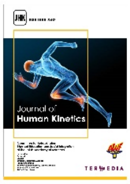

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Section I – Kinesiology

Acute Kinetic and Kinematic Responses to Varied Loading in the Behind-the-Neck Push Jerk: Impact on Force and Power Production

by
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While the influence of the load on mechanical outcomes has been investigated in weightlifting pulling derivatives, knowledge of these relationships in overhead pressing derivatives remains limited. To address this gap, this study examined the effects of varying loads on the force-time characteristics associated with peak power output in the behind-the-neck push jerk (BNPJ). Sixteen recreational male athletes were recruited and performed three repetitions of the BNPJ at 40%, 50%, 60%, 70%, and 80% of their 1RM. Mean system velocity (MSV), propulsive phase time (Time), peak force (PF), mean force (MF), peak power (PP), mean power (MP), the impulse and depth were calculated from force-time data during the propulsive phase and compared across loads. A series of one-way repeated measures analysis of variance (ANOVA) was used to compare the differences in each variable across intensities. The level of significance was set at $p \le 0.05$. Except for MSV, all variables progressively increased with loads. PF, MF, PP, MP, and the impulse were greatest at 80% 1RM with small to large significant differences between other intensities ($p = 0.00–0.02$, Hedge's $g = 0.26–2.49$). There were no significant differences between 70% and 80% 1RM in PV ($p = 0.35$, $g = 0.18$), but there were significant differences between 80% 1RM and 40%, 50%, and 60% 1RM ($p = 0.01–0.05$, $g = 0.14–0.64$). Prescribing the BNPJ at 80% 1RM is beneficial in enhancing power and force output.

***Keywords**: weightlifting overhead pressing derivatives; overload; lower extremities; athletic performance; biomechanics*

Introduction

Weightlifting exercises (i.e., snatch and clean and jerk) and their derivatives (i.e., catching, pulling, and overhead pressing) (Soriano et al., 2019) are frequently prescribed in resistance training programs to improve lower body strength, power, and speed performance (Hori et al., 2005; Makaruk et al., 2024; Newton and Kraemer, 1994; Suchomel et al., 2017). These exercises are commonly implemented in a wide range of sports populations because of the biomechanical similarities during the lifting movements to generic athletic movements that require rapid triple extension (i.e., rapid extension of the hip, knees, and ankle joints) while concurrently enhancing high levels of force and power production (Carlock et al., 2004; Kipp et al., 2019; Suchomel, et al., 2015a). Furthermore, as training adaptations are often results of the training stimulus provided, exploring the relationship between external loads and mechanical output may provide valuable insights into training prescriptions (Cormie et al., 2011a, 2011b; Hori et al., 2005). Considering that different loads elicit distinct mechanical stimuli, understanding the specific characteristics associated with various

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loads is crucial for an effective program design (Soriano et al., 2015, 2017; Suchomel et al., 2017).

Weightlifting overhead pressing derivatives (WOPDs) such as the push jerk (PJ), the push press, and the split jerk are prescribed in resistance training to enhance rapid force and power production (Comfort et al., 2016; Lake et al., 2014; Soriano et al., 2019). These exercises share similar movement patterns and lifting strategies involving the dip and thrust phases that are comparable to the CMJ (Lake et al., 2014; Soriano et al., 2024a) and allow non-weightlifter populations to rapidly accelerate large to moderate loads through lower body triple extension. Moreover, WOPDs were found to achieve greater mechanical output compared to exercises such as a traditional squat (Garhammer, 1993; Stone et al., 2006). However, only few studies have examined the effects of loads on mechanical output during WOPDs (Flores et al., 2017; Lake et al., 2014; Soriano et al., 2024a). In addition, for those who can achieve overhead positions, there is evidence to suggest that performing the behind-the-neck push jerk (BNPJ) by starting with the barbell on the shoulder and the upper back not only simplifies technical patterns but also elicits greater power values in the drive phase due to the absence of obstacles (e.g., the head) during the trajectory of the barbell upward (Flores et al., 2017; Soriano et al., 2019). Nonetheless, as the push jerk and the split jerk involve distinct receiving positions that may influence kinetic and kinematic performance (Soriano et al., 2024b), and given that the effects of loading on the BNPJ specifically have not been investigated, the biomechanical characteristics of this exercise across different loads remain unclear.

Previous research has explored the biomechanical responses of various exercises across different loads (e.g. peak power output [PPO] typically occurs between 30% and 80% 1RM for strength-based exercises and 0% and 30% 1RM for ballistic exercises) (Ikeda et al., 2025; Soriano et al., 2015, 2017), including exercises in the realm of WOPDs (Flores et al., 2017; Lake et al., 2014; Soriano et al., 2024b). However, the BNPJ is an alternative WOPD exercise that requires less technical prerequisite than full classical lifts, such as the clean and jerk. While recent literature has compared the kinetics of various front-racked overhead pressing derivatives (Padovan et al., 2025; Soriano et al., 2024a), the distinct behind-the-neck starting position of the BNPJ may alter movement mechanics and subsequent kinetic output (Flores et al., 2017). Therefore, as the specific load-dependent characteristics of the BNPJ have not been established, a detailed biomechanical analysis is warranted. Understanding these biomechanical characteristics across varying loads is crucial for informing training prescriptions, particularly when augmenting mechanical output is a primary objective for practitioners. To address this gap in the literature of how different loads influence biomechanical output during the BNPJ, this study aimed to compare kinematics (mean system velocity [MSV], propulsive phase time [Time], depth) and body-mass normalized kinetics (peak force [PF], peak power [PP], mean power [MP] and impulse) during the BNPJ based on the relative percentage of the participants' 1 RM. It was hypothesized that MSV in the BNPJ would decrease with heavier loads, while Time, PF, MF, PP, MP, the impulse and depth would be greater in heavier loads.

Methods

Participants

Sixteen recreational male athletes (age: 28.9 ± 4.3 years; body height: 173.0 ± 6.0 cm; body mass: 80.7 ± 12.8 kg; relative 1RM BNPJ 1.2 ± 0.2 kg/kg) were recruited for the study. The cohort included amateur athletes from team sports and with weightlifting background. An a priori power analysis was conducted using G*Power to determine the sample size required to achieve a power of 0.80, with an alpha level of 0.05, an estimated medium effect size (f = 0.5), 5 groups (loads), 5 measurements per participant, and an assumed correlation of 0.5 among repeated measures (Kang, 2021). The analysis indicated that a sample size of over 10 would be sufficient. Each participant had over two years of resistance training experience and was familiar with BNPJ training for at least one year. Competitive weightlifters or those who experienced musculoskeletal injuries or disorders in the previous 6 months were excluded from the study. All participants were instructed to avoid strenuous physical activity 48 hours before each experimental test. Weightlifting accessories (e.g., shoes, belts, knee sleeves, etc.) were allowed, and participants replicated the same condition during all testing sessions. All participants provided written informed consent before participating in the study.

This study was conducted following the principles of the Declaration of Helsinki, and approved by the Institutional Review Board (IRB) of the Fu Jen Catholic University, New Taipei, Taiwan (approval code: C110125; approval date: 22 February 2022).

Measures

One-Repetition Maximum Behind-the-Neck Push Jerk Testing. First, a familiarization session that included introducing the exercise criteria and checking the movement proficiency of the participants was conducted. In the subsequent session, participants performed a 1RM BNPJ test following the protocol defined and modified by previous research (Soriano et al., 2021). Participants first completed a standardized warm-up, which consisted of upper- and lower-body dynamic stretching, and continued with the exercise-specific warm-up after a 5-min rest interval. The exercise-specific warm-up included performing 1 set of 5 repetitions of the quarter-squat, the half-squat, and the BNPJ with an Olympic free weight barbell (20 kg). Subsequently, participants performed two warm-up sets of the loaded BNPJ before the official 1RM test. The BNPJ warm-up sets consisted of 5 repetitions at 50–60%, 3 repetitions at 70–85%, and a single repetition at 95% of the participant's self-reported 1RM with 5 min of rest provided between each set. After the warm up, the load was increased by 2.5–5% for the first 1RM attempt and subsequent attempts with a 5-min rest interval in between until participants reached their 1RM within 5 formal attempts (Soriano et al., 2021). Technical aspects required to assess the BNPJ during the 1RM and power testing were defined as follows (Figure 1): the participant started with the barbell resting on the upper trapezius and held it with a self-selected grip width (Waller et al., 2009). After achieving the starting position, the participant performed a countermovement to a self-selected depth by flexing the hip, knee, and ankle (dorsiflexion) joints before rapidly extending each joint to project the barbell upward. Upon reaching maximal extension of the lower extremities, participants then flexed each joint to drop under the barbell while simultaneously extending their upper extremities to catch the barbell overhead in a quarter-squat position. In line with previous research, participants were required to demonstrate approximately one second of control with the barbell in the catching position and achieve a fully standing position to complete the lift (Soriano et al., 2021; Waller et al., 2009). Unacceptable lifts included projecting the barbell upward through the propulsion phase and catching the barbell with the lower extremity joints in full extension, dropping under the barbell without fully locking out the elbows, or being unable to maintain the catching position for one second in the catch phase. All trials were visually monitored and video-recorded by the research team to identify mistrials.

Load Profiling. This session was separated by 2 to 7 days following the 1RM testing session. Before testing, each participant had their body mass recorded and completed the same standardized warm-up conducted in the 1RM testing session. Participants then completed 1 set of 3 consecutive maximal effort BNPJ repetitions using relative loads equivalent to 40%, 50%, 60%, 70%, and 80% of their predetermined 1RM, with a 5-min rest interval provided between each loading condition. The load ranges were chosen to reflect the range of loads most commonly reported to elicit peak power during WOPD variation exercise (Comfort et al., 2016). Reassessment of the 1RM in this session was omitted due to the limited practicality of repeated 1RM prescriptions within a typical strength training protocol. As recommended by Suchomel et al. (2015b), the loads were increased progressively to replicate a typical resistance training session. All trials were visually monitored and video-recorded by the research team to identify mistrials.

Data Collection and Processing. Two force plates were used to collect kinetic data for the study (Soriano et al., 2023). All testing was conducted in a custom-built rack with adjustable safety bars for increased safety. During power testing, participants performed the lifts with each foot standing on a force plate (9260AA, Kistler., Winterthur, Switzerland). The force plates were interfaced to an analog-to-digital converter (5695B, Kistler., Winterthur, Switzerland). Analog signals from the force plates were collected at 1,000 Hz for subsequent analyses. Vertical ground reaction forces (VGRFs) were recorded and exported as text files and analyzed using a custom-designed Microsoft Excel spreadsheet (version 2016, Microsoft Inc., Redmond, WA, USA). In the custom Excel sheet, we analyzed the system velocity by subtracting the system weight (barbell plus body weight averaged over a 1-s period of quiet standing prior to the exercise repetitions) from the recorded VGRFs and then dividing this by system mass on a sample-by-sample basis and integrating the product using the trapezoidal rule, allowing velocity-time and displacement-time data to be calculated. Power was achieved by displacing system mass, resulting in the product of the force and system velocity from the force plates as recommended in the literature (Soriano et al., 2023). All force-time variables were analyzed in the propulsive phase (Soriano et al., 2024a). The propulsive phase was deemed to have started when velocity exceeded 0.01 m/s and finished at peak velocity. The threshold for the movement onset was defined as the point at which the VGRFs were reduced by a threshold equal to 5 times the standard deviations of the system weight during the quiet standing (Soriano et al., 2024a). Table 1 provides a presentation of the dependent variables.

Design and Procedures

Participants took part in two sessions performed on two different days within a 7-day span, with at least 48 h of rest between each experimental test. Each participant completed an anthropometry assessment in the first session and completed a one repetition maximum (1RM) BNPJ test. In the second session, participants performed the BNPJ at relative intensities equivalent to 40%, 50%, 60%, 70%, and 80% of their pre-determined 1RM BNPJ.

Statistical Analysis

All data were reported as the mean ± SD, and their distribution was assessed by the Shapiro-Wilk normality test. For each variable, the mean output of the three trials was taken forward for statistical analysis. For metrics at each load, the two-way random effect model intraclass correlation coefficient (ICC) with 95% confidence intervals (CIs) was used to assess relative reliability (Bruton et al., 2000). The coefficient of variation (CV), calculated as the within-participant standard deviation/mean × 100, was used to determine absolute reliability as it estimates the measurement's error considering the within-participant variation (Bruton et al., 2000). Standards for reliability measures were determined based on previously established criteria, with estimated ICC ≥ 0.70 and CV ≤ 10% (Atkinson and Nevill, 1998; Koo and Li, 2016). One-way repeated measures analysis of variance (ANOVA) was used to compare the differences of the selected variables at the various intensities (40%, 50%, 60%, 70%, and 80%) based on the 1RM BNPJ. The criterion level for significance was defined by an alpha level of $p \leq 0.05$. The magnitude of differences between intensities was determined by Hedge's g effect size, which was interpreted as trivial, small, moderate, and large when magnitudes were <0.25, 0.25–0.49, 0.50–1.0, and >1.0, respectively, based on the scale noted within previous literature (Rhea, 2004). All statistical analyses were conducted with SPSS 20.0 (IBM, New York, NY, USA).

Results

All selected variables demonstrated acceptable relative reliability (estimated ICC = 0.716–0.962) and small within-participant variability (CV = 2.14–7.78%) (Table 2). All variables were normally distributed and are presented in Table 3. Time, PF, MF, PP, MP, the impulse and depth all progressively increased with the load and maximized at 80% 1RM (Table 3). Significant differences were observed between intensities for all variables ($p < 0.05$), except for MSV, which showed no significant differences across intensities ($p = 0.40$–0.10).

Post hoc comparisons revealed clear and substantial differences among most intensities for Time, PF, MF, PP, MP, the impulse and depth, such that higher intensities led to higher values (Tables 3 and 4). Differences among intensities were mostly small to large for Time, PF, MF, PP, and MP, and moderate to large for the impulse. MSV showed trivial and non-significant differences across all intensities (Figure 2, Table 4).

Table 1. Description of considered variables.

Variables	Abbreviation	Description
Mean system velocity (m/s)	MSV	Sum of system displacement in the propulsive phase divided by propulsive phase time
Propulsive phase time (s)	Time	Begins at 0 velocity and ends at peak concentric system velocity
Peak force (N/kg)	PF	Maximum VGRF attained during the propulsive phase relative to body mass
Mean force (N/kg)	MF	Average VGRF attained during the propulsive phase relative to body mass
Peak power (W/kg)	PP	Maximum power attained during the propulsive phase relative to body mass
Mean power (W/kg)	MP	Average power attained during the propulsive phase relative to body mass
Impulse (N·s/kg)	-	Defined as the force exerted multiplied by the time taken to produce it during the propulsive phase relative to body mass
Depth (m)		The distance between the onset point and the lowest point of system displacement before the propulsive phase

Table 2. Reliability and variability of the selected variables.

Variable	Intensity														
	40%1RM			50%1RM			60%1RM			70%1RM			80%1RM		
	ICC	95% CI	CV (%)	ICC	95% CI	CV (%)	ICC	95% CI	CV (%)	ICC	95% CI	CV (%)	ICC	95% CI	CV (%)
MSV (m/s)	0.925	0.838–0.971	3.49	0.799	0.617–0.914	5.00	0.933	0.859–0.973	3.10	0.946	0.885–0.978	2.37	0.930	0.849–0.972	2.55
Time (s)	0.863	0.721–0.945	5.07	0.861	0.719–0.942	5.72	0.896	0.786–0.958	5.24	0.940	0.874–0.976	4.14	0.957	0.907–0.983	3.36
PF (N/kg)	0.956	0.904–0.983	2.44	0.895	0.786–0.957	2.93	0.962	0.918–0.985	2.32	0.960	0.915–0.984	2.11	0.962	0.914–0.985	2.15
MF (N/kg)	0.958	0.908–0.984	1.80	0.909	0.812–0.963	2.24	0.971	0.936–0.988	1.65	0.970	0.935–0.988	1.60	0.978	0.950–0.991	1.47
PP (W/kg)	0.889	0.770–0.956	4.96	0.773	0.567–0.902	7.04	0.936	0.860–0.975	3.85	0.946	0.886–0.978	3.01	0.945	0.874–0.978	2.87
MP (W/kg)	0.923	0.836–0.970	4.60	0.813	0.640–0.920	6.37	0.955	0.905–0.982	3.57	0.954	0.902–0.982	3.15	0.951	0.888–0.981	3.20
Impulse (N·s/kg)	0.880	0.753–0.952	3.86	0.757	0.539–0.895	5.46	0.908	0.801–0.963	3.43	0.938	0.869–0.975	2.24	0.934	0.855–0.974	2.35
Depth (m)	0.935	0.860–0.978	6.44	0.883	0.764–0.948	9.93	0.860	0.715–0.939	8.36	0.935	0.861–0.979	6.32	0.853	0.707–0.932	7.06

Note. 1RM = 1 repetition maximum; ICC = intraclass correlation; CV = coefficients of variation; MSV = mean system velocity; Time = propulsive phase time; PF = peak force; MF = relative mean force; PP = relative peak power; MP = relative mean power

Table 3. Descriptive statistics for each variable (mean ± SD).

Variable	Intensity				
	40%	50%	60%	70%	80%
MSV (m/s)	0.86 ± 0.14	0.87 ± 0.12	0.88 ± 0.11	0.88 ± 0.10	0.89 ± 0.09
Time (s)	0.17 ± 0.03	0.18 ± 0.03	0.19 ± 0.03*	0.20 ± 0.04*†‡	0.21 ± 0.04*†‡§
PF (N/kg)	31.1 ± 3.8	33.5 ± 4.2*	35.5 ± 4.7*†	36.8 ± 4.7*†‡	38.1 ± 4.7*†‡§
MF (N/kg)	26.7 ± 2.6	28.8 ± 2.9*	30.7 ± 3.3*†	32.2 ± 3.5*†‡	33.6 ± 3.7*†‡§
PP (W/kg)	32.7 ± 6.5	35.6 ± 6.5*	39.4 ± 6.5*†	42.5 ± 6.2*†‡	45.4 ± 6.1*†‡§
MP (W/kg)	21.7 ± 4.6	23.4 ± 4.5*	25.6 ± 4.7*†	27.1 ± 4.6*†‡	28.7 ± 4.5*†‡§
Impulse (N·s/kg)	2.1 ± 0.3	2.3 ± 0.3*	2.6 ± 0.3*†	2.8 ± 0.3*†‡	3.1 ± 0.3*†‡§
Depth (m)	0.16 ± 0.05	0.16 ± 0.05	0.17 ± 0.05*†	0.18 ± 0.05*†‡	0.18 ± 0.04*†‡§

*Note. MSV = mean system velocity; Time = propulsive phase time; PF = peak force; MF = relative mean force; PP = relative peak power; MP = relative mean power. Significant differences from the 40%, 50%, 60%, 70% intensities are indicated by symbols *, †, ‡, §, (respectively)*

Figure 1. Behind-the-neck push jerk sequence.
Note. a: starting position; b: dip; c: propulsion; d: descent

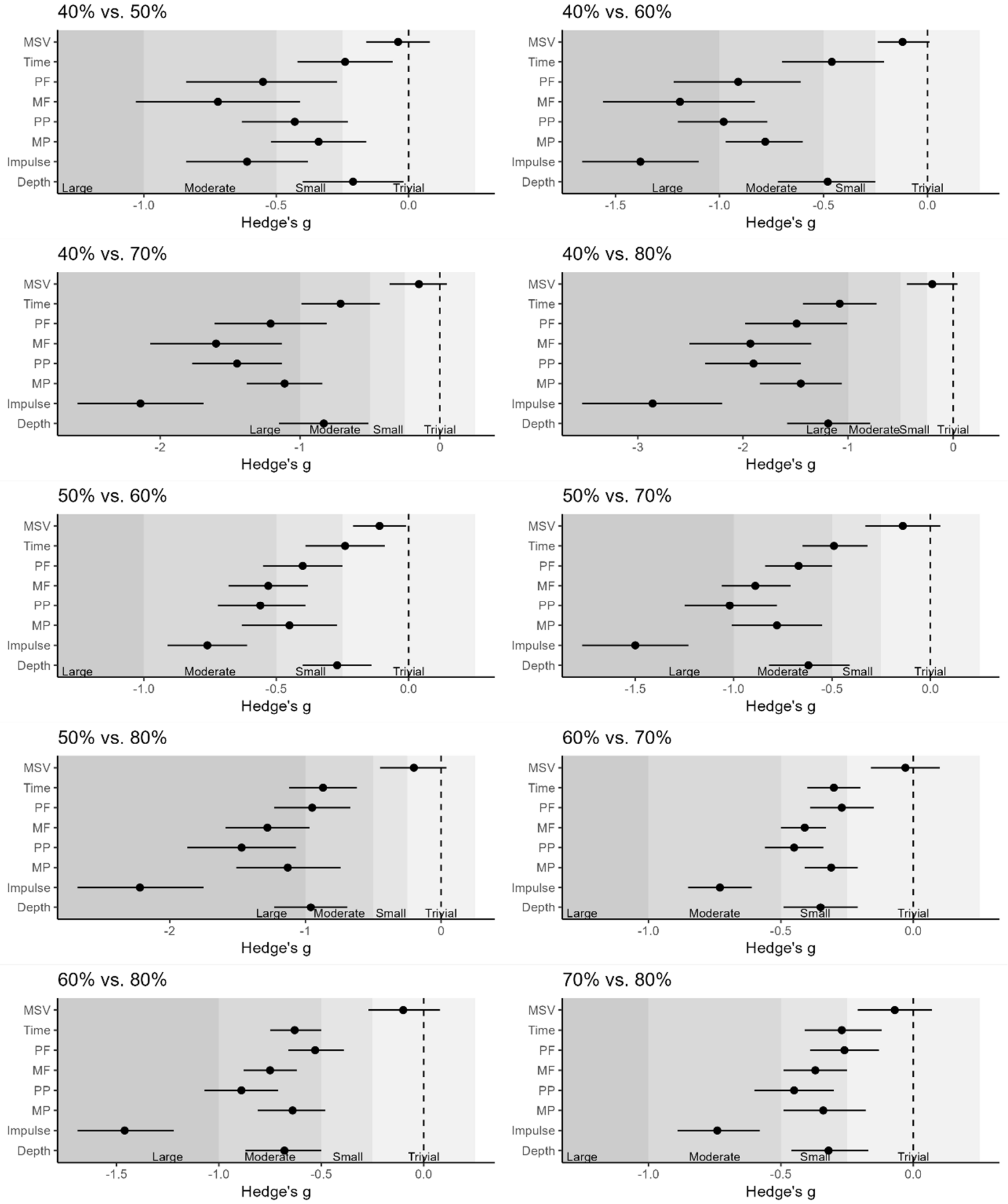

Figure 2. Effect sizes (Hedge's g) for kinetic and kinematic variables across different load intensity comparisons.

Note. Forest plots show effect sizes (Hedge's g) with 95% confidence intervals for mean system velocity (MSV), propulsive phase time (Time), peak force (PF), mean force (MF), peak power (PP), mean power (MP), and the impulse across different percentage comparisons of one-repetition maximum (40% vs 50%, 40% vs 60%, etc.). The vertical dashed line represents zero effect size. Negative effect sizes favor higher percentages, while positive effect sizes favor lower percentages. Error bars represent 95% confidence intervals

Discussion

The aim of this study was to investigate the effects of varying loads on kinematic and kinetic differences across different intensities in the BNPJ. Significant findings were as follows: (1) contrary to the authors' hypothesis, MSV was not significantly higher in heavier loads, with only trivial effect sizes across intensities; (2) in line with the authors' hypothesis, Time, PF, MF, PP, MP, the impulse and depth showed a progressive increase with loads, and were maximized at 80% 1RM.

Based on our results, MSV in the BNPJ did not significantly differ as the intensity increased. This was different than our hypothesis, and also contrasted with traditional strength-based exercises, where velocity typically decreases as the load increases (Banyard et al., 2018). It should be noted that system velocities were collected in this study instead of barbell velocity. In weightlifting exercises, the goal is to lift the barbell, which requires continuous acceleration of system mass while lifting, even at heavy loads (Soriano et al., 2019, 2023). This was supported by previous findings reporting that some weightlifting derivatives (e.g., hang high pull, hang clean pull, and hang power clean exercises) produced similar system velocities across loads, as opposed to the more pronounced relationships between load and barbell velocities (Suchomel et al., 2025). A direct explanation for the stable system velocity is a change in the movement strategy at higher loads. Our results revealed that participants exhibited greater system depth under heavier loads. This observation suggests that performers may adopt different strategies across varying loads in the BNPJ. At heavier loads, the increased system depth may allow for greater propulsion time and impulse, contributing to the maintenance of system velocities despite the increased load.

Increasing the load in the BNPJ resulted in a corresponding increase in propulsive phase time, with significant differences observed between moderate and heavy loads. Specifically, the 40% load differed significantly from the 60%, 70%, and 80% loads, and the 50% load differed significantly from the 60%, 70%, and 80% loads. Although a longer propulsion phase time may decrease force potentiation by reducing muscle spindle stimulation and elastic energy potentiation (Grabe and Widule, 1988; Soriano et al., 2019), it has been suggested that a longer phase time was necessary to produce a greater net impulse, and therefore greater acceleration (Soriano et al., 2019), especially when against heavier loads as in the BNPJ. This explanation could be verified by a previous study, indicating that prolonged time did not lead to a decrease in velocity during the jerk (Grabe and Widule, 1988).

As expected, PF and MF increased with heavier loads and were all maximized at 80% of 1RM. To the authors' knowledge, this was the first study to establish the loads that maximized both PP and MP during the BNPJ. The intensity was similar to those previously reported to optimize power in overhead pressing variants. According to Lake et al. (2014), the PPO was 75% of the 1RM push press, and the same trend was reported by Flores et al. (2017) who found that 90% of 1RM produced the greatest barbell peak power during the jerk and the back jerk. The higher percentages found by Flores et al. (2017) might be influenced by the strength profile of the participants (competitive weightlifters). Moreover, they calculated barbell power (Flores et al., 2017) while the current study calculated system power. Thus, it has been suggested that the participant's experience and their proficiency level could be expected to shift the percentage of maximum strength at which the highest power is produced either upward or downward (Flores et al., 2017; Kawamori et al., 2005). With this in mind, participants' eligibility criteria in the current study were resistance-trained men who had been familiarized with BNPJ training for over one year instead of competitive weightlifters because recruiting weightlifters as participants might not be directly applicable to other non-weightlifting populations who performed weightlifting and its derivatives as power training (Takei et al., 2021). In summary, the data presented in the current study support classifying the BNPJ as a strength-speed weightlifting derivative (Comfort et al., 2023), which may allow practitioners to easily train and overload the coordinated triple extension movement required by the vast majority of sport activities, and consequently, provide a superior lower body strength-power training stimulus in athletic populations (Kawamori et al., 2005; Makaruk et al., 2024; Suchomel et al., 2015a).

The impulse increased progressively with intensity and maximized at 80% 1RM. In many ways, this should be expected because, as mentioned earlier, heavier loads led to an increased time to produce force. The impulse is the product of force and time, and according to the impulse-momentum relationship, greater time to produce force would increase the amount of the impulse (force multiplied by time) generated, which in turn would result in a more significant change in the momentum (velocity) of the system (Argus et al., 2011). It should also be pointed out that dividing the net propulsive phase impulse by an individual's mass would provide their velocity at the end of the phase (Turner et al., 2020). This could mean that the greater the relative impulse one can apply during a training movement, the greater the velocity is produced, and may eventually induce ideal training adaptations required in athleticism. On the other hand, a key observation was that greater depth was also achieved with heavier loads (e.g., 80% 1RM). This alteration in movement strategy occurred concurrently with longer propulsive phase times and resulted in the maintenance of similar system velocities across loads. This observation suggests that participants may adopt a deeper countermovement to increase the time available for force production, thereby generating the necessary impulse to move heavy loads without a significant loss in velocity. Further biomechanical analyses of the BNPJ are warranted to elucidate the underlying mechanisms contributing to this phenomenon.

The findings of this study should be considered with few limitations. Due to safety concerns, loads over 80% 1RM were not assessed, as applying intensities exceeding 80% in a technically demanding exercise may expose the participants to more significant injury risk (Suchomel et al., 2025). Therefore, the authors cannot conclude that 80% is the load that maximizes PP in the BNPJ. It should be noted that the values obtained in the current study were only loosely comparable to those of previous works. This is mainly due to variations in the methodological procedures used across different studies. For instance, studies such as Flores et al. (2017) assessed barbell power, whereas the present study analyzed system power. Therefore, to account for the inclusion of body mass in our system-level analysis and to reduce between-participant variance, we normalized all kinetic variables. This necessary methodological difference limits direct comparisons between studies.

Conclusions

Our results indicate that kinetic output during the BNPJ, including peak and mean power, peak and mean force, and the impulse, progressively increased with loads and were maximized at 80% of 1RM. On the other hand, mean system velocity did not differ significantly across the tested intensities. Therefore, practitioners aiming to maximize lower-body power production using this exercise should implement heavy loads in the range of 70–80% 1RM. However, more research is still needed on the kinematic analyses and the long-term training effects of the BNPJ.

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