The effectiveness of an online intervention in stimulating injury-preventive behaviour in adult novice runners. Results of a randomised controlled trial.

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Abstract

Background

In addition to the beneficial health effects of being active, running is also associated with a risk of sustaining injuries. The online intervention Runfitcheck was developed to stimulate injury-preventive behaviour among adult novice runners. The objective of this study was to evaluate the effectiveness of Runfitcheck on injury-preventive behaviour among adult novice runners. Design Randomised controlled trial

Methods

A randomised controlled trial with a follow-up period of five months was conducted among adult novice runners. The intervention group had access to the Runfitcheck intervention, while the control group performed their running activities as usual. One, three, and five months after enrolment, participants reported retrospectively what they had done regarding injury-preventive behaviour (operationalised as (i) using a (personalised) training schedule; (ii) performing strength and technique exercises; and (iii) performing a warm-up routine prior to running). Relative Risks ((RR) and 95% Confidence Interval (95%CI)) were used to analyse behavioural change among runners who were not performing the favourable behaviour at enrolment.

Results

A total of 1,411 novice runners (72.6% female, mean age 38.1 years) were included in this study and assigned to the intervention group (n=715) or control group (n=696). Runners in the intervention group searched more often for information about a warm-up routine (55.6% versus 44.9%; RR 1.211 (95%CI 1.080-1.357); Table 2), and added more often strength exercises to their warm-up routine (49.3% versus 38.2%; RR 1.228 (95%CI 1.092-1.380)). Runners in the intervention group performed more often running technique exercises compared to runners in the control group (58.6% versus 51.5%; RR 1.134 (95%CI 1.015-1.267)), but less often strength exercises (71.9% versus 77.9%; RR 0.865 (95%CI 0.752-0.995)). Within the group of runners that did not perform any warm-up routine at enrolment (n=272; 69.5% female, mean age 35.8 years (SD 9.3), runners in the intervention group performed a regular warm-up routine more often than runners in the control group (47.1% versus 28.4%; n=196; RR 1.461 (95%CI 1.084-1.968)) No significant results were found for using a training schedule.

Conclusions

The online intervention Runfitcheck was effective in stimulating aspects of injury-preventive behaviour in adult novice runners, mostly related to a warm-up routine.

Background

Worldwide, running is one of the five most popular sports activities among adults and one of the most favourite sports for starting to become physically active[1]. In the Netherlands, around 30% of the running population consists of novice runners who have less than one year of running experience[2].

In addition to its beneficial health effects, running is also associated with a high risk of musculoskeletal injuries. The incidence of running-related injuries (RRIs) is reported to range from three to 59 injuries per 1000 exposure hours[3–5]. In particular, novice runners are at high risk of sustaining a RRI, especially in the lower extremities[2,3,6]. Risk factors for RRIs have been extensively investigated, but evidence remains contradictory and inconclusive. A history of previous injury in the past 12 months is reported to be the main risk factor for RRIs[7,8]. According to several review articles, half of all RRIs in runners are related to training errors[9,10]. Furthermore, goal-setting seems to be of more importance to runners than a realistic training load. Sports goal-oriented running, and especially running in order to complete a certain distance plus participating in an event, is associated a higher risk of a RRI [Romeijn, Kemler, Huisstede, submitted].

RRIs among novice runners could be prevented by favourable injury-preventive behaviour such as modifying the training load[9,10]. However, novice runners might not be able to assess their training load properly, are probably not aware of the training errors they make, or simply ignore signals their body gives due to their goal-setting behaviour in running [Romeijn, Kemler, Huisstede, submitted]. To stimulate favourable injury-preventive behaviour in novice runners, such as performing a warm-up and cool down routine, adjusting running volume/intensity, and responding to body signals (listening to your body), some interventions have recently been developed and have been used by runners with promising results, leading even to the prevention of RRIs[11,12]. Hespanhol et al. (2017) showed that an online tailored injury-preventive advice led to a reduction of RRIs among trail runners[11]. The intervention developed by Adriaensens et al. (2014) was effective in stimulating injury-preventive behaviour among runners[12], but was very time-consuming.

A new online intervention (‘Runfitcheck’) was developed in order to stimulate injury-preventive behaviour among novice runners. The objective of this study was to evaluate the effectiveness of Runfitcheck on injury-preventive behaviour among adult novice runners.

Methods

A randomised controlled trial (RCT) with a follow-up period of five months (March 2017 – July 2017) was conducted. The design of this study is described in detail elsewhere[13]. The study design and protocol were approved by the Medical Ethics Review Committee of the Academic Medical Center (W16_335 # 16.417; Amsterdam, the Netherlands). The trial is registered in the Dutch Trial Registry (ID: NL6225).

The group of participants consisted of adult novice runners. Inclusion criteria were: (i) aged 18 and older; (ii) having less than one year of running experience and/or not considering themselves as an experienced or very experienced runner. Participants were recruited via social media networks (Facebook, websites, Twitter, LinkedIn, newsletters) of the participating organizations. Participants who completed all

questionnaires were entered into a draw offering a possibility to win a gift voucher to the value of €200 for running clothes. All participants of the study provided informed consent online.

Participants within the intervention group obtained access to the Runfitcheck intervention[13]. No further conditions were applied to the use of the intervention. The Runfitcheck intervention was developed according to an evidence-based (Knowledge Transfer Scheme and Intervention Mapping) and practice-based (running experts) approach to stimulate injury-preventive behaviour among novice runners. Through an expert consultation and research process, two main dimensions in the risk for RRIs were identified: (1) the physical load-taking capacity of runners; and (2) the motivation of runners to achieve their running goals. Across these two domains, runners were classified into four categories: (1) a low physical load-taking capacity and a low goal-orientation; (2) a low physical load-taking capacity and a high goal-orientation; (3) a high physical load-taking capacity and a low goal-orientation; and (4) a high physical load-taking capacity and a high goal-orientation. Depending on their classification, runners directly received tailored advice on the website for achieving optimal running practice. This advice consisted of: 1) advice about the use of a training schedule based on the runner's load-taking capacity and motivation. Runners could also subscribe to receive a personalised running schedule for 6 or 12 weeks (0–3 KM, 0–5 KM, 3–5 KM, 5–10 KM, 10–16 KM). The running schedules were amplified on the runner's load-taking capacity, motivation, and specified time frame until a running event; 2) Four exercises to be performed three times a week to increase strength or improve running technique (plank, skipping, tripling, and leaping sideways on two legs), and the possibility to receive a more varied training programme based on load-taking capacity; 3) An instruction video with voice-over and additional information on performing a warm-up. The warm-up routine consisted of tripling, one-leg skipping, normal skipping, heel-to-buttocks exercise, squats, good mornings, lunges, six different leaping exercises, skating jumps, six different one-leg leaping exercises, squats with arm swing, and high jumps. More information on the development process and content of the Runfitcheck is described in detail elsewhere[14]. The participants in the control group performed their running activities as usual.

The main outcome measure of the study was injury-preventive behaviour, being operationalised as: (i) using a (personalised) training schedule; (ii) performing strength and technique exercises[15]; and (iii); performing a warm-up prior to running[16]. Each of these injury-preventive behaviours was divided into preparatory and executional actions:

(i)
training schedule consisted of two preparatory and one executional action, namely: searching for a training schedule, creating a personal training schedule, using a general training schedule.
(ii)
strength and technique exercises consisted of two preparatory and two executional actions: searching for both strength and technique exercises, and executing both strength and technique exercises.
(iii)
the warm-up consisted of one preparatory and two executional actions: searching for information about a warm-up routine for runners, performing a warm-up routine (extensive or otherwise), and adding strength

exercises to a warm-up An extensive warm-up is a warm-up routine in which the runner starts at a slow pace, performs strength exercises and sport-specific All injury-preventive behaviours were assessed through single-answer questions (Yes/No/Not applicable).

Participants were asked to fill in four online questionnaires (T0-T3). At enrolment (T0), participants were asked to report the injury-preventive behaviour (warm-up routine, strength and technique exercises, use of a (personalised) training schedule) they usually performed before or during their running activities. Additionally, participants were asked about their demographic characteristics (age in years, gender), running experience (in months), frequency per week of running and other sports activities in the previous three months, and other injury-preventive behaviour. One month after T0 (T1), three months after T0 (T2), and five months after T0 (T3), participants were asked to retrospectively report in detail, via an online questionnaire, what they had done in that time frame (past month, past two months, past two months, respectively) in terms of preparatory and executional actions during their running activities.

In previous literature, a 12.6% increase in injury-preventive behaviour among recreational adult runners (in this case, the inclusion of a warm-up) was found during a three-month follow-up period[7]. Therefore, in this study, it was hypothesized that the Runfitcheck intervention could lead to a 10% difference in favourable injury-preventive behaviour in the intervention group in comparison to the control group. A choice was made to use the word difference instead of increase, as a difference between the two groups was considered as more important than an increase only. For example, if more runners in the intervention group execute the favourable injury-preventive behaviour, but runners in the control group change their behaviour as well, an increase will be found, but this is unlikely to be a statistically significant difference.

To achieve 80% power with a significance level of 0.05, the sample size calculation revealed that 384 participants per study group were needed in this study. Considering a response rate of 85% and a drop-out rate of 10% over the five-month follow-up period, a total of at least 1,000 participants (500 per study group) in this study needed to be approached.

As our main outcome measure injury-preventive behaviour was divided in three different behaviours with several preparatory and executional actions, participants could perform one part of the outcome measure (e.g. performing a warm-up routine), while they did not perform the other behaviours. Hence, after T0, all eligible participants were included in the study, and allocated at random to the intervention or control group after T0 simultaneously, using a computerized random number generator (the Aselect function in Excel). No restrictions were imposed to achieve a balance between groups in size or characteristics for the allocation, and simple randomization was performed. Concealed allocation was used. All steps in the randomization process were performed by the principal researcher. Neither participants in the intervention group nor researchers were blinded in this study.

Descriptive analyses (mean, standard deviation, frequency) were conducted for the different baseline variables in both study groups. Baseline variables were analysed for differences between the intervention and control groups (chi square test, independent T-tests).

For the executional actions, structural behavioural change was evaluated. A behaviour change is regarded as structural if runners changed their behaviour at a certain point in time, and continued to execute the behaviour till the end of the follow-up period, or if runners executed the behaviour at baseline, and continued to execute the behaviour till the end of the follow-up period.

Relative Risks ((RR) and 95% Confidence Interval (95%CI)) were calculated using the risk estimates within the chi square analyses (only available for a 2 × 2 table) and were used to analyse behavioural change in the preparatory and executional injury-preventive actions between T0 and T3. Analyses were performed according to the intention to treat analyses: (i) using a (personalised) training schedule; (ii) performing strength and technique exercises; (iii) performing a warm-up routine (extensive or otherwise). Participants were included in the study until they dropped out, or after completing all four questionnaires. Missing data were not imputed.

For the analyses, those participants who executed the desired behaviour at baseline, and those participant who did not execute the desired behaviour at enrolment, but did execute the desired behaviour during the follow-up period were grouped together and compared with participants who did not execute the desired behaviour at enrolment, and did not start or execute the desired behaviour during the follow-up period.

In sub analyses, participants only were included if they did not perform the favourable injury-preventive behaviour at enrolment. Relative Risks and 95%CI, were performed to reveal the 'actual effect' of the intervention on injury-preventive behaviour.

For all analyses, significance was accepted at $p < 0.05$.

Results

In total, 2,148 participants were interested in participating in the study, of whom 1,411 were eligible for participation according to the inclusion criteria. Of these eligible participants, 715 were randomly allocated to the intervention group and 696 to the control group. Eighty percent of the participants (n = 1,135) completed at least one of the follow-up questionnaires and were therefore included in the analyses. Almost half of the participants completed all questions in all four questionnaires (45.5%; n = 642) The complete flow of the participants can be found in Fig. 1.

Of the 1,411 participants, 72.6% (n = 1,025) were female, and the mean age was 38.1 years (SD = 10.4; Table 1). Almost one third of the participants had less than one year of running experience (29.7%). In the three months prior to the study, 13.6% of the participants had run less than once per week, 20.8% had run once per week on average, and 65.6% had run at least twice per week.

Table 1
Baseline characteristics of the participants (n = 1,411)

	Intervention group (n = 715)	Control group (n = 696)	Total (n = 1411)
Gender, male, n (%)	192 (26.9%)	194 (27.9%)	386 (27.4%)
Mean age in years (SD)	38.2 (10.5)	37.9 (10.3)	38.1 (10.4)
Running experience, n (%) - < 6 months - 6–12 months - 12–18 months - 18–24 months - > 24 months	71 (9.9%) 140 (19.6%) 121 (16.9%) 105 (14.7%) 278 (38.9%)	61 (8.8%) 147 (21.1%) 113 (16.2%) 98 (14.1%) 277 (39.8%)	132 (9.4%) 287 (20.3%) 234 (16.6%) 203 (14.4%) 555 (39.3%)
Running frequency in previous three months, n (%) - Less than once per week - Once per week - Twice per week or more	105 (14.7%) 137 (19.2%) 473 (66.2%)	87 (12.5%) 157 (22.6%) 452 (64.9%)	192 (13.6%) 294 (20.8%) 925 (65.6%)
Sport frequency in previous three months other than running, n (%) - Not active in other sports - Less than once per week - Once per week - Twice per week or more	134 (18.7%) 140 (19.6%) 183 (25.6%) 258 (36.1%)	109 (15.7%) 121 (17.4%) 194 (27.9%) 272 (39.1%)	243 (17.2%) 261 (18.5%) 377 (26.7%) 530 (37.6%)
SD Standard deviation			

At baseline, 80.9% of the participants in the intervention group reported that they performed some kind of warm-up routine at the start of their training session, 19.0% performed an extensive warm-up routine in which they started to run at a slow pace, and performed strength and sport-specific exercises. In the control group, 79.9% performed some kind of warm-up routine, while 19.5% performed an extensive warm-up routine. A general training schedule was used by 43.2% of the runners in the intervention group and 43.1% in the control group, and a personalised training schedule by 18.2% in the intervention group and 16.7% in the control group. More than half of the runners in the intervention group performed strength exercises (56.2%) and 30.9% performed exercises to improve their running techniques. In the control group, 56.0% performed strength exercises, and 27.9% performed exercises to improve their running techniques. No significant differences were found between the two groups.

After five months of follow-up, it turned out that runners in the intervention group searched more often for information about a warm-up routine (55.6% versus 44.9%; RR 1.211 (95%CI 1.080–1.357); Table 2), and added more often strength exercises to their warm-up routine (49.3% versus 38.2%; RR 1.228 (95%CI 1.092–1.380)). Runners in the intervention group performed more often running technique exercises compared to runners in the control group (58.6% versus 51.5%; RR 1.134 (95%CI 1.015–1.267)), but less often strength exercises (71.9% versus 77.9%; RR 0.865 (95%CI 0.752–0.995)).

Table 2
Preparatory injury-preventive actions and executional injury-preventive actions taken by all runners over five months of follow-up

	Intervention group (%)	**Control group (%)**	**RR (95%CI)**
Using a (personalized) training schedule			
Searched for a training schedule (n = 970)	79.8%	77.1%	1.071 (0.941–1.218)
Created a personal training schedule (n = 970)	49.2%	45.0%	1.077 (0.963–1.205)
Used a general training schedule (n = 970)	36.5%	33.0%	1.070 (0.949–1.206)
Strength and technique exercises			
Searched for information on strength exercises (n = 961)	59.0%	68.8%	0.826 (0.730–0.936)
Searched for information on running techniques (n = 961)	51.5%	50.9%	1.011 (0.904–1.131)
Performed strength exercises (n = 962)	71.9%	77.9%	0.865 (0.752–0.995)
Performed running technique exercises (n = 984)	58.6%	51.5%	1.134 (1.015–1.267)
Warm-up routine			
Searched for information on a warm-up routine for runners (n = 969)	55.6%	44.9%	1.211 (1.080–1.357)
Performed a warm-up routine (n = 1000)	89.7%	85.9%	1.155 (0.996–1.340)
Added strength exercises to warm-up routine (n = 999)	49.3%	38.2%	1.228 (1.092–1.380)

Sub Analyses.

After five months of follow-up, within the group of runners that did not perform any warm-up routine at the start of the study (n = 272; 69.5% female, mean age 35.8 years (SD 9.3)), runners in the intervention group searched more often for information on a warm-up routine (53.6% versus 33.6%; n = 194; RR 1.444 (95%CI 1.098–1.901)), performed a regular warm-up routine more often than runners in the control group (47.1% versus 28.4%; n = 196; RR 1.461 (95%CI 1.084–1.968)), and added strength exercises to their warm-up routine more often than runners in the control group (32.6% versus 17.4%; n = 192; RR 1.504 (95%CI 1.039–2.179) Table 3).

Table 3
Preparatory injury-preventive actions and structural executional injury-preventive actions taken by runners over five months of follow-up

	Intervention group (%)	**Control group (%)**	**RR (95%CI)**
Using a (personalised) training schedule			
Searched for a training schedule (n = 376)	46.3%	42.1%	1.074 (0.900-1.283)
Created a personal training schedule (n = 792)	38.3%	32.1%	1.130 (0.986–1.295)
Used a general training schedule (n = 376)	10.6%	10.2%	1.021 (0.763–1.365)
Strength and technique exercises			
Searched for information on strength exercises (n = 426)	48.4%	57.9%	0.845 (0.712–1.003)
Searched for information on running techniques (n = 668)	26.4%	30.3%	0.923 (0.802–1.062)
Performed strength exercises (n = 426)	36.6%	50.0%	0.790 (0.669–0.932)
Performed running technique exercises (n = 691)	40.8%	31.3%	1.208 (1.042-1.400)
Warm-up routine (no routine at baseline)			
Searched for information on a warm-up routine for runners (n = 194)	53.6%	33.6%	1.444 (1.098–1.901)
Performed a regular warm-up routine (n = 196)	47.1%	28.4%	1.461 (1.084–1.968)
Added strength exercises to warm-up routine (n = 195)	32.6%	17.4%	1.504 (1.039–2.179)
Warm-up routine (no extensive *routine at baseline)*			
Searched for information on a warm-up routine for runners (n = 859)	56.4%	45.2%	1.222 (1.083–1.380)
Performed a regular warm-up routine (n = 882)	52.8%	40.2%	1.257 (1.112–1.421)
Added strength exercises to warm-up routine (n = 880)	42.5%	29.9%	1.290 (1.127–1.478)

Analyses within the group of runners that did not perform an extensive warm-up routine at the start of the study (n = 882; 71,3% female, mean age 38.1 years (SD 10.2)) revealed similar results. Runners in the intervention group searched more often for information concerning a warm-up routine (56.4% versus 45.2%; n = 859; RR 1.222 (1.083–1.380)), performed a regular warm-up routine more often than runners in the control group (52.8% versus 40.2%; n = 882; RR 1.257 (95%CI 1.112–1.421)), and added strength exercises to their warm-up routine more often (42.5% versus 29.9%; n = 880; RR 1.290 (95%CI 1.127–1.478)) compared to similar runners in the control group.

Analyses within the group of runners that did not perform any running technique exercises at the start of the study (n = 619; 71.9% female, mean age 38.7 (SD = 10.3)) revealed that runners in the intervention group performed these exercises more often than those in the control group (40.8% versus 31.3%; RR 1.208 (95%CI 1.042-1.400)).

Analyses within the group of runners that did not perform any strength exercises at the start of the study (n = 619; 71.9% female, mean age 38.7 (SD = 10.3)) revealed that runners in the intervention group performed these exercises less often than those in the control group (36.6% versus 50.0%; n = 426; RR 0.790 (95%CI 0.669–0.932)).

Runners may have added strength exercises to their warm-up routine, or performed strength exercises at some other time point during a week. The analysis showed that among those runners who did not perform any strength exercises at baseline (n = 424), runners in the intervention group added strength exercises to their warm-up routine more often (22.2% versus 11.3%), while runners in the control group started to perform strength exercises at some other point of time during a week more often (29.7% versus 18.4%) (Pearson's chi square 13.546, p = 0.004). In both the intervention and control group, around 19% added strength exercises to their warm-up routine and started to perform strength exercises at some other point in time during a week. Forty percent in both groups did not perform any strength exercises at all.

With regard to the use of a (personalised) training schedule, no significant differences were found at all.

Discussion

In this study, the effectiveness of the online intervention Runfitcheck in stimulating injury-preventive behaviour was evaluated among adult novice runners. Similar results were found in analyses in which the whole study population was included, and in analyses in which runners were included who did not perform a specific type of injury-preventive behaviour at enrolment. Runners in the intervention group searched more often for information about a warm-up routine, added strength exercises more often to their warm-up routine, and performed more often running technique exercises compared to runners in the control group. Runners in the intervention group who did not perform any warm-up routine at enrolment performed a regular warm-up routine more often, compared to runners from the control group who did not perform any warm-up routine at enrolment. Similar results were found for runners who did not perform an extensive warm-up routine at baseline. Additional analysis showed that among those runners who did not perform any strength exercises at baseline (n = 424), runners in the intervention group added strength

exercises to their warm-up routine more often (22.2% versus 11.3%), while runners in the control group started to perform strength exercises at some other point in time during a week more often (29.7% versus 18.4%).

Performing a warm-up routine at the start of a training session was one of the important elements of the Runfitcheck intervention. In the Runfitcheck intervention, the injury-preventive advice on a warm-up consisted of a short introduction about the benefits of performing a warm-up routine, followed by an instruction video with voice-over of a warm-up routine for runners (lasting five minutes). The video was immediately accessible on the runner's mobile phone, tablet or computer. Providing an easily accessible video thus seems to be effective in stimulating favourable injury-preventive behaviour. However, several aspects of the results with regard to the warm-up routine need to be addressed. A high percentage (80.9%) of runners performing any kind of warm-up routine at baseline might have made it difficult to identify an effect of the intervention as only 20% could benefit from it. This might have led to increasing ceiling effects of the intervention. However, with a total of 2.1 million runners in the Netherlands in 2013, of whom 620,000 were novice runners[2], we believe that a huge group of runners could benefit from the intervention.

As mentioned before, 80.9% of the runners performed some kind of warm-up routine at baseline. We asked what this warm-up consisted of (starting at a slow pace, stretching, an extensive warm-up in which the runners start at a slow pace, performing strength exercises and sport-specific exercises). As stretching is not beneficial for injury prevention in runners[10,16,17], it is arguable how many of these 80.9% actually perform a warm-up routine. For this reason, we performed other analyses with those runners who did not perform an extensive warm-up routine at baseline. These analyses showed that runners in the intervention group who did not perform an extensive warm-up at baseline performed a regular warm-up routine more often than runners in the control group (52.8% versus 40.2%; n = 882; RR 1.257 (95%CI 1.112–1.421)), and added strength exercises to their warm-up routine more often (42.5% versus 29.9%; n = 880; RR 1.290 (95%CI 1.127–1.478) compared to similar runners in the control group. Although we do not know the quality of the warm-up routine that the runners started to perform, we do know that around 80% of the runners in the intervention group who started a warm-up routine added strength exercises to this routine, and 75% of the runners in the control group.

In contrast to injury-preventive aspects of a warm-up routine, runners in the intervention group performed strength exercises less often compared to runners in the control group. The results with regard to strength exercise came as a surprise for the research team, especially as the runners in the intervention group added more strength exercises to their warm-up routine. A possible explanation for this result might be that in the online questionnaires for both the intervention and control groups, the questions related to this topic were not completely identical, and perhaps also triggered the control group. The intervention group was asked whether they had started to perform the strength exercises available in the intervention. Information on the performance of other strength exercises was, unfortunately, not collected. The control group was asked if they performed any kind of strength exercises. This could have influenced the results of this part of the study. Also, an additional analysis revealed especially that the moment the runners

performed the strength exercises caused the difference between the two groups. Runners in the intervention group added strength exercises to their warm-up routine more often (22.2% versus 11.3%), while runners in the control group started to perform strength exercises at some other point in time during a week more often (29.7% versus 18.4%) (Pearson's chi square 13.546, p = 0.004). Forty percent in both groups did not perform any strength exercises at all. Although these additional analyses showed that the negative outcome of the intervention with regard to strength exercises is probably actually not that negative at all, a positive outcome could not be demonstrated either.

In addition to the positive effects of their warm-up routine and running technique exercises, runners in the intervention group were more often triggered to search for more information on injury prevention in running. They reported visiting two Dutch websites, one for the Dutch Consumer Safety Institute with information on the prevention of sports injuries, including RRIs (23% versus 8%; RR 1.964 95%CI 1.523–2.534), and a website of the Royal Dutch Athletics Association, more often than runners in the control group (29% versus 18%, RR 1.365 95%CI 1.162–1.605). These websites were accessible in the Runfitcheck intervention via direct links to the specific websites.

For the preparatory and executional actions for training schedules, no differences were found between the intervention group and control group. If we did find any differences, they were possibly difficult to interpret as a negative or positive outcome. Training errors are mentioned as a main cause of RRIs[9,10], although a recent review found that very limited evidence exists to support the notion that changes (increases and decreases) in training load are associated with injury development[17] Fields et al. (2010) stated in their review that excessive mileage and changes in training schedule are associated with an increased incidence of RRIs. And, since each person's body responds differently to the stress caused by running, individualised training programmes are recommended[10]. Linton and Valentin (2018), on the contrary, found in their study that in the first year of running, runners using a self-devised training programme were more likely to be injured compared with runners using a structured programme. Although a self-devised training programme is not the same as a personalised training programme, it is difficult to determine what a good programme or training schedule is for a runner. Furthermore, we do not have enough detailed information to judge the training schedules the runners in our study used. We do know whether it was a personalised schedule or a regular training schedule, but we do not know the exact content of the schedules used, which is a limitation in our study.

Several other methodological considerations of our study can be addressed. Firstly, the original sample size calculation revealed that at least 1000 novice runners were needed to be enrolled in the study. Achieving such a high number of participants was challenging. Several methods were used to enhance enrolment, such as social media (Facebook, LinkedIn and Twitter), newsletters from the KNAU (digital) and the magazine Runner's World (in print and digital), and the possibility to pre-register for the study. Furthermore, participants who completed all questionnaires were entered into a draw in which they could win a gift voucher to the value of €200 for running clothes. The methods worked, since 2,148 volunteered for the study, of whom 1,411 were eligible. However, the adherence to the study after five months of follow-up was relatively low (45.5%). Additional analysis did not reveal relevant significant differences in

characteristics between runners who dropped out of the study or were lost to follow-up, and those who completed all questionnaires. Therefore, we still consider our results as meaningful. Secondly, a strength of our study is the design used. A RCT, when well designed, provides the strongest evidence of any epidemiological study design, and is usually used to evaluate the effectiveness of an intervention in an experimental setting. In this study, however, we did not evaluate the effectiveness of the Runfitcheck intervention in an experimental setting, but in a real-world setting, which, in our opinion is another strength of the study. It is well-known that it is difficult to transfer interventions whose efficacy has been proved into real-world settings (efficacy versus effectiveness)[21]. With the development of Runfitcheck, the research group made the assumption that an increase in injury-preventive behaviour will ultimately lead to a decrease in RRIs. Our main focus was therefore on stimulating injury-preventive behaviour rather than preventing RRIs, as adjustment of behaviour is crucial before prevention of RRIs is even possible. In our study, participants in the intervention group were given access to the Runfitcheck intervention, but no further conditions were applied to the use of the intervention. We demonstrated effects of the Runfitcheck intervention in stimulating some aspects of injury-preventive behaviour among adult novice runners, indicating that an intervention like Runfitcheck actually could work in 'the real world'.

Although we did find some positive outcomes, it is still unclear whether the results of our intervention with benefits of a warm-up routine are clinically relevant, and if these are enough to prevent RRIs. As mentioned in the introduction, RRIs among novice runners could be prevented by favourable injury-preventive behaviour such as modifying the training load[9,10]. In our intervention we tried to focus on the physical load-taking capacity of runners and the motivation of runners to achieve their running goals to stimulate runners to modify their training load when necessary. Performing a warm-up routine was one of our suggestions. Although we did stimulate injury-preventive behaviour, this might not be enough to prevent RRIs. The transition from injury-preventive behaviour to the prevention of RRIs needs to be addressed in another randomised controlled trial.

The starting point of the development of the Runfitcheck intervention was a potentially effective but time-consuming – and therefore unattractive and complex – intervention for injury prevention in running[12], and information on the number and severity of running-related injuries in the Netherlands. Adriaensens et al. (2014) developed a tailor-based online injury-prevention intervention (website) with informational videos about the aetiology and mechanisms of RRIs, combined with injury-preventive advice, and an online questionnaire. This online questionnaire allowed the website to provide tailored feedback based upon a series of predefined questions that create a personal risk profile of the user[12]. A 12.6% increase in injury-preventive behaviour (in this case, the inclusion of a warm-up) was found over a three-month follow-up period[12]. Although the intervention developed by Adriaensens et al. (2014) was effective, the online questionnaire for tailored feedback was time-consuming. Therefore, the Dutch Consumer Safety Institute developed the Runfitcheck intervention to encourage injury-preventive behaviour among novice runners without the associated time burden, and was indeed able to induce a 10% difference in several aspects of injury-preventive behaviour in runners in favour of the intervention group. Furthermore, the

results of this study showed that the realisation of a difference of 10% in injury-preventive behaviour is feasible using an online intervention.

Conclusions

The online intervention Runfitcheck was effective in stimulating aspects of injury-preventive behaviour in adult novice runners, mostly related to a warm-up routine. The realisation of a 10% difference in favourable injury-preventive behaviour is feasible with an online intervention.

Abbreviations

RRI
Running-related injury
ZonMW
Netherlands Organization for Health Research and Development

Declarations

Ethics approval and consent to participate:

The study protocol was approved by the Medical Ethics Review Committee of the Academic Medical Center (December 1st, 2016; Amsterdam, the Netherlands, W16-335 # 16.417). All participants included in our study provided informed consent to participate.

Consent for publication:

Not applicable.

Availability of data and material:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. Our institution is exploring the possibilities of data sharing, but has not formulated a final policy on this subject.

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Author contribution:

All authors were responsible for the conceptualization of the idea and the preparation of the study proposal. EK was responsible for the data collection, data analyses, interpretation of the data, and preparation of the manuscript. MC was responsible for the data collection, data analyses, and the critical

review of the manuscript. VG was responsible for the interpretation of the data and preparation of the manuscript. All authors read and approved the final manuscript.

Competing interests:

Ellen Kemler, Maaike Cornelissen and Vincent Gouttebarhe have no conflicts of interests to report.

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Not applicable.

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Figures

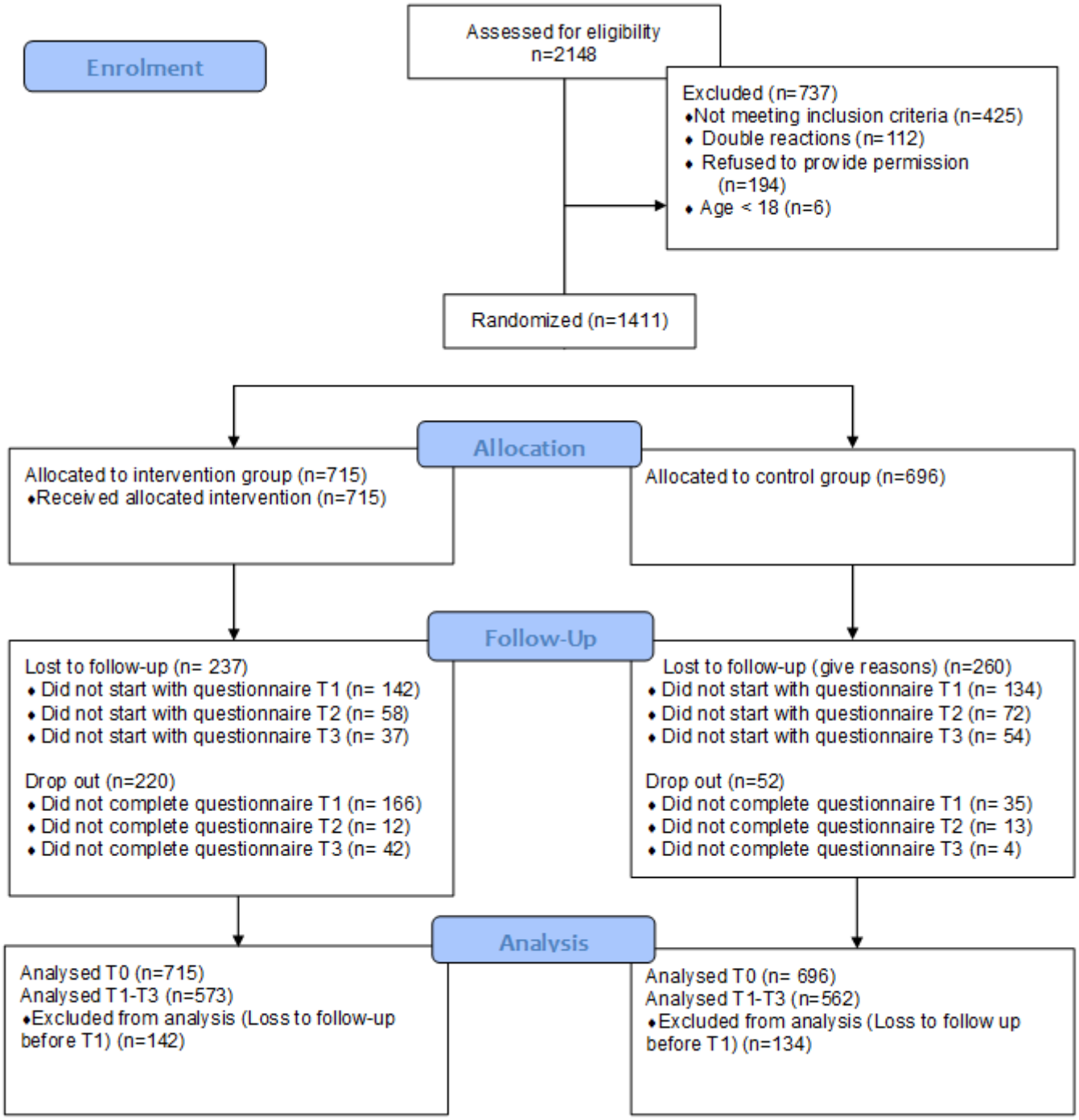

Figure 1

Flow chart of the participants of the randomised prospective controlled trial

Supplementary Files

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- CONSORT2010Checklist.doc