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Influence of Step Frequency on Running Kinetics

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BACKGROUND

Many people go running as compensation for a sedentary lifestyle and to improve their cardio-vascular health. However, in one year, up to nearly 80% of the runners experience a running related injury (RRI) (Van Gent 2010). In severe cases such as tibia stress fractures, this results in training breaks of up to three months which often lead to a decline in physical fitness, loss of motivation and thus in termination of running. Biomechanical factors associated with RRI are the active peak (maximum vertical force), the vertical loading rate (VLR) or the impulse. E.g. a constantly increased VLR results in higher strain rates of human tissues leading to micro traumata (Warden 2014). These may - accumulated over time- result in injuries such as stress fractures (Warden 2014). In a previous study (Hobara 2012), it was shown that increasing the step frequency (SF) by 15% can significantly reduce these loading parameters. However, such a large increase in SF is not implementable in practice. Furthermore, the subjects in this study ran at a relatively slow pace of only 9 km/h. Therefore, the current study aims to discover whether a relatively small increase of SF at a moderate velocity also reduces the loading.

METHODS

9 experienced runners (4 male, 5 female, age: 27 ± 4 years, height: 175 ± 8 cm, weight: 62 ± 10 kg) ran at 11 km/h on a treadmill (quasar, h/p/cosmos sports & medical GmbH, Nussdorf-Traunstein, Germany) instrumented with a pressure plate (FDM, zebris Medical GmbH, Isny, Germany). Preferred step frequency (PSF) was set as baseline (100%). Then, subjects ran with 5% and 10% in- and decrease of their PSF in random order for a total of four minutes. After three minutes, data were recorded for one minute. Thereby the number of steps analyzed was equal to the step frequency during that trial. A digital metronome was used in order to facilitate the right SF. For each subject and all five trials (90%, 95%, 100%, 105%, 110% SF), the vertical impulse, active peak and VLR maxima were computed and averaged across trials. All variables were normalized to the mean value at PSF. Subsequently for each of the outcome variables, a local polynomial regression (LOESS) model was fit with SF as predictor.

RESULTS

The vertical impulse decreased nearly linearly by 13% on average from 90% to 110% SF. While active peak and VLR maximum also decreased by 12% from 100% to 110% SF, the changes at 90% and 95% varied between subjects from a 14% increase to a 16% decrease. This large variance led to a mean increase of about 0% of theses parameters referenced to their values at PSF.

CONCLUSIONS

Increasing the SF by 5% (SF of 105%) can be an effective and easy to implement change in running technique to decrease kinetic parameters associated with RRI and thereby may reduce the likelihood of (re-) developing such an injury. The subjects reported that the SF increase felt comfortable. However, a reduction of SF led to diverse kinetic effects between runners, which may be caused by various kinematic strategies to achieve the reduced SF. Future measurements with instrumented insoles (Pedoped, novel GmbH, Munich, Germany) as well as instrumented implants measuring the *in vivo* joint contact loads (Damm 2010) are planned to corroborate these results.

REFERENCES

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