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Acute Mechanical and Skin Temperature Responses to Different Interrepetition Rest Intervals During Full-Squat Exercise

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Purpose: This study aimed to (1) evaluate the acute effects of different interrepetition rest full-squat protocols on countermovement jump (CMJ) height, velocity loss (VL), and skin temperature (T_{sk}) and (2) determine whether the VL, the changes in T_{sk}, or the individual strength level is associated with the change in CMJ height. ***Methods:*** Sixteen resistance-trained men randomly performed 3 squat protocols at maximal intended velocity with 60% of the 1-repetition maximum (sets × repetitions [interrepetition rest]): traditional (2 × 6 [0 s]), cluster 2 (2 × 6 [30 s every 2 repetitions]), and cluster 1 (1 × 12; [36 s every repetition]), plus a control session. CMJ height was assessed before and 2, 4, and 8 minutes after the protocols. ***Results:*** There was a significant main effect of protocol for the VL ($F = 20.54$, $P < .001$) and loss in mean power ($F = 12.85$, $P < .001$; traditional > cluster 2 > cluster 1). However, we found a comparable reduction of CMJ height after 8 minutes: traditional (−3.4% [4.2%]), cluster 2 (−5.3% [4.9%]), cluster 1 (−5.4% [2.9%]), and control (−4.2% [3.6%]). Overall, mean T_{sk} acutely decreased after all the protocols. Higher individual strength level (but not VL or the changes in T_{sk}) was associated with lower CMJ-height loss ($P < .05$). ***Conclusions:*** Although different interrepetition rest full-squat protocols may alter the loss in velocity and power, they result in a similar decrease in T_{sk} and CMJ height, which could be more influenced by individual strength level than VL or changes in T_{sk}.

Keywords: set configurations, resistance training, vertical jump, velocity loss

Vertical jump is a decisive skill for performance in many sports such as basketball, volleyball, or soccer.[1] Specific conditioning activities are prescribed to increase maximal voluntary strength, power, or speed, which may lead to better ballistic performance.[2,3] The physiological mechanisms underpinning this ballistic performance enhancement may be increased muscle temperature, nerve conduction velocity, or mechanical stiffness, which may lead to a greater rate of force development and muscle shortening velocity.[3,4] Importantly, the time course of recovery after resistance training (RT) depends on numerous factors (eg, exercise type, volume, intensity, or individual strength level) that determine the acute mechanical, metabolic, and hormonal response.[2,4,5]

Introducing intraset rest periods after a certain number of repetitions or after every repetition (ie, cluster set configuration) might modulate the subsequent response.[6–9] Thus, compared with traditional set configurations based on continuous repetitions, cluster set configurations allow for maintaining higher movement velocity and power while decreasing the mechanical and metabolic response.[6,10] In that sense, it has been reported that training adaptations are velocity-specific.[11] Thus, the most significant number of repetitions performed near the target training velocity, the largest increases in neuromuscular performance.[10,11] Therefore, lower velocity loss (VL; ie, lower fatigue) during the set results in greater neuromuscular performance due to lower metabolic and hormonal disturbances (ie, lower increases in blood ammonia, lactate, insulin-like growth factor, cortisol, or creatine kinase).[6,11,12] Given the known detrimental effects of fatigue on subsequent neuromuscular performance, monitoring VL during the set might explain the acute change in vertical jump performance.

Monitoring lifting velocity during the concentric phase also enables adjusting the loads daily to match a specific percentage of the 1-repetition maximum (1RM) based on a subject's readiness to train.[12] Thus, the intensity is easily adjusted with precision simply by executing the first repetition against a given load at the maximum intended velocity,[13] which helps to equate the target intensity among subjects.[10] Even though, most of the literature did not corroborate whether the lifted absolute load corresponded with the target relative intensity proposed for each subject in each experimental session. Although 2 meta-analyses suggested moderate (60%–84% 1RM) or heavy loads (85%–90% 1RM) to acutely increase ballistic performance,[5,14] Dello Iacono et al[15] recently proposed using the load that maximizes power production in the squat jump to maximize vertical jump performance, which is expected to be less fatiguing than heavier loads (ie, >85% 1RM).[15] Velocity-based training might help to elucidate whether the changes in vertical jump differ between experimental conditions, while matching the intensity across individuals and sessions.

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The individual strength level and the increases in muscle temperature seem to mediate both the neuromuscular performance and the acute response to RT. Thus, stronger individuals need shorter recovery periods compared with their weaker counterparts to increase vertical jump height.[5,14,16] Likewise, increases in muscle temperature have a direct impact on the rate of force development and muscle shortening velocity, with cross-bridge cycling rates being influenced by the temperature-sensitive myosin ATPase reaction.[3,4] Of note, skin temperature (T_{sk}) is a noninvasive method that provides information about the thermoregulatory response (ie, the changes in the superficial tissue as consequence of the changes in temperature that occurs in working muscle areas) but not the inside muscle temperature.[17] Several studies have already reported an acute drop in T_{sk} during and after traditional set configurations of resistance exercises such as half squat, bench press, or biceps curl.[17,18] This decrease may be attributed to a peripheral vasoconstrictor response as the muscle blood flow increases.[17,18] Despite its use as a surrogate of inside muscle temperature during endurance exercise,[19] no studies have investigated whether the changes in T_{sk} measurements during RT may be associated with the change in the vertical jump height.

The aims of the current study were: (1) to evaluate the acute effects of different interrepetition rest (IRR) full squat protocols on countermovement jump (CMJ) height, VL, and T_{sk}; and (2) to determine whether the VL, the changes in T_{sk}, or the individual strength level is associated with the change in CMJ height.

Methods

Subjects

Sixteen resistance-trained men (age: 23.5 [2.0] y; height: 178.6 [3.8] cm; body weight: 77.6 [7.2]; squat 1RM strength = 122.4 [26.5] kg; and 1.57 [0.37] normalized per kg of body weight; mean [SD]) with at least 2 years of RT experience in the squat exercise participated in this study. All the subjects were informed of the risks and benefits of the study and not to perform intense training at least 24 hours before testing. They gave their written consent before the initiation of the study. This study was approved by the local ethics committee.

Design

We used a randomized cross-over study design composed of 5 sessions: one initial strength assessment and 4 experimental sessions, one per protocol (traditional, cluster sets of 2 repetitions, cluster set of 1 repetition, and control) in a counterbalanced order. All sessions were separated by 48 to 72 hours. The initial strength assessment was conducted to estimate the squat 1RM through the individualized load–velocity relationship. Mechanical performance was quantified by measuring the mean velocity (MV) and mean power (MP) during every repetition as well as the CMJ height before (Pre), 2 minutes (Post2), 4 minutes (Post4), and 8 minutes (Post8) after the squat protocols. Thermodynamic response was assessed through T_{sk} during the 4 protocols. Subjects performed all experimental sessions in the same time frame (±1 h).

Procedures

Assessment of 1RM in the Squat Exercise (Session 1)

At the beginning of each session (sessions 1–5), subjects performed a standardized comprehensive warm-up protocol, including 5 minutes of jogging, lower-limb dynamic stretching, 2 progressive sprints of 20 m at 70% and 90% of the athletes' self-perceived maximal velocity, 3 sets of 10 squats with their own body weight, interspersed by 1 minute of recovery, and 3 CMJs with increasing effort. To complete the warm-up, the subjects performed 3 repetitions of the squat exercise against 20 kilograms.

The full squat exercise was performed in a Smith Machine with no counterweight mechanism to ensure the vertical displacement of the bar in all experimental sessions (Multipower Fitness Line, Peroga). Movement velocity of the concentric phase of all repetitions was recorded with a linear velocity transducer (T-Force System, Ergotech). Subjects were instructed to stand up with their knees and hips fully extended, and the barbell held across the top of the shoulders and upper back. Thereafter, they squatted until the tops of their thighs were below the horizontal plane, then immediately reversed motion, and ascended back to the upright position at the maximum intended velocity.[10,20] An elastic band was attached to the Smith Machine to eliminate the effect of knee angle on the load–velocity relationship. This required the athlete's buttock to touch it at the specific full squat depth for each individual.[21] Two authors supervised the test. Subjects repeated the set with the same absolute load if they did not complete their established range of motion or did not perform the lift at the maximum intended velocity.

The initial external load used in the incremental loading test was set at 20 kilograms for all participants and was gradually increased in 10 kilogram until the attained MV was lower than 0.60 $m \cdot s^{-1}$ (~85% 1RM). Three repetitions were performed for light (MV ≥ 1.00 $m \cdot s^{-1}$), 2 for medium (1.00 $m \cdot s^{-1}$ > MV ≥ 0.80 $m \cdot s^{-1}$), and only one for heavy loads (MV < 0.80 $m \cdot s^{-1}$).[20] The highest MV was used to determine the individual load–velocity relationship. They were encouraged to perform all repetitions at the maximum intended velocity. Interset rest ranged from 3 minutes for the light and medium loads to 5 minutes for heavy loads.[20,22]

Experimental Protocols (Sessions 2–5)

During the squat protocols, after the standardized warm-up, subjects performed 3 squats against the 50% of the absolute load associated with the individual 60% 1RM assessed during session 1. Since daily changes in the actual 1RM may affect the proposed load (in kilograms),[20] relative loads (60% 1RM) were checked during the warm-up by monitoring movement velocity.[10,20] Moreover, whether the velocity of the first repetition did not match the target velocity for the protocol (±0.02 $m \cdot s^{-1}$), we adjusted the absolute load from the load–velocity relationship to equalize the intensity among subjects (Table 1). Thereafter, subjects performed the squat sets (Figure 1). Just as in the initial strength assessment, subjects were instructed to make contact with the elastic band to standardize the individual range of motion. They were also instructed to perform the concentric phase at maximum intended velocity, without any pause between the eccentric and concentric phases of the lift.

During the control protocol, subjects only performed the standardized warm-up before resting 3 minutes and 20 seconds (ie, the equivalent time to the interset rest plus the approximated time spent for completing the traditional set) between the CMJ Pre and CMJ Post2 assessment. The same authors supervised all sessions and provided strong verbal stimulation to perform all repetitions at the maximum intended velocity. A timer was used to control the intraset rest periods in the cluster protocols. The VL of the bar was used as a measure of mechanical fatigue, and it was calculated as the percentage loss in MV from the fastest to the last repetition of each set.[11]

Table 1 Mechanical Characteristics of Each Protocol (Average of 12 Repetitions)

	Traditional	Cluster 2	Cluster 1	Control
Load, kg	67.56 (17.07)	66.81 (14.71)	67.69 (15.36)	—
MV_{BEST}, $m \cdot s^{-1}$	0.92 (0.09)	0.92 (0.09)	0.93 (0.09)	—
Mean velocity, $m \cdot s^{-1}$	0.84 (0.11)	0.86 (0.10)*	0.87 (0.01)*	—
Mean loss in velocity, %	25.59 (11.55)	16.59 (8.01)*	11.55 (6.95)*,†	—
Mean power, W	593 (9.62)	607.79 (9.78)*	615.86 (10.22)*,†	—
Countermovement jump Pre, cm	38.62 (4.9)	39.20 (4.9)	39.54 (5.4)	38.89 (5.2)

Abbreviation: MV_{BEST}, velocity of the fastest (usually first) repetition in the set. Note: Data are presented as mean (SD).
*Statistically significant differences from traditional set configuration ($P < .05$). †Statistically significant differences with cluster set of 2 repetitions ($P < .05$).

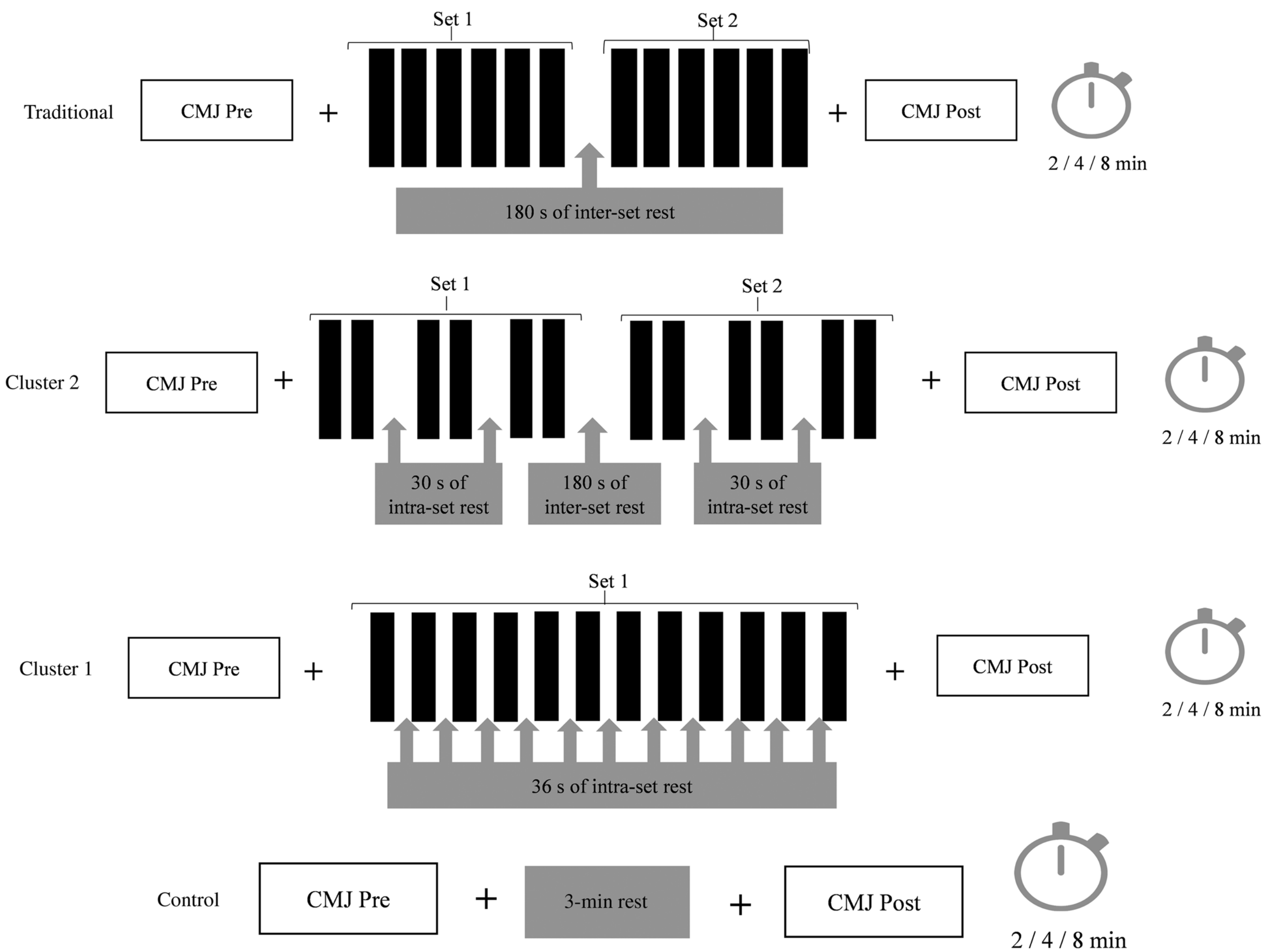

Figure 1 — Overview of the 3 set configurations used in the current study. Cluster 1 indicates cluster set of 1 repetition; cluster 2, cluster set of 2 repetitions; CMJ, countermovement jump.

Vertical Jump Assessment

CMJ height was measured Pre and Post2, Post4, and Post8 after the protocol. Two attempts were performed at each time point. The average CMJ height was used for the analysis. Jump height was estimated from the flight time recorded with the Optojump infrared platform (Microgate). Before each jump, participants were instructed to stand up straight keeping their hands on the hips. Thereafter, they squatted until a self-selected depth and jumped as high as possible. The trials were checked by an experienced researcher to ensure that participants contacted the ground with their knees extended, being repeated if this was not met.

T_{sk} Measurements

We measured the T_{sk} using 8 iButtons (DS-1922 L, Thermochron; resolution: 0.0625 °C, Maxim), which are valid and reliable devices to assess T_{sk} in humans during exercise.[23,24] Immediately upon arrival, subjects were dressed in training shoes and underpants. The researchers dried out the subjects' skin to avoid sweat. The iButtons were attached to the skin with adhesive tape in the following anatomical positions: forehead, left chest, left forearm, left top of forefinger, right quadriceps, left hamstrings, right shinbone, and left gastrocnemius.[23] Subjects remained seated for 5 minutes before the beginning of the warm-up. We calculated the mean T_{sk} as the average of T_{sk} in all anatomical positions. Changes in T_{sk} were calculated as the measurement after the protocol minus the baseline.[23] The iButtons data were analyzed using the Temperatus software (http://profith.ugr.es/temperatus).[23] The temperature of the room was controlled at ~22.5 °C using an air conditioner (Midea, Hi-wall Split Mission II).

Statistical Analysis

Descriptive data are presented as means and standard deviations. The normal distribution of the data (Shapiro–Wilk test) was confirmed ($P > .05$). Sphericity was violated only for the factor "time," and the Greenhouse–Geisser correction was applied. A repeated measures analysis of variance with Bonferroni post hoc corrections was applied to the CMJ height with "protocol" and "time" (Pre, Post2, Post4, and Post8) as within-subject factor. One-way analyses of variance were performed to evaluate whether there were differences between protocols for (1) VL and loss in mean power, and (2) change of T_{sk} (mean temperature after squat protocol—CMJ Pre). Pearson correlation coefficients (r) were used to assess the association of VL, individual strength level, and the change of T_{sk} with the change in CMJ height. Statistical significance was set at $P < .05$. All the statistical analyses were performed with SPSS (version 25.0).

Results

There was a significant main effect of time for the CMJ height ($F = 20.6$, $P < .001$), whereas the main effect of protocol ($P > .05$) and the protocol × time interaction ($P > .05$) were not significant (Table 2). The main effect of time was caused by the lower CMJ height at Post8 compared to Pre for the traditional (−1.3 [0.4] cm [95% CI, −2.5 to −0.1]; −3.4% [4.2%]), cluster 2 (−2.1 [0.5] cm [95% CI, −3.5 to −0.6]; −5.3% [4.9%]), cluster 1 (−2.1 [0.3] cm [95% CI, −2.9 to −1.3]; −5.4% [2.9%]), and control protocols (−1.6 [0.3] cm [95% CI, −2.6 to −0.5]; −4.2% [3.6%]).

There was a significant main effect of protocol for the VL ($F = 20.54$, $P < .001$) and loss in mean power ($F = 12.85$, $P < .001$). Specifically, the VL over the 2 sets of the traditional protocol was significantly higher than cluster 2 (*set 1,* $P = .003$ and *set 2,* $P = .020$), while the total VL over the TR protocol was significantly higher than cluster 2 ($P = .007$) and cluster 1 ($P < .01$; Figure 2). The VL over the cluster 1 protocol was significantly lower than cluster 2 ($P = .032$). The mean T_{sk} acutely decreased 2 minutes after the squat protocols (Figure 3). The VL and the change of mean T_{sk} were not significantly associated with the change in CMJ height for any of the protocols (all $P > .05$), whereas the individual strength level showed a moderate association with the change in CMJ height at Post2 and Post4 (Table 3).

Table 2 Comparison of Countermovement-Jump Height (cm) Between the Protocols and Time Points

	Time of measurement			
Protocol	**Pre**	**Post2**	**Post4**	**Post8**
Traditional	38.6 (4.9)	37.9 (5.4)	38.2 (5.4)	37.3 (4.9)*
Cluster 2	39.2 (4.9)	37.6 (6.1)	37.8 (5.6)	37.1 (5.4)*
Cluster 1	39.5 (5.4)	37.6 (5.2)#,†	38.3 (5.3)*	37.4 (5.4)#
Control	38.9 (5.2)	38.1 (5.5)	38.00 (5.7)	37.3 (5.5)*

Abbreviations: Cluster 1, cluster sets of 1 repetition; Cluster 2, cluster sets of 2 repetitions; Pre, before the squat protocol; Post2, 2 minutes after the squat protocol; Post4, 4 minutes after the squat protocol; Post8, 8 minutes after the squat protocol. Note: Data are presented as mean (SD). No significant differences between protocols were observed at any time point ($P > .05$).

*Significantly lower compared to Pre ($P < .05$). #Significantly lower compared to Pre ($P < .001$). †Significantly lower compared to Post4 ($P < .05$).

Discussion

The main findings of this study indicate a comparable change in CMJ height after all 4 experimental protocols. While the use of cluster set configurations significantly reduced the velocity and power loss within the sets (cluster 1 < cluster 2 < traditional), there was a similar decrease in T_{sk} across squat protocols. Moreover, higher individual strength level (but not VL and change in T_{sk}) was associated with lower CMJ height loss. Thus, these findings suggest that including IRR intervals may mitigate the loss in velocity and power, but the change in CMJ height VL or T_{sk} seems to be comparable across IRR full squat protocols. In addition, the change in CMJ height seems to be more influenced by the individual strength level than VL or T_{sk}.

We observed significantly lower loss in velocity and power for cluster set of 1 repetition (Figure 2), which concurs with previous studies that analyzed the acute effects of adding IRR intervals.[7,9,10,13] Moreover, this cluster set configuration also allowed for higher velocities than traditional set configuration (Table 1). Since traditional set configurations result in a steeper decrease in muscle phosphocreatine stores within the set,[25] it seems that including IRR intervals (10–45 s) could help to attenuate the loss in velocity and power within the session.[7,26] Despite the VL within the squat protocols differed among set configurations, a similar decrease in CMJ height was observed for all 3 squat protocols in the current study. In fact, VL was not associated with the change in CMJ height for any of the protocols (Table 3). These findings concur with Cuevas-Aburto et al[9] that reported similar losses in CMJ height 10 minutes after 3 sets of 6 repetitions with the 10RM. In contrast, other studies have reported significantly lower decreases in CMJ height for cluster rather than traditional set configurations (3 × 6 to 10 repetitions) when it was assessed immediately after completing the last repetition of the protocol.[6,10] Interestingly, we complement this background using lower volume (2 × 6) and different time points (2–8 min), suggesting that the residual neuromuscular fatigue (ie, decrease in CMJ height) did not differ between set configurations.

An important aspect of the current study is that we equated the individual relative load (60% 1RM) for each subject in each experimental session through measuring movement velocity and adjusting the actual load to be lifted from the individual load–velocity relationship. Equating the target intensity (% 1RM) across IRR full squat protocols becomes essential to truly understand the impact of varying the IRR intervals. In contrast, prescribing the

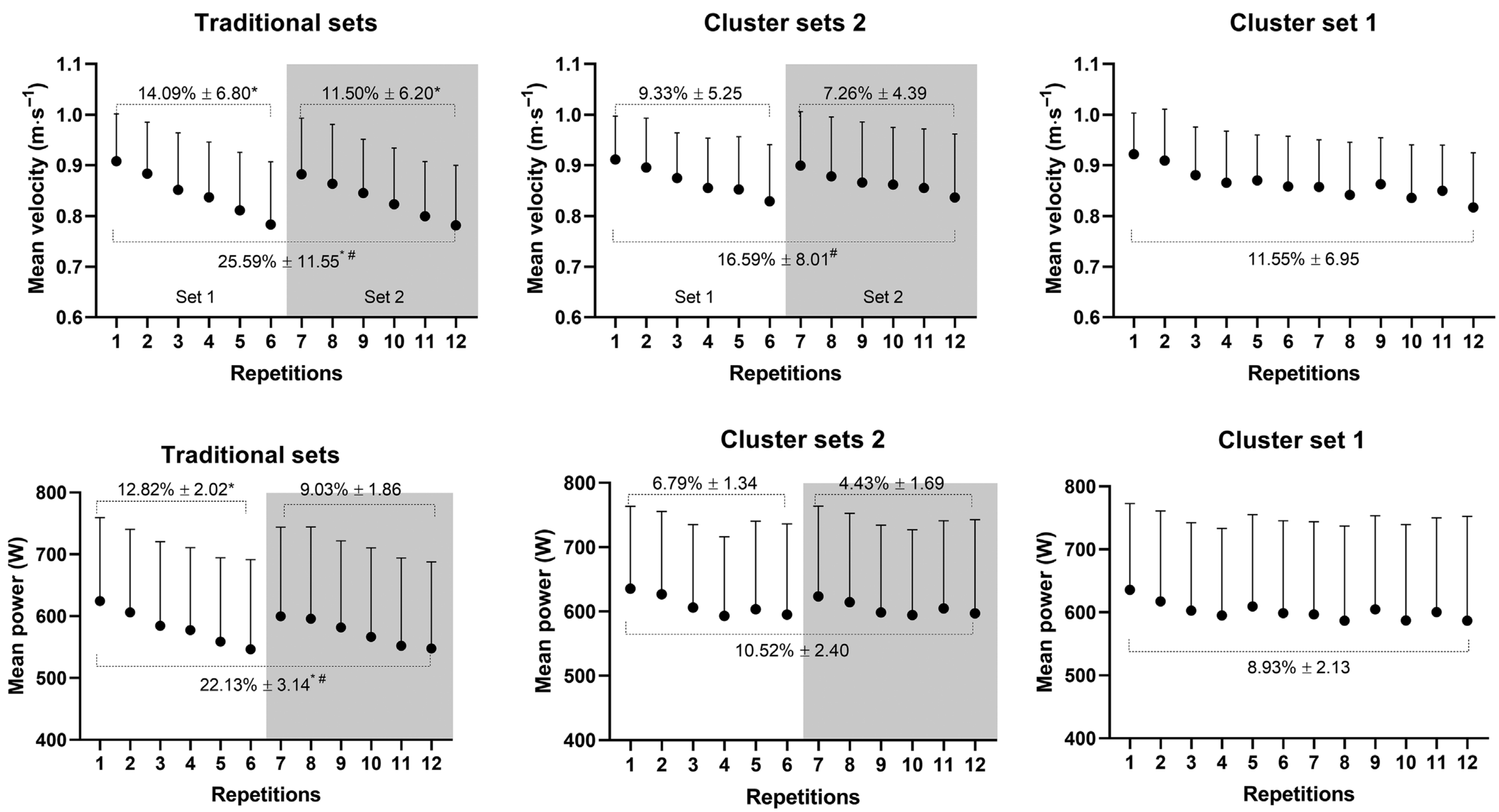

Figure 2 — Evolution of mean velocity and mean power throughout the 12 repetitions for each squat protocol. Data are presented as mean (SD). *Significantly higher velocity/power loss compared to cluster set of 2 repetitions ($P < .05$). #Significantly higher velocity/power loss compared to cluster set of 1 repetition ($P < .05$).

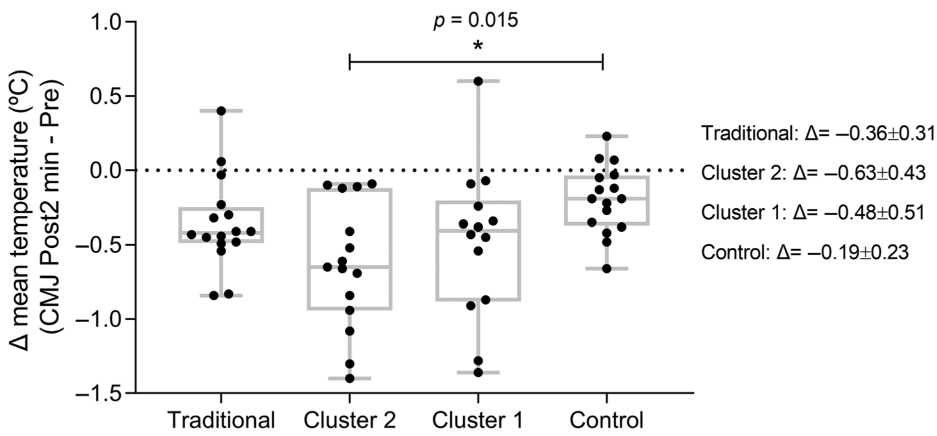

Figure 3 — Changes in mean skin temperature across protocols. Δ, change (after protocol – CMJ Pre); cluster 1, cluster set of 1 repetition; cluster 2, cluster sets of 2 repetitions. *Significant differences between protocols ($P < .05$).

Table 3 Association of the Change in CMJ Height With Velocity Loss and Change in T_{sk}

	Velocity loss	Δ T_{sk}	1RM	1RM/BW
Traditional				
Δ% CMJ Post2	0.11	–0.06	0.54*	0.48
Δ% CMJ Post4	0.23	–0.16	0.59*	0.43
Δ% CMJ Post8	–0.08	–0.11	0.30	0.19
Cluster 2				
Δ% CMJ Post2	–0.01	0.02	0.42	0.50*
Δ% CMJ Post4	–0.02	–0.25	0.30	0.33
Δ% CMJ Post8	–0.07	–0.18	0.27	0.36
Cluster 1				
Δ% CMJ Post2	0.04	–0.04	0.12	0.03
Δ% CMJ Post4	0.20	–0.23	0.31	0.27
Δ% CMJ Post8	0.15	0.09	0.32	0.39
Control				
Δ% CMJ Post2	—	–0.48	0.09	0.03
Δ% CMJ Post4	—	–0.18	0.39	0.33
Δ% CMJ Post8	—	–0.27	0.37	0.22

Abbreviations: CMJ, countermovement jump; Pre, before the squat protocol; Post2, 2 minutes after the squat protocol; Post4, 4 minutes after the squat protocol; Post8, 8 minutes after the squat protocol; 1RM, 1-repetition maximum; 1RM/BW, 1RM normalized per kg of body weight; T_{sk}, skin temperature. Note: The change in CMJ height at the different time points was expressed in relative values (Δ% = [post-CMJ height – pre-CMJ height]/pre-CMJ height × 100), and the change in T_{sk}, in raw values (Δ = post-T_{sk} – pre-T_{sk}).
*Statistical significance ($P < .05$).

intensity according to the maximum number of repetitions performed with a given load (ie, nRM) or a given %1RM measured in a previous test might lead subjects to train with a different intensity than the one prescribed.[12,20] Dello Iacono et al[15] reported enhanced CMJ height after 3 sets of 6 repetitions with the load that maximizes power production in jump squat among professional basketball players. On the contrary, Crum et al[27] reported reduced CMJ height 3, 5, 10, and 15 meters after an ascending quarter back squat protocol at 65% 1RM using a traditional set configuration. For the first time, we prescribed the optimal load for power output in the full squat exercise (~60%–65% 1RM) across different IRR protocols (rather than just a traditional set configuration). However, the CMJ height was still not enhanced. Importantly, the acute decrease in CMJ height may be explained by the volume of the protocol or the individual strength level. Thus, previous studies have reported enhanced CMJ performance after low-volume/high-load squat protocols.[5] Similarly, González-García et al[28] reported that weaker participants (half squat relative = 1.76 1RM/kg of body weight) did not enhance CMJ height at any time point, while Chiu et al[16] suggested that the squat exercise could be a viable method to acutely enhance mechanical performance in athletic but not in recreationally trained individuals.

Monitoring T_{sk} during RT exercise is getting more research in recent years.[17–19,29] Specifically, it has been suggested that T_{sk} above the quadriceps decreased abruptly during and after completing a squat exercise with a traditional set configuration up to minute 15 (thereafter, T_{sk} increases abruptly).[17,18] Moreover, the time course of T_{sk} seems to be influenced by the speed of the execution, with faster decreases in T_{sk} when performing squats at higher speeds in both the eccentric and concentric phases of the movement (1 s vs 5 s).[17] In the present study, T_{sk} acutely decreased across all set configurations (Figure 3), but no significant differences were observed in the change of T_{sk} between cluster and traditional squat set configurations. Likewise, the change of T_{sk} was not associated with the changes in CMJ height (Table 3). In this regard, Weigert et al[29] reported that T_{sk} seems not suitable to differentiate between exercise intensities from 30% to 70% 1RM during traditional set configuration (3 × 10 repetitions of unilateral biceps curl). This is the first study to examine the acute thermodynamic response to different squat set configurations, and further research is needed to confirm or contradict these findings. However, T_{sk} seems not suitable to distinguish between set configurations and does not provide additional insight into the acute changes in CMJ height following RT.

This study has limitations that must be addressed. First, equaling the total resting time is a matter of future prospective and experimental research since the work-to-rest ratios may determine the acute response to RT. Second, further research with athletic sample and highly trained CMJ subjects should be conducted to elucidate whether the CMJ height is increased after the squat set configurations with the selected intensity. Finally, although this is the first experiment performed on the potential association of T_{sk}

with squatting and jumping exercises, further research increasing the sample size is needed to corroborate or contrast our findings.

Practical Applications

Cluster set configurations significantly attenuated the loss in velocity and power in comparison with traditional set configurations. However, a similar decrease in CMJ height was observed for all protocols. Thus, although cluster set configurations mitigate the neuromuscular fatigue during RT, the residual fatigue does not appear to be influenced by the set configuration or the VL. Although we ensured that all subjects trained with the same intensity at each experimental session (60% 1RM; approximately associated with the load that maximizes power output in the full squat exercise), CMJ height was reduced. Thus, we speculate that lower training volume could reduce the residual neuromuscular fatigue. Moreover, coaches should consider their individuals' training status and strength level since it seems to be associated with the change in CMJ height. Thus, RT exercises are more recommended for athletic than recreationally trained individuals. Finally, although T_{sk} does not seem to be associated with the change in CMJ height, further research should corroborate these preliminary findings.

Conclusions

In summary, 12 squat repetitions performed at 60% of 1RM at the maximal intended velocity produced a comparable reduction of CMJ height, irrespective of the IRR full squat protocol used. While the use of cluster-set configurations significantly reduced the velocity and power loss within the sets, there was a similar decrease in T_{sk} across squat protocols. In addition, higher individual strength level (but not VL and change in T_{sk}) was associated with lower CMJ-height loss.

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