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**Effectiveness of online
tailored advice (*TrailS₆*) on
the determinants and actual
preventive behaviour, and on
the prevention of running-
related injuries in Dutch
trailrunners: a randomised
controlled trial**

Luiz Carlos Hespanhol Junior
Willem van Mechelen
Evert Verhagen

Submitted

Abstract

Background

The health benefits of running are well recognised. However, running-related injuries (RRI) are a side effect of running practice and prevention is warranted. Trailrunning is a mode of running gaining in popularity worldwide for which no preventive intervention exists.

Objective

To evaluate the effectiveness of online tailored advice on the determinants and actual preventive behaviour towards RRI prevention, and on the prevention of RRIs in Dutch trailrunners.

Methods

This was a two-arm randomised controlled trial over six months. A total of 232 adult trailrunners were randomly assigned to an intervention or control group. 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 (no RRI, non-substantial RRI, or substantial RRI) as reported through the Oslo Sports Trauma Research Centre Questionnaire on Health Problems. The control group received no intervention during the follow-up. The outcome measures were: determinants of following the intervention (intention, attitude, subjective norm, and perceived behaviour control); RRI preventive behaviours; and RRI measures (trailrunners with RRIs and number of RRIs). Bayesian mixed models were used to analyse the data.

Results

The odds of a trailrunner to sustain RRIs reduced in the intervention group compared to the control group (odds ratio [OR] 0.92; 95% highest posterior density credible interval [CI] 0.86 to 0.98; Bayes factor [BF] 205.6). Also, the number of RRIs sustained per trailrunner reduced in the intervention compared to the control group (rate ratio [RR] 0.96; 95% CI 0.92 to 0.99; BF 78.6). No significant between-group difference was observed on the determinants and actual preventive behaviours.

Conclusions

The online tailored advice was effective on preventing RRIs in trailrunners. The level of evidence (BF) supporting the preventive effects was classified as ‘very strong’ for the odds of a trailrunner in sustaining RRIs, and ‘strong’ for the number of RRIs per trailrunner. No effect was observed on determinants and actual preventive behaviours.

Trial registration

The Netherlands National Trial Register NTR5431.

Introduction

The world pandemic of physical inactivity is worrisome and the reduction of its prevalence and burden is considered a public health priority.¹⁻³ Running is a very popular mode of physical activity worldwide, its related-health benefits are well described in the literature,⁴⁻⁶ and there is evidence suggesting that implementing running as a means of promoting physical activity is cost-effective.^{7,8} A mode of running known as trailrunning is quickly gaining popularity.⁹ Trailrunning consists of running in the outdoors, mainly on unpaved, rugged, muddy, and/or hilly/mountain terrain.⁹ To illustrate the spike in popularity; in 2010 there was no trailrunning event in the Netherlands and Belgium, and in 2015 there were over 150.

Nonetheless, the risk of running-related injuries (RRI) is a matter of concern, since RRIs may lower the motivation to run and RRIs can also reach severity levels that might lead to dropping out of running practice.^{9,10} This counteracts efforts to increase physical activity levels, which is a priority of the World Health Organization.³ Despite the burden of RRIs to the runners and for society,⁹⁻¹¹ there is no substantial evidence on interventions to prevent RRIs.¹²⁻¹⁵ This is worrisome, because RRI is an avoidable side effect of running, and, therefore, preventive efforts are warranted.

Tailored online interventions are promising in promoting preventive behaviour in runners.¹⁶ They are attractive due to their convenience, availability, interactivity, relative low cost to develop and implement, and their ability to reach a large number of people.^{16,17} A previous study has found that an online tailored intervention was effective in changing the determinants and actual preventive behaviour after three months of follow-up in recreational runners.¹⁶ However, there are no randomised controlled trials aimed at investigating the effectiveness of online tailored interventions on the prevention of RRIs, and the effects of such interventions on the determinants and actual preventive behavior in periods longer than three months have never been described. In addition, there is no evidence on interventions to prevent RRIs in trailrunners. Therefore, the purpose of this study was to evaluate the effectiveness of online tailored advice on the determinants of performing the intervention, on promoting preventive behaviours towards RRI prevention, and on the prevention of RRIs in Dutch trailrunners.

Methods

Study design

This study was a two-arm randomised controlled trial over six months with blind assessment and blind delivery of the intervention. The inclusion of individuals in the study was performed electronically, based on the eligibility criteria procedure implemented in the baseline questionnaire. This procedure ensured that the allocation of the participants in the intervention and control groups was concealed. After the inclusion, all participants were randomly assigned to the intervention or control group according to a computer-generated simple randomisation scheme. The assessment and the delivery of the intervention were blinded as all data were collected via an online questionnaire, and the intervention was delivered online via the website of the project, ensuring no influence or bias of healthcare providers or assessors of outcomes. This study was approved by the medical ethics committee of the VU University Medical Center Amsterdam, and has been prospectively registered in the Netherlands National Trial Register (NTR5431).

Sample size

The sample size was estimated based on calculations for longitudinal studies with repeated measurements.¹⁸ The difference in change from baseline for warming-up found in a previous study (13% in the intervention, and 4% in the control group) investigating the effects of an online tailored intervention in runners was used as a reference effect size for preventive behaviours.¹⁶ The reference value for the mean proportion of trailrunners sustaining RRIs (22.4%) was based on a previous prospective cohort study conducted with the same source population.⁹ The hypothesised reduction in the proportion of trailrunners sustaining RRIs was 20% in the intervention and 10% in the control group, on average. Considering an α of 0.05, power of 0.8, three repeated measurements (at baseline and, at two and six months after baseline) for preventive behaviours, 13 repeated measurements (every two weeks during six months) for RRIs, a within-person correlation of 0.3,⁹ and a response rate of 70%,^{9,10} the sample size was estimated at 105 participants for each group (total of 210 participants) for preventive behaviours, and 92 participants for each group (total of 184 participants) for RRI outcome measures.

Participants

This study was composed of a sample of Dutch trailrunners registered in the MudSweatTrails database.¹⁹ In order to assure that the participants were active in trailrunning, all participants of a recent trailrunning event organised by MudSweatTrails at the time of the recruitment (i.e., ‘*Salomon Koning van Spanje Trail*’ held in May 2015) were invited to participate (n=1,327). This trail is a traditional Dutch event that covers eight trailrunning races with distances varying from 15 to 62 km. In addition, the participants of a previous observational study were also invited to participate (n=185).⁹ Individuals who agreed to participate through online informed consent, aged 18 years or over, involved in trailrunning, and who completed the baseline questionnaire were eligible to participate.

Development of the intervention

The five steps of the Knowledge Transfer Scheme (KTS)²⁰ were followed in order to develop an intervention aimed at preventing RRIs in trailrunners (Table 8.1). The KTS process resulted in an evidence and practice-based online intervention, tailoring advice towards RRI prevention taking into account the RRI profile provided by the Oslo Sports Trauma Research Centre (OSTRC) Questionnaire on Health Problems.²¹ The online tailored intervention was named *TrailS₆* (Supplementary Material Appendix S1; available upon request). The *TrailS₆* intervention was composed of pieces of preventive advice grouped together in six categories. The aim of *TrailS₆* was to promote preventive behaviours towards RRI prevention and, consequently, to prevent RRIs in trailrunners.

Intervention group

One week after baseline, all participants received a general advice towards RRI prevention. During the follow-up, tailored advice was delivered based on the RRI classification generated by the OSTRC questionnaire, i.e., (1) no RRI; (2) non-substantial RRI; or (3) substantial RRI. Participants who reported no RRI received advice aimed at maintaining their uninjured status (i.e., primary prevention). Participants who reported non-substantial RRIs received tailored advice aimed at promoting a fast recovery and to prevent the non-

Table 8.1 Steps of the Knowledge Transfer Scheme (KTS) followed in order to develop the *TrailS₆* intervention

Steps of KTS	Description of performed activities
Step 1: problem statement	A prospective cohort study ⁹ was conducted with the same source population of the current trial in order to investigate the burden of RRIs in Dutch trailrunners.
Step 2: evidence description	A summary of the available scientific evidence on RRIs, mainly with published systematic reviews, ^{15,46-48} was conducted, and this evidence was compiled with the results of the cohort study that was part of the Step 1 that investigated the burden of RRIs in Dutch trailrunners. ⁹
Step 3: knowledge transfer group (KTG)	A KTG was composed of 5 participants: <ul style="list-style-type: none"> - 1 researcher in the field of sports injury prevention, who was also the chair of the KTG; - 2 trailrunners; - 1 healthcare professional, who is also a researcher in the field of RRIs; - 1 stakeholder (head of MudSweatTrails¹⁹).
Step 4: product development	The KTG had one face-to-face meeting in order to discuss the cumulative evidence-based information generated in Steps 1 and 2, and to propose an intervention aimed at preventing RRIs in trailrunners. Further discussions with the participants of the KTG were carried out in order to revise the intervention materials and to adapt them to the needs, preferences, and reality of trailrunners (i.e., evidence-practice-based intervention). This process resulted in an online tailored advice intervention (<i>TrailS₆</i>).
Step 5: evaluation	The evaluation of the intervention (<i>TrailS₆</i>) was conducted with the current randomised controlled trial.

RRI: running-related injury.

substantial RRI to become a substantial RRI (i.e., secondary prevention). Participants who reported substantial RRIs received tailored advice in order to prevent further consequences (i.e., long-term burden and prolonged absence from running), permanent damage due to RRIs, and subsequent RRIs (i.e., tertiary prevention).²²

The advice was instantaneously and automatically delivered after the completion of the RRI questionnaire by directing the participant to a webpage (three different online webpages based on the RRI classification) hosted by the study website. This procedure was repeated every two weeks in order to monitor the RRI status and to adapt the tailored advice accordingly. Adherence to the intervention was assessed asking the participants which components of the tailored advice received in the last 2-week period they employed.²³

Control group

The participants assigned to the control group received a general advice towards RRIs prevention one week after baseline. This advice was equal and in the same form as received by the intervention group at this stage. During follow-up the control group did not receive any further advice (Figure 8.1).

Baseline questionnaire

After giving informed consent, a secured link to an online baseline questionnaire was sent by e-mail to the participants. This questionnaire asked about demographics (age, gender, height, and weight), education level, running experience, trailrunning experience, history of RRIs (last 12 months), and current RRIs. If no response was received within a week, a reminder was sent by e-mail encouraging the participant to complete the questionnaire.

Preventive behaviour questionnaire

The Theory of Planned Behaviour was used as the conceptual model of behaviour in this study.^{24,25} Briefly, this theory postulates that behaviour can be predicted by the intention to perform the behaviour. In turn, intention is determined by attitude, subjective norm, and perceived behavioural control. Intention captures the motivational factors that influence behaviour. Attitude is the result of the beliefs about the consequences of the behaviour. Subjective norm refers to the beliefs on what others think about the person performing the behaviour. Perceived behavioural control is the results of the perceived ease or difficulty in performing the actual behaviour.^{26,27} The determinants of performing the intervention and the behaviours towards RRI prevention were assessed at baseline, two months after baseline, and at the end of the follow-up (six months after baseline) (Supplementary Material Appendix S2; available upon request). If no response was received within a week, a reminder was sent by e-mail encouraging the participant to complete the questionnaire.

Preventive behaviour was assessed by a multiple-choice question. Five-point Likert scales were used to assess the determinants of performing the intervention. A single question

Figure 8.1 Design and flow of participants during the study.

and statement was used to assess intention and subjective norm, respectively. Attitude was assessed by the good-bad and the pleasant-unpleasant rating of the same statement, and by one additional question. The average of the three attitude items was used in the analysis.²⁷ Perceived behavioural control was assessed by the able-unable and the easy-difficult rating of the same statement. The average of the two perceived behavioural control items was used in the analysis.^{27,28} Higher scores indicated higher intention, attitude, subjective norm, and perceived behavioural control.

RRI questionnaire

A secured link to an online RRI questionnaire was sent by e-mail every two weeks. The aim of this questionnaire was to collect information on running exposure and any RRI experienced in the preceding two weeks, and to deliver the online tailored advice based on the RRI classification generated by the OSTRC questionnaire. If no response was received within a week, a reminder was sent by e-mail encouraging the participant to complete the questionnaire.

RRI registration

In order to prospectively register RRIs during the follow-up, the translated Dutch version of the OSTRC Questionnaire on Health Problems was used.^{21,29} The OSTRC questionnaire consists of four key questions on: (1) the extent to which injury, illness, or other health problems have affected running participation; (2) training volume; (3) running performance; and (4) the extent to which participants have experienced symptoms during the previous two weeks. If according to these four key questions no problem was reported, the questionnaire was finished. In case a problem was reported in any of the four key questions, the participant was asked to specify whether the problem was an illness or an injury. In case of an illness, the questionnaire was finished. In case of an injury, the participant was asked to report the anatomical location, the injury type, a description of the symptoms and onset, the number of days of time loss (defined as the number of training sessions not fully accomplished or completely missed due to injury), and whether

the injury was related to running. In case of multiple injuries in the past fortnight, the participants were asked to register the injury that had caused most complaints. Other injuries could be reported in an open question. Participants were instructed to report all problems, regardless of whether or not they had already reported the same problem in previous RRI questionnaires.^{9,10,21}

RRI definition and classification

All reported health problems were evaluated case by case, in order to confirm and classify RRIs. RRI was defined as any disorder of the musculoskeletal (e.g., muscles, tendons, ligaments, nerves, and bones) or integumentary (e.g., blisters and nail injuries) systems, or concussions experienced or sustained by an individual during participation in running. RRIs were subcategorised into acute (i.e., the onset could be linked to a specific injury event) or overuse injuries (i.e., the onset could not be linked to a clearly identifiable event).^{9,10,21} The Orchard Sports Injury Classification System version 10.1 (OSICS-10.1)³⁰ was used to provide a diagnostic classification for each RRI.

Substantial health problems were defined as those leading to moderate or major reductions in training volume, moderate or major reductions in running performance, or complete inability to run, as identified in the response options of the key questions 2 or 3 of the OSTRC questionnaire.^{9,10,21} A recurrent RRI was defined as an RRI at the same location and of the same type of the index RRI, even if it concerned re-injuries (after full recovery) or exacerbations (not full recovery).^{9,10,31}

Data analysis

All analyses were performed in R version 3.3.0 (R Foundation for Statistical Computing, Vienna, Austria) and followed the principle of intention-to-treat. Descriptive analyses were performed to summarise the baseline data. Mean and standard deviation (SD) were calculated for the continuous variables with Gaussian distribution, otherwise the median and the 25% to 75% interquartile range (IQR) were calculated. Percentages were calculated for categorical variables. Follow-up data were summarised using Bayesian linear

mixed models (BLMM) and Bayesian generalised mixed models (BGMM)³² in order to account for repeated measurements. The injury rate (number of RRIs divided by the sum of total running exposure in hours) was estimated using Bayesian inference,³³ and the results were expressed as the number of RRIs per 1,000 hours of running and its 95% highest posterior density credible interval (95% CI).

The Bayesian approach was considered for analysing the results in order to estimate the probability of the effect sizes considering the population distribution instead of the sampling distribution, providing levels of evidence for decision-making in practice.^{32,34} The effects of the intervention on the main outcomes were analysed as follows: (1) the determinants of performing the intervention were analysed using BLMM; (2) preventive behaviours and the odds of trailrunners sustaining RRIs were analysed using logistic BGMM; and (3) the number of RRIs was analysed using Poisson BGMM. Group, time, and the interaction term composed by group and time were used as independent variables, and a random intercept was included in all analyses. Non-informative priors were used for the fixed effects (Cauchy distribution with centre 0 and scale 2.5³⁵) and for the random effects (uniform distribution with lower and upper bounds of 0 and 10, respectively³⁶). Calculations were based on sampling from the posterior distribution using the No-U-Turn Sampler³⁷ with five chains, 20,000 interactions for each chain, and leaving out the 5,000 initial interactions of each chain. The 95% CI was calculated using the highest posterior density interval.³²

The Bayes factor (BF) was estimated by calculating the probability of a preventive effect, divided by the probability of no preventive effect.³⁸ Preventive effects were defined as mean differences > 0 for the BLMM models on determinants of performing the intervention; odds ratios (OR) > 1 for the logistic BGMM models on preventive behaviours; OR < 1 for the logistic BGMM model on the odds of trailrunners sustaining RRIs; and rate ratio (RR) < 1 for the Poisson BGMM model on the number of RRIs. No preventive effect was defined as the opposite of the preventive effects. Levels of evidence favouring preventive effects of the intervention were classified as ‘barely worth mentioning’ (BF ≤ 3), ‘positive’ ($3 < \text{BF} \leq 20$), ‘strong’ ($20 < \text{BF} \leq 150$), and ‘very strong’ (BF > 150).³⁸ The results were considered significant when the 95% CI did not contain the null effect (i.e., non-substantial uncertainty), and when the BF > 3 (i.e., substantial evidence supporting the preventive effect in favour of the intervention group).³⁹

Results

Flow of participants, baseline, and follow-up summary

From the 1,512 trailrunners who were invited to participate, 232 (15.3%) responded and were included in the study. The flow of participants can be found in Figure 8.1. During the follow-up, 10 participants (four in the intervention and six in the control group) dropped out of the study. However, the data collected of these participants until the time they dropped out were included in the analysis. The median of the response rate during the follow-up was 78.6% (IQR 74.8 to 85.2) for the intervention group and 83.9% (IQR 74.1 to 89.3) for the control group. The results of the baseline questionnaire are summarised in Table 8.2.

A summary of the running exposure and RRI characteristics can be found in Table 8.3. A total of 87 participants (75.5%) reported 135 RRIs in the intervention group, and 91 participants (77.8%) reported 151 RRIs in the control group. Most RRIs were overuse injuries, either for the intervention (74.1%, n=100) or the control group (74.2%, n=112). The most commonly reported RRIs in the intervention group were: Achilles tendon injury (11.1%, n=15), calf muscle injury (8.1%, n=11), and unspecified knee pain (7.4%, n=10); and in the control group were: unspecified knee pain (16.6%, n=25), Achilles tendon injury (9.3%, n=14), and calf muscle injury (9.3%, n=14). A breakdown list with all RRIs reported per group (by OSICS-10.1, body region, and damaged tissue) can be found in the Supplementary Material Appendix S3 (available upon request).

Effects of the intervention on determinants of behaviour

The intervention presented a trend in decreasing the level of intention, attitude, subjective norm, and perceived behavioural control towards performing the intervention after two and six months of follow-up, although the BFs suggested 'barely worth mentioning' effects in favour of the intervention group ($BF \leq 3$) (Table 8.4). Therefore, the effects on the determinants of performing the intervention are considered non-significant.

Table 8.2 Baseline characteristics of the participants (n=232)

Characteristics	Intervention n=115	Control n=117
Age, mean (SD)	44.3 (9.8)	44.8 (9.3)
Gender, % (n)		
Male	68.7% (79)	66.7% (78)
Female	31.3% (36)	33.3% (39)
Height, mean (SD)	178.0 (8.2)	178.4 (9.0)
Weight, mean (SD)	72.3 (10.0)	72.9 (12.4)
BMI, mean (SD)	22.8 (2.1)	22.8 (2.5)
Running experience, median (IQR)	10.0 (5.0 to 21.5)	7.0 (5.0 to 17.0)
Trailrunning experience, median (IQR)	2.0 (1.5 to 4.0)	3.0 (2.0 to 4.0)
Education, % (n)		
Primary	2.6% (3)	1.7% (2)
Secondary	64.3% (74)	72.6% (85)
Tertiary	33.0% (38)	25.6% (30)
Current RRI, % (n)	29.6% (34)	21.4% (25)
Previous RRI, % (n)	41.7% (48)	41.0% (48)

SD: standard deviation. IQR: 25% to 75% interquartile range. RRI: running-related injury.

Table 8.3 Running exposure and running-related injury (RRI) characteristics

Characteristics	Intervention n=115	Control n=117
Running exposure		
Duration (hours/week) ^a	3.3 (3.0 to 3.6)	3.4 (3.0 to 3.8)
Frequency (times/week) ^a	2.5 (2.3 to 2.7)	2.5 (2.3 to 2.7)
Distance (km/week) ^a	30.2 (28.1 to 32.3)	30.8 (28.8 to 32.8)
Participation in events (per 2-week period) ^b	35.6% (28.9 to 42.8)	32.3% (26.5 to 38.4)
RRI characteristics		
Number of RRIs	135	151
Injury rate ^c	18.0 (15.1 to 21.1)	18.8 (15.8 to 21.8)
Participants with RRIs ^b	27.5% (21.2 to 34.2)	26.9% (21.2 to 33.1)
Severity score ^a	40.1 (36.8 to 43.2)	37.3 (34.2 to 40.4)
Time loss (days/week) ^a	1.5 (1.1 to 1.8)	1.3 (1.0 to 1.6)
Duration (weeks) ^a	6.7 (5.7 to 7.7)	5.8 (4.8 to 6.8)

^a The results are expressed as the mean over time and its 95% highest posterior density credible interval (95% CI) obtained by Bayesian linear mixed models.

^b The results are expressed as the average percentage over time and its 95% highest posterior density credible interval (95% CI) obtained by Bayesian generalised mixed models.

^c The injury rate is expressed as the number of RRIs per 1,000 hours of running and its 95% highest posterior density credible interval (95% CI).

Table 8.4 Effectiveness of the online tailored advice (*TrailSs*)

Outcomes	Within group effect				Between group effect			
	After 2 months		After 6 months		After 2 months		After 6 months	
	Intervention ES (95% CI)	Control ES (95% CI)	Intervention ES (95% CI)	Control ES (95% CI)	ES (95% CI)	BF	ES (95% CI)	BF
Determinants of performing the intervention^a								
Intention	-0.20 (-0.38 to -0.03)	0.20 (0.02 to 0.36)	-0.10 (-0.20 to -0.01)	0.01 (-0.08 to 0.11)	-0.40 (-0.64 to -0.15)	0.0	-0.12 (-0.26 to 0.02)	0.1
Attitude	-0.07 (-0.18 to 0.04)	0.12 (0.01 to 0.22)	-0.02 (-0.08 to 0.04)	0.06 (0.00 to 0.12)	-0.18 (-0.34 to -0.03)	0.0	-0.08 (-0.16 to 0.00)	0.0
Subjective norm	0.04 (-0.19 to 0.27)	0.11 (-0.12 to 0.34)	0.06 (-0.06 to 0.18)	0.12 (0.00 to 0.24)	-0.07 (-0.39 to 0.26)	0.5	-0.06 (-0.23 to 0.12)	0.3
Perceived behavioural control	-0.11 (-0.26 to 0.03)	0.01 (-0.12 to 0.16)	-0.05 (-0.13 to 0.02)	0.00 (-0.08 to 0.07)	-0.13 (-0.34 to 0.07)	0.1	-0.05 (-0.16 to 0.06)	0.2
Preventive behaviours included in the intervention^a								
Warming-up	0.94 (0.33 to 1.92)	0.38 (0.13 to 0.78)	0.93 (0.58 to 1.35)	0.72 (0.45 to 1.07)	2.45 (0.47 to 6.73)	15.2	1.30 (0.63 to 2.18)	4.3
Cooling-down	0.89 (0.33 to 1.79)	1.09 (0.40 to 2.22)	0.90 (0.58 to 1.30)	0.83 (0.52 to 1.21)	0.83 (0.17 to 2.11)	0.6	1.09 (0.56 to 1.83)	1.6
Trailrunning shoes	0.47 (0.18 to 0.89)	0.30 (0.10 to 0.60)	0.67 (0.43 to 0.99)	0.54 (0.34 to 0.80)	1.52 (0.33 to 3.81)	3.6	1.22 (0.62 to 2.03)	3.0
Strength training	0.52 (0.17 to 1.04)	0.88 (0.33 to 1.74)	0.68 (0.41 to 1.01)	1.11 (0.68 to 1.61)	0.57 (0.11 to 1.44)	0.2	0.61 (0.30 to 1.04)	0.1
Core training	0.89 (0.32 to 1.75)	1.21 (0.45 to 2.35)	0.88 (0.54 to 1.29)	0.96 (0.59 to 1.41)	0.74 (0.16 to 1.81)	0.4	0.91 (0.44 to 1.54)	0.6
Neuromuscular training	0.59 (0.17 to 1.30)	0.49 (0.14 to 1.06)	0.67 (0.37 to 1.03)	0.79 (0.45 to 1.23)	1.18 (0.18 to 3.34)	1.5	0.84 (0.35 to 1.53)	0.5
Flexibility training	0.47 (0.16 to 0.93)	0.62 (0.22 to 1.23)	0.66 (0.39 to 0.98)	0.94 (0.58 to 1.40)	0.94 (0.15 to 1.87)	0.4	0.69 (0.33 to 1.20)	0.1
Preventive behaviours not included in the intervention^a								
Brace	-	-	-	-	-	-	-	-
Compression clothing	1.40 (0.15 to 4.62)	2.32 (0.22 to 8.85)	0.98 (0.38 to 1.91)	1.47 (0.51 to 3.02)	0.63 (0.01 to 3.12)	0.5	0.67 (0.14 to 1.71)	0.3
Compression stocking	0.47 (0.10 to 1.08)	0.67 (0.16 to 1.56)	0.67 (0.36 to 1.08)	0.88 (0.45 to 1.44)	0.67 (0.07 to 2.09)	0.4	0.76 (0.29 to 1.47)	0.3
Insoles	0.51 (0.08 to 1.34)	0.77 (0.13 to 2.12)	0.67 (0.32 to 1.16)	0.71 (0.30 to 1.26)	0.62 (0.03 to 2.43)	0.4	0.94 (0.28 to 2.05)	0.8
Stretching before	0.35 (0.09 to 0.77)	0.85 (0.28 to 1.79)	0.84 (0.48 to 1.29)	1.00 (0.58 to 1.57)	0.38 (0.05 to 1.08)	0.1	0.83 (0.35 to 1.51)	0.4
Stretching after	0.70 (0.24 to 1.43)	1.41 (0.48 to 2.84)	0.82 (0.50 to 1.22)	1.02 (0.61 to 1.51)	0.48 (0.09 to 1.29)	0.1	0.81 (0.39 to 1.40)	0.3
Supervised training	0.33 (0.09 to 0.72)	0.92 (0.27 to 2.00)	0.72 (0.39 to 1.15)	0.87 (0.46 to 1.43)	0.33 (0.04 to 0.98)	0.1	0.83 (0.31 to 1.57)	0.5
Taping	0.64 (0.05 to 2.03)	0.11 (0.00 to 0.66)	1.22 (0.49 to 2.29)	0.43 (0.07 to 1.09)	5.46 (0.05 to 62.50)	10.4	2.93 (0.44 to 9.32)	18.2
RRI								
Participants with RRI ^b	1.08 (0.80 to 1.38)	1.06 (0.80 to 1.37)	0.90 (0.86 to 0.95)	0.98 (0.94 to 1.03)	1.01 (0.67 to 1.42)	1.0	0.92 (0.86 to 0.98)	205.6 ^d
Number of RRI ^c	0.99 (0.87 to 1.13)	1.03 (0.90 to 1.18)	0.95 (0.93 to 0.98)	1.00 (0.97 to 1.02)	0.96 (0.79 to 1.15)	2.0	0.96 (0.92 to 0.99)	78.6 ^d

Results regarding the effects between groups are in favour of the intervention group.

^a Effect sizes are expressed as mean differences obtained by Bayesian linear mixed models.

^b Effect sizes are expressed as odds ratios (OR) obtained by Bayesian generalised mixed models (logit link).

^c Effect sizes are expressed as rate ratios (RR) obtained by Bayesian generalised mixed models (log link).

^d Significant results (i.e., 95% CI not containing the null effect and BF > 3).

RRI: running-related injury. ES: effect size. CI: highest posterior density credible interval. BF: Bayes factor.

Effects of the intervention on preventive behaviours

The intervention presented a trend in increasing the odds of performing three out of seven preventive behaviours included in the intervention (warming-up, cooling-down, and the use of specialised trailrunning shoes) after six months of follow-up, although the BF's suggested 'barely worth mentioning' effects in favour of the intervention group ($BF \leq 3$) (Table 8.4). Also, there was a 'positive' ($3 < BF \leq 20$) effect on the use of taping in favour of the intervention group. The use of taping was not included in the intervention. Therefore, no effect was expected for taping a priori. This was confirmed by a large uncertainty found for the estimated effect on using taping (95% CI 0.44 to 9.32). Therefore, the effects of the intervention on preventive behaviours are considered non-significant.

Preventive effects of the intervention on RRIs

No significant effects were found on RRI outcomes after two months of follow-up (Table 8.4). Nonetheless, there was a 'very strong' level of evidence ($BF > 150$) supporting a significant effect on reducing the odds of trailrunners sustaining RRIs after six months (OR 0.92; 95% CI 0.86 to 0.98). Also, there was a 'strong' level of evidence ($20 < BF \leq 150$) supporting a significant effect on reducing the number of RRIs after six months of follow-up (RR 0.96; 95% CI 0.92 to 0.99). Therefore, the preventive effects of the intervention on RRI outcomes were significant after six months of follow-up.

Adherence to the intervention

The results regarding the adherence of the intervention group to the online tailored advice can be found in Table 8.5. The adherence to at least one advice was higher for those reporting substantial RRIs than for those reporting no RRI. Core stability, strength, and flexibility training were among the most performed components for all advice packages delivered by the intervention (i.e., for the 'no RRI', 'non-substantial RRI', and 'substantial RRI' intervention packages). The percentage of participants reducing running exposure and taking a longer time to recovery was higher for those reporting substantial RRIs than for those reporting no RRI. The percentage of participants seeking medical attention was

higher for those reporting substantial RRIs than for those reporting non-substantial RRIs. Interestingly, the percentage of participants taking no advice was lower for the participants reporting substantial RRIs than for those reporting non-substantial or no RRI.

Table 8.5 Adherence to the online tailored advice (*TrailS₀*) in the intervention group (n=115)

Intervention component	Intervention received		
	No RRI Mean % (95% CI)	Non-substantial RRI Mean % (95% CI)	Substantial RRI Mean % (95% CI)
Following at least 1 advice	59.8% (50.7 to 69.5)	76.5% (64.1 to 88.8)	93.4% (80.6 to 100.0)
Core training	27.4% (19.9 to 35.5)	32.4% (21.5 to 44.8)	40.0% (28.6 to 52.6)
Strength training	19.5% (12.7 to 27.4)	36.1% (25.3 to 47.7)	33.9% (23.0 to 44.9)
Flexibility training	11.0% (6.2 to 16.8)	23.0% (13.8 to 34.0)	28.9% (18.2 to 41.2)
Neuromuscular training	4.4% (1.7 to 8.0)	3.6% (0.2 to 9.7)	11.5% (4.7 to 20.1)
Warming-up	14.7% (9.3 to 21.2)	14.5% (6.5 to 24.5)	16.7% (8.5 to 26.1)
Cooling-down	11.7% (6.2 to 18.2)	13.6% (6.2 to 22.4)	10.2% (3.9 to 18.5)
Trailrunning shoes	10.9% (6.0 to 16.7)	13.4% (6.5 to 21.8)	7.4% (2.3 to 14.3)
Trailrunning shoes (n of pairs)	14.4% (9.2 to 20.5)	17.8% (10.1 to 26.6)	5.7% (1.5 to 11.6)
Longer recovery period	7.0% (3.5 to 11.1)	13.5% (6.0 to 23.1)	21.3% (12.8 to 31.0)
Reduction of running exposure	7.1% (3.9 to 10.7)	15.6% (8.7 to 23.8)	35.0% (25.9 to 45.0)
Slow progression after reduction	–	14.7% (7.5 to 23.3)	26.5% (18.7 to 34.9)
Medical attention	–	9.3% (3.5 to 17.1)	35.1% (23.4 to 48.4)
RICE	–	4.0% (1.1 to 7.7)	2.0% (0.0 to 6.3)
No advice	17.9% (11.2 to 25.5)	11.9% (5.3 to 20.1)	1.3% (0.0 to 4.8)

The results are expressed as the average percentage over time and its 95% highest posterior density credible interval obtained by Bayesian generalised mixed models.

RRI: running-related injury. CI: highest posterior density credible interval. RICE: rest, ice, compression, and elevation.

Discussion

Effectiveness on determinants and actual preventive behaviour

The level of evidence supporting a change on the determinants of performing the intervention, and on increasing the odds of performing behaviours towards RRI prevention was considered non-significant after two and six months of follow-up. A recent study found a statistically significant effect after three months of follow-up of an online tailored intervention on determinants (intention, attitude, and risk perception) and on actual preventive behaviour (i.e., warming-up before training, before competitions, and performing a proper workout regime) in Dutch runners.¹⁶ These conflicting results may be explained by differences in the content (e.g., informative videos) and in the delivery of the intervention (e.g., exposure to the intervention of 30 min) evaluated in the study of Adriaenssens et al.¹⁶ Also, the delivery of general advice to the control group at the beginning of the current study could have suppressed the effects of the intervention on preventive behaviour.

Effectiveness of the intervention on RRI

In contrast to no effect on behaviour towards RRI prevention, the intervention was effective in reducing the odds of trailrunners sustaining RRI and on reducing the number of RRI after six months of follow-up. The mechanisms of the preventive effect of the online tailored advice on RRI cannot be certainly determined in a behavioural perspective, whilst the intervention was not effective in changing preventive behaviour. Maybe, six months of implementation of online tailored advice was too short to yield effects on preventive behaviour. Nonetheless, the small and/or non-significant effects on several preventive behaviours combined (e.g., warming-up and trailrunning shoes that presented a ‘positive’ level of evidence) could have resulted in the significant effects found for RRI.

The Bayesian approach

Bayesian inference is a probabilistic statistical approach that treats the parameters of interest as random variables and, therefore, they can be described with probability distributions.^{32,40} The results of a Bayesian analysis provide a range of possible estimates, and also provide levels of evidence supporting these estimates in terms of probability. For example, the average effect size (i.e., mean difference, OR, or RR) is the most likely estimate for the parameter investigated, and the Bayesian 95% CI contains the most likely effect sizes with 95% probability. The level of evidence can be classified according to the BF in order to translate the strength of evidence provided by the data given a hypothesis (e.g., preventive effect) in relation to an alternative hypothesis (e.g., no preventive effect).^{32,38} The implication is that stakeholders can use such levels of evidence to improve judgment regarding the value of implementing the intervention in practice. A detailed description of the advantages of using Bayesian inference is beyond the scope of this chapter, but it can be found elsewhere.^{32,34}

Strengths and limitations

This was the first study to investigate the effects of an online intervention to prevent RRI. The allocation of the participants to the intervention and control groups was concealed,

reducing the risk of selection bias.⁴¹ The assessment of the outcomes and the delivery of the intervention were blinded, reducing the risk of detection bias.⁴¹ Reducing the risk of bias increases the interval validity of the results.⁴² The adherence of each component of the intervention was reported in order to tailor future prevention programmes to the components with higher adherence, or to create strategies to increase the adherence of those less performed.

Although the sample of trailrunners included in this study is likely to be representative of the Dutch trailrunning community,⁹ this study was composed of a convenience sample. Blinding of participants was not possible, because of the impossibility to develop a sham intervention mimicking the online tailored intervention evaluated in this study. This study has not investigated the influence of competing interventions on the effects of the online tailored intervention. Since the effects of the intervention included primary, secondary, and tertiary prevention,²² specific effects on each prevention level might be latent in the results. However, this study had no sufficient power for a subgroup analysis in order to investigate the effects of the intervention in each level of prevention. Last but not least, the implementation of a minimal intervention in the control group may have resulted in an attenuation of the effectiveness of the online tailored intervention, especially in the determinants and actual preventive behaviours.

Implications for practice and recommendations

The level of evidence supporting a significant preventive effect of online tailored advice was classified as ‘very strong’ for the odds of trailrunners sustaining RRIs, and ‘strong’ for the number of RRIs, suggesting that its implementation in practice may be supported by this evidence. This is relevant, because online interventions are inexpensive, easy to implement, and reachable for a large number of people.^{16,17} However, the average magnitude of these preventive effects was modest (i.e., OR=0.92; RR=0.96, respectively). Therefore, online tailored advice may be used for RRI prevention in practice, but maybe not alone. Tailored advice may constitute a basic prevention component in a multi-component prevention programme including, for example, supervised strengthening and proprioceptive training.^{43,44} Adding the preventive effects of these interventions may

enhance the likelihood of preventing RRIs. However, multi-component interventions aimed at preventing RRIs still need to be developed and evaluated in randomised controlled trials.

The average adherence to the intervention found in the current study varied from 59.8% to 93.4%, suggesting that online tailored advice may be successfully implemented in practice.⁴⁵ Nonetheless, future efforts on adapting, developing, or implementing tailored advice on RRI prevention should focus on the components with the highest adherence presented in this study, and/or develop additional strategies to enhance the components with lower adherence. Adding informative videos and/or online instantaneous feedback with human interaction (e.g., live video consultations) may be suggestions to increase adherence. In addition, long-term effects (≥ 12 months) and implementation outcomes of online tailored interventions should be investigated.

Conclusions

There was a ‘very strong’ level of evidence ($BF=205.6$) supporting a significant but modest preventive effect of online tailored advice on reducing the odds of trailrunners sustaining RRIs (OR 0.92; 95% CI 0.86 to 0.98), and a ‘strong’ level of evidence ($BF=78.6$) supporting a significant but modest preventive effect on the number of RRIs (RR 0.96; 95% CI 0.92 to 0.99). No effect was observed on determinants of performing the intervention and on promoting behaviour towards RRI prevention.

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