The epidemiology of running for health: on health benefits, burden and costs of injuries, and injury prevention in running

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Summary

Physical inactivity is a public health concern worldwide due to its substantial contribution to the global disease burden and risk of mortality. Running may be a powerful ally in increasing physical activity levels, because it is easily accessible, time efficient, and relatively inexpensive. Therefore, running is very popular nowadays. The health benefits of physical activity are well documented. However, the investigation of the health effects related to specific physical activity modes is important in order to tailor physical activities to populations that would benefit most from the effects provided by them.

Running-related injuries (RRI) are side effects of running practice. Therefore, the prevention of RRIs is warranted. Nonetheless, there is no substantial evidence on interventions to prevent RRIs. Also, in the literature prospective surveillance on the health and economic burden of RRIs, especially focused on overuse injuries, is sparse.

Therefore, the objectives of this thesis were: (1) to summarise the health benefits achieved through running; (2) to describe the health and economic burden of RRIs in different running populations; and (3) to evaluate the effectiveness of an intervention developed by following the Knowledge Transfer Scheme (KTS) on the prevention of RRIs in trailrunners.

Health benefits of running

A systematic review was conducted in order to summarise the effects of habitual running on indices of health in physically inactive adults. The meta-analyses revealed a significant reduction in body mass (weighted mean difference [WMD] 3.3 kg; 95% confidence interval [CI] 4.1 to 2.5), body fat percentage (WMD 2.7%; 95% CI 5.1 to 0.2), resting heart rate (WMD 6.7 beats.min^{-1}; 95% CI 10.3 to 3.0), and triglycerides (WMD 16.9 mg.dl^{-1}; 95% CI 28.1 to 5.6 / or 0.19 mmol.l^{-1}; 95% CI 0.32 to 0.06); and a significant increase in maximal oxygen uptake (WMD 7.1 ml.min^{-1}.kg^{-1}; 95% CI 5.0 to 9.1) and high-density lipoprotein (HDL) cholesterol (WMD 3.3 mg.dl^{-1}; 95% CI 1.2 to 5.4 / or 0.09 mmol.l^{-1}; 95% CI 0.03 to 0.14) after one year of training. No significant effect was found for lean body mass, body mass index, total cholesterol, and low-density lipoprotein (LDL) cholesterol. A dose-response analysis suggested that larger health benefits are achieved by running programmes that last longer. Therefore, running can be advised to physically inactive adults, who seek to improve health through physical activity.

Health burden of RRIs

A systematic review was conducted in order to summarise the incidence and prevalence of specific RRIs (i.e., diagnostic classifications of RRIs). The most frequent RRIs in the general running population were the medial tibial stress syndrome or shin splints (incidence ranging from 13.6% to 20.0%; prevalence of 9.5%), Achilles tendinopathy (incidence ranging from 9.1% to 10.9%; prevalence ranging from 6.2% to 9.5%), and plantar fasciitis (incidence ranging from 4.5% to 10.0%; prevalence ranging from 5.2% to 17.5%). The most frequent RRIs during ultra-marathon races were Achilles tendinopathy (prevalence ranging from 2.0% to 18.5%) and patellofemoral pain syndrome (prevalence ranging from 7.4% to 15.6%).

Prospective cohort studies were conducted in order to investigate the health burden (i.e., prevalence and severity measures) of RRIs in runners training for an event and in trailrunners. The mean prevalence of RRIs measured over time varied from 22.4% (95% CI 20.9 to 24.0) in trailrunners to 30.8% (95% CI 25.6 to 36.0) in runners training for an event. Most RRIs were overuse injuries (> 75%). Approximately half of RRIs was classified as substantial (i.e., caused a moderate or major reduction in running volume or running performance, or had caused a complete inability to participate in running). The average severity score (scale ranging from 0 to 100, i.e., from low to high) per RRI was 35.0 (25% to 75% interquartile range [IQR] 22.0 to 55.7) in trailrunners and 39.5 (IQR 22.0 to 68.0) in runners training for an event. An RRI lasted approximately 2.0 weeks (IQR 2.0 to 6.0) in trailrunners and 4.0 weeks (IQR 2.0 to 4.0) in runners training for an event. These results suggest that the health burden of RRIs may significantly impact running participation.

Economic burden (direct and indirect costs) of RRIs

Prospective cohort studies were conducted in order to investigate the economic burden (i.e., direct and indirect costs) of RRIs in novice runners, runners training for an event, and in trailrunners. Direct costs were estimated based on healthcare utilisation. Physiotherapy consultations represented 80% to 89% of the healthcare utilisation, whereas visits to

a general practitioner represented 6% to 9% and to a medical specialist represented 5% to 14% of the healthcare utilisation. An RRI was estimated to have a direct cost of approximately €60. Indirect costs were estimated based on absenteeism from work. An RRI was estimated to have an indirect cost of about €26 in novice runners, and approximately €110 in runners training for an event and in trailrunners. Therefore, an RRI was estimated to have a total cost (direct plus indirect) of about €83 in novice runners, and €170 in runners training for an event and in trailrunners. These results suggest that the economic burden of RRIs may be significant from a societal perspective, since part of the RRIs could be prevented, leading to economic savings.

Prevention of RRIs

A participatory approach was used to develop an intervention aimed at preventing RRIs. To do so, the KTS was used as a framework. The result was an evidence-practice-based online intervention, tailoring advice towards RRI prevention (*TrailS*$_6$). A six-month randomised controlled trial was conducted aimed to evaluate the effectiveness of *TrailS*$_6$ on the determinants and actual preventive behaviour towards RRI prevention, and on the prevention of RRIs. All participants received online general advice on RRI prevention one week after baseline. Participants in the intervention group received every two weeks specific advice tailored to their RRI status (categorised as no RRI, non-substantial RRI, or substantial RRI). The control group received no intervention during the follow-up. There was a 'very strong' level of evidence (Bayes factor [BF] 205.6) supporting a significant, but modest, preventive effect of online tailored advice in reducing the odds of a trailrunner in sustaining RRIs (odds ratio [OR] 0.92; 95% highest posterior density credible interval [HPD-CI] 0.86 to 0.98). Also, there was a 'strong' level of evidence (BF 78.6) supporting a significant, but modest, preventive effect in reducing the number of RRIs sustained per trailrunner (rate ratio [RR] 0.96; 95% HPD-CI 0.92 to 0.99). However, no significant change over time was observed between groups in the determinants and actual preventive behaviours. Based on these results, online tailored advice may be implemented to prevent RRIs in trailrunners.

Conclusions

Running significantly improves indices of health. Therefore, running can be advised to physically inactive individuals who seek to improve health and, consequently, may reduce the physical inactivity burden. However, the implementation of running carries a risk of RRIs that may lead to substantial health and economic burden for the runners and for society. RRIs can reach such severity levels that they might lead to dropping out of running practice, counteracting efforts towards increasing physical activity levels. Therefore, the prevention of RRIs is important to minimise the health and economic burden of RRIs and, consequently, to enhance the health benefits and economic savings related to running. Online tailored advice may be a component to be implemented within an RRI prevention programme, since it was effective in preventing RRIs in trailrunners; can reach a large number of people; and can be considered easily accessible and relative inexpensive. However, implementation research and economic evaluations of RRI prevention programmes (including online tailored advice) should be included in the agenda for future investigations on RRIs.