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Characterizing different loads with the same velocity loss percentage in the bench press throw exercise Caracterización de diferentes cargas con el mismo porcentaje de pérdida de velocidad en el ejercicio de lanzamiento en press de banca

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Abstract. Velocity loss has been recognized as an effective fatigue index in resistance training. However, the physiological consequences of this fatigue should be described. Traditionally, researchers have debated the hormonal response to non-failure resistance training. Cortisol on salivary concentration was one of the hormones under study, which is linked to the inflammatory process from exercise. This study aimed to compare the acute salivary cortisol (Sal-C) response at different percentages of 1RM with fatigue standardized by a 10% velocity loss. An experimental, randomized, and counterbalanced activity was designed. Fifteen men took part in the study (they fasted for 12 hours before carrying out the test), performing 6 sets of bench press throw with different 1RM percentages (30% - 90% 1RM). Salivary Cortisol was collected before and after each test. Velocity loss was measured by a linear encoder. ANOVA and Effect Size were performed. Sal-C showed a significant decrease in all percentages and effect size was greater with low loads (1.61 high) than with high loads (0.95-1 moderate). Peak power was significantly higher between 40-70% of 1RM compared to other percentages (30-80% 1RM). The results of this research support the idea that velocity-based training sustains the dynamic equilibrium of organisms independently of intensity training. Moreover, untrained subjects could perform efficiently up to six sets at all percentages but with fewer repetitions at higher intensities, as this study shows that untrained subjects achieved 10% velocity loss under four repetitions.

Keywords: Salivary Cortisol; Velocity-based resistance training; Fatigue; Bench press. Caracterización de diferentes cargas con el mismo porcentaje de pérdida de velocidad en el ejercicio de lanzamiento de press de banca.

Resumen. La pérdida de velocidad ha sido reconocida como un eficaz índice de fatiga en el entrenamiento de resistencia. Sin embargo, debe describirse la consecuencia fisiológica de esta fatiga. Tradicionalmente, la respuesta hormonal ha sido objeto de debate entre los investigadores en relación con el entrenamiento de resistencia sin fatiga. Una de las hormonas estudiadas ha sido el cortisol, una hormona relacionada con el proceso inflamatorio del ejercicio, en la concentración salival. Este estudio pretendía comparar la respuesta aguda del cortisol salival (Sal-C) a diferentes porcentajes de 1RM con fatiga estandarizada por una pérdida de velocidad del 10%. Se diseñó un estudio experimental, aleatorizado y contrabalanceado. Quince hombres participaron en el estudio (ayunaron 12 horas antes de realizar la prueba), realizando 6 series de lanzamiento de press de banca con diferentes porcentajes de 1RM (30% - 90% 1RM), Se recogió cortisol salival antes y después de cada prueba. La pérdida de velocidad se midió con un codificador lineal. Se realizaron ANOVA y tamaño del efecto. El Sal-C mostró una disminución significativa en todos los porcentajes y el tamaño del efecto fue mayor con carga baja (1,61 alta) que con carga alta (0,95-1 moderada). La potencia máxima fue significativamente mayor entre el 40-70% de 1RM en comparación con otros porcentajes (30-80% de 1RM). Los resultados de esta investigación apoyan la idea de que el entrenamiento basado en la velocidad mantiene el equilibrio dinámico de los organismos independientemente del entrenamiento de intensidad. Además, los sujetos no entrenados podían realizar eficazmente hasta seis series en todos los porcentajes, pero realizando menos repeticiones a intensidades más elevadas, ya que este estudio muestra que los sujetos no entrenados alcanzaron una pérdida de velocidad del 10% en cuatro repeticiones.

Palabras clave: Cortisol Salival; Entrenamiento de fuerza basado en la velocidad; Fatiga, Press de banca

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Introduction

Velocity-based resistance training (VBRT) is a key method to improve strength performance and ascertain the athlete's fatigue state (Pareja-Blanco et al., 2017). As far as fatigue is concerned, it could be triggered by many mechanisms, yet it is unclear which of these contributes most and to what extent according to the characteristics of the effort made (Allen et al., 2008). However, all of them can lead to a loss in execution velocity (Jones, 2010). Sanchez-Medina and Gonzalez-Badillo (2011) specifically reported that as effort increases, mean propulsive velocity (MPV) decreases. This loss in velocity is associated with poorer performance and higher concentrations of metabolic byproducts like lactic acid and ammonia. In addition, other variables, such as optimal load (OL), optimal repetition number (OR) and time under tension (TUT), should be considered (Sarabia et al., 2017) since they can influence fatigue states and, consequently, the physiological response to the resistance training (Burd et al., 2012). Accordingly, OL, which is defined as those loads for which the subjects manage to produce their maximal acceleration in a specific movement, and which can optimise dose-response for strength training (Soriano et al., 2015). Nevertheless, OR, which is defined as the sum of repetitions that subjects can carry out before achieving a pre-established velocity loss criteria, and TUT, which is 10% of the maximum, could have an impact on the hormonal response (Mangine et al., 2015) and consequently on performance (Crewther et al., 2018). Thus, knowing how the OR and TUT behave depending on loads could facilitate the optimization of prescription in resistance training.

The hormonal response has been widely assessed to explain acute performance loss (Crewther et al., 2006) since hormonal changes could impair strength output (Hamdi & Mutungi, 2010). Specifically, cortisol has been documented to have inhibitory effects on a broad range of specific immune responses as well as potent suppressive effects on the effector functions of phagocytic cells. Due to their inhibitory effects on both the acquired and innate immunologic functions, cortisol is remarkably efficacious in managing many of the acute disease manifestations of inflammation from physical activity (Azizbeigi et al., 2015; Rhen & Cidlowski, 2005). In this regard, increments in cortisol concentration occur after a stressful situation, regularly 4 minutes after (Hall & Hall, 2020). Therefore, cortisol is considered a good indicator of psychobiological stress (Hellhammer et al., 2009), despite the wide variability in hormonal concentration among individuals (Crewther et al., 2013; Papacosta & Nassis, 2011). Compared to vein puncture (Gatti & De Palo, 2011), Salivary cortisol (Sal-C) as a free cortisol marker, has been proposed as an alternative to the serum solution because it can be measured through a non-invasive technique that maintains hormonal concentration.

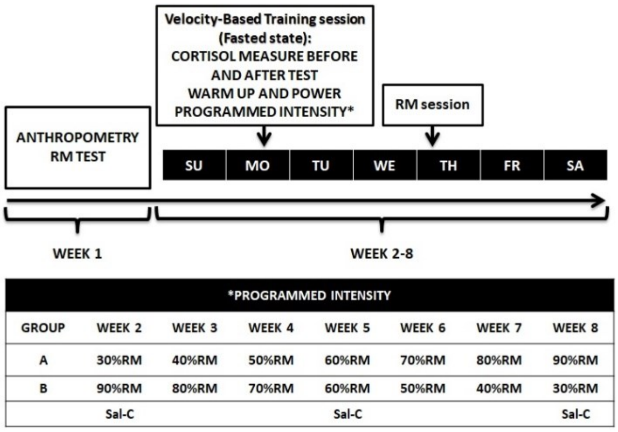
Specifically, Sal-C responses in high-intensity resistance training have been compared with the responses obtained after a low-intensity one. In said comparison, the former showed the greatest increase in cortisol concentration (McGuigan et al., 2004). Likewise, several authors have reported differences in Sal-C response after failure or non-failure training obtaining cortisol concentration rises at different intensities, volumes, and types of exercise (Becker et al., 2021; Cairns et al., 2005; McCaulley et al., 2009; Stokes et al., 2013). A possible explanation for these results may be the lack of adequate standardization of the prescription, measurement protocols, and exercises (Crewther et al., 2009; Viru et al., 2001). In this sense, knowing the timing the cortisol response will optimise collecting (Hall & Hall, 2020). The same happens with the implementation of an easily replicable, standardised exercise, and transferring it to sports abilities such as bench press throw, which has been used by other authors (Baker et al., 2001; Sánchez-Medina et al., 2014; Stokes et al., 2013). Moreover, since fatigue is continuous until the muscle fails (Sánchez-Medina & González-Badillo, 2011), the level of effort needs to be standardized to obtain a better overview of the relation between fatigue and its hormonal consequences. Therefore, individualized training has great importance as equal fatigue levels could result from OL and OR, instead of using a traditional performance criterion as doing half the number of repetitions that are possible in each percentage of one-repetition maximum (1RM) (Legaz-Arrese et al., 2007).

Nevertheless, there is a lack of knowledge about acute Sal-C response because of velocity loss caused by resistance training. Therefore, the aim of this study was two-fold: i) to characterize 7 different loads, related to the 1RM, with the same velocity loss criteria in the bench press throw exercise and ii) to compare acute Sal-C response at different percentages of 1RM. In this context, higher loads may necessitate longer TUT, leading to increased Sal-C.

Method

Experimental approach

A randomised and counterbalanced design was used (figure 1). The subjects carried out two sessions per week for seven weeks, with a 72-h recovery interval between sessions. One of them included 1RM measurement in bench press exercise, while the other weekly session (experimental session) included measurements of velocity execution and velocity loss reached in each repetition of the exercise (bench press throw). Sal-C concentration was only assessed before and immediately after the experimental sessions that used 30% 1RM, 60% 1RM and 90% 1RM intensities. Subjects were randomly allocated to two groups. Each session started with a brief dynamic warm-up (i.e., 15 s of joint mobility by movements in each joint involved and three series of 10 reps at 5%, 10% and 20% of 1RM respectively) followed by training (Borgenvik et al., 2012; McMillian et al., 2006). The experimental sessions consisted of six series of bench press throws until a 10% loss of mean propulsive velocity (MPV) was reached after two consecutive repetitions, resting five minutes between series (Ahtiainen et al., 2005). Exercise intensities were different each week (30%RM-90%RM). Only the VBRT session was performed in a fasted state. All sessions and measurements were performed at the same time of day by each subject every day (all of them between 8:00 and 9:00 a.m.).



*PROGRAMMED INTENSITY

GROUP	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8
A	30%RM	40%RM	50%RM	60%RM	70%RM	80%RM	90%RM
B	90%RM	80%RM	70%RM	60%RM	50%RM	40%RM	30%RM
	Sal-C			Sal-C			Sal-C

Figure 1. Experimental design.

Participants

Fifteen healthy and active males (26.4 ± 4.3 years; 178.6 ± 6.2 cm; 76.7 ± 10.7 kg) voluntarily accepted to participate in this study. Subjects were randomized into each group using a dice roll until achieving a similar number of participants in both groups. Additionally, all subjects were required to have at least one year of experience in resistance training (including the bench press throw exercise as a part of their weekly strength training regime and previous testing). Subjects did not engage in any other training or nutritional supplement intake during the seven weeks of the study, and all of them were encouraged to maintain their nutritional habits. Subjects with endocrine disruption, heart disease, or injuries to the shoulder, wrist, or elbow were excluded from the research. Each subject provided written informed consent before participation, after being fully informed about its aims, potential benefits, and associated risks. The study received approval from the University Ethics Committee (DPS.MMR.01.18) and was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Procedures

Bench press throw

A Smith Machine (Multipower M953; Technogym, Italy) was used to perform the bench press throw exercise. Subjects began by lying supine on the bench with elbows fully extended and gripping the bar. The subjects lowered the bar until it touched the chest slightly, approximately 3 cm superior to the xiphoid process, before extending the elbows to raise the bar with the head and hips remaining in contact with the bench and the feet in contact with the floor. No bouncing of the bar on the chest or arching of the back was allowed.

1RM Assessments

An incremental load test was performed to obtain the 1RM value (Sánchez-Medina & González-Badillo, 2011). The initial load was 20 kg for all subjects, which was increased by 10 kg in each set until 0.5 m/s in MPV. Then, the load was increased by 5 to 2.5 kg until it could not be moved by the subject. The rest period between sets was of at least 5 minutes. The RM session was conducted by the same researcher and all conditions were standardized.

Velocity loss measure

An isoinertial dynamometer (T- Force Dynamic Measurement System, Ergotech, Murcia, Spain) was used for mechanical measurements, which consists of a linear velocity transducer interfaced with personal and custom software. Vertical instantaneous velocity was directly sampled by the device at a frequency of 1000 Hz. VBRT session was conducted by the same researcher and all conditions were standardized. Maximum mean propulsive velocity (MPV max), peak power, OR and TUT were analysed.

Salivary hormonal response

Salivary samples were collected immediately before the exercise and after the last set. The subjects were asked to avoid food and drink intake or using toothpaste 2 h before the assessment. Fifteen minutes before collecting the samples, they were asked to sit so as to take their basal values. A 5-10 ml sample of saliva was taken and placed in a sterilized plastic tube (Salivette®, Sarstedt, France) and frozen at -20 ºC until analyzed (Sarabia et al., 2015). Analyses were carried out on duplicate samples using Cortisol Enzyme-Linked Immunoassay Kit (Salimetrics, State College, PA) with 0.007 µg/dL sensibility and a variability coefficient of 4. Their calibration was performed according to the manufacturer's instructions.

Statistical analysis

All data are shown as mean ± standard error of the mean (SEM). The Kolmogorov-Smirnov test was carried out to find the normal distribution of data, followed by ANOVA to identify any relationship between OL and 1RM load. No influence was confirmed; therefore, the normality and independence assumptions were met as well as Levene's test revealed equal variance. After checking, an ANOVA of repeated measures was performed because of its ability to compare means across multiple conditions within the same subjects. A Bonferroni Post hoc test was performed when differences were found. Mechanical and hormonal variables were used as within-subject factors. The first one with 7 levels (RM percentages): 30%, 40%, 50%, 60%, 70%, 80% & 90%. The second one with only 3 levels (RM percentages): 30%, 60% & 90%. A bivariate correlation with the percentage of change in Sal-C and TUT was performed, but no relationship was found. Effect Size was calculated using Hedges' g (Freeman et al., 1986; Hedges & Pigott, 2004). The authors of this study interpreted the effect size as trivial effect (<0.35), small effect (0.35-0.80), moderate effect (0.80-1.50), and high effect (>1.50) according to Rhea (2004). Significance was considered $p < 0.05$. Data were processed using PASW Statistics 18 software (Chicago, IL, EE.UU.)

Results

The analysis examining the independence between the initial load (OL) lifted and the one-repetition maximum (1RM) revealed no significant influence ($F(1,14) = 0.546$; $p = 0.473$). This finding indicates that the initial load lifted by participants did not have a statistically significant effect on the percentage of 1RM at which they reached their peak performance. In other words, the starting weight used by participants did not bias or alter the outcome related to the percentage of 1RM at which they ultimately performed best. Therefore, it was deemed appropriate to proceed with repeated ANOVA measurements for subsequent analyses, as this statistical method is suitable when the same subjects are measured under different conditions.

The ANOVA results demonstrated significant differences across intensities for key performance metrics, including velocity ($F(6, 84) = 410.89$; $p < 0.001$), TUT ($F(6, 84) = 2.248$; $p = 0.045$), peak power ($F(6, 84) = 11.627$; $p < 0.001$), and OR ($F(6, 84) = 22.185$; $p < 0.001$). Specifically, velocity showed a remarkable variation across all tested intensities, highlighting how performance speed changes significantly depending on the percentage of 1RM used. In contrast, TUT, which measures how long the muscles are under strain during the lift, did not show differences in post-hoc analysis, and remained consistent across different 1RM percentages, suggesting that the time spent under tension did not vary much despite changes in load intensity. Peak power shows differences between moderate intensity and light and high intensities.OR, which reflects the repetition number where velocity loss criteria were achieved, revealed significant differences among the various intensities.

However, these differences were not observed between adjacent intensity levels, particularly between 50% and 70% 1RM, indicating a certain range where OR remains relatively stable. Descriptive statistics and comparisons across the different training loads are presented in Table 1.

Table 1.
Descriptive data (mean ± SEM; [95%CI]) and comparison among loads.

Load	MPV max (m/s)	OR (n)	Peak Power (W)	TUT (s)
30% 1RM	1.09 + 0.01 *[1.07; 1.11]	4.58 ± 0.20 ^{bcdefg}[4.19; 4.97]	505.6 ± 30.35 [445.5; 564.4]	21.16 ± 1.35 [18.48; 23.75]
40% 1RM	0.97 + 0.01 *[0.96; 0.98]	3.67 ± 0.14 ^{acdefg}[3.40; 3.94]	547.9 ± 30.10 ^{a}[488.0; 606.0]	23.08 + 1.02 [21.00; 25.00]
50% 1RM	0.84 + 0.01 *[0.83; 0.85]	3.39 ± 0.16 ^{aefg}[3.08; 3.70]	562.7 ± 28.64 ^{a}[505.9; 618.1]	24.04 + 1.19 [21.67; 26.33]
60% 1RM	0.69 + 0.01 *[0.68; 0.70]	2.86 ± 0.16 ^{abfg}[2.55; 3.17]	558.8 ± 25.98 ^{a}[507.1; 608.8]	25.02 ± 1.52 [22.02; 27.98]
70% 1RM	0.58 + 0.01 *[0.56; 0.60]	2.57 ± 0.13 ^{abcg}[2.32; 2.82]	543.9 ± 33.40 [477.5; 608.5]	25.14 + 1.28 [22.59; 27.67]
80% 1RM	0.43 + 0.01 *[0.41; 0.45]	2.18 ± 0.12 ^{abcdg}[1.94; 2.42]	475.2 ± 23.16 ^{bcde}[429.6; 520.3]	25.26 +1.56 [24.10; 26.30]
90% 1RM	0.32 + 0.01 *[0.29; 0.35]	1.53 ± 0.09 ^{abcdef}[1.35; 1.71]	417.1 ± 22.82 ^{cde}[372.3; 461.7]	25.37 ± 1.96 [21.46; 29.14]

Notes: MPV max = maximum of mean propulsive velocity; OR = optimal repetitions; TUT = Time under tension; * = p < 0.05 compared with all percentages; ^{a} = p < 0.05 compared with 30% 1RM; ^{b} = p < 0.05 compared with 40% 1RM; ^{c} = p < 0.05 compared with 50% 1RM; ^{d} = p < 0.05 compared with 60% 1RM; ^{e} = p < 0.05 compared with 70% 1RM; ^{f} = p < 0.05 compared with 80% 1RM; ^{g} = p < 0.05 compared with 90% 1RM.

Regarding the analysis of Sal-C, no significant correlation was found between hormonal levels and the different training loads ($d = 0.16$; $p = 0.281$). This lack of correlation suggests that the amount of weight lifted did not directly influence the baseline hormonal response. However, Sal-C levels did demonstrate substantial changes following the intervention across all load intensities ($F(1, 14) = 45.071$; $p < 0.001$), as detailed in Table 2. Specifically, Sal-C levels showed a significant reduction across all tested percentages of 1RM, with a more dramatic effect size observed at lower loads (30% 1RM) compared to higher loads (90% 1RM). This indicates that lighter loads had a greater impact on reducing Sal-C levels post-exercise. Despite these overall reductions, no significant differences were observed between the individual 1RM percentages ($F(2, 28) = 1.258$; $p = 0.300$), meaning that while Sal-C levels dropped across the board, the degree of reduction did not vary significantly between the different load levels.

The effect size analysis provided further insight into the changes in Sal-C levels (Δ% Sal-C) across different load comparisons. A trivial effect was observed when comparing the changes between 30% vs. 60% 1RM (ES = 0.35) and 60% vs. 90% 1RM (ES = 0.24), suggesting that the magnitude of Sal-C reduction was minimal between these specific comparisons. However, a small effect was noted when comparing 30% vs. 90% 1RM (ES = 0.63), indicating a slightly more noticeable reduction in Sal-C levels when contrasting the lightest and heaviest loads. These findings highlight the nuanced impact of load intensity on hormonal responses, with lower intensities leading to more substantial reductions in Sal-C levels.

Table 2.
Changes in Sal-C concentration (mean ± SEM; [95%CI]) after intervention in each load.

Load	Pre (µg/dL)	Post (µg/dL)	Δ% Sal-C	ES	p
30% 1RM	0.58 ± 0.04 [0.50; 0.66]	0.37 ± 0.03 [0.31; 0.43]	~21.14%	1.61 (high)	0.000
60% 1RM	0.52 ± 0.05 [043; 0.63]	0.37 ± 0.03 [0.31; 043]	~16.02%	0.95 (moderate)	0.001
90% 1RM	0.48 ± 0.03 [0.42; 0.54]	0.35 ± 0.03 [0.29; 0.41]	~12.83%	1.00 (moderate)	0.001

Notes: Sal-C = Salivary Cortisol; Δ% Sal-C = percentage change of Salivary Cortisol.

Discussion

The aim of this study was two-fold: a) to characterize 7 different loads, related to the 1RM, with the same velocity loss percentage in the bench press throw exercise and b) to compare acute Sal-C response at different percentages of 1RM. This is the first study that compares the changes in Sal-C after a protocol based on the press bench exercise in 3 different percentages of 1RM.

The main results showed that the MPV max was different between percentages although the time under tension to achieve10% of velocity loss was kept on among loads. Besides, there were differences in optimal repetitions that could be achieved in each percentage and the peak power was found at around 50% of 1RM. In addition, Sal-C concentration decreased in all loads, while higher changes in Sal-C after intervention were found in the lower load (30% 1RM). The MPV max found in this study diverges from the data provided by other authors at moderate and light intensities (García-Ramos, Pestaña-Melero, et al., 2018; Loturco et al., 2017). These differences could be due to the participants' training level since these authors included participants with higher training backgrounds (at least one additional year). Another possible explanation may be the use of a specific Smith machine, as the assisted rolling bearing on this equipment might have influenced results in velocity.

Besides, contrary to what was expected, TUT was similar among the intensities, thus velocity loss could have a non-linear behavior related to the intensity in training and directly related to effort time (Trybulski et al., 2022). In this sense, velocity loss could be regarded a good index of volume training (García-Ramos, Torrejón, et al., 2018; Guez-Rosell et al., 2020) since participants showed the same time of effort and stress across intensities when only one velocity loss criterion was applied. Therefore, velocity loss could be used for individualised training (González-Badillo et al., 2011; Pareja-Blanco et al., 2017), because it allows to establish the same level of fatigue during the resistance training regardless of the exercise's intensity.

This study focused on the acute effect of training on Sal-C and velocity loss at different percentages of 1RM. There has been prior research on the hormonal response in resistance training, but it appears to show contradictory results, perhaps because the samples were collected at different times (McCaulley et al., 2009; McGuigan et al., 2004; Stokes et al., 2013) without considering the hormonal trigger response time (Hall & Hall, 2020). In addition, previous studies of Sal-C response have not dealt with providing the same fatigue (Cairns et al., 2005; McCaulley et al., 2009; Stokes et al., 2013).

In this study, where an exercise and timing sample was standardized, Sal-C decreased in all percentages compared to the first samples collected in each measure and no difference among intensities was found. However, previous literature such as Kraemer & Mazzetti (2003) reported that cortisol increased when high-intensity exercise was done. Subsequently, the presence of higher cortisol concentrations promotes a higher muscle protein degradation (Wing & Goldberg, 1993). Therefore, it could be suggested that velocity-based training regardless of intensity is an ideal training method to improve the strength-conserving muscle protein as Pareja-Blanco et al. (2017) has shown when low-velocity loss criteria are applied.

Nevertheless, despite the fact that no significant change in Sal-C was found in any percentage, a high effect size was reported when the subject performed at 30% of 1RM compared to higher percentages. However, Δ% Sal-C did not show any differences between percentages of 1RM, despite a lower decrease in Sal-C when subjects trained with higher intensities. The effect size showed trivial and small values. Therefore, this study follows Walker et al. (2022) results since they revealed that VBRT had a low physiological impact on cortisol concentration. Thus, for the aforementioned reasons, it could be hypothesized that lower intensities might have slightly stronger conservative effects than higher intensities.In addition, this study shows that untrained subjects could do up to six sets at all percentages. Since, although the peak power was reduced during exercise, it did not show statistical significance between six sets. Moreover, ORs were maintained without variation throughout each session in each percentage. Therefore, ORs could be a good parameter for training volume. It has been suggested that the repetitions for optimising power training should be half the number than are possible (Legaz-Arrese et al., 2007). This does not appear to be the case at a percentage lower than 80%, where subjects needed a few repetitions (four or less) for achieving criteria performance.

Furthermore, the present results showed that repetitions appear less in the peak power load than in a lower percentage of 1RM (Allen et al., 2008; Sánchez-Medina et al., 2014). This evidence is supported by effort character (González-Badillo & Gorostiaga-Ayestarán, 2002), since the higher the intensity the fewer repetitions, thus assuming that the velocity is characteristic of an exercise and intensity (González-Badillo & Sánchez-Medina, 2010), the velocity loss by repetition might be higher in percentages closer to 1RM. Furthermore, this study shows that peak power is reached between 40%-70% intensities of 1RM. These results are consistent with those of several authors (Baker et al., 2001; Cronin et al., 2001; Stock et al., 2010) who have similarly observed that peak power occurs at moderate intensity levels. This consistency across studies reinforces the notion that medium intensities are optimal for maximizing power output during resistance training exercises. Nevertheless, several limitations could be identified in this research. (i) Hormonal determination should be sampled a few minutes after performing the exercise, since the main findings have been detected even 30 minutes after training. Additionally, (ii) Sal-C should have been measured at all percentages which would have allowed to establish a regression between intensities and cortisol modulation. (iii) Future design will need to implement a blinding procedure, higher sample size and to include a control group to improve the quality of research.

Perspective

This study provides valuable insights into the acute salivary cortisol response and velocity-based resistance training (VBRT) across different percentages of 1RM in the bench press throw exercise. The findings underscore the importance of understanding the physiological implications of fatigue induced by resistance training, particularly about hormonal responses (Bermejo et al., 2022). The decrease observed in salivary cortisol concentration across all intensities suggests that VBRT may not significantly influence cortisol levels, indicating a potential dissociation between intensity and hormonal response. This challenges conventional notions regarding the impact of resistance training on cortisol modulation and highlights the need for further investigation into the complex interplay between training variables and hormonal dynamics. Moreover, the maintenance of time under tension at various intensities highlights the potential of velocity loss criteria as a reliable index for monitoring training volume and fatigue. This reinforces the utility of velocity-based metrics in optimizing resistance training protocols and individualizing training prescriptions. While this study provides valuable insights, it also points to avenues for future research. Further exploration into the temporal dynamics of cortisol response post-exercise and its relationship with velocity-based training volume could elucidate the nuanced effects of resistance training on hormonal regulation. Additionally, quantifying optimal training volume based on power loss in each set could enhance training efficiency and performance outcomes.

Conclusion

The maximum propulsive velocity and optimal repetition showed a decrease with increasing intensity while the time under tension was maintained at each of the intensities. Additionally, the results of this research support the idea that Sal-C might not be influenced by intensity training in VBRT, since decreases are similar (25-35%) at all percentages of 1RM. Sal-C could possibly be influenced by volume training because no differences were found in time under tension between intensities. However, so as to be more accurate, it is recommended to wait until the cortisol salivary response is known at a different volume of training. In addition, due to power loss in each set, it could be useful to quantify the optimum training volume. In this way, athletes would be able to train without experiencing high fatigue.

Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions

According to the CRediT taxonomy, the contributions of each author are as follows: Conceptualization: M.M.-R. & A.G.-V.; Data curation: A.G.-V. & D.P.; Formal analysis: A.G.-V. & M.M.-R.; Funding acquisition: M.M.-R.; Investigation: A.G.-V.; Methodology: M.M.-R. & A.G.-V.; Project administration: M.M.-R.; Resources: M.M.-R. & D.P.; Supervision: M.M.-R.; Validation: D.P. & M.M.-R.; Visualization: A.G.-V.; Writing – original draft: A.G.-V.; Writing – review & editing: M.M.-R & J.R.-G.

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