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A Biomechanical Comparison Between Conventional, Sumo, and Hex-Bar Deadlifts Among Resistance Trained Women

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Abstract

Gundersen, AH, van den Tillaar, R, Falch, HN, Fredriksen, AB, and Larsen, S. A biomechanical comparison between conventional, sumo, and hex-bar deadlifts among resistance trained women. *J Strength Cond Res* 39(3): 281–288, 2025—The deadlift is a multijoint exercise frequently used to strengthen the lower extremities and spinal erectors. Despite variations, such as the conventional, sumo, and hex-bar deadlifts, little is known about how these techniques affect the concentric phase of maximal deadlifts among strength trained women. Therefore, this study used statistical parametric mapping to compare kinematics, net joint moments (NJMs), and surface electromyography amplitude between these deadlift variations during the last repetition of a 3 repetition maximum (3RM) in strength trained women. Eleven women (body mass: 67.64 ± 7.27 kg, height: 161.91 ± 3.05 cm, age: 23.18 ± 3.46 years) performed 3RM deadlifts in conventional, sumo, and hex-bar deadlifts, lifting 103.18 ± 18.47, 101.54 ± 15.01, and 99.70 ± 15.94 kg, respectively. The main findings showed that deadlifting with conventional and sumo techniques resulted in larger hip NJMs near the lockout. Conversely, deadlifting with the hex-bar technique resulted in greater barbell velocity, knee NJMs, and increased hip and knee flexion angles. Therefore, when training maximal 3RM deadlifts, we suggest that hex-bar deadlifts may be beneficial for targeting knee extensors and enhancing barbell velocity among strength trained women. Conversely, sumo and conventional deadlifts may be more effective for targeting the hip extensors near the lockout during the last repetition of 3RM deadlifts.

Key Words: resistance training, biomechanics, kinetics, kinematics, surface electromyography

Introduction

The conventional deadlift is a foundational multijoint exercise extensively incorporated into strength and rehabilitation programs (3). From a performance perspective, the conventional deadlift is most commonly executed to induce strength, power, and hypertrophy in the posterior chain muscles (17,29). Several deadlift variations exist, including the sumo and low-handle hexagonal deadlift (hex-bar). Sumo deadlifts vary from the conventional through a wider foot placement (23). Yet, both sumo and conventional are permitted deadlift techniques in the sport of competitive powerlifting, where the athlete is required to elevate the weights to an upright position with both knees and hips extended (14). The hex-bar often uses a similar stance width as the conventional; however, the hex-bar technique differs from conventional and sumo as it creates a frame that encloses the athlete during the lift and, therefore, a larger knee flexion angle (31). In contrast to conventional and sumo, the hex-bar is not permitted in competitive powerlifting but has gained popularity across a wide variety of athletic cohorts as higher peak force, power, and velocities have been reported when deadlifting with the hex-bar technique (5).

Importantly, previous studies have compared velocities, joint angles, net joint moments (NJMs), and surface electromyography (sEMG) between the conventional, sumo, and hex-bar techniques during maximal deadlifts (5–8,22,23,31). Two studies observed no differences in hip NJMs between maximal conventional and sumo deadlifts (6,7). Notably, Escamilla et al. (7) observed larger knee NJMs in sumo compared with conventional deadlifts. This increased knee NJM in the sumo deadlift may explain the higher knee extensor sEMG amplitudes observed with sumo deadlifts compared with conventional deadlifts (8). Also, smaller hip flexion angles have been observed for sumo compared with conventional deadlifts (7,23). This might increase the efficiency of the gluteus maximums to contribute to the hip NJM as a greater hip extension angle has been observed to increase the internal gluteus maximus moment arm (25). In addition, owing to a wider stance, the sumo deadlift has been observed to require less vertical barbell displacement from start to end compared with the conventional (7,23), reducing the mechanical work by 25–30% (7). These efficiencies could theoretically enhance an athlete's ability to lift external load, though, from a competitive standpoint, this does not seem to significantly apply based on the number of sumo and conventional deadlift record holders (11).

Furthermore, comparisons have also been made between the conventional and hex-bar deadlifts (1,5,31). In an 80% 1RM assessment involving male powerlifters, Swinton et al. (31) discovered higher peak knee NJMs in the hex-bar relative to the conventional while observing no difference in hip NJM between the 2 techniques at 80% 1RM. In addition, Camara et al. (5) observed a significantly greater peak force and peak barbell velocity in the hex-bar than in conventional, but no differences between conditions in 1RM load lifted. They also observed increased knee extensor and reduced knee hip extensor sEMG

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Journal of Strength and Conditioning Research 39(3)/281–288

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amplitudes with the hex-bar deadlift. In support of this, Andersen et al. (1) reported increased hip extensor sEMG amplitudes in conventional compared with hex-bar deadlifts during 1RM. Anecdotally, this may lead practitioners to equate hex-bar deadlifts with back squats because of the increased knee flexion angle, which may not be the case as the back squat is reported in several studies to have different hip and knee flexion angles (28,30) than studies on the hex-bar (31).

Moreover, all the aforementioned studies comparing the conventional deadlift with the hex-bar deadlift were conducted solely on men, and none of them reported lower extremity NJMs or joint angles during maximal conditions. Therefore, interpreting the self-organization patterns of women during maximal deadlift conditions remains speculative because of the scarcity of deadlift research focused exclusively on women. The literature acknowledges that women and men differ on a spectrum of anthropometrical parameters relevant to the deadlift (4,13,15,16,24). For example, women on a populational average have a more pronounced q-angle (4,13), an anatomical characteristic inversely correlated with the strength of knee extensors, as reported previously (2,13). Consequently, more research solely comparing the deadlift techniques in strength trained women during maximal deadlifts is needed, as studies primarily done on men might not be generalizable to women because of deviations in anthropometry and movement strategies. Such biomechanical information can be beneficial for strength and conditioning practitioners and coaches when aiming to enhance performance by deadlifting.

Therefore, this study aimed to compare lower extremity NJMs, kinematics, and sEMG amplitude between conventional, sumo, and hex-bar deadlifts during the final repetition of a 3RM deadlift among strength trained women. We hypothesized that the hex-bar would result in the largest knee NJMs and knee flexion angles based on the current literature (6,7,31).

Methods

Experimental Approach to the Problem

A repeated measures design was performed to investigate the deadlift technique's impact on kinematics, NJMs, and sEMG amplitude. All subjects underwent a familiarization session and an experimental test session. During the familiarization session, subjects received augmented feedback from 2 proficient powerlifting coaches intended to maximize performance in the experimental test sessions. Subjects were required to rest for at least 7 days between the familiarization and experimental test sessions to minimize the chance of fatigue-induced performance. Dependent variables were joint angles, NJMs, barbell velocity, and sEMG amplitude, whereas independent variables were deadlift conditions.

Subjects

Eleven strength trained women (aged 18–30 years) volunteered to participate in the study (age: 23.18 ± 3.46 years, height: 161.91 ± 3.05 cm, body mass: 67.64 ± 7.27 kg). Among the subjects, 4 were competitive powerlifters, while the remaining 7 subjects trained deadlifts weekly for noncompetitive reasons. Inclusion criteria were (a) being able to lift at least 1.5 times their own body mass for 1RM with hips fully extended in their preferred deadlift technique and (b) no injury that could reduce maximal performance. In addition, subjects were instructed not to participate in any type of training, hard physical activity, or consume alcohol <48 hours before both sessions. Written consent was signed and obtained before participation. The study was submitted and approved by SIKT (project number: 404365) per the latest revision of the Helsinki Declaration.

Sample Size Rationale

Although a priori power analyses are typically used to determine an ideal sample size for detecting the smallest effect size, recruitment is often limited by resource constraints (19). Therefore, we aimed to recruit as many strength trained women as resources permitted to maximize statistical power, using a within-subject design to further enhance it. Ultimately, we recruited 11 strength trained women.

Procedures

The familiarization session started by acquiring the subject's body height and horizontal acromion length (right to left) using a measuring tape before body mass was measured with a Tanita scale (MC-780 MA, Riga, Latvia). Then, subjects completed a questionnaire stating their previous 1RM in each technique. During both sessions, the stance width for all techniques was marked with tape, where 1.0 times the horizontal acromion length decided conventional and hex-bar stance width and 1.6 times the horizontal acromion length decided sumo stance width. Subjects were instructed to position the medial part of the calcaneus on the tape for the entirety of the 3RM. During the familiarization, subjects performed a 3RM with all 3 techniques. The selection of 3RM was adopted because of its prevalence in powerlifting training (27). The order of each deadlift technique during familiarization and experimental test sessions was randomized using an online randomizer (https://www.randomizer.org). Throughout the familiarization phase of 3RM testing, testing accuracy was enhanced by the repetitions in reserve-based rate of perceived exertion scale (33) alongside measurement of mean concentric barbell velocity. Mean concentric barbell velocity was used to achieve uniform ascent velocities and ensure initial repetitions at true maximum across all testing conditions. Rest intervals of 120 and >180 seconds were used between warm-up and test sets, respectively.

On the experimental test day, each subject underwent appropriate shaving and cleansing with alcohol to reduce interference from hair and dead skin on the sEMG amplitude (12). Reflective markers for motion capture and electrodes for measuring the sEMG were attached. Subjects then performed a general warm-up consisting of 3 sets of 10 repetitions with an unloaded Olympic barbell (Rogue, Ohio power bar) before undergoing a standardized warm-up protocol (20). To mitigate the risk of failure attributable to daily variations in readiness and strength (10), the first test set commenced at the minimum 3RM established in the familiarization session. Thereby, the load was increased by 1–10 kg based on the proximity to the mean concentric barbell velocity achieved at the given technique in the familiarization session. The same procedure was followed for all 3 techniques. A 20 kg hex-bar (Gymleco Hex Bar) was flipped to use a low grip and used for the hex-bar. Importantly, we aimed to compare the impact of deadlift kinematics and kinetics without powerlifting rules to see how the body self-organizes during maximal effort with the different deadlift conditions. Therefore, the lockout position was approved when the hip was extended independent of the knee flexion angle.

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Measurements. Kinematic data were collected with Qualisys software coupled with eight 3-dimensional cameras (Qualisys, Gothenburg, Sweden) sampling at 500 Hz to track reflective markers. The laboratory was calibrated following developer guidelines (qualisys.com). Two force plates (Kistler force plate, Type 9260AA6, Winterthur, Switzerland) were integrated into the Qualisys motion capture system to acquire ground reaction force data for kinetic modeling. Markers were placed on anatomical landmarks (e.g., acromion, anterior superior iliac spine, posterior superior iliac spine, trochanter major, bilateral condyles of the knee, lateral and medial malleolus, sternum, tuber calcanei, and first and fifth proximal phalanx). In addition, clusters of passive reflective markers were placed posteriorly from the iliac crest down to the posterior superior iliac spine. To ensure accuracy in marker placement, all markers were attached by a researcher with at least an MSc degree in sports sciences. Using static trials, planar angles were computed in the YZ projection plane through 3-point measurements involving the heel center, toe center, and ankle center, then incorporated into the ankle flexion angle to counteract the ankle offset. Surface electromyography data were collected with Trigno Avanti sensors (DELSYS, Natick, MA) sampling at 1,111 Hz placed on the dominant side of 6 different muscles (e.g., erector spinae iliocostalis, gluteus maximus, gluteus medius, biceps femoris, semitendinosus, and vastus lateralis). Electrodes were placed according to SENIAM recommendations (12).

Data Analysis. All data were gap filled in Qualisys software (Qualisys, Gothenburg, Sweden). Thereby, the data were transported to Visual 3D (C-motion, Germantown, MD) through C3D files for segment building and analysis. Data were filtered using a low-pass Butterworth filter at 6 Hz. The model comprised 2 versions of the pelvis segment, 1 kinetic for inverse dynamics and 1 kinematic for resolving joint angles. Joint angles were estimated as the distal segment relative to the proximal segment. Three-dimensional joint moments for hip, knee, and ankle were computed in a resolute coordinate system and calculated using inverse dynamics with the right-hand rule convention. All joint moments are external NJM, expressed as means and *SD*s for the resolute coordinate system of the distal segments. The reported joint moments for the hip, knees, and ankles are summed between the left and right sides. The sagittal plane NJM represents flexion/extension moment, whereas the frontal plane represents adduction/abduction moments. Net joint moments were normalized to the subject's body mass and articulated as $Nm \cdot kg^{-1}$ (21). Barbell velocity was defined as the barbell relative to the laboratory. Surface electromyography data were converted into a c3d-file format and analyzed using Visual 3D v6 software (C-motion, Germantown). The raw sEMG signals were filtered with high-pass and low-pass filters at 20 and 500 Hz, respectively, and zero-mean normalized. Subsequently, the sEMG signals were fully wave rectified, and the mean root mean square values were computed.

Statistical Analyses

Data processing and statistical analysis were conducted in MATLAB R2024A (MathWorks, MA) with a custom script. All deadlift conditions were time normalized from 0 to 100% of the concentric phase, controlled for normality, and analyzed with statistical parametric mapping (SPM) using an open-source SPM tool package spm1d 0.4 (26). A repeated measures analysis of variance (ANOVA) based on random field theory assessed the effects of deadlift technique (e.g., conventional, sumo, and hex-bar) on kinematics, kinetics, and sEMG amplitude. Significant differences were further analyzed using 2-tailed paired *t*-tests with a Bonferroni correction. Statistical significance was determined at an alpha level of 0.05.

Results

Subjects lifted 103.18 ± 18.47, 101.54 ± 15.01, and 99.70 ± 15.94 kg during 3RM with the conventional, sumo, and hex-bar deadlift, respectively. No significant differences in load lifted were observed between conditions ($F \leq 0.374$; $p \geq 0.693$; $\eta^2 \leq 0.040$).

Kinematics

The SPM ANOVA revealed significant main effects of deadlift condition on barbell velocity, commencing between 7–32 and 55–79% of the concentric phase (Figures 1 and 2). Statistical parametric mapping post hoc analysis revealed higher barbell velocities with the conventional compared with the hex-bar technique, between 14 and 29% in the concentric phase. Also, deadlifting with the hex-bar resulted in higher barbell velocities, between 55–76 and 70–77%, compared with conventional and sumo deadlifts, respectively. Moreover, there was a significant main effect between 0 and 79% of the concentric phase when comparing hip flexion angles. Post hoc SPM analysis revealed larger hip flexion angles with the hex-bar than conventional and sumo deadlifts, occurring between 3–62% and 32–70% of the concentric phase, respectively. Also, the SPM ANOVA revealed a significant main effect on hip abduction angles during 100% of the concentric phase. More specifically, larger hip abduction angles were observed for the sumo deadlift compared with the other conditions during 100% of the concentric phase. For knee flexion angles, a significant main effect was detected between 0 and 78% during the concentric phase, where SPM post hoc analysis revealed larger knee flexion in hex-bar compared with conventional and sumo deadlifts between 5–66 and 0–73% of the concentric phase, respectively. In addition, a significant main effect for ankle dorsal flexion angles was observed between 0 and 100% of the concentric phase. Post hoc SPM analysis revealed that ankle dorsal flexion angles were significantly larger in conventional than in sumo deadlifts between 22 and 100% of the concentric phase, whereas hex-bar dorsiflexion angles were larger between 22–100 and 0–100% of the concentric phase compared with conventional and sumo deadlifts, respectively.

Kinetics

When comparing NJMs, the SPM ANOVA revealed a significant effect of deadlift condition on all NJM parameters (Figures 3 and 4). More specifically, we observed significant hip extension NJM main effects between 34–48 and 71–100% of the concentric phase. Statistical parametric mapping post hoc tests revealed that smaller hip extension NJM occurred for the hex-bar condition compared with conventional and sumo conditions, between 75–100 and 74–100% of the concentric phase, respectively. Also, larger knee extension NJMs were observed for the hex-bar than for conventional and sumo deadlifts, transpiring between 9–75 and 32–88% of the concentric phase, respectively. Moreover, we observed smaller ankle plantar flexion NJMs with sumo

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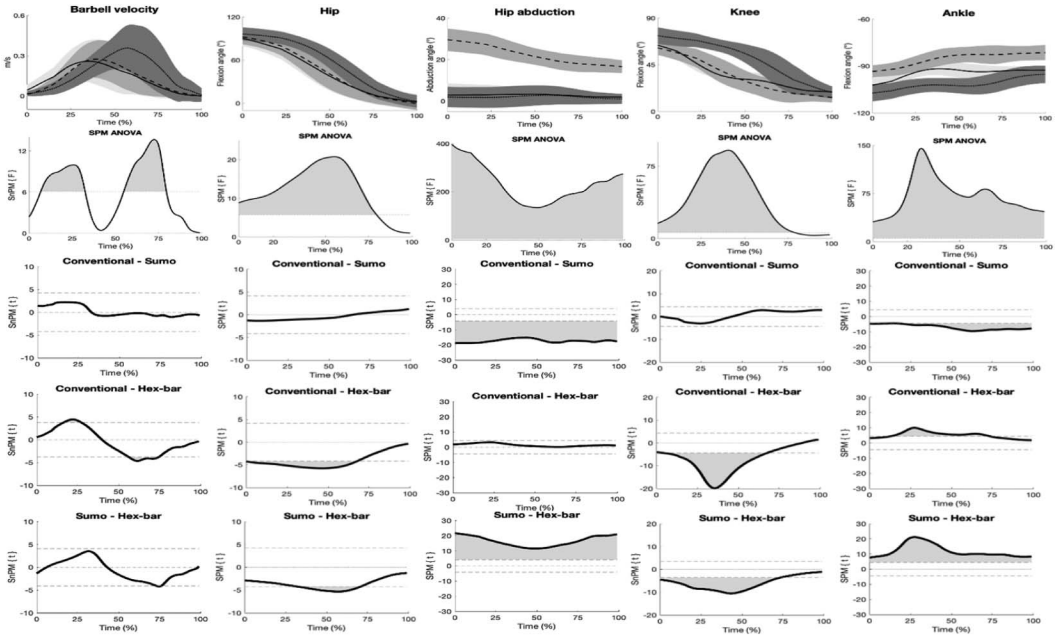


Figure 1. The top row displays mean (±*SD*) barbell velocity (m·s^{-1}), hip flexion, hip abduction knee flexion, and ankle dorsal flexion angles (°) time normalized from 0 to 100% in the conventional (solid lines), sumo (dashed lines), and hex-bar deadlifts (dotted lines) during the concentric phase. The second row displays statistical parametric mapping (SPM) analysis of variance curves, with a gray-shaded area representing significant main effects when surpassing the significance line (red dotted line, $p \leq 0.05$). The bottom 3 rows show SPM, paired *t* test curves with a Bonferroni correction.

compared with conventional (9–55 and 92–100%) and hex-bar deadlifts (0–53 and 83–100%) of the concentric phase.

Surface Electromyography Amplitude

The SPM ANOVA revealed a significant effect of deadlift condition on sEMG amplitude for the gluteus medius and maximus, biceps femoris, semitendinosus, and vastus lateralis (Figure 5). A significant main effect was discovered between 81 and 85% for the gluteus medius. Statistical parametric mapping post hoc analysis revealed higher sEMG amplitude in the sumo compared with the hex-bar technique between 81 and 82% of the concentric phase. Regarding gluteus maximus, significant main effects were found for sEMG amplitude between 29–31 and 66–89% of the concentric phase. Statistical parametric mapping post hoc analysis revealed higher gluteus maximus sEMG amplitude in the sumo than in the hex-bar deadlift between 29–31 and 66–80% of the concentric phase. Moreover, for the semitendinosus, significant main effects were observed between 69–85 and 89–100% of the concentric phase. Statistical parametric mapping post hoc tests revealed higher semitendinosus sEMG amplitude for the sumo than for the hex-bar deadlift between 55–62 and 68–81% of the concentric phase. For vastus lateralis, lower sEMG amplitude was observed for conventional than for the hex-bar between 28 and 65% and for sumo between 24 and 25% of the concentric phase.

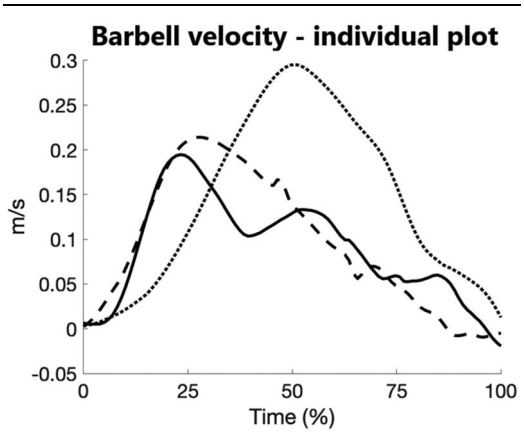


Figure 2. An individual plot of barbell velocity (m·s^{-1}) for a representable subject time normalized from 0 to 100% in the conventional (solid line), sumo (dashed line), and hex-bar deadlifts (dotted line) during the concentric phase.

Discussion

This study investigated the impact of kinematics, NJMs, and sEMG amplitude between maximal conventional, sumo, and hex-bar deadlifts among resistance trained women. The main findings were that the hex-bar condition exhibited significantly lower hip NJMs during around 70–100% of the concentric phase compared with the other conditions. Conversely, deadlifting with the hex-bar resulted in statistically larger hip and knee flexion angles, together with knee NJM and vastus lateralis sEMG amplitude compared with the other deadlift conditions.

Regarding kinematics, the hex-bar technique induced larger knee flexion angles (0–70%) and hip flexion angles (3–62% compared with conventional, 32%–70% compared with sumo) of the concentric phase. Notably, our kinematic findings align with the kinetics, as the hex-bar NJMs of the hip joint significantly decrease with the reduction of hip flexion. This can be explained by the mechanics of the lift. Larger hip flexion angles in the initial stages of the concentric phase might shift the hip joint more posteriorly, as illustrated in Figure 4. This likely increases NJMs, which is enhanced when the distance vector increases

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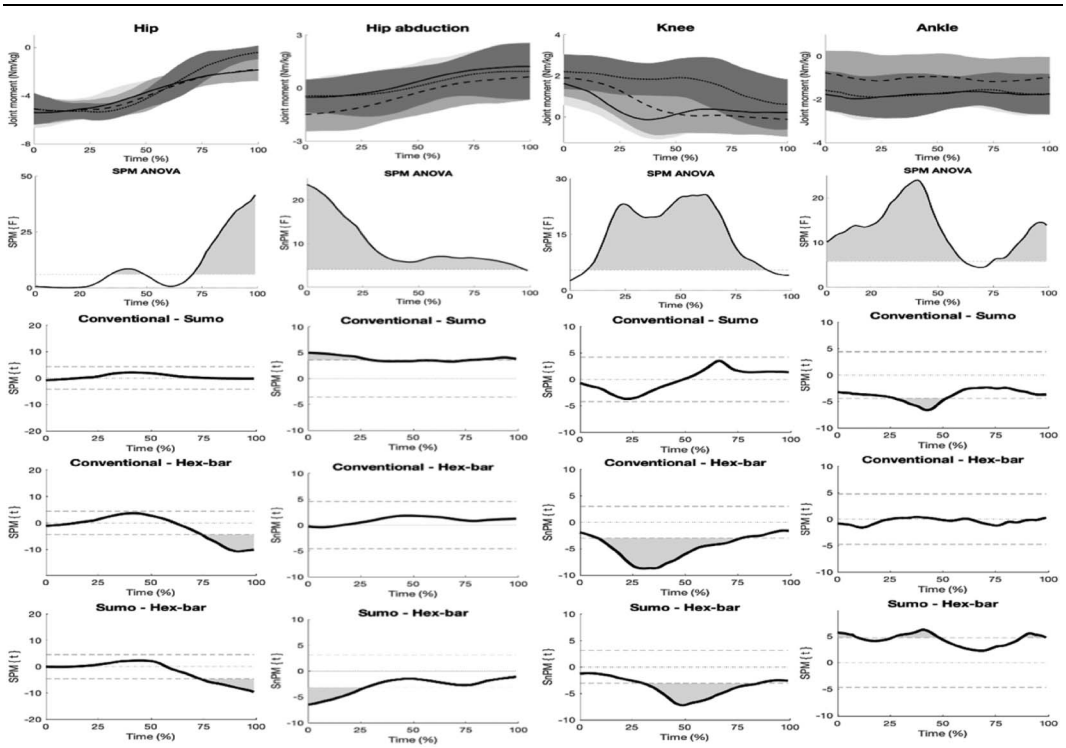


Figure 3. The top row displays mean (±*SD*) hip flexion net joint moment (NJM), hip abduction NJM, knee flexion NJM, and ankle dorsal flexion time normalized from 0 to 100% in the conventional (solid lines), sumo (dashed lines), and hex-bar deadlifts (dotted lines) during the concentric phase. The second row displays statistical parametric mapping (SPM) analysis of variance curves, with a gray-shaded area representing significant main effects when surpassing the significance line (red dotted line, $p \leq 0.05$). The bottom 3 rows show SPM, paired *t* test curves with a Bonferroni correction.

because of larger hip flexion. Consequently, this might explain why we observed no difference in hip NJMs during the initial stages of the concentric phase. Based on these findings, the hex-bar might facilitate training at longer muscle lengths by increasing joint flexion while maintaining lower hip NJMs than conventional and sumo deadlifts. In addition, the hex-bar resulted in prolonged acceleration and higher peak velocities (Figure 2), corroborating previous studies conducted with submaximal loads (5,18,31). Thus, this study is the first to show that even when lifting maximal loads, the hex-bar still achieves a longer acceleration phase and higher peak barbell velocities than the other conditions. However, no differences were discovered between the conditions in mean load lifted. Therefore, the hex-bar deadlift might facilitate larger force and power development than the conventional and sumo during maximal deadlifts.

Aligned with existing research comparing the impact of the deadlift technique on lower limb NJMs across the deadlift techniques (6,7,31), we did not observe differences in hip NJMs during the initial stages of the concentric phase. However, smaller hip NJMs were observed in the hex-bar compared with conventional and sumo deadlifts between 75 and 100% of the concentric phase. This difference is likely endorsed by the hexagonal shape of the bar, which encloses the athlete during the lift and allows closer proximity from the hip joint to the barbell center of mass (31). This is shown in Figure 4, where a more posteriorly generated ground reaction force vector moves straight through the body in the hex-bar deadlift during lockout, reducing its distance to the hip joint. In contrast, the conventional and sumo deadlifts induced a posterior shift in the hip during lockout and a more anteriorly directed ground reaction force vector (Figure 4). Thus, the distance from the ground reaction force vector to the hip joint is increased. Based on our findings, differences in hip NJMs are pronounced in the final third of the lift, and it likely occurs because a more extended hip and torso more efficiently use the posteriorly directed ground reaction force vector generated with the hex-bar deadlift. Therefore, the hex-bar technique might reduce hip NJMs compared with the others in the final third of the concentric phase. In addition, and consistent with the literature (7,31), this study showed the hex-bar deadlift induces the largest knee NJMs, followed by the sumo and then the conventional deadlift. The larger observed knee NJMs for the hex-bar are likely a result of the posterior shift in the external resistance vector together with larger knee flexion angles. This shift is caused by the design of the hexagonal barbell, which moves the barbell's center of mass behind the knees (7,31). These spatial adjustments may have resulted in a posterior elongation of the moment arm from the knee joint to the ground reaction force vector, causing the larger observed knee flexion moment. As such, the hex-bar, but also the sumo techniques, imposes greater knee extensor demands compared with the conventional. Thus, we recommend strength trained athletes focused on strengthening the knee extensors through deadlifting to choose the hex-bar technique. In addition, aligning with the literature (7,31), we observed no differences in ankle NJMs between conventional and hex-bar (31) and smaller ankle NJMs in sumo compared with conventional and hex-bar conditions. This may be attributed to the more externally rotated position of the ankle joint in the sumo deadlift, which might reduce the distance from the ground reaction force vector to the ankle joint. Consequently, this shorter moment arm likely contributes to the reduced ankle NJMs observed in the sumo deadlift. Furthermore, an increased hip abduction NJM was observed in the sumo, which may be attributable to the subjects adopting

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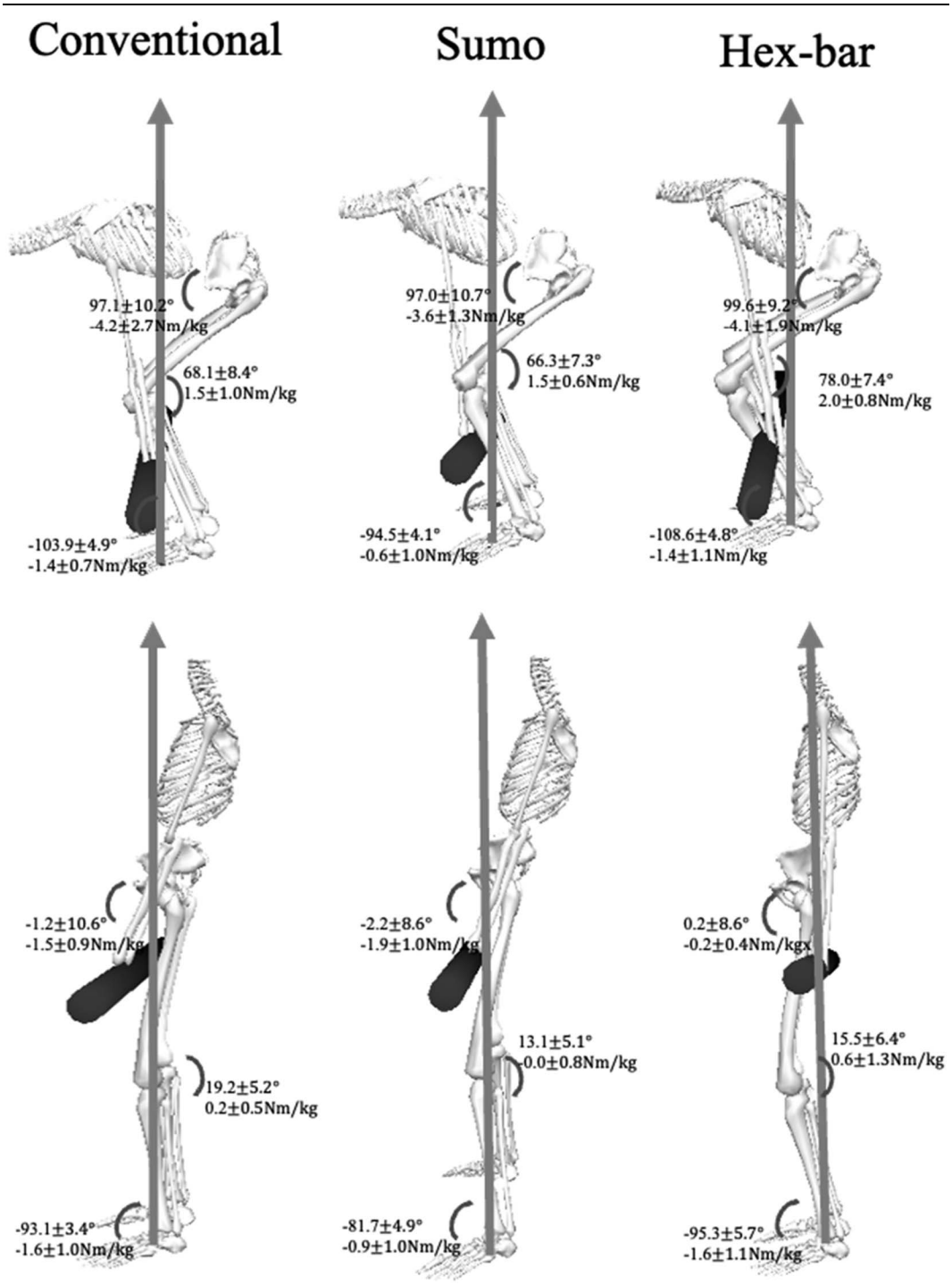


Figure 4. The figure displays ground reaction force vectors, mean (±*SD*) joint flexion angles (°), and net joint moments (NJMs) ($Nm \cdot kg^{-1}$) of the hip, knees, and ankles of the different deadlift techniques during the bottom position (row 1) and lockout (row 2). The figure is made from representative subjects; thus, the skeletal joint angles and ground reaction forces do not wholly align with the mean.

stance widths equivalent to 1.0 acromion widths for conventional and hex-bar, and 1.6 acromion widths for the sumo. It is possible the wider stance enhanced hip abduction NJMs and laterally directed forces, creating a superior medially directed resultant force vector (20). This might result in less efficient vertical lifting because of more laterally directed forces and more hip abduction NJM and could explain why Escamilla et al. (7) necessitated the sumo to require 25–30% less mechanical work than the conventional.

Finally, our findings imply that the hex-bar technique induces the largest vastus lateralis sEMG amplitude while the conventional technique induces the smallest. This is in line with the literature (5,9) and may be related to the larger knee flexion angles and NJMs observed with the hex-bar compared with the conventional deadlift. In addition, concomitant with the literature (8), we observed no difference in the sEMG amplitude of hip and spinal extensors between conventional and sumo deadlifts.

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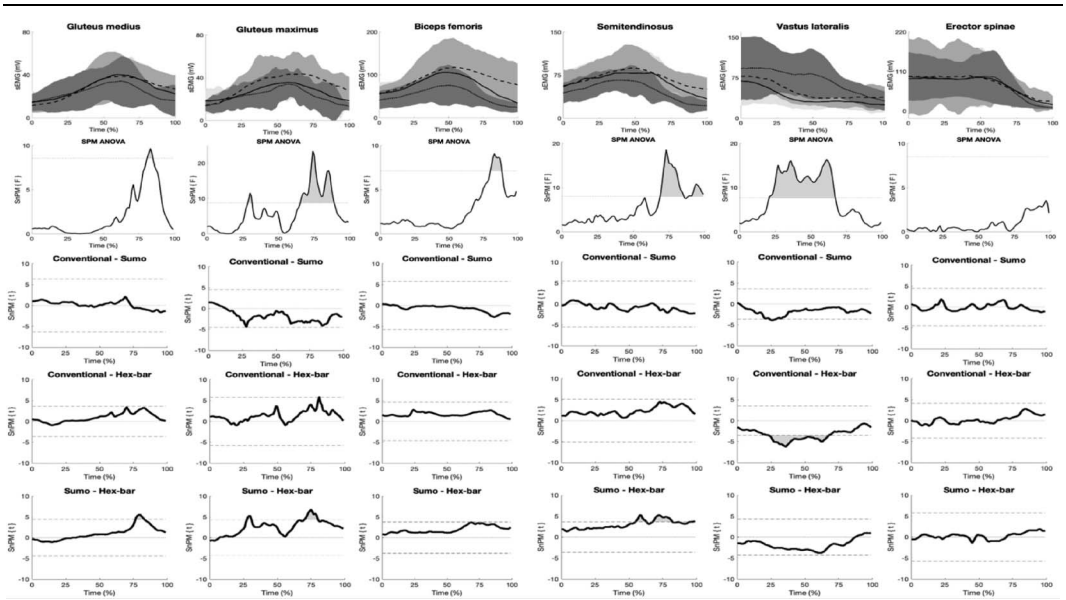


Figure 5. The top row displays mean (±*SD*) surface electromyography amplitude (mV) for gluteus medius, gluteus maximus biceps femoris, semitendinosus, vastus lateralis, and erector spinae time normalized from 0 to 100% in the conventional (solid lines), sumo (dashed lines), and hex-bar deadlifts (dotted lines) during the concentric phase. The second row displays statistical parametric mapping (SPM) analysis of variance curves, with a gray-shaded area representing significant main effects when surpassing the significance line (red dotted line, $p \leq 0.05$). The bottom 3 rows show SPM, paired *t* test curves with a Bonferroni correction.

However, this study is the first to compare sEMG amplitude between sumo and hex-bar, revealing a larger sumo gluteal and hamstring sEMG amplitude of around 70% in the concentric phase. This may be explained by the lower hip NJMs observed for the hex-bar deadlift near the lockout, resulting in lower working demands for the hip extensors. Moreover, no significant differences were discovered in sEMG amplitude of hip extensors between the conventional and hex-bar techniques. This was unexpected given the not significantly different hip NJMs and kinematics between the conventional and sumo deadlifts, and it contrasts with the literature (1) reporting larger biceps femoris sEMG amplitude in the conventional deadlift. It is speculated that because the sumo deadlift typically has greater hip external rotation compared with the conventional (7), this could have affected the sEMG signal for the gluteus maximus. Nevertheless, more research should be conducted to compare the sEMG of these 3 techniques and draw more definitive conclusions.

This study has several limitations that should be addressed. First, this study did not require athletes to fully extend their knees during lockout. Therefore, our findings might not be fully attributable to the literature and athletes following regulations set by the International Powerlifting Federation (14). Second, we only reported NJMs calculated from inverse dynamics. This methodology neglects muscle forces, which often are the primary sources of joint loading (32). Third, we used SPM based on the random field theory to compare kinematics and kinetics between deadlift conditions during concentric phase. Thus, estimating effect sizes is challenging. Fourth, we did not compare NJMs on the spine between conditions. As the deadlift has been observed to load the spine (6,31), differences in movement strategies may occur in the spine. Fifth, we standardized stance width. If the subjects could choose their stance width, we speculate this may have led to divergent findings.

Conventional and sumo deadlifts increase hip NJMs near the lockout. Conversely, deadlifting with the hex-bar technique increases knee NJMs and hip and knee flexion angles. In addition, deadlifting with the hex-bar may result in higher barbell velocities near lockout. Therefore, we suggest that hex-bar training may be beneficial when deadlifting for knee extensor development and higher barbell velocities among strength trained women, whereas sumo and conventional deadlifts may be more suitable for involving hip extensors during deadlifts.

Practical Applications

Deadlifting with a hex-bar during the last repetition of 3RM results in greater loading on the knee extensors and greater vertical barbell velocity. In contrast, deadlifting with a conventional or sumo technique increases loading on the hip extensors near the lockout phase. Based on these findings, we suggest that deadlifting with a hex-bar may be advantageous for targeting the knee extensors and achieving a faster vertical barbell velocity. Moreover, sumo and conventional techniques may be beneficial for targeting the hip extensors near the lockout phase among resistance trained women during the last repetition in 3RM deadlifts.

Acknowledgments

The authors would like to thank all the subjects for their time and effort in contributing to this study. The authors also extend our gratitude to Eirik Lindset Kristiansen for his assistance in data collection, and to the Department of Sports Science and Physical Education at Nord University for providing the facilities and equipment necessary for this research. No funding was received for this study. The results of this study do not constitute an endorsement of any product by the authors or the National Strength and Conditioning Association (NSCA).

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