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Kinetic Analysis of Combat Moves: Associations between Body Segment Weights and Punches, Front Kick and Countermovement Jump Performance

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Abstract: Despite the recognized influence of maximum or acceleration strength on combat techniques and countermovement jump (CMJ) performance, the relationship between body segment weights and combat techniques remains unexplored. This study aimed to examine the impact of body segment weights, including striking arm weight (SAW), kicking leg weight (KLW), and trunk weight (TW), on the dynamics of direct punches (DP), palm strikes (PS), elbow strikes (ES), front kicks (FK), and CMJ performance. Sixteen male military cadets (22.3±1.8 years, 181.4±7.0 cm, 83.0±8.1 kg) performed combat techniques, with performance measured by using a force plate and body segment weights assessed by Dual-energy X-ray absorptiometry. Spearman's correlation analysis was applied. Results indicated a strong correlation between KLW and FK impulse ($r = 0.64$, $p \le 0.01$) and CMJ impact force ($r = 0.80$, $p \le 0.01$). SAW showed moderate correlations with DP impulse ($r = 0.53$, $p \le 0.05$) and ES impulse ($r = 0.54$, $p \le 0.05$). Additionally, FK peak and impact forces were strongly correlated with CMJ jump height ($r = 0.74$, $p \le 0.01$; $r = 0.77$, $p \le 0.01$), and FK peak force moderately correlated with CMJ peak velocity ($r = 0.63$, $p \le 0.05$). These findings suggest targeted arm strength training could enhance striking abilities, while improvements in leg acceleration strength may directly boost kicking performance and vertical jump capabilities, which are crucial in combat scenarios.

Keywords: martial art; biomechanics; body composition; dynamic forces

1. Introduction

Combat sports or martial arts often emphasize the importance of physical strength, speed, and technique [1–3]. The efficiency of combat moves, such as punches, kicks, and jumps, is a matter of skill but can also be related to the athlete's body composition [4–7]. Based on this knowledge, researchers have developed an interest in how body composition and somatotype influence the efficacy of these movements [4,8,9]. It is also known that enhancing the striking force of combat sports athletes involves effectively utilizing their body mass; this enhancement can refine movement techniques and consequently boost combat efficiency [10]. However, these existing studies primarily focus on the differences in subjects' weight, body composition, and somatotype estimates. Therefore, this study aimed to address this gap by exploring how the striking arm weight (SAW), kicking leg weight (KLW), and trunk weight (TW) affect the peak force, impact force, and impulse of direct punches (DP), palm strikes (PS), elbow strikes (ES), front kicks (FK), and jump height, peak velocity, and peak and impact forces within the breaking phase of the countermovement jumps (CMJ).

Previous studies have explored the dynamic forces of punches and front kicks [11–17]. Additionally, some studies have demonstrated that dynamic forces like a peak or impact force within the kicks partially depend on a subject's weight [5–7,18]. These findings underscore the relevance of body weight in combat techniques, particularly among novice practitioners [5]. Therefore, it is

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recommended that advanced participants consider the effective mass, which was examined based on knowledge of the total mass and the acceleration of the kick [10]. However, the association between the body segment weights and dynamic forces remains unexplored.

The countermovement jump is used to measure the muscle power of the lower limbs [19–21]. The higher muscle power of the lower body segments is also associated with a higher performance level in combat sports [22–25]. The ability to transition quickly from the eccentric to the concentric phase of muscle action is especially vital in executing combat moves, kicks, and jumps [26].

The higher body weight can be related to achieving lower height within the CMJ in the general population [27]. However, while body weight is a known predictor of physical performance in the general population, its significance may diminish among elite athletes [28]. Therefore, it is questionable if the weight of the lower limbs can be related to achieving higher height within CMJ, even in connection with the dynamic forces of punches and front kicks.

The study aimed to find how the SAW, KLW, and TW affect the dynamic forces of the punches and front kicks and the performance of the CMJ within the breaking phase. This research included a cohort of male soldiers (sub-elite level) from the Czech Army who had regular training in close combat. Kinetic measurements and body segment weights were measured by analysis employing advanced techniques like force plate analysis and dual-energy X-ray absorptiometry (DXA), ensuring our findings' accuracy. Based on previous studies, we hypothesized that the higher weight of the striking arm and kicking leg will have higher associations with the peak and impact force of the punches and front kicks than the overall body weight in a group of military personnel at the sub-elite level in close combat.

2. Materials and Methods

The influence of overall body weight on the dynamic forces of punches and kicks and jump performance has been examined in many studies focused on combat sports. The question that needed to be addressed was whether the knowledge of the weight of individual segments could provide a higher association with the dynamic forces of punches and kicks and with the acceleration during a breaking phase of the jump. Therefore, this quantitative study utilized a cross-sectional design (Figure 1) to explore the relationship between dynamic forces in selected punches, front kicks, and performance metrics of CMJ with the body segment weights (kicking leg, striking arm, and trunk). The study conformed to ethical sports and health research standards and received approval from the Faculty of Physical Education and Sport Ethics Committee, Charles University (No. 085/2022). All procedures were conducted following the Declaration of Helsinki.

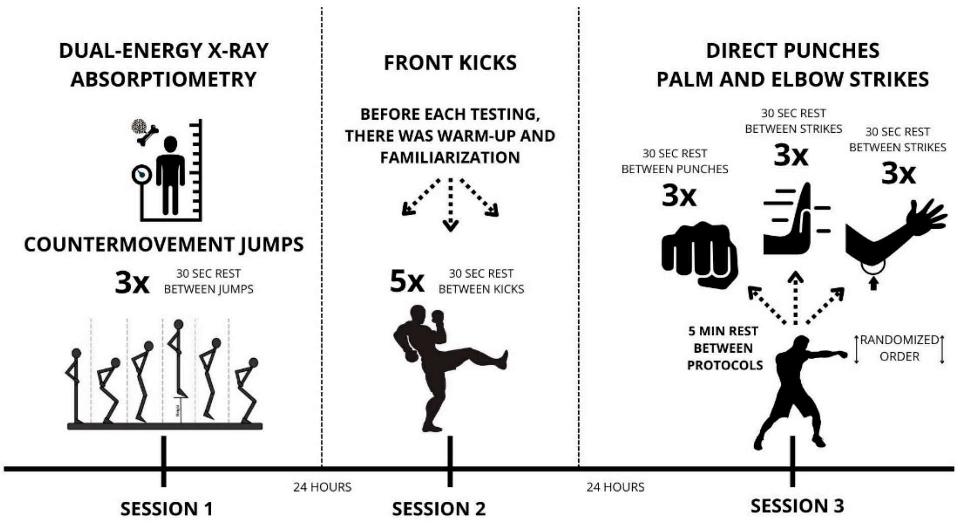

Figure 1. Testing protocol of the study.

2.1. Participants

The study involved sixteen male military cadets (22.3 ± 1.8 years, 181.4 ± 7.0 cm, 82.9 ± 8.1 kg, all measurements reported as mean ± SD), selected based on their regular involvement in combat training and military physical training that commonly included punches, kicks and jumps. The participants were highly familiar with the DP, PS, ES, FK, and CMJ experimental protocols. All participants were informed about the study's purpose and procedures and provided their consent. All the participants were healthy and without traumatic injury affecting performance or musculoskeletal injuries occurring within three months before the start of the study.

2.2. Testing Protocol (Punches and Front Kick)

Following the 10-minute warm-up, which included 5 minutes of rela-xed-paced stationary cycling and dynamic exercises, such as calf raises, hip hinges, lunges, squats, and hopping, participants underwent a familiarization process with the punches and kicks, encompassing five test strikes. They then adjusted their individual distances to the impact area. All front punches and kicks began with a front-facing posture and were executed such that the hand made contact at a height equivalent to the head and foot at midsection height [17,29,30]. They were instructed to deliver each strike with maximum effort following these preparatory activities.

Each participant performed a series of combat moves, including three DP, PS, ES, and five FK (each strike or kick was followed by a 30-second rest period). These were executed on a force plate (Kistler 9281; Winterthur, Switzerland, adjusted at a minimum sampling rate of 1,000 Hz) that was mounted in the front as the target, with the impact area of the plate individualized to each subject. The force plate was covered by tatami (400×300×25 mm, StrongGear) to reduce the risk of injury and connected to a computer with a 16-bit A/D board and BioWare V5.3.2.9 software.

The peak force (N) was recorded, and impact force (N) and impulse (N.s) were calculated in MATLAB software (version 1.8.0.121; MathWorks, Natick, MA) as the maximum value of the 2 ms sliding mean net force over the contact period from all three axes (x, y, z) [29,31].

2.3. Testing Protocol (Countermovement Jumps)

At the lab, participants started with a standardized warm-up, which included 5 minutes of relaxed-paced stationary cycling and dynamic exercises, such as calf raises, hip hinges, lunges, squats, and hopping. After this, they performed five less intense CMJs, taking a 30-second break between each [32]. After a warm-up and a brief 2-minute rest, the participants, wearing the standard Czech military training footwear, positioned themselves on a calibrated force plate. They were advised to remain stationary for 5 seconds and then leap as high as possible upon the research assistant's signal. The CMJ routine consisted of a preliminary squat phase leading into a forceful jump, focusing on achieving maximum height and power. During these jumps, participants kept their hands on their hips to focus on lower body strength, thereby limiting the involvement of the upper body. The objective was to land accurately back on the force plate, ensuring the entire jump motion was recorded [33]. Each person completed three maximum effort CMJ, with the freedom to choose their countermovement depth and a 60-second pause between each jump [34]. The force plate was placed on the ground and connected to a computer with a 16-bit A/D board and BioWare V5.3.2.9 software. The maximum jump height (cm) and peak force (N) at the end of the breaking phase [32] were recorded, and the impact force (N) within the breaking phase was calculated as an impulse (N.s) from initial contact to the time to reach the peak force [29] using MATLAB software (version 1.8.0.121; MathWorks, Natick, MA).

2.4. Body Segment Weights (Dual-Energy X-ray Absorptiometry)

Upon morning arrival following an overnight fast, participants prepared for body composition analysis via Dual-energy X-ray Absorptiometry by removing metallic and inorganic materials to eliminate potential imaging artifacts. Following these initial preparations, the participants had to lie motionless on the scanning table, adhering to standardized measurement conditions to ensure the

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accuracy and consistency of the DXA scans[35]. The assessment utilized a narrowed fan-beam DXA system (Lunar Prodigy; GE Healthcare, Madison, WI), with subsequent analysis performed using GE Encore 12.30 software to ensure precise body composition metrics. The DXA system calibration was verified daily against a standard phantom to ensure consistent measurement accuracy [36]. The analysis focused on whole-body lean and fat mass alongside body segment weights such as the striking arm, kicking leg, and trunk—vital for evaluating the influence of body segment weights on combat techniques and CMJ performance in further analysis.

2.5. Statistical Analyses

The force plates used for kicks, punches, and jumps measured peak force (N), impulse (N·s), height (cm), concentric peak velocity (m/s), and peak and impact force (N). The data for the DXA scans and force plate measurements were compiled and analyzed using Spearman's correlation coefficient to determine the relationships between body segment weights and performance metrics in combat moves. The statistical analyses were performed using SPSS ver. 25.0 (IBM) and Excel 2019 ver. 2312 (Microsoft). A sensitivity analysis was conducted using G*Power (v 3.1.9.6) to determine the statistical significance of the calculated Spearman correlation coefficient in our sample of 16 participants. Exact-bivariate correlations were utilized with a two-tailed test and an alpha error probability set at 0.05 and 20% β levels (80% Power). The computed sensitivity to observe significant correlations was r ≥ 0.64. This approach ensured that our sample size was sufficient to detect a statistically significant correlation that would inform the impact of body segment weights on punches, kicks, and CMJ performance.

3. Results

Table 1 shows the descriptive statistics for the performance metrics of direct punches, palm strikes, elbow strikes, front kicks, countermovement jumps, and body segment weights assessed using Dual-energy X-ray absorptiometry. The results indicate that the FK achieved the highest values of all dynamic forces, and the PS and ES achieved higher values than the DP on the peak and impact force but not on the impulse.

Table 1. The performance of punches, front kicks, and countermovement jump and descriptive statistics of body weight and body segment weights.

Dynamic Forces	Direct punch		Palm strike		Elbow strike		Front kick	
	Mean ± SD	CI Low–Up	Mean ± SD	CI Low–Up	Mean ± SD	CI Low–Up	Mean ± SD	CI Low–Up
Peak Force (N)	2501 ± 625	2168–2834	4210 ± 1125	3610–4809	4677 ± 973	4159–5196	6310 ± 1554	5482–7138
Impact time (ms)	17.3 ± 4.2	15.1–19.5	7.9 ± 2.6	6.5–9.2	10 ± 3.7	8.1–12	9.9 ± 3.3	8.1–11.6
Impulse (N.s)	17.2 ± 3.5	15.3–19.1	14.9 ± 3.6	12.1–18.7	17.6 ± 2.8	16.1–19	154.4 ± 31.5	139–171
Impact Force (N)	1023 ± 220	906–1141	1968 ± 487	1708–2228	1878 ± 420	1654–2102	3111 ± 735	3719–3502

	Countermovement jump			
	Peak Force (N)	Impact Force (N)	Peak velocity (m/s)	Jump height (cm)
Mean ± SD	4531 ± 1051	1798 ± 237	3.10 ± 0.97	38.43 ± 4.72
CI Lower–Upper	3971–5091	1672–1924	2.58–3.62	35.92–40.94
	Body weight (kg)	Striking arm weight (kg)	Kicking leg weight (kg)	Trunk weight (kg)
Mean ± SD	82.9 ± 8.1	5.29 ± 6.1	14.1 ± 1.39	38.72 ± 4.66
CI Lower–Upper	77.6–86.7	4.96–5.61	13.32–14.81	36.24–41.21

Abbreviations: CI—95% confidence interval, PF—peak force, SD—standard deviation.

3.1. Correlation Analysis between Body Segment Weights and Punches, Front Kick or CMJ

Spearman's correlation coefficient was used to determine the association between body segment weights (including striking arm, kicking leg, trunk, and body weight) and dynamic forces of DP, PS, ES, FK, and performance metrics of CMJ (Table 2). The highest positive significant correlation was

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revealed between impact force within the breaking phase of the CMJ and lower limb weight (kicking leg), trunk weight, and body weight. However, no association existed between the DP, PS, ES, FK impact force and individual body segment weights. Considering the impulse, there were the highest correlation coefficients between the weight of the striking arm, the weight of the kicking leg, and FK.

Table 2. Spearman's correlation coefficients between body segment weights and punches, front kick or CMJ.

	Peak force (N)					Impulse (N.s)				Impact force (N)					Impact time (ms)			
	DP	PS	ES	FK	CMJ	DP	PS	ES	FK	DP	PS	ES	FK	CMJ	DP	PS	ES	FK
BW	0.34	0.14	0.20	0.23	0.45	0.55*	0.46	0.53*	0.52*	0.16	-0.09	-0.02	0.01	0.70**	0.33	0.42	0.27	0.40
TW	0.41	0.15	0.30	0.02	0.32	0.52*	0.40	0.47	0.47	0.21	0.08	0.09	-0.19	0.67**	0.27	0.34	0.13	0.43
SAW	0.28	0.11	0.16	0.31	0.6*	0.53*	0.45	0.54*	0.58*	0.14	0.07	0.04	0.19	0.54	0.34	0.43	0.36	0.01
KLW	0.08	0.17	0.04	0.35	0.41	0.46	0.41	0.48	0.64**	0.08	0.23	0.04	0.14	0.80**	0.5	0.46	0.30	0.26

Abbreviations: DP—direct punch, PS—palm strike, ES—elbow strike, FK—front kick, CMJ—countermovement jump, BW—body weight, TW—trunk weight, SAW—striking arm weight, KLW—kicking leg weight. All participants in this research were right-handed (SA and KL are the weight of the right limb); * $p \leq 0.05$, ** $p \leq 0.01$ (and $r \geq 0.64$).

The lowest correlation coefficients were between the body segment weights and PS. Regarding the peak force, there was only one significant correlation coefficient between the CMJ and strike arm weight. Finally, small associations (r = -0.14 to 0.29) existed between body segment weights and peak velocity or jump height within CMJ.

3.2. Correlation Analysis between Front Kick and CMJ

Table 3 depicts the association between the dynamic forces of FK and CMJ. A strong positive correlation was revealed between jump height and FK's peak or impact force. Furthermore, similar associations but moderate were revealed between peak velocity and FK's peak force or impact force. However, the interesting finding is that the impact force of CMJ does not correlate with FK's peak and impact force, and the peak force of CMJ does not have the highest relationship with the dynamic forces of FK.

Table 3. Spearman's correlation coefficients between front kick dynamic forces and CMJ performance.

	Countermovement jump			
	Peak force (N)	Impact Force (N)	Peak velocity (m/s)	Jump height (cm)
FK Peak Force (N)	0.53*	0.10	0.63*	0.74**
FK Impulse (N.s)	0.42	0.47	0.16	0.44
FK Impact Force (N)	0.41	-0.10	0.54*	0.77**

Abbreviations: FK—Front kick; * $p \leq 0.05$, ** $p \leq 0.01$ (and $r \geq 0.64$).

3.3. Graphical Representation of Findings

Several key findings emerged from the correlation analysis. Figure 2 illustrates the correlation between the striking arm weight and the impulse generated during DP (Figure 2a) and ES (Figure 2b). The regression line suggests a positive relationship, indicating that as the striking arm weight increases, the impulse generated in DP or ES also tends to increase.

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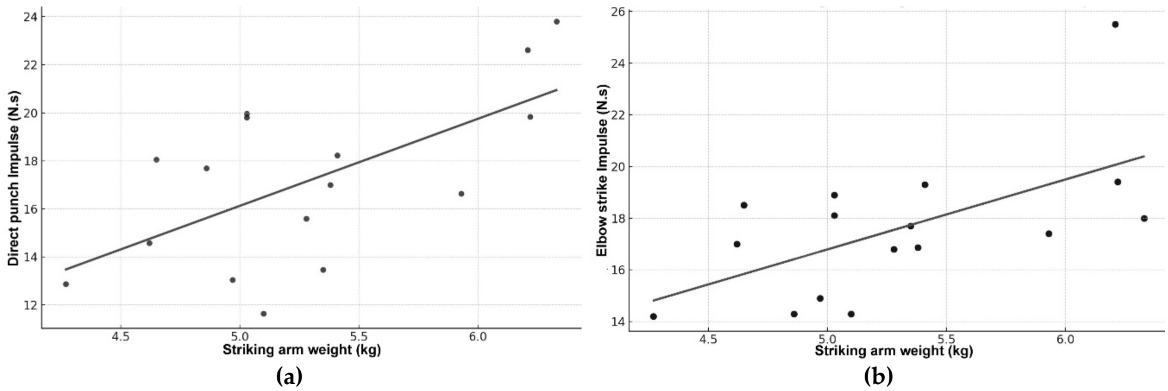

Figure 2. The correlation between the striking arm weight and the impulse: **(a)** Generated during direct punches; **(b)** Generated during during elbow strikes.

Similarly, a strong positive correlation was found between the kicking leg weight and the impact force during CMJ. Figure 3a depicts the relationship between the kicking leg weight (right leg) and the impact force in CMJ. Similar to Figure 2, this also shows a positive relationship, suggesting that heavier leg weights are associated with higher impact forces during CMJ. Figure 3b illustrates the correlation between the kicking leg weight and the impulse generated during FK. This relationship highlights the potential influence of leg mass on the effectiveness of FK in terms of impulse, providing valuable.

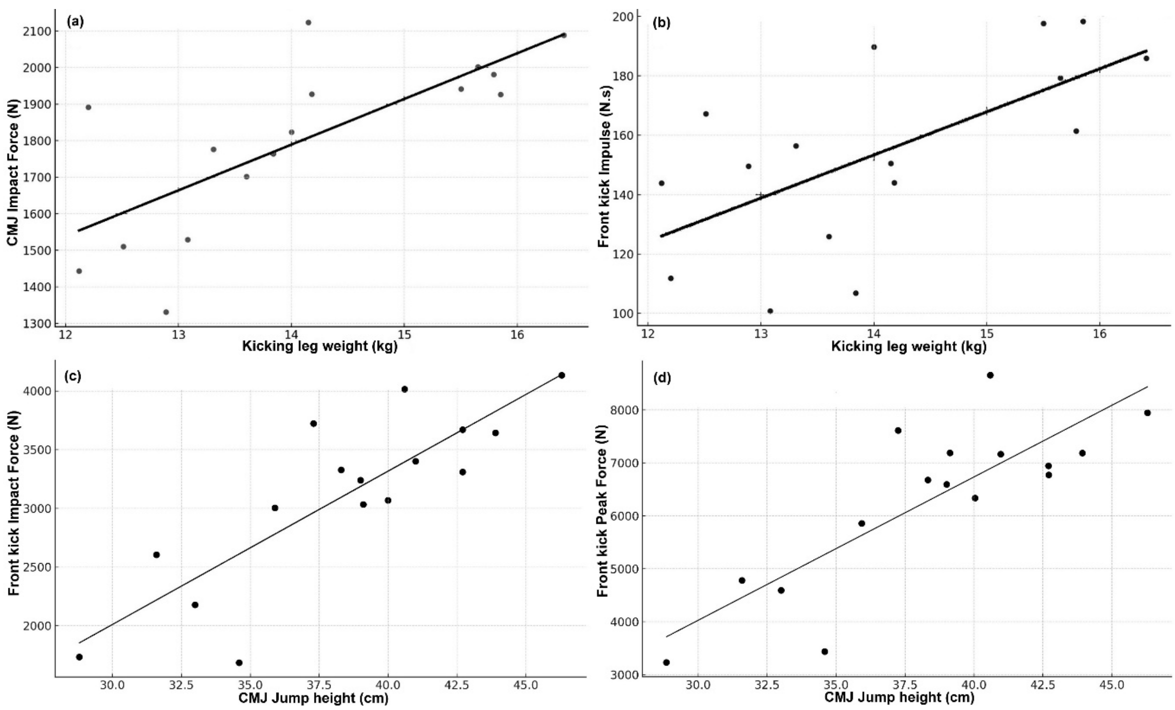

Figure 3. The correlation between kicking leg weight and CMJ and front kick: **(3a)** kicking leg weight and impact force in CMJ; **(3b)** kicking leg weight and front kick impulse; **(3c)** CMJ jump height and front kick impact force; **(3d)** CMJ jump height and front kick peak force.

A strong positive correlation was found between CMJ jump height, impact force, and peak force during FK. Figure 3c displays the relationship between CMJ jump height and FK impact force. This figure corroborates the findings in Figure 3a,b, where an increase in jump height results in a corresponding increase in impact force. Figure 3d presents the relationship between CMJ jump height and FK peak force. The tighter clustering of data points around the regression line, as compared to

Figure 3c, indicates a more consistent and possible relationship between CMJ jump height and impact force in FK.

4. Discussion

This study points to the relationship between the body segment weights and the dynamic forces in combat moves, such as direct punches, palm strikes, elbow strikes, and front kicks. It also includes the countermovement jump test, often used for testing acceleration lower limb strength. Furthermore, our study utilized dual-energy X-ray absorptiometry to provide accurate information on participants' body segment weights. That allowed for an analysis correlating the weights of striking arm, kicking leg, and trunk with combat move and CMJ performance, thereby offering a nuanced understanding of how these individual body segment weights influence the dynamic forces of the punches, FK, and CMJ.

Our hypothesis posited that a greater weight of the lower and upper limbs would be more strongly associated with the peak and impact force of front kicks and punches than the overall body weight in a group of military personnel at the sub-elite level in close combat.

On one hand, the results of our study do not offer substantial support for this hypothesis. We found a low correlation between the SAW or KLW and the peak or impact force generated during DP, ES, and FK. Additionally, the associations regarding the SAW, KLW, or TW were not higher than the participants' body weight. On the other hand, we found a moderate to strong positive correlation between the SAW or KLW and the impulse generated during DP, ES, and FK. This correlation was particularly pronounced for FK, underscoring the significant role that the weight of the lower limbs may enhance the effectiveness of these movements. Moreover, the weight of the KLW was strongly associated with the CMJ impact force, and the FK impact and peak force was strongly associated with the peak velocity and jump height of the CMJ.

Our findings align with the studies suggesting that body weight and composition influence the dynamics of combat techniques. Previous studies have explored dynamic forces involved in punches and FK, highlighting the role of energy production partially dependent on a subject's weight in influencing kick dynamics [5,6]. Additionally, our analysis aligns with the findings that reported the importance of the lower body's muscle power in combat sports performance [24,25]. However, our results do not support these findings in the case of impact force, where the association between the dynamic forces of the punches and FK with body segment weights was low.

4.1. Dynamic Forces of the Punches or Front Kick and CMJ Performance

Comparing the peak force of the DP in our study (2501 N) with values from previous studies (3427 N [37], 2600 [38], 1605 N [39], 1152 N [40], 1659 N [13], 1124 N [41], 2880 N [42]), our findings are in the upper half within the range of previous studies. Similarly, in terms of PS, our value of 4210 N was in the upper half of earlier studies (832 N [43], 1593 N [44], 3445 N [45], and 4750 N [42]). Regarding ES, our value of 4677 N fell within the range of values from previous studies (4490 N [42] and 6047 N [45]). However, the differences between the values of individual studies may caused by varying levels of participants, stance position, distance from the target, type of target, and often different measuring equipment and the amount or stiffness of the material that protects the striking surface of the participants before the injury. For example, when we investigated the studies that stated lower values, there were usually used for force measure: the acceleration of the punching ball [39]; a body shield covered the force plate and the boxers used competition gloves [40]; a dynamometric punching bag with an in-built strain gauge [13]; and force sensor embedded in the area of the glove [41]. Contrarily, in the case of higher force values, the studies used a Hybrid III dummy [37] or the force plate covered only by two or three centimeters of vinyl [42,45], similary as in our study.

Regarding the FK impact force, our value of 3111 N was within the range of previous studies (1620 N [2], 2447 N [31], 2661 N [46], 3600 N [17], and 3691 N [11]). Contrary to the FK peak force, our value 6310 N was higher than the authors stated in previous studies (5200 N [6], 5551 N [31], and 5604 N [46]) at sub-elite participants' level of fighting activities.

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Considering the CMJ performance, our value 38.43 cm of jump height was in the range of previous studies (31.1 cm [47], 34.1 cm [48], 35.3 cm [21], 37 cm [49], 39.2 cm [24], 40 cm [50], 44.2 cm [22], and 48.2 cm [23]) that were conducted in the groups of military cadets, sport university students and sub-elite or elite participants level of fighting activities. Regarding peak velocity, our value of 3.1 m/s was slightly higher than in the previous studies (2.55 m/s [47], 2.69 m/s [22], and 3 m/s [33]). The value of the CMJ impact force in our study was 1798 N. Compared with previous studies, it was in the upper half (1190–1235 N [50], 1534–1575 N [24], 1582 N [48], and 1832 N [33]).

4.2. Association between Punches or Front Kick Dynamic Forces and Body Segment Weights

We found that BW and body segment weights (SAW, KLW, and TW) showed differential associations between maximal force, impact force, and impulse achieved during punching or kicking execution. The association between the peak force of the punches or FK and body segment weights was in the r = 0.14–0.34 range, while the impulse was in the r = 0.46–0.55 range. This is in line with previous studies, where the authors found that the correlation coefficient between the FK peak force and body weight was r = 0.32, and for FK impulse was r = 0.44 [46]. Furthermore, we found that the correlation coefficient between the impact force of the punches or FK and body segment weights was in the range of r = -0.09–0.16, which does not follow findings in studies where the correlation coefficients were in the range of r = 0.33–0.75 [5,6,51]. Different levels of participants and gender may explain these contrasting findings [5,6]. For example, in the study by Ramakrishnan et al. [6] the participants (novices, sub-elites, women, and men) were included in one group. When the authors split this group, the body weight had no significant influence on the kick force in the group of male sub-elite participants.

Finally, the highest associations were found between body segment weights and impulse. It is unsurprising because our participants executed the punches and front kicks with maximum effort, like a push kick, where the impulse also depends on the duration of the object's surface interaction with a target surface.

4.3. Associations between Front Kick Dynamic Forces and CMJ Performance

We found the highest association between FK impact or peak force and CMJ jump height. This aligns with the study where the authors found higher CMJ jump heights for Brazilian jiu-jitsu experts than novices [24]. This finding could suggest that individuals who can achieve greater jump heights may be able to generate more forceful impacts or peak force in FK, which enhances the FK performance. This association suggests that higher CMJ jump height may indicate higher peak and impact force potential within FK, offering practitioners and coaches a measurable parameter to target when training for maximum force production in FK.

Similarly, there was a moderate association between the impact or peak force of the FK and peak velocity within CMJ.

4.4. Associations between Body Segment Weights, Countermovement Jump, and Dynamic Forces

The study revealed the strongest correlation between KLW and impact force within the CMJ. Moreover, BW and TW also demonstrated significant associations with the CMJ impact force. Contrary to expectations, CMJ peak force exhibited a moderate to a weak relationship with body segment weights. Our research uncovered that BW and chosen body segment weights were associated with CMJ impact force and impulse of FK, and the peak or impact force of the FK was associated with CMJ peak velocity or CMJ jump height. This aligns with the investigation by Diaz-Lara et al. [24], which stated that the experts in Brazilian Jiu-jitsu achieved higher values in CMJ metrics like jump height, peak power, and velocity at peak power than novices. Nevertheless, our study brings a novel perspective by illustrating a robust correlation between CMJ impact force and both BW and body segment weights, even though the connection between FK impact force and BW or chosen body segment weights was surprisingly low. The significant relationship emerged specifically in the context of the impulse generated by punches or FK, underscoring the nuanced interplay between body composition and the mechanics of DP, PS, ES, and FK.

4.5. Limitations

The study presents a few limitations. Firstly, the sample size is small, comprising only sixteen male military cadets. This limited sample may not provide a comprehensive representation of the broader population engaged in combat sports or military training, potentially affecting the generalizability of the findings. Secondly, the study focuses solely on male participants, omitting female athletes, limiting the results' applicability across genders. Another limitation is the study's reliance on specific body composition assessment and kinetic measurement techniques (Dual-energy X-ray absorptiometry and force plate analysis), which, while accurate, might not be universally accessible for practical application in training environments. Furthermore, the study does not account for the potential influence of training history, skill level, and other individual physical characteristics (beyond body segment weights) that could affect combat move dynamics and CMJ performance. Lastly, the correlation-based analysis provides insights into associations but does not establish causality between body segment weights and performance metrics.

5. Conclusions

This study contributes to understanding how the weight of individual body segments (specifically the striking arm, kicking leg, and trunk) correlates with the dynamics of combat moves (direct punches, palm strikes, elbow strikes, and front kicks) and CMJ performance. The findings indicate a moderate to a strong positive correlation between the weight of the striking arm or kicking leg and the impulse generated during these moves, highlighting the importance of targeted strength training in these limbs for enhancing combat performance. However, the individual body segment weights showed a higher or similar correlation with dynamic forces than overall body weight. It could suggest that mass distribution across body segments may play a role in the effectiveness of combat techniques and jump performance. The study lays the groundwork for future research to explore tailored training programs that consider individual body composition to optimize combat sports performance. Despite its limitations, the study offers valuable insights that could help combat athletes and coaches develop more effective training strategies based on the knowledge of body segment weights and their impact on performance from the biomechanics perspective.

In conclusion, while the influence of overall body weight in combat sports is known, our study highlights the importance of understanding the weight distribution across different body segments related to the dynamic forces of the punches and front kicks and even in the context of countermovement jump performance.

Author Contributions: Conceptualization, M.V. and P.S.; methodology, M.V. and J.M.; software, M.V.; validation, M.V., L.P. and P.S.; formal analysis, M.V. and L.P.; investigation, M.V. and V.O.; resources, M.V. and J.M.; data curation, M.V.; writing—original draft preparation, M.V.; writing—review and editing, P.S., L.P. and V.O.; visualization, M.V.; supervision, P.S.; project administration, M.V.; funding acquisition, P.S. All authors have read and agreed to the published version of the manuscript.

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