Physical Therapy in Sport xxx (2012) 1–7

Contents lists available at SciVerse ScienceDirect

Physical Therapy in Sport

journal homepage: www.elsevier.com/ptsp

Original research

A randomized trial to consider the effect of Romanian deadlift exercise on the development of lumbar extension strength

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ARTICLE INFO

Article history:
Received 6 December 2011
Received in revised form
28 March 2012
Accepted 7 April 2012

Keywords:
Strength training
Lower back
MedX

ABSTRACT

Objective: To consider the efficacy of 10 weeks of Romanian deadlift (DL) training in increasing lumbar extension strength compared to isolated lumbar extension (LUMX) training.
Design: Comparison of pre- and post-test data for Romanian deadlift 1RM, and lumbar extension torque between and within groups.
Participants: Male trained subjects ($n = 36$; ($\bar{x} \pm$ SD) 24.9 ± 6.5 years; 178.5 ± 5.2 cm; 81.6 ± 10.0 kg).
Main outcome measures: Pre- and post-testing included a Romanian deadlift 1RM and isometric strength tests every 12° through full range of motion on the MedX lumbar extension machine (MedX, Ocala, FL).
Results: Repeated measures analysis of variance (ANOVA) with Bonferroni adjustments revealed that 1RM Romanian deadlift significantly increased from pre- to post-test in the DL group ($p < 0.008$; 143.3 ± 23.4 kg to 166.3 ± 21.9 kg) and the LUMX group ($p < 0.008$; 135.8 ± 23.1 kg to 146.0 ± 25.5 kg). In contrast, tested functional torque (TFT) significantly increased at 6 out of 7 joint angles ($p < 0.008$) for the LUMX group only. The control group showed no significant differences pre- to post-test.
Conclusions: These data suggest that the Romanian deadlift does not enhance lumbar extension torque. However, performing specific isolated lumbar extension training appears to improve both lumbar extension torque and Romanian deadlift 1RM.

1. Introduction

The prevalence of low back pain and injury in both trained and untrained persons, as well as amateur and competitive athletes (e.g. weight lifters, ballet dancers, gymnasts, javelin throwers, tennis players, cross-country skiers, rowers, orienteerers and golfers) is well documented (Alexander, 1985; Alricsson & Werner, 2006; Bahr, Anderson, Loken, Fossan, Hansen & Holme, 2004; Bono, 2004; Calhoon & Fry, 1999; DeHaven & Lintner, 1986; Gluck, Bendo, & Spivak, 2008; Hutchinson, 1999; Mazur, Yetman, & Risser, 1993; Nadler, Malanga, Bartoli, Feinberg, Prybicien, Deprince, 2002; Renkawitz, Boluki, & Grifka, 2006; Stuelcken, Ginn, & Sinclair, 2008). Bono (2004) discussed the importance of both lower back dynamic power in movements such as the golf or baseball swing, a gymnast's landing, a power-lifter's squat and a boxer's punch, as well as static strength in examples such as an infielder's stance, a cyclers tuck or a ballerina's arabesque.

Bono (2004) stated that "*low back pain is a symptom not a diagnosis*", which is fitting with studies that have shown a relationship between low back pain and weak lumbar musculature (Luoto, Heliövaara, Hurri, & Alaranta, 1995; Mayer, Graves, Robertson, Pierra, Verna & Ploutz-Snyder, 1999; Risch et al., 1993; Suni, Oja, Miilunpalo, Pasanen, Vuori & Bos, 1998). Other research has shown that the muscles of the lumbar region can be strengthened using specific isolated machine-based training, improving function and reducing low back pain symptoms and disability (Carpenter et al., 1991; Choi, Pai Raiturker, Kyung-Joon, Dai Jin, Yu-Sik & Sang-Ho, 2005; Graves et al., 1990, 1994; Pollock, Leggett, Graves, Jones, Fulton & Cirulli, 1989; Risch et al., 1993). This plethora of evidence suggests benefits, for almost all individuals, in performing some form of lower back exercise whether in an effort to maximize athletic performance or simply to reduce the potential for low back pain.

Mayer, Mooney, and Dagenais (2008) highlight four ways to exercise and improve lumbar strength; (i) machines, (ii) benches and roman chairs, (iii) free weights (e.g. deadlift), and (iv) floor and stability balls. Indeed many major gyms now include some form of

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doi:10.1016/j.ptsp.2012.04.001

lower back exercise machine, or roman chair. Great success has been attained with the MedX lumbar extension machine (see method for validity and reliability data) in both measuring isometric force production and strengthening the lumbar muscles (Bruce-Low, Smith, Bissell, Burnet, Fisher & Webster, in press; Carpenter et al., 1991; Graves et al., 1990; Pollock et al., 1989; Smith, Bruce-Low, & Bissell, 2008). However, more common 'lower-back' exercises, such as the roman chair, have been shown not to improve lumbar extension strength when tested on an isometric dynamometer, even where training resistance has increased throughout an intervention (Mayer, Udermann, Graves, & Ploutz-Snyder, 2003). Other research has considered alternative lumbar extension machines that do not fixate the pelvis and therefore do not isolate the lumbar extensors, once again reporting no significant increase in isometric torque production in the lumbar muscles from training on such machines (Graves et al., 1994). These authors reported that this was likely due to the rotational movement of the pelvis permitted by such exercises, allowing gluteal and hamstring activation to assist in the movement. Indeed, researchers have reported significantly greater activation of the lumbar multifidus during back extension where the pelvis was stabilized (San Juan, Yaggie, Levy, Mooney, Udermann & Mayer, 2005), adding that muscle activation of the gluteus maximus and biceps femoris were decreased where the pelvis was restrained (Da Silva, Lariviere, Arsenault, Nadeau, & Plamondon, 2009). In contrast, another study found greater activation of the erector spinae muscles in an unrestrained condition (Benson, Smith, & Bybee, 2002), although participants in this study subjectively reported greater effort in the lumbar muscles where the pelvis was restrained.

In addition to these machine-based exercises, a popular barbell exercise, the stiff-legged deadlift (also commonly referred to as the 'Romanian deadlift') is often advocated for strengthening the back extensors (Mayer et al., 2008; Piper, 2001; Sheppard, 2003). Based on this, many strength and conditioning coaches and personal trainers also recommend this exercise to strengthen the lumbar muscles, supported by the National Strength and Conditioning Association (NSCA Baechle & Earle, 2008). Indeed, researchers using electromyography (EMG) have found activation of the lumbar muscles from performing variations of the deadlift. For example, Chulvi-Medrano, Garcia-Masso, Colado, Pablos, Alves de Moraes & Fuster, (2010) report lumbar activation (measured on the lumbar multifidus and the lumbar erector spinae) when considering the deadlift (non-specific reference to conventional, sumo, or Romanian although the pictures within their article clearly represent the Romanian deadlift); and Escamilla, Francisco, Kayes, Speer, and Moorman (2002) report lumbar activation (measured on the L3 'paraspinals') when considering both the sumo and conventional deadlifts.

Since variations of the deadlift have been shown to activate lumbar muscles through EMG (Chulvi-Medrano et al., 2010; Escamilla et al., 2002) researchers have advocated the use of the Romanian deadlift exercise for strengthening of the back extensors (Frounfelter, 2000; Mayer et al., 2008; Piper, 2001; Sheppard, 2003). However, EMG data only infer an acute training response. In addition we might be careful in interpretation of EMG data of specific lumbar muscles; De Luca (1997) details limitations of using EMG signals to include crosstalk (readings from synergist muscles) and indeed; Stokes, Henry, and Single (2003) specifically discuss the lumbar multifidus as a challenging area to accurately record EMG data.

To date we could find no peer reviewed research that has shown that performing the Romanian deadlift, or any of its variations, will enhance the torque production of the lumbar muscles. It is surely of considerable interest to many athletic- and personal-trainers as well as athletes and recreational gym goers to know the efficacy of this exercise as regards to whether it can strengthen the lumbar muscles and thus potentially reduce the risk of injury or likelihood of low back pain. Therefore, the aim of the present study was to determine the effects of a 10-week, progressive Romanian deadlift training program upon lumbar extension torque. By comparing the force increases (lumbar extension torque and Romanian deadlift 1RM) between a MedX training group and a Romanian deadlift training group we can consider whether the Romanian deadlift enhances force production to a similar degree as specific isolated lumbar extension training.

2. Methods

2.1. Experimental approach to the problem

The effect of a 10-week progressive training program, using the Romanian deadlift, on lumbar torque production was evaluated using a MedX (Ocala, Florida) lumbar extension machine. This machine can be used to measure lumbar extension range of motion (ROM) in a seated position as well as test isometric strength at 12° intervals. It can also be used for dynamic, variable resistance lumbar extension training. Pre and Post strength testing was performed for all subject groups using the Romanian deadlift 1RM, and the Lumbar Extension Machine. A prospective, between groups, repeated measures exercise training study was conducted with healthy individuals who were randomly allocated to 1 of 3 groups; lumbar extension training once a week (LUMX; $n = 12$), Romanian deadlift training once a week (DL; $n = 12$) or a control group (CON; $n = 12$).

2.2. Subjects

Following approval by the relevant ethics committees, 36 asymptomatic male subjects ($\bar{x} \pm$ SD) (age = 24.9 ± 6.5 years), were recruited by advertisement within a University environment (specifically requesting participants who did not suffer from any lower back pain). All subjects provided written informed consent prior to participation, were required to have had greater than 2 years resistance training experience, including a deadlift variation (non-specific) and were currently involved in a resistance training program that did not include specific lumbar exercises or the Romanian deadlift. All subjects were asked to refrain from other deadlifts (any variation), squats or other exercises that might place a direct stress or training effect on the lower back or gluteal and hamstring chain of muscles throughout the duration of their participation, other than those required by the study itself.

Two subjects, who verbally reported through interview, currently suffering from a form of lower back pain or discomfort, were excluded from the study. Six participants who, at some point during the study, failed to attend a training session ($n = 4$, DL; $n = 2$, LUMX) were withdrawn from the study. One participant, who did not complete the post-test was also excluded ($n = 1$, CON). When asked about their withdrawal from the study all but one of these participants cited inconvenience of the training session/post-test as their reason for withdrawal. One participant who underwent 3 training sessions for the DL group withdrew reporting severe delayed onset muscle soreness (DOMS) from training to muscular failure (see also Fig. 1). All other participants completed the 1×/week protocol with the required compliance.

2.3. Testing procedures: (i) deadlift

Prior to testing, all subjects were provided with a comprehensive training session to familiarize them with the Romanian deadlift and verify their ability to perform it safely. Once appropriate

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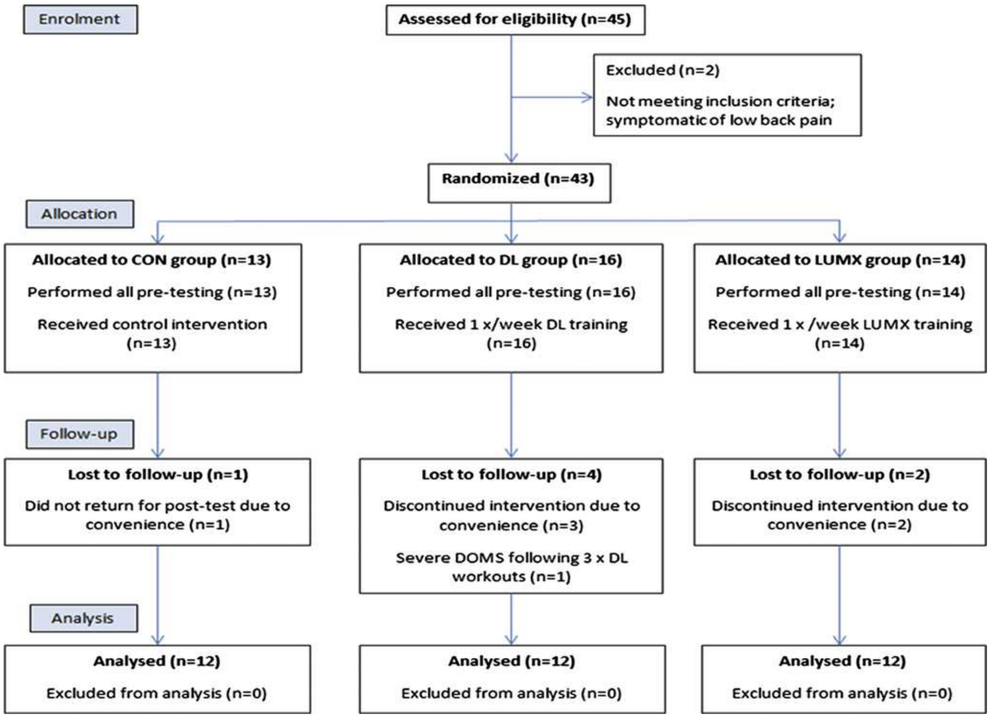

Fig. 1. Consort diagram showing enrollment, allocation, continuence and analysis.

technique was demonstrated subjects returned for a second session where they performed a standardized 5 min warm-up on a cycle ergometer up to 70% heart rate maximum, followed by 8 repetitions at 50%, and then 3 repetitions at 70% of their predicted 1-repetition-max (1RM). Each subject was then given 3–5 attempts to perform a maximal lift with approximately 3 min rest in between to allow for adequate recovery (Brown & Weir, 2001). For the Romanian deadlift 1RM lifting straps were used to ensure the weight was maximal, and not limited by the grip strength of the subjects (Fig. 2).

2.4. Testing procedures: (ii) lumbar extension machine

Subjects were seated in the MedX Lumbar extension machine in an upright position with their thighs at an angle of 15° to the seat. A restraining belt was secured over the anterior part of the upper thigh and femur restraint pads were firmly positioned over the thigh just superior to the knees. These restraints prevent unwanted vertical movement of the pelvis or thighs. The machine also incorporates a counter-weighting procedure to counterbalance the mass of the upper body and also the effects of gravity acting on the upper body. When ready to test, the movement arm on the machine was locked at the relevant joint angle (measured using the machine's goniometer) and the subject was requested to build up to maximal tension over 2–3 s and to maintain the contraction for a further 1 s. The torque produced was measured by a load cell attached to the movement arm. The validity and reliability of both the restraint and counter-weighting procedures are well-established (Graves et al., 1990, 1994; Inanami, 1991) and the torque measurements show very high test–retest reliability at all angles ($r = 0.63$–0.96 (Robinson, Greene, Graves, & Mac Millan, 1992) for patients with lumbar pain and $r = 0.94$–0.98 (Pollock, Graves, Leggett, Young, Garzarella & Carpenter, 1991) for asymptomatic patients) (Fig. 3).

One week following the 1RM maximal Romanian deadlift, subjects then completed two isometric lumbar extension strength tests (not less than 72 h apart). As previous research (Graves et al., 1990) has shown it is important that subjects are familiar with the testing procedure to produce reliable results, the initial testing session was designated as a familiarization session. The second test was used to obtain pre-test measures of lumbar extension strength.

Fig. 2. Romanian deadlift, showing range of motion.

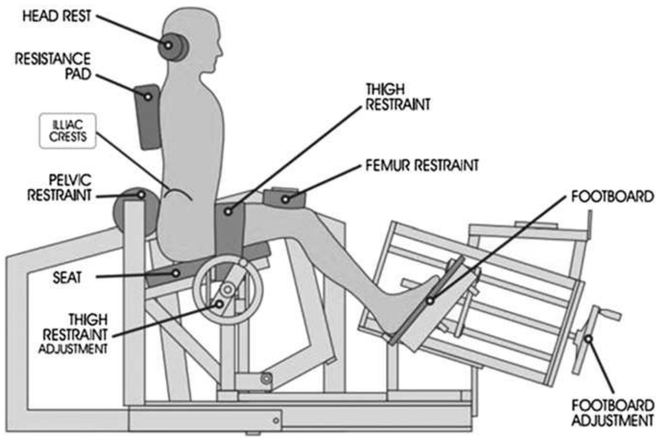

Fig. 3. MedX lumbar extension machine, showing restraint system.

In accordance with standard procedure on this machine, isometric lumbar extension torque was measured at intervals of 12°, starting from full lumbar flexion (72°) to full lumbar extension (0°). Prior to testing, the restraining and counter-weighting procedures were carried out as described previously, and lumbar ROM in the machine was measured using the machine's goniometer.

Following these procedures, strength tests were conducted at each joint angle using the procedure described, with approximately 10 s rest between the strength tests at each joint angle. Subjects were asked if they felt they exerted maximal effort at each angle and any tested angles in which the subject felt he did not give a maximal effort were repeated.

2.5. Group assignment

Subjects were assigned to one of the training groups or the control group using simple randomization (blindly selecting 1 of 3 cards denoting group allocation), following testing and prior to any training. One of the test administrators and one of the statisticians were blinded to group assignment, however due to the research design the administrator supervising training intervention could not be blinded to group assignment. A power analysis of previous research with asymptomatic subjects (Graves et al., 1990) was conducted to determine sample size (n). A treatment effect size (ES) of 1.26 for the MedX lumbar extension machine was calculated using Cohen's d (Cohen, 1992). Subject numbers were calculated using equations from Whitley and Ball (2002). These calculations revealed that each group required a minimum of 10 subjects to meet the required power of 0.8 at an alpha value of $p \leq 0.05$.

2.6. Exercise training

Subjects in the LUMX group performed one lumbar extension training session per week for 10 weeks. Subjects in the DL group performed one DL training session per week for 10 weeks. All testing and training was performed within the University sport science laboratories. For each of the training groups this involved one set of ~8–12 repetitions at a weight equivalent to ~80% of the maximum tested functional torque (TFT)/1RM through the subject's full ROM on either the lumbar extension machine or the DL to volitional fatigue within a time frame of between 60 and 90 s. Subjects performing the DL were permitted to use lifting straps to ensure the exercising set was not limited by grip strength, and were supervised and provided with coaching guidance based on that of previous research (Frounfelter, 2000; Gardner & Cole, 1999). Verbal commentary during any testing/training was restricted to coaching guidance of technique rather than encouragement of performance. Whilst the protocol used for the DL group might not be perceived as optimal, the volume and frequency were balanced with that of the LUMX group which was essential for an unbiased comparison. Also, it is important to note that contrary to the perceptions of many individuals involved in resistance training, research has shown that single-set workouts, 1×/week are sufficient to stimulate optimal strength gains (e.g. Fisher, Steele, Bruce-Low, & Smith, 2011; Smith & Bruce-Low, 2004).

Repetitions for both groups were performed slowly, with the LUMX group advised to take 2 s to lift the weight and 4 s to lower it as is the standard protocol with the machine. The DL group were advised the same; to lift in a slow and deliberate manner without explosive movements. This is fitting with other literature (Gardner & Cole, 1999) and allowed accurate comparison between the training modalities. When subjects could perform more than 12 repetitions the weight was increased by approximately 5%. This training protocol is standard in studies using the machine and in resistance training in general (Ratamess et al., 2009) and has been found to produce optimal strength increases. Training at a non-explosive repetition rate is suggested to maximize muscular tension, eliminate external forces such as momentum, and to reduce the risk of injury (Bruce-Low & Smith, 2007).

2.7. Statistical analysis

Descriptive statistics (means and SDs) were derived for demographic data and strength variables. 1RM Romanian deadlift (measured in kg) and force at each lumbar extension joint angle (measured in Nm) as well as lumbar extension SI value were evaluated within each group using an analysis of variance (ANOVA) with repeated measures for training effects. The lumbar extension SI value is a product of force produced at each joint angle reported as the area under a force curve. This allows for inclusion of potential increases and decreases throughout the entire strength curve at all 7 test positions (0°, 12°, 24°, 36°, 48°, 60°, and 72°) without biasing the data by seeing an average increase or decrease or only considering specific joint angles. Where a significant difference was observed, a paired samples t-test was completed with a Bonferroni adjustment (to reduce the risk of type-2 error); meaning significance was accepted at the alpha level $p \leq 0.008$.

3. Results

All data were checked and confirmed to be normally distributed using a Kolmogorov–Smirnov test. There were no significant differences in age, stature, or body mass between the groups ($p > 0.05$ in all cases; Table 1). In addition, between-group pre-test analyses revealed no significant differences for the Romanian deadlift 1RM, the MedX SI value, and the lumbar extension joint angles ($p > 0.05$ in all cases). Analysis of the lumbar extension joint angle data, expressed as the mean ± standard deviation ($\bar{x} \pm$ SD), using a repeated measures ANOVA revealed a significant time-× group interaction effect ($p < 0.05$), as did the lumbar extension SI data ($p < 0.05$). The Romanian deadlift 1RM values, expressed as the mean ± standard deviation, also showed a significant interaction effect ($p < 0.05$).

Table 1
Subject characteristics (mean ± SD).

Group	n	Age (y)	Height (cm)	Weight (kg)
LUMX	12	23.1 ± 4.5	177.7 ± 4.1	77.2 ± 9.7
DL	12	26.5 ± 7.0	178.4 ± 6.8	82.1 ± 8.3
CON	12	24.5 ± 7.5	179.3 ± 4.5	84.4 ± 11

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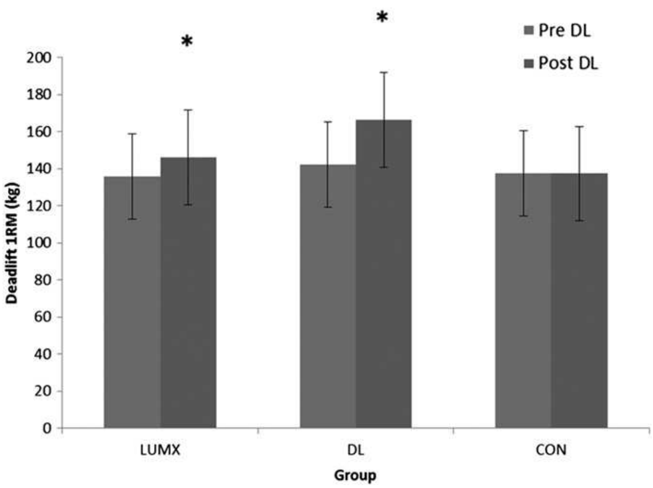

Fig. 4. Deadlift 1-repetition-max (kg), *Post-test > pre-test ($p < 0.008$). Error bars represent SD values.

Paired samples *t*-tests with a Bonferroni adjustment showed the following pre- to post-test results. For the Romanian deadlift 1RM (Fig. 4); there were no significant differences for the CON group; ($t_{(11)} = 0.178$, $p = 0.862$), there was a significant difference for the DL training group; ($t_{(11)} = -8.23$, $p < 0.008$ [pre- 143.3 kg ± 23.4 to post- 166.3 kg ± 21.9]), and there was also a significant difference for the LUMX training group; ($t_{(11)} = -3.57$, $p < 0.008$ [pre- 135.8 kg ± 23.1 to post- 146.0 kg ± 25.5]).

For the MedX SI values (Fig. 5); there was no significant difference for the CON group ($t_{(11)} = 1.03$, $p = 0.328$), there was no significant difference for DL group ($t_{(11)} = -1.37$, $p = 0.199$), however, there was a significant difference for the LUMX training group ($t_{(11)} = -8.15$, $p < 0.008$ [pre- 16262.8 ± 4273.0 to post- 19472.4 ± 4932.3]).

For the lumbar extension joint angles (Fig. 6); there was no significant difference for the CON group ($p > 0.008$), there was no significant difference for the DL training group ($p > 0.008$), however, there was a significant difference for 6 out of the 7 tested joint angles for the LUMX training group ($p < 0.008$).

4. Discussion

The present study considered the use of the Romanian deadlift exercise as a method of training the lumbar extensor muscles in asymptomatic males with previous training experience. The data showed that progressive training of the Romanian deadlift, 1×/week for 10 weeks, significantly improved the 1RM performance of the Romanian deadlift, but did not significantly enhance lumbar extension torque at any of the joint angles tested on the MedX lumbar extension machine. These findings are supported by previous research, which has suggested that pelvic stabilization is necessary to optimally activate and strengthen the lumbar extensors (Da Silva et al., 2009; Graves et al., 1994; Mayer et al., 2003; San Juan et al., 2005). Indeed, other authors have suggested that where there is no pelvic stabilization it is the hamstring and gluteal muscles that are primarily acting to "de-rotate" the pelvis, rather than the lumbar muscles acting to provide lumbar extension (Graves et al., 1994).

In contrast, performing isolated lumbar extension exercise once per week for 10 weeks was sufficient to significantly increase

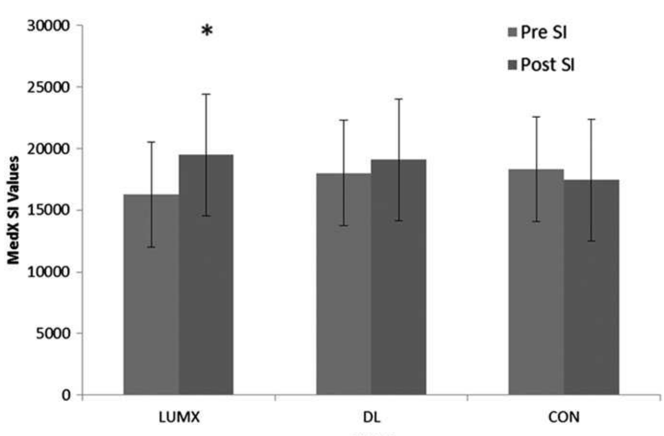

Fig. 5. MedX SI values. *Post-test > pre-test ($p < 0.008$). Error bars represent SD values.

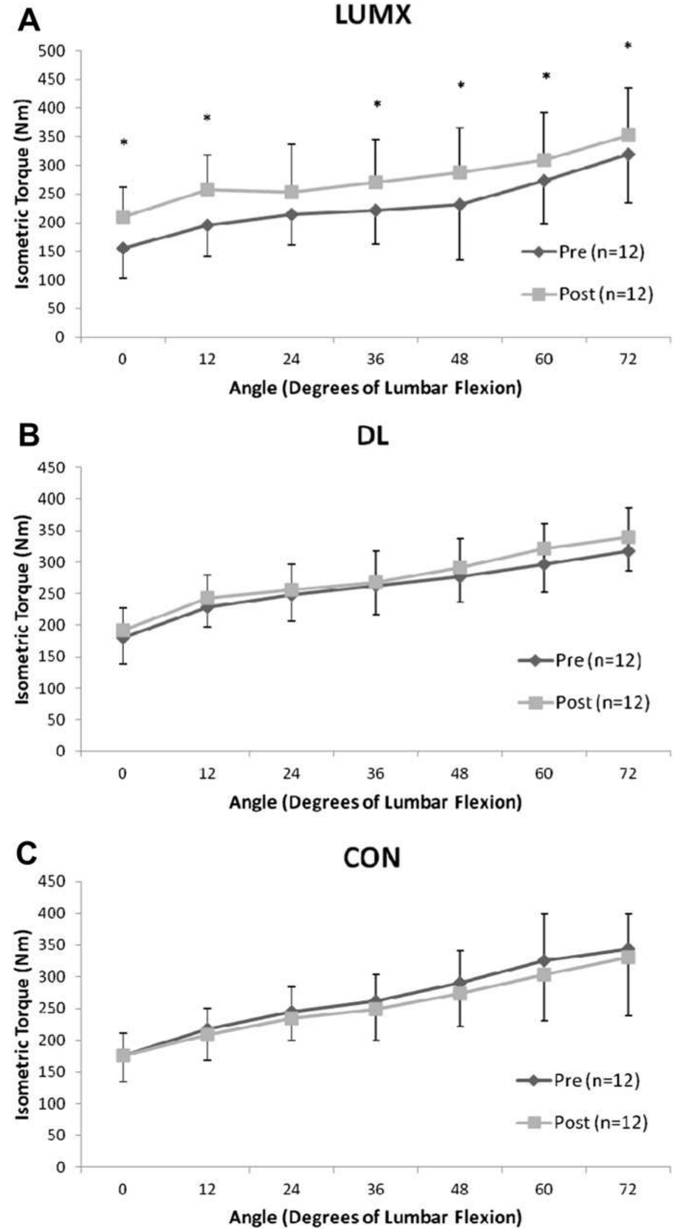

Fig. 6. Pre- and post-training isometric lumbar extension torque values (mean ± SD) for the LUMX group (A, $n = 12$), DL group (B, $n = 12$), and CON group (C, $n = 12$) plotted as a function of angle of lumbar flexion (* = $p < 0.008$).

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lumbar extension torque at 6 of the 7 tested angles, as well as significantly increasing the Romanian deadlift 1RM. This increase in 1RM supports previous research showing activation of the lumbar muscles during Romanian, sumo, and traditional deadlift variations (Chulvi-Medrano et al., 2010; Escamilla et al., 2002) and suggests that isolated training of the lumbar extensors can enhance compound movement performance.

We should acknowledge that a specificity of training related to the testing machine may exist. The DL group was disadvantaged by an absence of practice on the lumbar extension machine on which they were pre- and post-tested for functional torque. However, the same is true of the LUMX group and the Romanian deadlift testing; they did not practice the Romanian deadlift testing method, and yet still showed significant improvements pre- to post-intervention.

It could be argued that the Romanian deadlift-trained group required a higher frequency and/or volume of training to stimulate torque increases in the lumbar muscles. However, the Romanian deadlift group made significant improvements in their Romanian deadlift 1RM pre- to post-test (16%) by performing only one set, once per week. This is fitting with other research that has reported strength increases from low-volume, low-frequency training (e.g. Fisher et al., 2011; Smith & Bruce-Low, 2004) and suggests that it was not the reduced volume but the movement itself that was insufficient to stimulate strength changes. Indeed, a once-weekly training frequency appears effective in strengthening the lumbar muscles using specific isolated training within the present study as well as proving as effective as 2× and 3×/week protocol in previous studies (Carpenter et al., 1991; Graves et al., 1990). In addition, the 1×/week protocol used herein by the LUMX group provided sufficient stimulus to produce significant improvements in their pre- to post-test 1RM Romanian deadlift.

5. Future research

In consideration of the data presented, it could be hypothesized that training using the Romanian deadlift itself serves to strengthen the posterior chain of hip extensors (gluteals, biceps femoris, semitendinosus and semimembranosus amongst others), without directly enhancing the strength of the lumbar extensors. Certainly the literature suggests that these muscles show considerable activation during the Romanian, and, sumo and traditional deadlift exercise (Chulvi-Medrano et al., 2010; Escamilla et al., 2002; respectively), however perhaps future research might consider testing the force production of the hamstrings and gluteal muscles as a result of Romanian deadlift training. This contrasts with the effects of the lumbar extension exercise, which clearly strengthened the lumbar extensors. Interestingly, subjects in the LUMX group reported some muscular soreness in their gluteal and hamstring muscles in the days following their lumbar extension exercises. Therefore, whilst the restraining mechanism in the machine prevents these muscles from contributing to the measured lumbar force production (Graves et al., 1994), they might still be activated in an isometric contraction against the restraints. Since there was no measurement of activation, force production, or strength testing for the gluteal and hamstring muscles in the present study this is purely speculative. However, future research could examine possible training effects in these muscles from isometric contraction when performing isolated lumbar extension exercise.

We should also acknowledge that the present study used male, asymptomatic participants with previous deadlift experience, performing the Romanian deadlift variation and as such the results cannot be generalized to other persons, or variations of the deadlift. Future research might consider other specific population groups based on age, gender, training experience, low back pain, etc. as well as other variations of the deadlift exercise.

6. Conclusion and practical applications

In conclusion the present data suggest that training using the Romanian deadlift appears to enhance 1RM performance of the Romanian deadlift but does not specifically strengthen the lumbar extensors. Therefore, coaches and athletes should ideally employ isolated lumbar extension exercise in addition to the Romanian deadlift if strength increases in the lumbar muscles are also desired. Given the well documented potential of this area for injury, and the debilitating effects of injury to the lumbar region, we argue that protection of this vulnerable area should certainly be a priority for athletes engaged in sports as well as the lay person wishing to remain injury free. As previous research has shown that isolated lumbar extension exercise can be effective in both prevention and treatment of lower back injuries (see, for example, Bruce-Low et al., 2012; Choi et al., 2005; Leggett et al., 1999; Mooney, Kron, Rummerfield & Holmes; 1995), we suggest that this exercise would be a valuable addition to many athletes' strength training regimens, even when performed in low-volume and low-frequency (e.g. 1×/week). In application, although the Romanian deadlift can be a valuable exercise, strength coaches should not assume that this will be sufficient exercise for the lumbar extensors as well as for the posterior chain.

Conflict of interest

None declared.

Ethical approval

The present study received ethical approval from the departmental and University ethics board, Southampton Solent University, UK.

Funding

None declared.

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