T-Force Dynamic Measurement System, Ergotech, Murcia, Spain) attached to the barbell. For the bench press, participants started supine with their feet on the floor, elbows extended, and hands shoulder-width apart. They descended the barbell in a controlled manner until it touched their chest. Between the eccentric and concentric phases, there was a 2 s pause to allow for more reliable measurements. The concentric phase was performed with the maximal intended velocity. For the squat, participants started upright with their knees fully extended, feet shoulder-width apart, and the barbell placed on their upper trapezius. They descended the barbell in a controlled manner until they reached full knee flexion (full squat) and immediately performed the concentric phase with the maximal intended velocity without jumping off the ground (heel raise was allowed). All participants began the tests with a weight of 20 kg, which was progressively increased by 5–10 kg until an MPV of 0.40 m·s^{-1} on the bench press and 0.60 m·s^{-1} on the squat was reached [8,17]. An inter-set rest period of 3–5 min was provided. In the bench press, the participants performed three repetitions for an MPV > 1.00 m·s^{-1}, two repetitions for an MPV between 0.65 and 1.00 m·s^{-1}, and one repetition for an MPV < 0.65 m·s^{-1} [7]. In the squat, the participants performed three repetitions for an MPV > 1.15 m·s^{-1}, two repetitions for an MPV between 0.70 and 1.15 m·s^{-1}, and one repetition for an MPV < 0.70 m·s^{-1} [19]. We estimated the 1 RM loads through the following load–velocity equations [8,17]: 1 RM bench press: $(100 \times \text{load})/(8.4326 \times \text{MPV}^2) - (73.501 \times \text{MPV}) + 112.33$; 1 RM squat: $(100 \times \text{load})/(-5.961 \times \text{MPV}^2) - (50.71 \times \text{MPV}) + 117$.

2.3.3. Resistance Training Protocols and Data Collection

Participants were randomly divided into two groups, each assigned to complete the BP + S and S + BP protocols (according to a computer-generated allocation schedule). Having completed the assigned protocol, both groups were then instructed to perform the exercises in the reverse order, corresponding to the remaining protocol, in different sessions (Figures 1 and 2). In both protocols, the subjects performed the Smith machine squat and Smith machine bench press exercises using the same execution technique described for the tests. The warm-up consisted of two sets of six repetitions at 32% and 64% of their 1 RM load for the first exercise of each protocol [22]. Then, participants performed three sets of six repetitions at 80% of their 1 RM for each exercise, with a 3 min inter-set rest period. Between each protocol, participants had at least 48 h of rest to ensure optimal performance in each session. We attached the cable of the T-Force System to the Smith machine barbell to measure each repetition's MPV, PV, and TPV and registered the maximum value for further analysis. We also measured blood lactate using a hand-held portable device (Lactate Pro 2 LT-1730, Arkray Inc., Tokyo, Japan) and heart rate using a Polar band (Polar H10, Electro, Kempele, Finland) before and immediately after each protocol.

2.4. Statistical Analysis

The sample size was estimated using Microsoft Office Excel v.2407 (Microsoft Inc., Redmond, WA, USA) with a spreadsheet (Sample Size Calculator v2.0) available online [18]. We used SPSS v28.0 (IBM Corp., Armonk, NY, USA) to conduct the statistical analysis and GraphPad Prism v7 (GraphPad Inc., San Diego, CA, USA) to generate the figures. We calculated descriptive statistics for each variable, such as means, standard deviations, and 95% confidence intervals. We analyzed and confirmed the normality of the data with the Shapiro–Wilk test. Paired samples *t*-tests compared the velocity data of each exercise after the protocols (i.e., squat velocity after BP + S vs. squat velocity after S + BP and bench press velocity after BP + S vs. bench press velocity after S + BP). Furthermore, paired *t*-tests compared the relative differences (percentage of change) between protocols in terms of blood lactate and heart rate responses. We set the statistical significance at a bilateral $p < 0.05$ and calculated the effect size (Hedges g) to compare the magnitude of the differences. The effect size (g) was interpreted as follows: trivial, 0.0–0.2; small, 0.2–0.6; moderate, 0.6–1.2; large, 1.2–2.0; very large, 2.0–4.0; and extremely large, >4.0 [23].

3. Results

3.1. Bench Press and Squat Velocity Performance

Table 2 shows the bench press velocity performance after the BP + S and S + BP protocols. There were significant differences between protocols only in the MPV after the first and second training sets and in the PV after the second set. These results indicate that performing the squat first decreased the subsequent bench press velocity performance. This is particularly notable when the MPV is analyzed in each repetition and compared between conditions. In Figure 3, it is evident that the bench press was faster when performed before the squat (BP + S), especially in the first set. In this set, five out of six repetitions showed higher values, while in the second and third sets, three repetitions were found to be faster. There was a tendency to achieve these higher values in the first repetitions.

Table 2. Comparison between training protocols on bench press performance after each set.

Variable	BP + S	S + BP	Difference (95% CI)	*p*	*g*-Value
MPV-S1 ($m \cdot s^{-1}$)	0.50 ± 0.08	0.42 ± 0.08	0.07 (0.01 to 0.14)	**0.03** *	0.81
MPV-S2 ($m \cdot s^{-1}$)	0.50 ± 0.07	0.42 ± 0.08	0.08 (0.01 to 0.14)	**0.03** *	0.94
MPV-S3 ($m \cdot s^{-1}$)	0.47 ± 0.07	0.42 ± 0.06	0.05 (−0.01 to 0.11)	0.07	0.73
PV-S1 ($m \cdot s^{-1}$)	0.75 ± 0.12	0.65 ± 0.12	0.09 (−0.01 to 0.20)	0.08	0.72
PV-S2 ($m \cdot s^{-1}$)	0.74 ± 0.11	0.62 ± 0.10	0.11 (0.03 to 0.20)	**0.01** *	1.03
PV-S3 ($m \cdot s^{-1}$)	0.68 ± 0.12	0.61 ± 0.08	0.07 (−0.01 to 0.15)	0.09	0.59
TPV-S1 ($m \cdot s^{-1}$)	1040.30 ± 258.57	1162.40 ± 352.79	−122.10 (−343.08 to 98.88)	0.24	−0.36
TPV-S2 ($m \cdot s^{-1}$)	1075.10 ± 202.98	1136.00 ± 267.14	−60.90 (−254.25 to 132.45)	0.49	−0.23
TPV-S3 ($m \cdot s^{-1}$)	1043.20 ± 199.92	1109.80 ± 209.62	−66.60 (−270.58 to 137.38)	0.48	−0.30

* $p < 0.05$; p in bold denotes statistical significance; data are presented as mean ± standard deviation unless otherwise stated. BP + S, bench press followed by squat; S + BP, squat followed by bench press; CI: confidence interval; g: Hedge's g effect size; MPV: mean propulsive velocity; PV: peak velocity; TPV: time to peak velocity; S, set.

Table 3 shows the squat velocity performance after the BP + S and S + BP protocols. Although the S + BP protocol exhibited higher squat velocity values in all variables compared to the BP + S protocol, there were no significant differences between protocols in terms of squat velocity performance. These results can be confirmed in Figure 3, where it can be verified that the MPV value in each repetition of the squat exercise was not different between the conditions assessed.

Table 3. Comparison between training protocols on squat velocity performance after each set.

Variable	BP + S	S + BP	Difference (95% CI)	*p*	*g*-Value
MPV-S1 ($m \cdot s^{-1}$)	0.62 ± 0.09	0.65 ± 0.10	−0.03 (−0.08 to 0.02)	0.22	−0.29
MPV-S2 ($m \cdot s^{-1}$)	0.63 ± 0.09	0.63 ± 0.12	−0.01 (−0.07 to 0.06)	0.86	−0.05
MPV-S3 ($m \cdot s^{-1}$)	0.61 ± 0.07	0.61 ± 0.10	0.00 (−0.04 to 0.04)	1.00	0.00
PV-S1 ($m \cdot s^{-1}$)	1.14 ± 0.14	1.21 ± 0.13	−0.07 (−0.19 to 0.04)	0.18	−0.49
PV-S2 ($m \cdot s^{-1}$)	1.15 ± 0.11	1.16 ± 0.18	−0.01 (−0.13 to 0.11)	0.86	−0.06
PV-S3 ($m \cdot s^{-1}$)	1.12 ± 0.10	1.11 ± 0.17	0.00 (−0.10 to 0.11)	0.95	0.02
TPV-S1 ($m \cdot s^{-1}$)	735.50 ± 93.44	849.30 ± 311.05	−113.80 (−324.17 to 96.57)	0.25	−0.45
TPV-S2 ($m \cdot s^{-1}$)	802.90 ± 149.38	810.00 ± 164.12	−7.10 (−83.25 to 69.05)	0.84	−0.04
TPV-S3 ($m \cdot s^{-1}$)	806.20 ± 195.80	881.80 ± 216.52	−75.60 (−191.78 to 40.58)	0.18	−0.34

Data are presented as mean ± standard deviation unless otherwise stated. BP + S, bench press followed by squat; S + BP, squat followed by bench press; CI: confidence interval; g: Hedge's g effect size; MPV: mean propulsive velocity; PV: peak velocity; TPV: time to peak velocity; S, set.

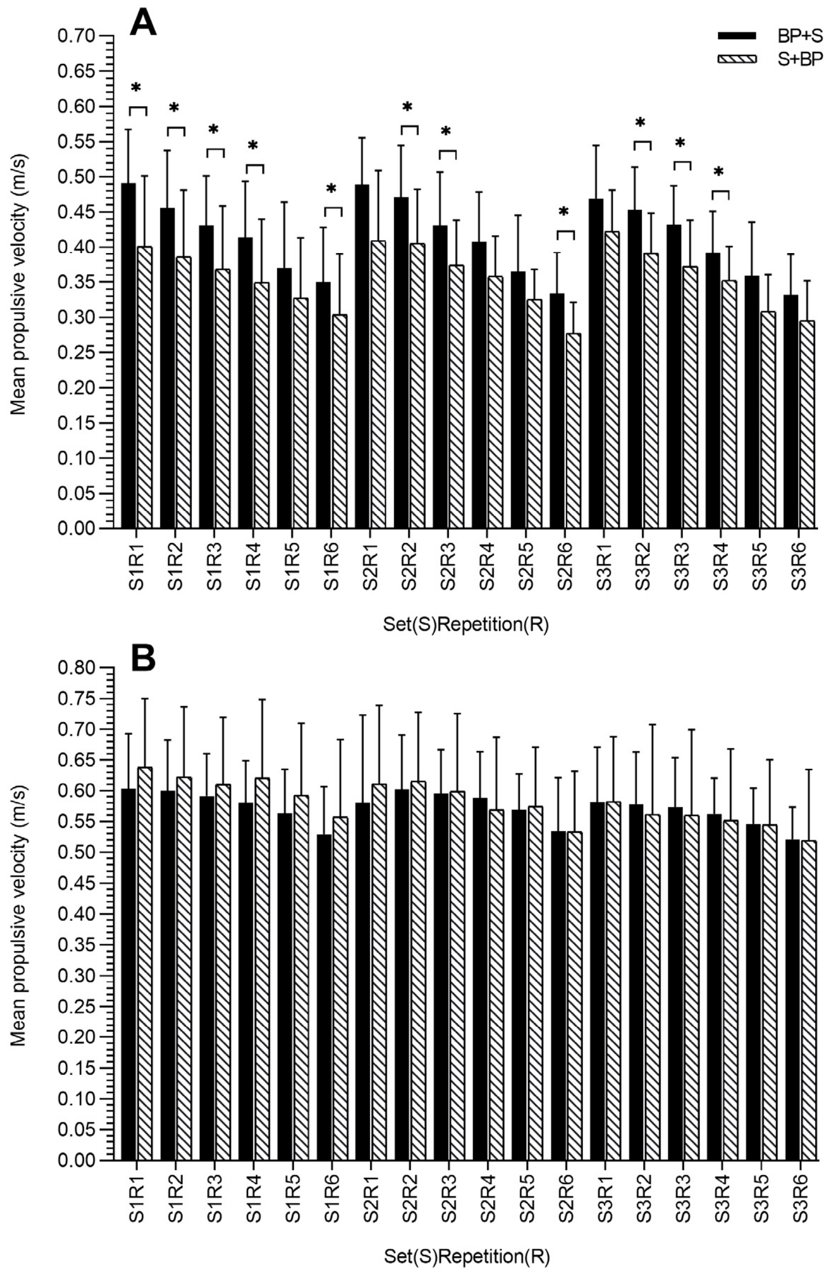

Figure 3. The mean propulsive velocity values in each repetition performed during the bench press (**A**) or squat (**B**). The values were obtained in the six repetitions (R1 to R6) during the first (S1), second (S2), and third set (S3) after the protocols: the bench press followed by the squat (BP + S) or the squat followed by the bench press (S + BP). * $p \leq 0.05$.

3.2. Blood Lactate and Heart Rate Responses

Figure 4 shows the relative differences between the BP + S and S + BP protocols in terms of blood lactate and heart rate measures. We did not observe significant differences between protocols ($p > 0.05$). Blood lactate increased from 1.8 ± 0.2 mmol/L to 6.2 ± 1.7 mmol/L after the BP + S protocol and from 1.8 ± 0.2 mmol/L to 6.5 ± 1.0 mmol/L after the S + BP protocol. Heart rate increased from 69.1 ± 6.9 bpm to 117.8 ± 13.4 bpm after the BP + S protocol and from 68.7 ± 7.5 bpm to 124.2 ± 12.8 bpm after the S + BP protocol.

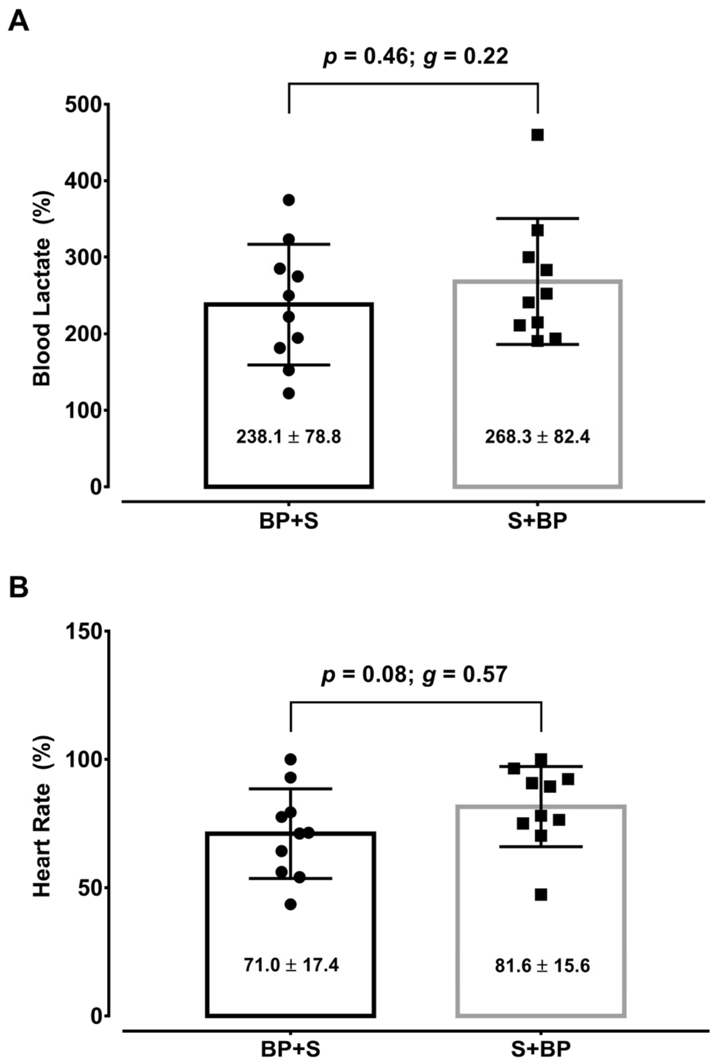

Figure 4. Relative differences between bench press followed by squat (BP + S) protocol (black circles) and squat followed by bench press (S + BP) protocol (black squares) in terms of blood lactate (**A**) and heart rate (**B**). g: Hedge's g effect size.

4. Discussion

This study analyzed the influence of exercise order using the bench press and squat as the first or second exercise of the session on velocity performance. The main findings show that performing the squat as the first exercise of the resistance training session negatively impacted subsequent bench press velocity performance. On the other hand, performing the bench press as the first exercise of the resistance training session did not decrease subsequent squat velocity performance. Therefore, these results align with our first study hypothesis which was designed based on previous results [4,5]. Considering the possibility of the order of exercises impacting the level of effort and metabolic contributions [24,25], it was expected that blood lactate and heart rate values would be higher when performing the squat as the last exercise (i.e., this exercise induces higher metabolic and hemodynamic stress than the bench press) [6]. Nevertheless, our results did not demonstrate significant differences between the BP + S and S + BP protocols in terms of blood lactate and heart rate responses, thus challenging our second hypothesis of observing a higher hemodynamic and metabolic response when performing the squat after the bench press exercise.

The impact of exercise order on performance outcomes is well documented in the literature, with a consensus that exercises performed earlier in a session tend to benefit from greater performance due to lower levels of fatigue [3,4]. Simão et al. [4] highlighted that exercise order significantly influences repetition performance, with exercises at the beginning of a session allowing for greater total repetitions and training volume. This aligns with our findings where bench press performance was compromised when preceded by the squat. In the bench press, the MPV was lower in the S + BP protocol in the first and second sets, and this trend was similar to that of the PV. Moreover, almost all repetitions of the first set were performed with a lower MPV, and this dropped to half of the repetitions in subsequent sets, even when the mean value analysis did not indicate significant differences (i.e., the third set). It can be hypothesized that the difference in the muscle mass recruited in the bench press and squat exercises (more prominent in the latter) played a significant role in these observations [4,5].

The observed reduction in bench press velocity following the squat-first sequence can be attributed to several mechanisms, primarily related to fatigue and neuromuscular demands. The squat, being a multi-joint exercise that recruits large muscle groups, induces substantial neuromuscular fatigue, which likely diminishes the central nervous system's ability to effectively recruit the muscles needed for the bench press, reducing force production [3–5]. Previous findings noted that when larger muscle group exercises are performed first, they can create a level of fatigue that impairs the performance of subsequent smaller muscle group exercises [3–5]. Furthermore, energy expenditure is higher when an exercise is performed later in a session, likely due to accumulated fatigue [26]. Miranda et al. [27] further support these findings by demonstrating that upper body exercises performed later in a session, such as after a squat, suffer from reduced repetition performance, particularly when shorter rest intervals are used. In fact, cumulative total force production was shown to be higher when structural, multi-joint exercises like squats were performed first, with subsequent exercises exhibiting reduced force output [28]. This likely stems from the neuromuscular fatigue induced by the initial high-demand exercise, which can impair performance in subsequent exercises involving smaller muscle groups, as seen in our study.

Additionally, our study did not observe differences between resistance training protocols regarding squat velocity performance. These results align with a recent study by Neves et al. [5], where the authors observed that performing the bench press first did not affect subsequent power production during the squat exercise. Therefore, performing three sets of six repetitions at 80% of one's 1 RM bench press does not seem to influence subsequent squat velocity performance. This is not entirely consistent with previous research, which indicated that performing an exercise last in a sequence may have a negative impact [24]. Inconsistent findings exist, as Monteiro et al. [29] showed that performing the bench press before the leg press induced less fatigue in the latter exercise than in the opposite order. Usually, the second exercise in a sequence would be expected to show more fatigue due to non-local muscle fatigue, which can impair the performance of muscles that have not yet been exercised [30]. This could be explained by mechanisms like central nervous system inhibition, which involves reduced neural drive to the muscles, and psychological factors such as decreased motivation or focus after performing a fatiguing exercise [31]. However, the greater balance of excitatory mechanisms over fatiguing ones might explain the non-impact of exercise order in the literature as well as in the current study [29,32].

We expected that the previous exercise would cause some post-activation potentiation enhancement (PAPE) [33,34] in the following exercise. However, while these strategies can improve performance in certain situations [33,34], it seems that this did not occur in our study. On the contrary, it seems the fatigue from the squat exercise outweighs any potentiation effects, thereby impairing bench press performance. Performing power exercises like the squat first can sometimes enhance subsequent exercise performance due to post-activation potentiation mechanisms. However, when the initial exercise induces significant fatigue, the negative effects of fatigue outweigh the benefits [35]. It is known that the effectiveness of the PAPE protocols depends on several variables (e.g., the specific sport, the timing of the conditioning activity, and the athlete's characteristics) [33]. For example, the specificity of the conditioning activity is essential for maximizing subsequent exercise [33]. This way, the bench press cannot be understood as specific for the squat, and vice versa, as each exercise targets different muscle groups and movement patterns.

According to our second hypothesis, higher blood lactate and heart rate responses would be observed immediately after the session with the squat performed as the last exercise (i.e., BP + S protocol). As the squat exercise performed with heavy loads (i.e., three sets of eight maximum repetitions) induces higher metabolic and hemodynamic stress than the bench press [6], we expected to observe a higher response immediately after the session. However, our results did not confirm this hypothesis. Previous findings suggested that no clear results exist regarding the influence of exercise order on other physiological responses [36]. Performing the squat first and then the bench press resulted in non-significantly higher metabolic and hemodynamic changes compared to the reverse order. This result may be related to a greater accumulation of fatigue at the beginning of the resistance training session, which was maintained with the subsequent performance of the bench press. Therefore, the present results highlight a possible higher metabolic and hemodynamic demand when the squat is performed first in a resistance training session with the maximal intended velocity.

The literature underscores the significance of exercise order in resistance training, particularly in long-term adaptations [3,36,37]. While increases in strength seem to be higher in exercises that are performed at the beginning of a training session, muscle hypertrophy effects may be achieved regardless of exercise order [3,37]. However, it is important to emphasize that the literature mainly focused on the analysis of traditional strength tests, such as one-repetition maximum and the number of repetitions until failure [3]. The current study used velocity monitoring during an entire training session, allowing us to analyze the acute response in each set and repetition and to compare the performance throughout the training session. The findings from our study, combined with the existing literature, suggest that the sequence of exercises in a training session should be carefully planned according to the specific goals of the training session. If the main goal is to maximize upper body performance, it is beneficial to start with upper body exercises such as the bench press before more challenging lower body exercises like the squat. The first exercise benefits from lower levels of physical fatigue, leading to better overall performance and outcomes, as suggested previously. Additionally, our results suggest that exercise order may not significantly impact metabolic responses, as no significant differences in blood lactate and heart rate were observed between the two exercise sequences.

Our study presents limitations that should be addressed. The small sample size can prevent us from drawing more grounded recommendations on this topic. Additionally, it must also be considered that the cross-sectional nature of our study does not allow us to assess the long-term implications of different exercise orders. Another constraint was the lack of comparative data concerning the impact of resistance exercise order on velocity performance. Ultimately, it can also be pointed out that the lack of control over the subjects' activities during the experimental procedures may have impacted the results. Therefore, researchers may consider these limitations as guidelines for future studies. Additionally, we recommend implementing a similar research methodology with other resistance exercises to gain a broad perspective on the influence of exercise order on velocity performance.

5. Conclusions

This study showed that performing the squat first in a resistance training session significantly reduces subsequent bench press velocity performance, while squat velocity performance remains unaffected when the bench press is performed first. Furthermore, there were no differences in blood lactate and heart rate between the protocols, indicating that both protocols induced similar levels of metabolic and cardiovascular stress. These results could suggest that the muscle mass recruited in each exercise is crucial in how subjects perform the subsequent exercise, underscoring the importance of exercise order in training sessions where velocity is prioritized. These findings provide strength and conditioning professionals with valuable insights into how to structure workouts for optimal performance outcomes. In summary, if the training goal is to maintain high-velocity performance during heavy-load training, the bench press exercise should be performed before the squat exercise.

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