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Full Length Article

Effects of running retraining on biomechanical factors associated with lower limb injury

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ABSTRACT

Injury risk is an important concern for runners; however, limited evidence exists regarding changes to injury risk following running style retraining. Biomechanical factors, such as absolute peak free moment, knee abduction impulse, peak foot eversion and foot eversion excursion, have been shown to predict lower limb injury. The aim of this study was to assess the effects of Pose running retraining on biomechanical factors associated with lower limb running injury. Twenty uninjured recreational runners were pair-matched based on their five km run time performance and randomly assigned to control (n = 10) and intervention (three 2-h Pose running retraining sessions) groups (n = 10). Three dimensional kinetic and kinematic data were collected from all participants running at relative (REL: 1.5 $km \cdot h^{-1}$ below respiratory compensation point) and absolute (ABS: 4.5 $m \cdot s^{-1}$) speeds. Biomechanical factors associated with lower limb injury, as well as selected kinematic variables (to aid interpretation), were assessed. Following a six-week, non-coached time-period, all assessments were repeated. No changes to the biomechanical factors associated with lower limb injury examined in this study were observed ($P > .05$). Intervention group participants (presented as pre- and post-intervention respectively) exhibited an increased foot strike index (REL speed: 21.79–42.66%; $ES_W = 4.73$; $P = .012$ and ABS speed: 22.38–46.98%; $ES_W = 2.83$; $P = .008$), reduced take-off distance (REL speed: −0.35 to −0.32 m; $ES_W = 0.75$; $P = .012$), increased knee flexion at initial contact (REL speed: −14.11 to −18.50°; $ES_W = -0.88$; $P = .003$), increased ankle dorsiflexion at terminal stance (REL speed: −33.61 to −28.35°; $ES_W = 1.57$; $P = .036$) and reduced stance time (ABS speed: 0.21–0.19 s; $ES_W = -0.85$; $P = .018$). Finally, five km run time did not change (22:04–22:19 min; $ES_W = 0.07$; $P = .229$). It was concluded that following Pose running retraining, retrained participants adopted a running style that was different to their normal style without changing specific, biomechanical factors associated with lower limb injury or compromising performance.

1. Introduction

Running is a popular form of recreational exercise in many parts of the world (Lun, Meeuwisse, Stergiou, & Stefanyshyn, 2004). The health benefits of regular exercise are apparent (Agresta & Brown, 2015). However, such health benefits are not devoid of risk; the incidence of lower limb running injuries – which can impede training – is reported to range from 19% to 79% (Van Gent et al., 2007). Advocates of the Pose method of running claim that the running style may reduce running injury and improve performance

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(Romanov & Robson, 2003). The Pose method of running asserts that an 'optimal running technique' exists, which emphasises a specific body geometry at foot strike (Dallam, Wilber, Jadelis, Fletcher, & Romanov, 2005). This results in a ball-of-foot striking style, aligning the ipsilateral shoulder, hip and ankle of the stance limb (Arendse et al., 2004). When compared to heel-toe running, Pose method retrained runners exhibit shorter stance times, shorter stride lengths, greater knee flexion at initial contact, reduced centre of mass vertical oscillation as well as reduced eccentric work at the knee joint and increased eccentric work at the ankle joint (Arendse et al., 2004; Dallam et al., 2005; Fletcher, Romanov, & Bartlett, 2008). Previous studies (Arendse et al., 2004; Dallam et al., 2005; Diebal, Gregory, Alitz, & Gerber, 2012; Fletcher et al., 2008) have suggested that with appropriate training, running style can be successfully retrained in comparatively short time periods, i.e. five to seven training sessions. However, despite claims of reduced running injury (Romanov & Robson, 2003), Arendse et al. (2004) suggest that such alterations to running style could be associated with different types and frequencies of running injury. Whilst strong evidence for immediate biomechanical effects of running retraining exists (Barton et al., 2016), changes to injury susceptibility is an important concern when attempting to adopt a new running technique (Agresta & Brown, 2015). Currently, there is limited evidence regarding changes to injury susceptibility, following running style retraining using the Pose method.

Biomechanical assessment of running can provide insight into how loads experienced by the body can become abnormal, altering a runners' risk of injury (McClay & Manal, 1999). Exercise-related lower-leg pain (ERLLP) is a frequently reported form of overuse injury and is a broad term for many lower limb pathologies including shin splints, shin pain, medial tibial stress syndrome, periostitis, compartment syndrome and stress fractures (Willems et al., 2006). Willems et al. (2006) prospectively identified several mechanical characteristics during stance, such as central heel-strike, increased foot pronation (particularly greater eversion) and greater lateral roll off, as risk factors for ERLLP. Greater foot pronation in particular was associated with increased torsional loads about the tibia, due to shoe-surface friction (Willems et al., 2006). In running, the tibia is the most commonly injured bone (Barnes, Wheat, & Milner, 2008), with 35–49% of stress fractures attributed to tibial stress fracture (TSF). Milner, Davis, and Hamill (2006) highlighted that values of peak adduction free moment, free moment (FM) at peak braking force and absolute peak free moment (|FM|) were greater in female runners with a history of TSF. Specifically, Milner et al. (2006) concluded that the magnitude of |FM| predicted TSF history in 66% of runners they studied. Milner et al. (2006) suggested that the greater incidence of TSF in females might reflect sex differences in lower limb geometry and stance phase alignment, a notion highlighted by broader analyses of running injury, i.e. ERLLP (Willems et al., 2006). The effects of skeletal alignment during stance were reiterated by Ferber, McClay Davis, and Williams (2003), who demonstrated that increased Q-angles predisposed female runners to greater hip adduction and thus greater internal abduction moments at the knee. Skeletal alignment is of particular importance when considering the relative excursion of the knee to ground reaction forces in the frontal plane. Patellofemoral pain develops from the lateral aspect of the patella and is a common and chronic condition in running (Stefanyshyn, Stergiou, Lun, Meeuwisse, & Worobets, 2006). Stefanyshyn et al. (2006) highlighted greater internal knee abduction impulse as a contributing factor in the development of patellofemoral pain in runners. Specifically, larger internal knee abduction impulse was suggested to be degenerative and a function of skeletal alignment to frontal plane reaction forces (Stefanyshyn et al., 2006), i.e. moment arm magnitude.

Factors related to running injury are diverse and multifaceted (Agresta & Brown, 2015). However, a number of biomechanical factors (absolute peak free moment, knee abduction impulse, peak foot eversion and foot eversion excursion) have been identified as predictors of lower limb injury in retrospective and prospective running injury studies (Milner et al., 2006; Stefanyshyn et al., 2006; Willems et al., 2006). When attempting to adopt a new technique, changes to injury susceptibility is a concern. Therefore, given that injury susceptibility might change as a result of retraining running style, preliminary research into running style retraining on biomechanical factors, shown to predict lower limb running injury, is warranted. The aim of this study was to assess the effects of Pose running retraining on biomechanical factors associated with lower limb running injury.

2. Methods

2.1. Participants

Based on previous kinematic effects of Pose running retraining (Fletcher et al., 2008), a sample of nine participants (total of eighteen) was required to provide adequate statistical power for the study (alpha of 0.05 and power of 0.8). In response to local advertisements, twenty-nine uninjured recreational runners meeting inclusion criteria (aged between 18 and 45 years and injury-free at the time of participation) volunteered for the study. In total, twenty participants (twelve male, eight female) completed all assessments ($\bar{x} \pm s$: age = 29.4 ± 3.5 years; stature = 1.70 ± 0.10 m; mass = 69.3 ± 10.0 kg). Data from nine participants (five control group and four intervention group participants), who were unable to complete all assessments (due to seasonal illnesses and in one case, work commitments), were excluded from analyses. Prior to participation, all participants were briefed and written informed consent was obtained. Approval for all procedures was obtained from the Research Ethics Committee of the Faculty of Health and Wellbeing, Sheffield Hallam University.

2.2. Participant pair-matching and run speed determination

Prior to biomechanical assessment, all participants undertook an individual and maximal effort five km time trial ($\bar{x} \pm s$: time = 22:00 ± 3:13 min; speed = 11.98 ± 1.37 km·h^{-1}) on a 200 m indoor running track. Participants were pair-matched based on their five km run time performance and randomly assigned to control (n = 10, comprising four male and six female participants) or intervention (n = 10, comprising six male and four female participants) groups. On a subsequent day, a relative running speed