COMPARISON OF THREE EXERCISE THERAPIES FOR RECREATIONAL RUNNERS WITH CHRONIC LOW BACK PAIN

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The prevalence of low back pain (LBP) in among recreational runners is high. A single-blinded (outcome assessor blinded) randomized trial was conducted to evaluate the effectiveness of a novel therapy using lower limb (LL) exercises, in comparison with 2 conventional therapies [(lumbar extensor (LE) exercises and lumbar stabilization (LS) exercises], in managing chronic LBP in recreational runners. Eighty-four runners, assigned to 1 of the 3 exercise groups, completed 8 weeks of exercise therapy. The findings revealed that LL exercise therapy was superior to the 2 conventional exercise therapies in improving running functional outcome and knee extension strength, and was equally effective in improving lumbar multifidus activation. Thus, the novel LL exercise therapy is recommended for clinical management of chronic LBP in recreational runners.

KEY WORDS: knee extensor, lumbar multifidus, lower limb, patient specific functional scale

INTRODUCTION: The prevalence of low back pain (LBP) was reported as high as 13.6% in a recreational runner population (Woolf et al., 2002). Moreover, as many as 75% of the injured runners have a history of LBP, suggesting that chronic LBP condition could affect runners' training and lifestyle significantly (Woolf et al., 2002). Altered muscle activation of lumbar stabilizers and lower knee extensors strength have been reported in runners with chronic LBP compared with healthy runners (Cai & Kong, 2015). Runners currently experiencing LBP also displayed greater knee joint stiffness during running compare with the controls (Hamill et al., 2009). Despite the high prevalence of LBP and evidence of back and lower limb muscles dysfunction, there is no study in the literature investigating the effect of exercise therapy on the management of chronic LBP among recreational runners. In the general population, 2 exercise therapy approaches are commonly adopted – 1) lumbar extensor (LE) exercises, targeting the lumbar extensors; and 2) lumbar stabilization (LS) exercises, focusing on muscles that are central to maintaining the dynamic spinal and trunk stability. The effectiveness of these 2 conventional treatment approaches, however, remained inconclusive (Helmhout et al., 2004; Cairns et al., 2006; Koumantakis et al., 2005). Given that running is a dynamic activity which primarily involves the lower limb (LL) muscles, it is worth to consider using LL exercises in the management of chronic LBP among runners. Therefore, this study aimed to evaluate the effectiveness of LL exercises as a novel therapy to the management chronic LBP in recreational runners.

METHODS: The study protocol was approved by the Nanyang Technological University Institutional Review Board and the National Healthcare Group Domain Specific Review Board. All participants provided written informed consent. A single-blinded (outcome assessor blinded) randomized trial was conducted. Eighty-four recreational runners with chronic LBP were randomly allocated into 1 of 3 exercise groups with equal sex distribution, namely LE exercise group [n = 28, age = 26.1 (4.1) y (values are mean with SD)], LS exercise group [n = 28, age = 26.9 (6.4) y] and LL exercise group [n = 28, age = 28.9 (5.3) y]. The inclusion criteria were: 1) age between 21 to 45 years old, 2) body mass indexed between 18 to 25 kg/m^2, 3) suffered from LBP for > 3 months and < 36 months, 4) ran 2 to 5 times a week for > 2 km per session, and 5) started running 6 months prior to the study, with no recent change in training intensity.
All participants were provided an 8-week exercise therapy treatment according to their group allocation, with supervised exercise sessions by a physiotherapist twice a week. Home exercise programs and exercise logs were provided. The details of the exercises for each

group are presented in Figures 1 to 3. Participants were advised to continue their regular running but not to perform any weight training except the prescribed exercises during the 8-week treatment period.

Figure 1. Exercises for lumbar extensor exercises group, a) 4-point kneeling with leg raises for week 1, b) 4-point kneeling with contralateral arm and leg raises for week 2, c) 4-point kneeling with contralateral arm and leg raises with ankle and wrist weights added from week 3 onwards. Neutral lumbar postion was required throughout the exercise. Participants were asked to perform 3 sets of 10 repetitions daily (5 s of hold and 2 s of rest).

Figure 2. Exercises for lumbar stabilization exercises group, a) stage 1, maintain lumbar spine in a neutral position and isolated contraction of the lumbar multifidus, b) stage 2, lower limb movement (hip flexion) added, c) stage 3, upper limb resistance (shoulder external rotation) added, d) stage 4, single leg stance with upper limb resistance (shoulder abduction). Neutral lumbar spine postion and contraction of the lumbar multifidus were required in all exercises (5 s of hold and 2 s of rest). During the 8-week period, participants were allowed to enter the next stage as soon as they were ready.

Figure 3. Exercises for lower limb exercises group, a) single leg wall-sit for weeks 1 to 4, with 5 kg weight added for weeks 5 to 8, b) single leg squat for weeks 1 to 4, c) single leg squat holding 2.5 kg weight for weeks 5 to 8. Participants were asked to perform 3 sets of 10 repetitions daily (5 s of hold and 2 s of rest).

Patient Specific Functional Scale (PSFS) with running as the sole functional outcome (0-10, 0 unable to do, 10 able to do without any difficulty) was administered at 5 time points: baseline, 4 weeks (middle of treatment), 8 weeks (end of treatment), and follow-ups at 3 months and 6 months after the completion of the exercise program. Muscle functions including lumbar multifidus (LM) muscle activation and isokinetic knee strength were assesed at 3 time points: baseline, 4 weeks and 8 weeks. To evaluate muscle activation of LM (a lumbar stablizer), the thickness of the LM during resting and contraction were measured using a rehabilitative ultrasound imaging device (Figure 4a, Cai & Kong, 2015). The LM contraction was induced by contralateral arm raise at 120° of shoulder flexion and 90° of elbow flexion while holding a 0.8 kg wrist weight in a prone position (Figure 4a). The percentage change in LM thickness between the rest and contracted conditions were calculated. To evaluate leg strength, the average of 3 trials of peak concentric knee extension torque at 60°/s was determined using an isokinetic dynamometer with the participants tested in a sitting position (Figure 4b). The peak torque values were normalized to participants' body mass for further analysis.

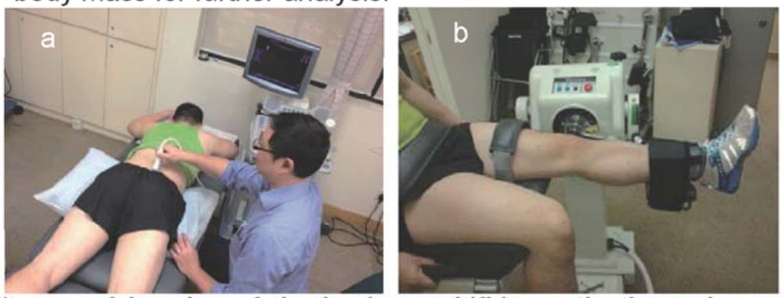

Figure 4, a) Ultrasound imaging of the lumbar multifidus activation using contralateral arm raise, b) Concentric knee extension test at 60°/s on an isokinetic dynamometer.

Generalized estimating equations (GEE) were used to compare the treatment effects for both between- and within-subjects factors (n = 84) using SPSS 19.0. The α level was set at .05. The dependent variables were the PSFS score for running, LM thickness changes and peak knee extension torque. The independent variables were the group allocation (LE, LS and LL), time point, sex, the interaction between group allocation and measurement time point, and the interaction between group allocation and gender. For LM thickness changes and peak knee extension torque, data of both body sides (dominant versus non-dominant) and the interaction between group allocation and body sides were also entered as independent variables. No covariate was used since there were no differences among the 3 exercise groups in participants' demographics, total number of exercise therapy sessions, total number of home exercise sessions or total distance ran during the 8-week treatment period (all $p > .10$). A backward elimination with 5% significance level approach was applied during the GEE model formation. The independent variables, except group allocation and time point, that were not significantly contributing to the GEE model were removed from the model. The analyses were then re-run with the model containing only significant independent variables.

RESULTS: For the PSFS score for running, after controlling all other variables, participants achieved an average rate of improvement of 0.949 points over each time point (95% CI: [0.877, 1.021], p < .001). Compared to the LL group, participants in the LE and LS group achieved 0.198 (95% CI: [-0.316, -0.080], p = .001) and 0.263 (95% CI: [-.406, -0.120], p<.001) points less by each time point, respectively. Over the treatment and follow-up period, the PSFS score improved by 3.80 points in the LL group, compared with 3.00 points in the LE group and 2.74 points in the LS group.

For LM thickness changes, after controlling all other variables, participants improved on average 9.2% over each time point (95% CI: [0.022, 0.162], p<.001). There was no significant difference among the three exercise groups (p = .188), with an average improvement of 18.4% over the 8-week treatment period.

For isokinetic knee extension torque, after controlling all other variables, participants improved on average 0.260 Nm/kg over each time point (95% CI: [0.193, 0.326], p < .001). Comparing to the LL group, participants in LE and LS groups improved 0.220 Nm/kg (95% CI: [-0.306, -0.105], p<.001) and 0.206 Nm/kg (95% CI: [-0.306, -0.105], p < .001) less by each time point, respectively. Taking the mean body mass of all participants in the current study as 61.2 (11.8) kg, the LL group improved their isokinetic knee extension strength by 31.82 Nm, whereby the LE and LS groups improved 4.90 Nm and 6.61 Nm, respectively over the 8-week treatment period.

DISCUSSION: To our best knowledge, this is the first study investigating the effectiveness of LL exercise therapy as a novel approach to the management of chronic LBP. Compared with the 2 conventional approaches (LE exercise therapy and LS exercise therapy), the findings revealed that the LL exercise approach was superior in improving self-rated running capability and knee extension strength, and was equally effective in improving LM muscle activation. In the literature, there are very few studies on chronic LBP in runners. The LM muscle activation level observed in this study was similar to those reported by other studies using similar test protocols (Marshall et al., 2005; Hamlyn et al., 2007; Tarnauen et al., 2012). One study found larger reduction in knee extensor activation in participants with LBP compared to the healthy controls after a 15-minute treadmill aerobic challenge (Hart et al., 2010). This suggests the need to consider adopting LL exercises in the management of chronic LBP management in runners. Findings from this study provide empirical evidence to support the use of LL exercise therapy among runners with chronic LPB over the conventional approaches of training the lumbar extensors or stabilizers.

CONCLUSION: Among recreational runners with chronic LBP, LL exercise therapy was more effective than conventional LE or LS exercise therapy in improving running functional outcome and knee extension strength. All exercise programs were equally effective in improving LM muscle activation. Thus, LL exercises should be recommended in the clinical management of chronic LBP in recreational runners.

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