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Monitoring Neuromuscular Function in Sprinters Using the Countermovement Jump: A Longitudinal Case Study

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ABSTRACT

The countermovement jump (CMJ) is a widely used test for monitoring neuromuscular (NM) function. However, its suitability for longitudinal NM function monitoring in sprinters remains uncertain. This study examines the relationship between quantified training load and sprinters' CMJ performance over a 10-week training block. Five high-level male university sprinters participated in this longitudinal study and underwent CMJ testing once a week. Their training load was quantified using the weekly training impulse (wTRIMP) calculated from training duration and session rate of perceived exertion (RPE). Subjective wellness ratings (Wellness) were assessed using a 7-point scale questionnaire based on the Hooper-Mackinnon Questionnaire. Average weekly Wellness and CMJ variables were used for further analysis, examining their relationship with wTRIMP. During the monitoring period, 80-85% of participants' wTRIMP was attributed to sprint training. Significant relationships were observed between wTRIMP and CMJ variables in four out of five participants (e.g. Sub A: Eccentric Impulse; r = -0.814, p = 0.014, Sub B: Concentric Impulse; r = -0.775, p = 0.041, Sub C: Jump height; r = -0.704, p = 0.034, Concentric mean power; r = -0.825, p = 0.006, Sub E: Jump height; r = -0.723, p = 0.028, Concentric Impulse; r = -0.737, p = 0.024), with force-time related variables being more sensitive to wTRIMP than jump height. Additionally, a significant relationship between Wellness and wTRIMP was observed for only one sprinter (Sub A: Wellness; r = -0.620, p = 0.056), while no significant relationship was found for the remaining four sprinters. In conclusion, our results demonstrated that the CMJ is suitable for longitudinal NM function monitoring of sprinters.

Keywords: Neuromuscular fatigue, Athlete monitoring, Countermovement jump

INTRODUCTION

Sprint running events in athletics involve athletes competing to cover set distances in the shortest time possible. Athletes and their coaches develop long-term training plans aimed at improving performance [1], with an understanding training load being essential for this long-term improvement based on the theories of supercompensation and the Fitness-Fatigue model [2,3]. It is also crucial to optimize performance variability by providing an optimal training load while considering the risk of sports injuries and overtraining [4,5]. Therefore, athletes and their coaches are required to optimize their conditioning to achieve peak performance in their target competitions, purposefully adjusting training load within the context of a long-term training plan.

Training load can be quantitatively assessed using methods such as the session rate of perceived exertion (sRPE) method [6] and wearable global positioning (GPS) technology [7,8]. The sRPE method, in particular, requires no specialized equipment. It calculates training load by multiplying an athlete's RPE for a given session (typically using a 1–10 scale) by the duration of the session (in minutes), to derive a training load in arbitrary units (a.u.). This method has been shown to correlate well with heart rate and blood lactate concentration [9], making it widely utilized in various sports settings [10]. In athletics, the sRPE method is also used, contributing to their performance improvement [11,12,13].

The countermovement jump (CMJ) is one of the most used tests for monitoring neuromuscular function when estimating athletes' conditions and prescribing appropriate training loads [14]. Previous studies have reported that CMJ performance serves as an objective marker of neuromuscular fatigue and supercompensation [14]. The advantages of the CMJ test include its simplicity and reliability [15,16], which has led to its widespread adoption for assessing neuromuscular function in various sports contexts [17,18,19,20]. CMJ analysis has traditionally focused on jump output (e.g., jump height) and gross values (i.e., peak, mean) related to the concentric phase [21,22]. However, this approach does not directly assess the stretch-shortening-cycle (SSC) component, including the eccentric phase, or the movement strategies used to perform the CMJ. This limitation may contribute to uncertainty in interpreting CMJ test response to fatigue [23]. In response to this limitation, it has been recommended to utilize force-time related variables in addition to jump height for a more detailed assessment of neuromuscular fatigue [24,25].

Several studies have assessed the response to training load during a sprint training session using the CMJ in sprinters [22,26]. For example, Hasegawa et al. [26] studied the effects of high-intensity sprint exercise on CMJ performance in sprinters and concluded that the CMJ could be used to assess neuromuscular function in this population. However, there is a lack of longitudinal research that have quantified the daily training load of sprinters and examined their relationship with CMJ performance [1]. In this context, Okudaira et al. [8] conducted a longitudinal study to examine investigated the relationship between training load and CMJ performance in an elite sprinter, quantifying training load using a GPS device. Their findings showed a significant relationship between the two and specifically reported that eccentric phase CMJ variables were effective in detecting neuromuscular fatigue in sprinters. Although this study provided valuable insights, it remains uncertain how the CMJ, which detects physical adaptations, responds to training load and whether there are differences among individual sprinters.

To address these issues, it is important to theoretically examine the relationship between training load and the physical responses it elicits, based on the accumulation of findings from actual training settings. Therefore, the purpose of this study was to assess the relationship between quantified training load and sprinters' CMJ performance over a 10-week training block in order to determine the suitability of the CMJ test for longitudinal monitoring of neuromuscular function in sprinters. CMJ performance was comprehensively examined using a number of force-time related variables (Table 1) in addition to changes in jump height. It was hypothesized that CMJ performance would decrease as training loads increased. Additionally, force-time variables would exhibit more pronounced

Table 1. Description of jump height and CMJ variables.

Variable	Abbreviation	Description
Jump Height (cm)	JH	The maximum jump height achieved, calculated using peak velocity
Peak Force (N\kg)	PF	Greatest force achieved during the jump
Peak Power (W/kg)	PP	Greatest power achieved during the jump
Eccentric Impulse (Ns/kg)	EccI	Force exerted eccentrically multiplied by the time taken eccentrically
Concentric Impulse (Ns/kg)	ConI	Force exerted concentrically multiplied by the time taken concentrically
Eccentric Mean Power (W\kg)	EccMP	Mean power generated during the eccentric phase of the jump
Concentric Mean Power (W\kg)	ConMP	Mean power generated during the concentric phase of the jump
Eccentric Duration (s)	EccDur	Time of eccentric contraction during the jump
Concentric Duration (s)	ConDur	Time of concentric contraction during the jump
Eccentric Duration : Concentric Duration (Time)	ED : CD	The ratio of eccentric duration to concentric duration

changes in response to training load than jump height. By clarifying these relationships, athletes and their coaches may improve their decision-making throughout the training process. This can contribute to adjusting training plans in the short or long term toward the ultimate goal of improving performance while minimizing the risk of sports injuries and overtraining.

METHODS

Design

A prospective cohort study was conducted on high-level sprinters from a university athletics team in Japan. We followed their regular training and conducted weekly CMJ tests over a period of 10 weeks, from March 14 to May 24, 2022. The initial four weeks were designated as a preparatory training phase characterized by high-intensity and high-volume training. The following six weeks were allocated to a competition phase emphasizing high-intensity and specific training. Although there was a general training regimen for the team as described above, each participant's pre-match conditioning training varied.

Participants and familiarization

Five high-level male university sprinters (see Table 2) participated in the longitudinal study. Sub A and Sub B won the National University Championships, Sub C and Sub D have won prizes in national competitions, and Sub C was selected for the national team for the World Championships the following year. Informed consent was obtained in writing, and the study protocol was approved by the Ethics Committee of the Faculty of Health and Sports Sciences at the University of Tsukuba (IRB ID: tai 012-129).

Participants underwent a single CMJ practice session 7–10 days prior to week 1 CMJ testing to ensure familiarity with the proper technique. They received visual demonstrations and were instructed to focus on "squatting quickly and jumping as high as possible". After reaching the lowest point of the squat, they quickly extended their hips, knees, and ankles to jump as high and fast as possible. Upon landing, they were instructed to absorb the impact by flexing these joints again to achieve their preferred squat depth. No restrictions were placed on the depth of the squat. Each participant completed 8–10 repetitions until CMJ technique was performed as consistently as possible.

Training performed and classification

Participants, as sprinters in their athletics team, followed a training plan throughout the study period. A representative example of a training cycle is shown in Table 3 (a. Sub A and b. Sub C). Typically, they trained five days a week (Sub A: 5.0 ± 0.4, Sub B: 5.0 ± 0.4, Sub C: 5.0 ± 0.9, Sub D: 5.0 ± 0.8, Sub E: 5.0 ± 0.7). Training sessions were classified into three categories. Sprint training included exercises conducted on the track or hill to enhance sprinting ability. Weight training referred to strength and power development sessions performed in the gym. Other types of training encompassed rehabilitation activities. Sprint training was conducted approximately four times per week, weight training was performed between one to three times per week, and other types of training were conducted two to five times during the monitoring period. A 10-point sRPE was obtained from the participants within 30 minutes after each training session [6]. Additionally, we recorded the duration of each participant's training session in minutes, defined from the beginning of the warm-up to the end of the cool-down.

Training load and wellness

Training load for each participant was quantified by multiplying training duration (in minutes) by sRPE, referred to as the training impulse (TRIMP) [6]. These values were calculated for each training session, and their total weekly value was used as the weekly TRIMP (wTRIMP). Subjective wellness ratings were determined using a 7-point

Table 2. Characteristics of participants.

	Sex	Height (m)	Weight (kg)	Specialized Event	Personal Best (s)	WA Score
Sub A	M	1.77	75.5	100 m	10.31	1,101
Sub B	M	1.72	72.0	100 m	10.39	1,075
Sub C	M	1.81	76.6	400 m	46.22	1,096
Sub D	M	1.79	62.3	400 m	49.36	896
Sub E	M	1.77	71.0	400 mH	50.31	1,114

WA: world athletics.

scale questionnaire examining sleep, fatigue and soreness (1: very poor, 7: very good), based on the Hooper-Mackinnon Questionnaire [27]. The questionnaire was completed within one hour of waking up, and a total value was used as the Wellness score (Wellness). It was performed using Google Forms (Google LLC, California, USA) and provided to the participants weekly along with wTRIMP. Average weekly Wellness and wTRIMP were used for further analysis.

Countermovement jump testing session

CMJ testing was performed weekly to assess participants' neuromuscular function. Participants performed a 15-minute warm-up consisting of light jogging (~5 min), dynamic stretching, and 2–3 practice CMJ trials, followed by 3 CMJ trials with 2–3 minutes of rest between each trial. The trials were performed on a force plate (Kistler, Winterthur, Switzerland) and sampled at 1,000 Hz using dedicated software (Ex-Jumper T, DKH, Tokyo, Japan) to obtain ground reaction force data. A successful jump was defined as a trial in which the participants landed stably on the force platform without losing their typical jumping form. All trials were performed with their hands on hips to negate upper limb influence. CMJ testing was performed between 9:00 and 9:30 a.m. every Tuesday and kept at the same time throughout the experimental period in order to eliminate the influence of circadian rhythm and other potential physiological factors.

Table 3. Evaluation of the training load with a training program (a: Sub A, b: Sub C).

(a) Sub A. Week 4

Day	Wellness	Training Session	Duration (min)	RPE	TRIMP
Monday	20	Recovery day	0	0	0
Tuesday	17	AM: Blocks (4x30m, 3x60m) 2x120 @ 100% (10 min)	190	6	1,140
		PM: Weight training (Upper body)	70	4	280
Wednesday	20	4x100m Hills @ 95% (7 min)	150	9	1,350
Thursday	14	Weight training (Lower body)	75	4	300
Friday	20	Recovery Day	0	0	0
Saturday	20	Blocks (5x30m), Wicket drill (2x60m), 3x100m @ 100% (7 min)	210	8	1,680
Sunday	17	AM: 3x150m @ 95% (15 min)	150	7	1,050
		PM: Weight training (Lower body)	60	5	300
Mean Weekly Load					1,220
Standard deviation of mean weekly load					476
Total weekly load (mean weekly load x7)					6,100

(b) Sub C. Week 4

Day	Wellness	Training Session	Duration (min)	RPE	TRIMP
Monday	17	Recovery day	0	0	0
Tuesday	16	AM: Blocks (1x60m, 1x100m, 1x150m)	105	3	315
		PM: Weight training (Upper body)	75	5	375
Wednesday	16	5x300m @ 90% (10 min)	120	9	1,080
Thursday	16	Weight training (Lower body)	120	5	600
Friday	17	Recovery Day	0	0	0
Saturday	17	5x60m Hills (5 min), 3x120m @ 95% (7 min)	160	10	1,600
Sunday	15	AM: 3x350m @ 90% (20 min)	150	4	600
		PM: Weight training (Lower body)	90	3	270
Mean Weekly Load					968
Standard deviation of mean weekly load					356
Total weekly load (mean weekly load x7)					4,840

RPE: rating of perceived exertion, TRIMP: training impulse.

Countermovement jump variables

Based on the method outlined by Chavda et al. [28], ground reaction force data obtained from the CMJ were categorized into distinct phases (i.e., eccentric phase and concentric phase), and the analysis file for CMJ variables was created using Microsoft Excel (Microsoft, Washington, USA). The calculated CMJ variables are shown in Table 1. In this study, force, impulse, and power were normalized to each participant's body mass. To ensure the validity and reliability of these variables, we averaged the values from three CMJ trials to represent each participant's performance per session [29].

Statistical analysis

Two-tailed Pearson product-moment relationships (r) were calculated to assess the relationships between wTRIMP, Wellness, and CMJ variables. Statistical significance was set at $p<0.05$, with $p<0.1$ considered marginally significant. Statistical analyses were performed using IBM SPSS version 25 (SPSS Statistics, IBM, NY, USA). Post-hoc statistical power analyses were conducted using G*Power 3.1 [30] based on the sample size and calculated effect sizes.

To examine the variation of CMJ variables correlated with wTRIMP over the experimental period, Z-scores were calculated. Based on the previous study [31], the following qualitative descriptions (see the following text in brackets) were allocated, ranging from extremely poor to excellent: < -3 (extremely poor), -3 to -2 (very poor), -2 to -1 (poor), -1 to -0.5 (below average), -0.5 to 0.5 points (average), 0.5 to 1 (above average), 1 to 2 (good), 2 to 3 (very good), 3 >(excellent). The Z-scores were calculated using Python (Python Software Foundation, Beaverton, OR, USA).

RESULTS

Participants (n = 5) completed an average of 8 ± 1 CMJ testing sessions during the monitoring period, with 2 participants completing all sessions. Due to facility scheduling conflicts, the CMJ testing session was not conducted in week 9. Additionally, for Sub A in week 3 and Sub B in week 7, averaged values were calculated from two trials due to unanalyzable data and a failed CMJ trial, respectively.

Figure 1 shows wTRIMP and Wellness for Sub A and Sub E during the monitoring period as representative examples. The wTRIMP values were as follows: 4,289 ± 1,349 arbitrary units (a.u.) for Sub A, 4,165 ± 1,516 a.u. for Sub B, 3,969 ± 1,553 a.u. for Sub C, 3,701 ± 947 a.u. for Sub D, and 3,967 ± 1,069 a.u. for Sub E. Sprint training TRIMP accounted for approximately 80–85% of all training performed by them. Wellness scores were as follows: 18 ± 1 a.u. for Sub A, 15 ± 1 a.u. for Sub B, 17 ± 1 a.u. for Sub C, 16 ± 1 a.u. for Sub D, and 17 ± 1 a.u. for Sub E. Figure 2 shows the relationship between wTRIMP, Wellness and CMJ variables for each participant. Seven of the 11 variables (Wellness, JH, PF, PP, EccI, ConI, and ConMP) exhibited correlations with wTRIMP. The specific CMJ variables showing correlations varied among individuals. For Sub D, no variables were found to correlate with wTRIMP.

Figure 3 shows the changes in EccI for Sub A and ConI for Sub E, both of which are representative examples correlated with wTRIMP, over the monitoring period. In terms of EccI, a decrease was observed in Week 4 (Z-Score: -1.21), and for ConI, decreases were noted in Week 1 (Z-Score: -1.45) and Week 6 (Z-Score: -1.55).

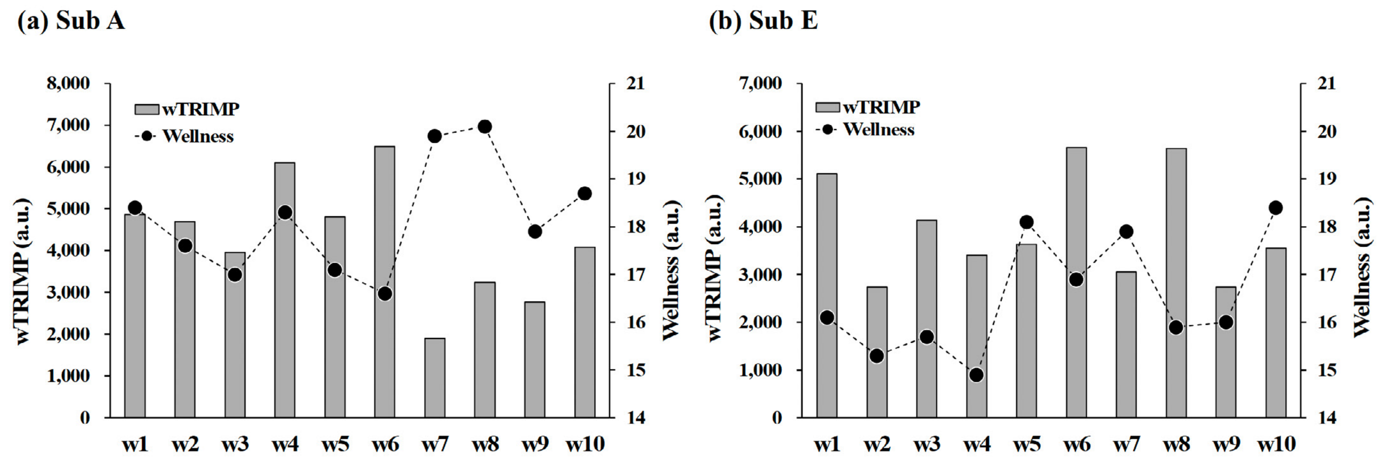

Figure 1. Weekly training impulse (a: Sub A, b: Sub E). TRIMP: Training impulse.

DISCUSSION

The purpose of this study was to assess the relationship between quantified training load and CMJ performance during a 10-week training block in high-level sprinters. To the best of our knowledge, this study is one of the most comprehensive longitudinal investigations of neuromuscular function in sprinters. During the monitoring period, the participants primarily engaged in sprint training. We found relationships between six CMJ variables (JH, PF, PP, EccI, ConI, ConMP) and wTRIMP (see Figure 2). As the training load increased, these variables tended to decrease. Additionally, individual differences were observed in CMJ variables that showed relationships. These findings support our hypothesis and suggest that the CMJ may effectively detect changes in neuromuscular function in sprinters.

Training load and wellness

The wTRIMP for the participants in this study ranged from 3,701 to 4,289 a.u., which, considering they trained five days a week, corresponds to a weekly average of approximately 740 to 860 a.u.. These values are consistent with the findings of a previous study by Cristina-Souza et al. [12], which investigated the weekly training load in track and field athletes and reported that the training load in sprinters was lower than in runners, with an average daily value of around 860 a.u.. Despite some minor discrepancies, the results were generally consistent with the values reported in a previous study.

Regarding Wellness, a significant relationship with wTRIMP was observed solely for Sub A, whereas no significant relationship was identified for the remaining four participants (see Figure 2). This result indicates the limitations of using only subjective measures to monitor changes in neuromuscular function in sprinters. Similarly, Gathercole et al. [24] suggested in a 6-week longitudinal study of rugby players that subjective measures may not uniformly decreased during the monitoring period. Previous studies have also reported that while the usefulness of subjective measures has been suggested [32,33], their values might reflect psychological and sociological aspects [34]. Therefore, for a comprehensive assessment of neuromuscular

	Wellness	JH	PF	PP	EccI	ConI	EccMP	ConMP	EccDur	Con DUr	ED : CD
Sub.A (n=8)	-.620†	-.360	.097	-.075	-.814*	.240	-.030	-.499	-.582	-.092	.515
Sub.B (n=7)	-.285	-.033	-.600	.151	.221	-.775*	-.142	-.166	.364	.119	-.048
Sub.C (n=9)	.049	-.704*	-.871**	-.639†	-.271	-.650†	-.095	-.825**	.108	.553	.408
Sub.D (n=8)	.370	.149	.586	.135	.427	-.091	.089	.581	.011	-.291	-.423
Sub.E (n=9)	-.043	-.723*	-.593†	-.662†	.402	-.737*	-.200	-.310	-.309	-.060	.210

Figure 2. Correlation coefficient (r) between wTRIMP and Wellness and each CMJ variables. Color coding represents statistical power (P) classification: Black for $P \geq 0.8$, Grey for $P = 0.70–0.79$, Light grey for $P = 0.60–0.69$, and White for $P \leq 0.59$. TRIMP: Training impulse. Relationship between variables: $^{**}p < 0.01$, $^{*}p < 0.05$, †$p < 0.1$.

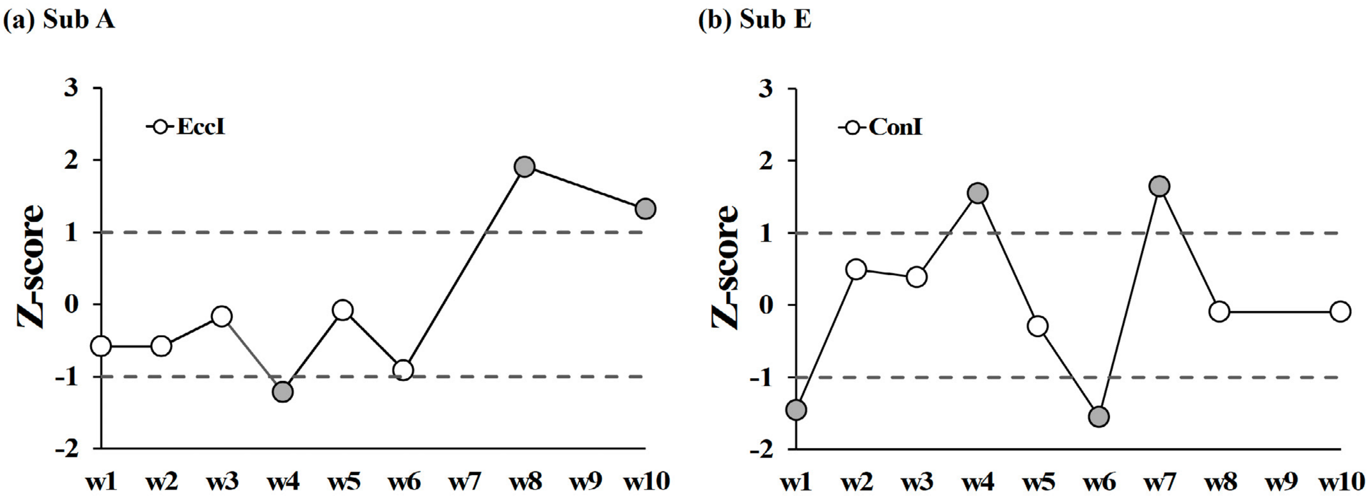

Figure 3. Weekly Z-Score values in (a) EccI for Sub A and (b) ConI for Sub E.
EccI: eccentric impulse, ConI: concentric impulse.

function in sprinters, it is recommended to combine both subjective and objective measures.

The relationship between training load and CMJ performance

In this study, significant relationships were observed between wTRIMP and CMJ variables in 4 out of 5 participants (see Figure 2). These results support the hypothesis that the CMJ may assess changes in sprinter's neuromuscular function with increasing or decreasing training loads. In training settings, there is a demand for insights into optimal training load adjustments tailored to athletes' conditions to enhance performance. To address this, the relationship between training load and objective measures has been longitudinally examined in sprinters [8,13]. However, due to methodological difficulties, there was still a lack of research on the biological responses of training performed [1]. This case study involving five sprinters provided new insights that enrich existing knowledge.

Although relationships were observed between wTRIMP and several CMJ variables, caution is warranted when selecting which variables to utilize for monitoring sprinters. Only two out of five participants (Sub A and Sub C) demonstrated a relationship between wTRIMP and jump height (Sub A: r=0.789, *p*=0.043; Sub C: r=0.789, *p*=0.043). This result challenges the use of CMJ jump height to assess neuromuscular function in sprinters. Similarly, Taylor et al. [20] investigated muscular fatigue induced by continuous resistance training intervention using the CMJ in five participants, reporting insufficient sensitivity of jump height. Furthermore, Gathercole et al. [25] reviewed the previous assessment methods of neuromuscular function using the CMJ and suggested that evaluating only jump height may overlook changes in neuromuscular function, particularly when considering the complexity of muscle fatigue [23]. While jump height is relatively easy to measure using contact mats and similar systems, its sensitivity in detecting neuromuscular changes in sprinters is inadequate.

On the other hand, force-time related variables demonstrated a significant relationship with wTRIMP in all participants except for Sub D. Among these, Sub A showed a significant correlation with eccentric phase variables, particularly with EccI. Conversely, Sub B, Sub C, and Sub E exhibited relationships with concentric phase variables (Sub B: ConI, Sub C: ConI and ConMP, Sub E: ConI). Neuromuscular fatigue can be described as a modification of skill and/or movement strategies without performance deterioration [23]. Rodacki et al. [35] assessed acute fatigue from continuous vertical jumping and suggested that changes in CMJ mechanics can help maintain jump height under fatigue. By utilizing force-time variables and examining the behaviors underlying jump height, such as eccentric and concentric phases, it may have contributed to more sensitive detection of neuromuscular fatigue [24,25].

Furthermore, individual differences were observed in the specific force-time variables associated with training load. The mechanisms of underlying fatigue are influenced by the method of fatigue inducement and are confounded by factors such as subject motivation, psychological status, muscle activation patterns, intensity, duration, and whether the task is continuous or intermittent [36]. The discrepancies in CMJ variables among sprinters in this study may stem from variations in sprint velocity, influenced by differences in sprint technique and muscle activation patterns during their respective sprint training sessions.

SSC muscle function during running is characterized by pre-activation to resist ground impact, followed by braking (the eccentric phase) and subsequent push-off (the concentric phase) [37]. Sub A, for instance, specializes in the 100 m, exhibiting the highest performance level among the participants. Conversely, Sub C and E are long sprinters specializing in the 400 m and 400 m hurdle, respectively. Due to their distinct specialties, variations in sprint velocity can be observed during their primary sprint training sessions. Specifically, Sub A frequently engaged in sprint training covering distances up to 100 m at near maximum sprint velocity, while Sub C conducted training sessions spanning 300 m or 350 m, maintaining a velocity below the maximum level (see Figure 1). As sprint velocity increases, the eccentric force during ground contact increases, while the concentric force decreases [38]. Therefore, their primary sprint training sessions may have contributed to differences in strain imposed on the muscles, potentially reflected in CMJ variables.

On the other hand, Sub B exhibited a correlation with the concentric variables (i.e., ConI), despite comparable performance to Sub A. This could also be influenced by differences in their respective sprint training regimens. Sub B refrained from sprint training at high velocity and primarily engaged in sessions at lower velocity to prevent the recurrence of injuries that had occurred before the experimental period. It should be noted that sprint velocity during training sessions was not directly measured in this study, and thus the interpretation remains speculative. Nonetheless, it may be suggested that Sub B had a low proportion of sprint training at high sprint velocity during this study period, and that the concentric phase variable was selected because of the low eccentric load. These findings demonstrate that selecting CMJ variables based on individual sprinter characteristics and training background may be necessary when assessing neuromuscular function in sprinters using the CMJ.

For Sub D, none of the CMJ variables showed a relationship with wTRIMP. The performance level of Sub D was low compared to the other participants. Therefore, he might be more likely to enhance his neuromuscular function through training compared to them, which can obscure the decline of neuromuscular function attributable to fatigue [8]. Sub D may therefore require more individualized monitoring, and given their high capacity for improvement, it might be necessary to focus on other objective measures, such as heart rate variability, and subjective measures rather than solely on measures of neuromuscular function.

CMJ performance changes over the monitoring period

Figure 3 shows representative examples of the changes in EccI and ConI during the monitoring period for two subjects (Sub A and Sub E) where a correlation between wTRIMP and CMJ variables was observed. These values fluctuated during it as training loads increased or decreased. For Sub A, the EccI value decreased during week 4 (Z-Score: -1.21), and for Sub E, the ConI value decreased during weeks 1 and 6 (Z-Scores: -1.45, -1.55). Their wTRIMPs during these weeks were approximately 5,000 to 6,000 a.u., respectively (see Figure 1).

Nakagaki et al. [39] examined the relationship between training load and heart rate variability in canoe athletes and suggested that training load of approximately 8,000 a.u. increased heart rate upon waking and led to poorer conditioning. Similarly, the results of this study suggest that training load of approximately 5,000–6,000 a.u. per week may influence neuromuscular function, particularly in sprinters. However, internal responses to training load may vary significantly between and within individuals [40]. Indeed, week 8 in Sub E did not show a reduction in ConI despite a higher training load (around 6,000 a.u.).

These values might serve as a guideline when adjusting RPE and training duration according to sprinters' conditions, utilizing the sRPE method. Future case studies should focus on verifying training content and examining the relationship between training load and neuromuscular function. As the number of such studies increases, the accuracy of understanding these relationships is expected to improve.

Limitation

This study examined high-level university sprinters in their regular training environment; however, it encountered several logistical constraints. CMJ testing was conducted on Tuesday, the commencement day of the weekly training regimen. However, three participants were unable to complete certain measurements due to participation in training camps and other commitments. Missing data in longitudinal studies could potentially have an impact on the accuracy of statistical analyses and the interpretation of results. Additionally, while many CMJ variables showed significant correlations, some variables exhibited insufficient statistical power. Despite these challenges, this study provides some practical insights. In the future, in addition to longer-term investigations, studies on sprinters of various performance levels and gender differences may contribute to a monitoring system tailored to individual characteristics.

CONCLUSION AND PRACTICAL APPLICATIONS

The findings of this study indicate that the CMJ is compatible for longitudinal neuromuscular function monitoring of sprinters. In particular, force–time related variables (e.g., EccI and ConI) appear to be more sensitive indicators of neuromuscular changes than jump height alone. Moreover, the results highlight individual variability in the selection of effective monitoring variables. By comprehensively examining the relationship with training load, including both jump height and force-time related variables, the most suitable variables for each individual can be clarified. Athletes and their coaches are then encouraged to adopt a tailor-made approach for each sprinter.

The CMJ is easy to perform and less demanding on athletes. Performing CMJ testing at the beginning of training week, as in this study, or at each microcycle, can contribute to a simplified understanding of athletes' physical adaptations. This approach may help develop optimal training plans based on these results. Furthermore, using an individualized Z-score in conjunction with training load might support a tailor-made approach.

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CONFLICTS OF INTEREST

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ETHICAL APPROVAL

Informed consent was obtained in writing, and the study protocol was approved by the Ethics Committee of the Faculty of Health and Sports Sciences at the University of Tsukuba (IRB ID: tai 012-129).

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