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Experience does not influence injury-related joint kinematics and kinetics in distance runners

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ABSTRACT

Purpose: Increased running experience and more time spent running appears to be advantageous in reducing injury risk, although the reason behind this is unclear. It is plausible that more experience results in better running mechanics leading to less injuries. Running mechanics are often screened during clinical assessments and targeted for correction in gait retraining, particularly those thought to be global indicators of injury or those associated with elevated knee joint loading. Examining the biomechanics of runners who are less-injury prone can improve our understanding of the significance of faulty running mechanics in relation to injury. Our goal was to examine if running experience was correlated to differences in kinematics and kinetics associated with increased knee joint loading and running-related injury risk.

Methods: One hundred runners with varying experience ran on a pressure-sensing treadmill at a self-selected speed. Trunk and lower extremity kinematics, spatiotemporal measures, and ground reaction forces were collected. Multiple linear regression was used to assess the association between experience and three-dimensional hip kinematics, sagittal plane lower-extremity mechanics, and ground reaction forces while controlling for age and speed.

Results: Increased running experience was not significantly associated with running mechanics. Increased age was significantly associated with reduced peak knee flexion and increased contact time. Running speed influenced several spatiotemporal, kinematic, and kinetic variables.

Conclusion: Increased years of running experience does not appear to significantly influence running mechanics. However, age and running speed do influence biomechanical variables associated with injury in distance runners. Thus, there may be factors, other than running mechanics, that contribute to less risk in more experienced runners.

1. Introduction

Lack of running experience has long been thought to be a risk factor for injury. Early epidemiological studies on running-related injury risk found that more years of running was protective against injury [1–3]. Recent investigations into running-related injury incidence found that when comparing time spent running, the rate of injury (injuries per 1000-h of running), in those with little to no running experience (novice runners) was 17.8 compared to 7.7 for recreational runners and 7.2 for ultra-marathon runners [4]. The running experience of recreational runners was unclear but included runners who either were running 10–25 km per week, had been consistently running in the last 12 months, or those who had taken part in marathon races in the past. Years of experience for ultra-marathoners was not described either, but one can surmise it is substantial. In relation to injury, experience is not an "all-or-none" factor. Individuals with less than 3 years of running experience were found to have more than twice the risk of injury (OR = 2.2) compared to more seasoned runners [5]. On an individual level, increased experience may also be protective against injury. van Mechelen and colleagues [5] found greater exposure times (i.e., more

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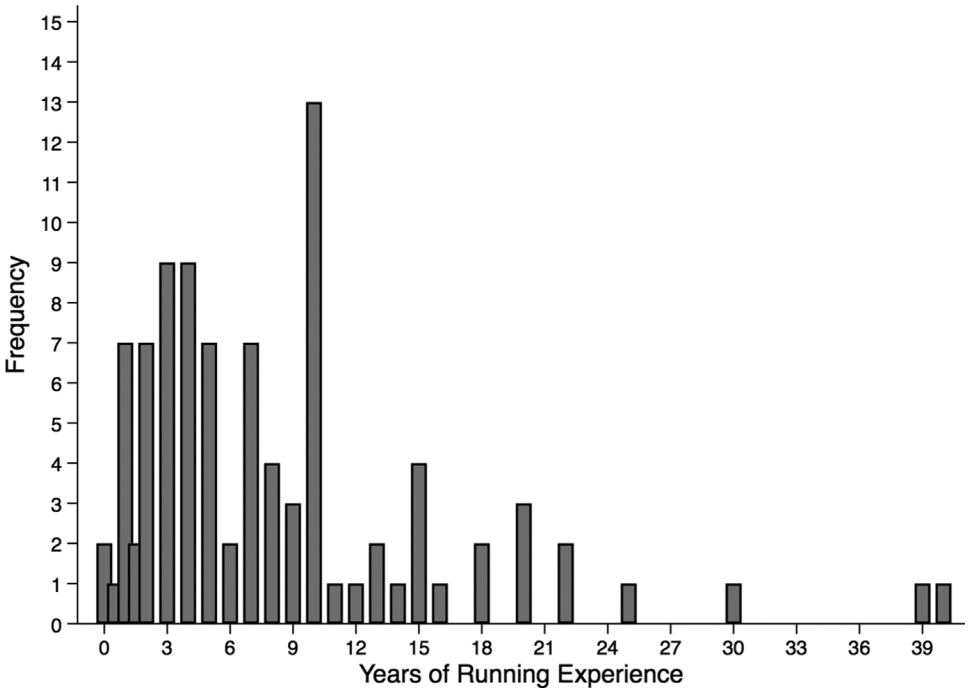

Fig. 1. Distribution of years running experience for participants. Y-axis indicates frequency of participants with specific years of experience.

time spent running) led to lower relative injury risk. While many have cautioned there may be a "healthy runner effect" bias where injury-prone individuals discontinue running leaving only the healthy ones to become seasoned athletes [1,2,6], identifying the mechanism by which experienced runners stay healthy and can continue to run may further our understanding of injury etiology and improve prevention or rehabilitation programs.

Overuse injuries among runners are reported to be between 19% and 79% with the knee being the most predominant site of injury [7]. Novice runners have a higher reported incidence of knee and lower leg injuries compared to both short and long-distance runners of varying running experience [8,9]. A plausible cause for greater knee and lower leg injuries in novice runners could be that runners with little experience have poor running mechanics that result in higher loads on musculoskeletal tissue, particularly at the tibia and about the knee. The higher strain, despite lower weekly mileage and less years of accumulated loading, could explain why more experienced runners can run longer and usually faster [10] without incurring more injuries.

Specific kinematic and kinetic characteristics have been identified as *global* indicators of injury. For instance, vertical ground reaction force (VGRF) loading rates have systematically been found in runners with lower-leg and foot tendinopathies, tibial stress fractures, and unspecified running injuries [11]. Likewise, abnormal frontal and transverse plane movement patterns at the hip have been found in runners with tibial stress fractures, patellofemoral pain, and iliotibial band syndrome [12–16]. Additional kinematics that are not globally linked to injured runners but are associated with increased loads at the knee joint are foot strike angle, peak knee flexion, stride frequency [17] and peak trunk flexion [18].

While running-related injury is multifactorial, the aforementioned running kinematics and kinetics are often targeted in clinical gait retraining interventions as a means to reduce pain and restore function in runners with knee and lower leg injuries [19–23]. These biomechanical measures are also frequently assessed in a clinical setting to determine injury risk [24–26]. Years of experience may also contribute to reduced injury via improved musculoskeletal tissue tolerance to repetitive loading or refined training programs that allow for appropriate rest time. However, determining the influence of experience on running form will inform clinicians as to whether faulty mechanics in novice runners is a predominant factor for higher injury risk when starting a running program and may offer an immediate option (gait retraining) to reduce risk.

Little is known about the influence of experience on running biomechanics, particularly those biomechanical measures associated with elevated injury risk. To our knowledge, only one study has examined global indicators of injury for experienced versus novice runners [27]. That study, however, only examined female runners who had either been running for more than one year (experienced) or had not run consistently for at least 5 years but were physically active (novice). Likely, if a change in mechanics was to occur, it would happen gradually. Thus, the delineation of novice versus experienced at one year assumes that no significant changes occur after one year of running experience and that a significant change occurs within the first 12 months of running. A better understanding of mechanics, and subsequently the potential risk of injury, would come from studying running experience as a continuous variable rather than a finite threshold one achieves after running consistently for one year.

The objective of this study was to determine the extent to which running biomechanics related to injury, particularly of the knee, are associated with years of running experience.

2. Methods

2.1. Participants

One hundred distance runners (50 males, 8.4 ± 7.7 years running experience; range: 0–40 years) (Fig. 1) were recruited through word-of-mouth and flyers to local running clubs. Runners were healthy and free of musculoskeletal injury for the past 12 months prior to data collection. All participants were currently running at least 19 km per week with their shortest run being at least 5 km. On average, participants ran 45.9 ± 22.4 km per week, 10.9 ± 1.7 months of the year, and 4.5 ± 1.2 days per week. Runners were excluded if they had a lower extremity surgery within the last 6 months, wore custom or over-the-counter orthotics, or used a prosthetic device. Each participant provided written informed consent before involvement in the study. Data were collected following a protocol approved by the Institutional Review Board at the University of Michigan.