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RunIn3: the development process of a running-related injury prevention programme

Caio Sain Vallio ,[1] Gabriela Martins de Oliveira ,[1] Giovana Araujo Kretli Mota ,[1] Alexandre Dias Lopes ,[2] Luiz Hespanhol [1,3,4]

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For numbered affiliations see end of article.

Correspondence to
Professor Luiz Hespanhol; l.hespanhol@outlook.com

ABSTRACT

Background Running is an important type of exercise to keep people physically active. However, running also carries a risk of developing running-related injuries (RRI). Therefore, effective and evidence-based RRI prevention programmes are desirable, but are scarce in practice. An approach to face this problem might be the application of methods to develop RRI prevention programmes based on theories of behaviour change.

Objective The purpose of the study was to develop an RRI prevention programme based on perspectives of behavioural and social science theories, as well as taking a framework development approach.

Methods This was a qualitative study using the Intervention Mapping (IM) framework held between February and March 2018 in São Paulo, Brazil. The participants were involved in running practice. The data collection was conducted during focus group meetings. The data analysis was based on semantic thematic approach using a content analysis orientation based on inductive reasoning.

Results The target population of the RRI prevention programme identified was 'adult recreational runners'. The objectives of the RRI prevention programme were established in two broad actions: (1) to provide feedback on individual training characteristics and RRI risk; and (2) provide/enhance knowledge, skills and self-efficacy on RRI preventive behaviours. The programme is aimed to be delivered through an online system.

Conclusion An RRI prevention programme was developed using the IM framework and a participatory approach. The programme was named 'RunIn3', and it is based on providing feedback on running volume and RRI risk, as well as providing knowledge, skills and self-efficacy on RRI preventive behaviours.

Key messages

What is already known

- Some running-related injury prevention strategies have been implemented in practice without a proper investigation of their effectiveness.
- Implementing preventive interventions to a broad population without a reasonable understanding of their effectiveness or knowledge on the risk of adverse events may be harmful.
- An approach to face this problem may be the application of methods to develop running-related injury prevention programmes from scratch, based on theories of behaviour change, and the application of sports injury prevention frameworks guiding the process from developing to evaluating effectiveness in implementation context.
- Developing injury prevention programmes based on behavioural theories may increase the probability of a successful implementation of such programmes, increasing thus the likelihood of being effective in the 'real world'.

What are the new findings

- This study has shown that it is possible to use methods of developing structured health promotion programmes, such as Intervention Mapping, to build sports (running-related) injury prevention programmes.
- A running-related injury prevention programme was developed using the Intervention Mapping framework and a participatory approach.
- The programme was named 'RunIn3' and it is based on providing feedback on running load and running-related injury risk, as well as providing knowledge, skills and self-efficacy on preventive behaviours.
- The prevention programme is aimed to be delivered online through a website.

INTRODUCTION

Running is an important exercise to stay physically active.[1] The health benefits of running include increasing longevity,[2] cost-effectiveness in preventing cardiovascular diseases[3] and improving health indicators.[4] However, running also carries a risk of developing musculoskeletal injuries. The incidence of running-related injuries is estimated at about 7.7 (95% CI 6.9 to 8.7) injuries per 1000 hours of running in adult recreational runners.[5] In São Paulo, Brazil, the incidence of running-related injuries in adult recreational runners is estimated at 10.1 (95% CI 7.9 to 12.3) injuries per 1000 hours of running,[6] which is comparable with the summary estimate above mentioned. An important possible consequence of running-related injuries is their negative influence on

runners' motivation in running practice.[7] This can lead to a higher probability of dropouts and, in turn, may reduce the beneficial health effects of running.[7 8]

Running-related injury prevention

According to the Translating Research into Injury Prevention Practice (TRIPP) framework, only research that can be translated to stakeholders and accepted, adopted and complied with by the target population can prevent injuries in practice.[9] The TRIPP framework describes the process to achieve sports injury prevention using the following steps:[9] (1) injury surveillance; (2) establishing aetiology and mechanisms of injury; (3) developing preventive measures; (4) evaluating efficacy in 'ideal conditions'; (5) describing the intervention context to inform implementation strategies; and (6) evaluating effectiveness in implementation context.

Injury prevention programmes have been shown to reduce the risk of running-related injuries.[10 11] Nevertheless, there is limited evidence on the effectiveness of running-related injury prevention strategies.[10] Some running-related injury prevention strategies have been implemented in practice without a proper investigation of their effectiveness as suggested by the TRIPP framework.[10 12 13] Implementing preventive interventions to a broad population without a reasonable understanding of their effectiveness or knowledge on the risk of adverse events may be harmful, and may lead to a higher risk of developing running-related injuries.[13] An approach to face this problem may be the application of methods to develop running-related injury prevention programmes from scratch, based on theories of behaviour change,[14] and the application of sports injury prevention frameworks guiding the process from developing to evaluating effectiveness in implementation context.[9] This approach might increase the likelihood of effectiveness, since prevention programmes can be built taking into account the running population needs, facilitators and barriers, and opinions in this field.[15–17]

Intervention Mapping

Intervention Mapping (IM) is a protocol for developing, planning, implementing and/or evaluating health promotion programmes considering behavioural and social science theories and structured processes on health needs.[15] The IM framework has six steps with the following purposes: (Step 1) *Needs assessment:* to determine the general objectives of the programme, including an analysis of the problem addressed in order to establish the behaviours that need to be adopted and/or modified, and who should promote such adoption and/or change (eg, runners, coaches, etc); (Step 2) *Matrices of change objectives:* to create matrices including each behaviour to be adopted and/or modified and the determinants of such behaviours (eg, belief, knowledge, social influence, etc); (Step 3) *Methods and practical applications:* to determine the strategies for implementing a new behaviour or changing risk behaviours following a theoretical model; (Step 4) *Programme production:* to develop the actions of the prevention programme by establishing the tasks for each agent of the programme (eg, runners, coaches, etc), the materials to be used and/or to be disclosed and the operational organisation of the programme; (Step 5) *Adoption and implementation:* to develop adoption, implementation and maintenance strategies including the creation of systems for the integration of all agents involved in the programme; and (Step 6) *Evaluation planning:* to monitor and evaluate the prevention programme. IM has been used to guide the development and implementation process of physical activity promotion[18 19] and sports injury prevention[20 21] programmes.

Behavioural and social science theories

Behavioural and social science theories are being considered essential to develop and implement prevention programmes.[14] These theories provide path models showing the influence of determinants on behaviour state, but also factors that might influence such determinants. Factors that influence behaviour are theorised in some behavioural and social science models as actions to be applied and/or cues on how to deliver or implement health promotion strategies. Therefore, behaviour change theories can inform intervention design and delivery. For example, the Integrated Behavioural Model[22] has been applied to smoking[23] and cancer[24] prevention programmes. This theory of behaviour change acts by providing information to optimise awareness factors such as knowledge, cues to action and risk perception that, in turn, would influence motivation factors (attitude, social norms and self-efficacy) towards intention to perform the behaviour. In turn, intention would directly influence ability factors (implementation plans, performance skills and action plans) and behaviour state, while ability factors would mediate the influence of intention on behaviour state.[22–24] The Integrated Behavioural Model is derived from the theory of planned behaviour,[22] which is one of the theories of behaviour change most commonly used in the sports science field.[25 26] From the 21 studies identified in two systematic reviews aimed at investigating the use of behavioural or social science theories or models in sports injury prevention programmes[25 26]: 38.1% (n=8) used the theory of planned behaviour; 23.8% (n=5) used the health belief model; 9.5% (n=2) used the diffusion of innovation theory; and 4.8% (n=1) used one of the following: the social cognitive theory, the attitude-social influence-self-efficacy model, the refined ecological model, the PRECEDE-PROCEED model (together with the Ottawa Charter), the health action process approach and the self-determination theory.

Rationale and objective of the study

Developing injury prevention programmes based on behavioural theories may increase the probability of a successful implementation of such programmes, increasing thus the likelihood of being effective in the 'real world'.[27] However, even though the importance of

sports injury prevention is well known, there is a paucity of studies on behavioural and social science theories and models in this field. Only about 10% of sports injury prevention programmes described the use of theoretical behavioural models for supporting or justifying the intervention strategies contained in such packages.[25] Therefore, our objective was to develop a running-related injury prevention programme based on perspectives of behavioural and social science theories, as well as taking a framework development approach.

METHODS

Study design

This was a qualitative study using the IM framework for the development of a running-related injury prevention programme. We use the Standards for Reporting Qualitative Research to guide the reporting of this study.[28] Important terms related to behavioural sciences and applied in this study were defined in the online supplemental appendix A.

This study is part of a broader project that was informed by the TRIPP framework.[9] Stage 1 ('injury surveillance')[6 29 30] and stage 2 ('establishing aetiology and mechanisms of injury')[6 31 32] were conducted *a priori* and the results related to these stages can be found elsewhere.[6 29–32] This study addressed stage 3 ('developing preventive measures') and we used the IM framework to guide this specific stage. Stage 4 ('evaluating efficacy in ideal conditions') will be addressed in a pragmatic hybrid type 1 randomised controlled trial.[33] Stage 5 ('describing the intervention context to inform implementation strategies') and stage 6 ('evaluating effectiveness in implementation context') will be partly addressed in the pragmatic hybrid type 1 randomised controlled trial[33] and partly addressed in future implementation studies yet to be designed based on the results of the trial.

Participants

The number of participants was defined considering the focus group method which suggests a minimum of four and a maximum of 12 participants.[34] A convenience sample was composed of individuals from different backgrounds but related to running practice at some level (eg, runners, coaches, health professionals, researchers, stakeholders, etc). We decided to recruit individuals with different backgrounds to allow for heterogeneity among the individuals' opinions on the matters discussed in the steps 1–5 of the IM. In this way, we would capture a broader spectrum on what should have been discussed in each step of the IM process.

Eligible participants should be residents of the Metropolitan Region of São Paulo, since the prevention programme was intended to be implemented in this region. The Metropolitan Region of São Paulo was chosen for two reasons: (1) the average estimate for the incidence of running-related injury in this population (ie, 10.1 injuries/1000 hours of running[6]) is higher than the upper bound of the 95% CI for the overall running-related injury incidence estimate (ie, 8.7 injuries/1000 hours of running[5]), indicating a demand for running-related injury prevention programmes in this population (see the Introduction section for detailed information on these estimates); and (2) by convenience, since the researchers and the stakeholders recruited for this study were located and have been working in this region.

Eligible individuals were identified through the network of the researchers involved in this study in two ways: (A) by tracking personal contacts of the researchers; and (B) by searching on social media networks related to running practice. Once identified the eligible individuals, a formal invitation was sent by email or text message (smartphone or social media). In case the invitation was not accepted, we sent an acknowledgement email or text message. In case the invitation was accepted, we sent an additional email with: (1) further information about the project; (2) an electronic copy of the informed consent form, so the participant could read and evaluate this form prior to the first focus group meeting; (3) an explanation regarding the signature of the informed consent form, informing that this would occur at the location and just before the first focus group meeting, and informing that bringing a print copy would not be necessary since we will have the necessary copies of the informed consent form; and (4) asking the available days and times to match the availability of all participants to schedule the first focus group meeting. All participants received a print copy of the informed consent form at the location of the first focus group meeting. They had the necessary time to read the entire informed consent form and clarify any query they might have. Then, all signed the personal informed consent form and handed over to the researchers.

Patient and public involvement

The intervention was developed in this study following a participatory approach. 'Participatory action approach' is the process of involving the community in participating and taking actions in investigations towards improving the health of those included in the community.[17] In this study, the participatory approach directly involved the running community (runners, coaches, health professionals, researchers and stakeholders) in discussions of the entire programme development process and in designing the pragmatic hybrid type 1 randomised controlled trial aimed at addressing step 6 of IM.[33] The benefit of involving the community was the tailoring to the real needs, preferences and reality of the running environment, which may contribute to a successful implementation of the running-related injury prevention programme.[35]

Data collection

Focus group was used to collect qualitative data during face-to-face meetings.[34] The 32-item Consolidated Criteria for Reporting Qualitative Research (COREQ) was used to guide the focus group.[36] The COREQ checklist for this

study can be found in online supplemental appendix B. A maximum of five focus group meetings were hypothesised *a priori* in the protocol of this study. The meetings were held until all IM topics related to steps 1–5 had been discussed and agreed by the participants. The number of focus group meetings was dependent on saturation of the information elicited during the focus group. Saturation was considered in this study when no new or additional information had been emerging during the focus group or the information started to repeat itself. All participants were informed about this process through the informed consent form (that all agreed with and signed) and by an explanation given in the beginning of the first focus group meeting. From the five focus group meetings hypothesised *a priori*, three were actually necessary to achieve saturation regarding steps 1–5 of IM. The topics covered at the meetings can be found in online supplemental appendices C–G. A semistructured guide for conducting the meetings was prepared *a priori* and was applied during the meetings (online supplemental appendix C). The contents of the focus group meetings were considered cumulative and interchangeable, meaning that there was no content or topic exclusive for each meeting. All contents could have been discussed in all meetings until saturation was reached. The audio was recorded with a laptop computer using the software Simple Recorder V.1.6.1. One of the authors (LH) had prior experience in this type of participatory research and was, therefore, the moderator of the meetings.[11]

We used the Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation (PRECEDE)[37] model to structure the needs assessment. The PRECEDE model suggests the following steps to be implemented: first, we identify the health problem of interest in the target population; second, we identify the behaviours that influence the risk of the health problem (behavioural outcomes); and finally, we identify the personal (eg, intention) and environmental (eg, subjective norm) determinants that influence such behaviours (determinants of behavioural outcomes).[15 37] Afterwards, we use the logic model of change (what is required to change and how) to create a matrix of change for step 1 of the IM framework.[15] The logic model of change has also an order to follow: first, we select the behavioural outcomes that should be changed in order to produce the desired health outcomes; second, we establish statements of what the participants of the programme should do/change in order to perform the health behaviour (performance objectives); and finally, what needs to change in the determinants of behavioural outcomes to accomplish the performance objectives.[15]

Data analysis

The data analysis was based on semantic thematic approach[38 39] and it was conducted following a quantitative content analysis orientation based on inductive reasoning.[40–42] Another qualitative study[43] was conducted aimed at exploring the 'participants' voices' through the investigation of the facilitators and barriers in developing a running-related injury prevention programme. For the study herein presented, a quantitative content analysis was deemed most suitable to reach our study aim. The data management and analyses were performed in R V.3.3.3 (R Foundation for Statistical Computing, Vienna, Austria). The R Qualitative Data Analysis package was used to assist in the data analysis.[44]

The transcription (T) of the audios to text and the evaluation of the accuracy of the transcriptions were done by CSV, GMO and GAKM in two phases: (T1) GMO and GAKM performed the transcriptions independently; and (T2) CSV, who was blinded to the transcriptions of T1, performed the evaluation of the accuracy of the text in relation to the audios. The data processing (DP) was performed by CSV and GMO independently in five phases[40–42]: (DP1) splitting the text transcripts in shorter text units (ie, meaning units); (DP2) condensation of the split text transcripts in shorter text units (ie, condensed meaning units); (DP3) definition of codes by labelling the condensed meaning units using the participants' own words; (DP4) allocation of the codes into broad categories; and (DP5) allocation of the categories into major themes. In case of disagreements in DP1–DP5, a third researcher (LH) provided a consensus.

The interpretation of the results was performed through discussions among the researchers (CSV, GMO and LH) until a consensus was reached. The counting of the themes elicited in DP5 was performed to facilitate the communication and the disseminations of the results, and it was carried out in two ways: (1) using the frequency of emerging themes (FET), defined as the number of times the participant mentioned the theme content during the interview; and (2) using the number of participants (n), representing the number of individual participants mentioning each theme content, regardless of the number of times they mentioned each theme content during the interview. We believe that both measures are complementary to better inform the importance/weight of each theme identified.

RESULTS

Fifteen individuals were invited to participate, but five (33.3%) declined the invitation due to conflicting agenda. Therefore, 10 participants signed the informed consent form and were included in this study. The participants were: one sports physician (10%); two physiotherapists (20%); two exercise and sports sciences practitioners (ie, running trainers; 20%); two researchers from the biomechanics field (20%); two recreational runners (20%); and one stakeholder who was the owner of a health-related shop (10%). A total of three face-to-face meetings held between February and March 2018 were required to cover all IM steps. These meetings had an average duration of 2.5 hours with an average interval of 4weeks between the meetings. The outcomes elicited during the focus group meetings can be found in online supplemental appendices D–G. All participants

collaborated directly to the design of the running-related injury prevention programme, and all had the opportunity to revise the proposed final product in the last focus group meeting, when the research group presented the prototype to the participants encouraging an open discussion on the matter.

Step 1: needs assessment

The target population of interest identified was adult recreational runners. 'Adults' were the focus of this running-related injury prevention programme based on the scientific evidence[6 29] and the perception of the participants during the focus group that most recreational runners presenting running-related injury issues in clinical practice in São Paulo are adults. We considered 'recreational runner' a classification based on a professionalism scale, where on one end we would have 'professional runners' (ie, those who practise running as the main occupation in their lives), and on the other end we would have 'recreational runners' (ie, those who practise running only in leisure time). We recognise that between the classifications above mentioned there are a range of possible runner profiles. However, for this study, we have operationalised the definition of 'recreational runner' in a pragmatic way aiming at including the population heterogeneity related to this classification in our target population in order to increase the generalisability of the developed running-related injury prevention programme. Therefore, we defined 'recreational runners' as those who do not practise running as the main occupation (profession) in their lives. Examples of 'recreational runner' profiles could be (but not limited to): (1) experienced runners who run during leisure time and for fun; (2) novice runners who run during leisure time to enhance their health; (3) runners who participate in running events at an amateur level; (4) runners who compete in running events at a professional level, but running is not their main occupation (eg, a lawyer who is also a runner, but her main occupation is advocacy, although she likes to compete for medals).

The reason to target 'recreational runners' was that most recreational runners have no or minor professional assistance, and usually they have doubts about injury prevention. By using the PRECEDE[37] model, we established 'running-related injury' as the health problem. Behaviours of the target population at risk were: (1) not listening to the body; (2) not identifying minor symptoms as the beginning of a potential running-related injury; (3) not following the training schedule; (4) lack of adaptation to running shoes; (5) changing shoes/foot strike pattern; (6) poor running technique (biomechanics); (7) going beyond the limits to 'show off' on social media; (8) doing what famous people say/do in social media; (9) feeling 'pushed' by being part of a group; (10) not performing conditioning exercises; (11) not learning how to run before starting to run; (12) not seeking for professional help/opinion; and (13) overtraining (beyond limits). The personal determinants towards the adoption of running-related injury risk behaviours identified were: risk perception not accurate; lack of knowledge; attitude towards risk behaviours; subjective norms influencing risk behaviours; low self-efficacy; and poor skills on adhering to preventive behaviours. The PRECEDE model elicited by the evaluation process of this study can be found in online supplemental appendix D.

The broader topics yielded from the needs assessment of the focus group were: (1) monitoring the volume of training by a running schedule (ie, NA.1 and NA.4; table 1), reaching 30.3% (FET=70) of the total mentions regarding the needs assessment codes; (2) attention for some symptoms (ie, NA.3, NA.5 and NA.8; table 1) reaching 28.1% (FET=65); (3) importance of conditioning exercises (ie, NA.2, NA.9 and NA.10; table 1) reaching 19.5% (FET=45); running shoes (ie, NA.6; table 1) reaching 12.1% (FET=28); and biomechanics (ie, NA.7; table 1) reaching 10.0% (FET=23).

Step 2: matrix of change objectives

Based on the needs assessment findings, behavioural outcomes of at-risk groups were defined: (1) identification of minor symptoms as the beginning of a potential injury; (2) not seeking professional (health-related or training-related) help/opinion when necessary; (3) not following the training schedule; (4) doubts about running shoes like comfort or adaptations; (5) doubts about biomechanics like running technique and foot strike patterns; and (6) the need and how to perform conditioning exercises underlying with running training. Matrices of change objectives connect the performance objectives with the personal determinants (eg, knowledge, self-efficacy and skills) that would probably/theoretically lead to a change in preventive behaviour. The intersection of the performance objectives with their personal or environmental determinants led to the matrix change objectives described in online supplemental appendix E.

Step 3: methods and practical applications

Based on the matrix of change objectives, the general objectives of the running-related injury prevention programme were established in two broad actions: (1) to provide feedback on individual training characteristics and running-related injury risk; and (2) provide/enhance knowledge, self-efficacy and skills towards running-related injury prevention divided into three specific objectives: (2.1) to provide knowledge on symptoms, foot strike patterns, running shoes and conditioning exercises; (2.2) to facilitate self-efficacy on keeping a running training programme; and (2.3) to enhance skills on incorporating conditioning exercises. Considering the two general and the three specific objectives described, the running-related injury prevention programme was developed based on the Integrated Behavioural Model.[22] Table 2 describes the methods and applications for the change objectives.

Table 1 Results of the needs assessment

Code	FET	FET %	n*	n %*
NA.1 Understand how to get a training schedule; understand the consequences of not following the training schedule.	40	17.3	8	80.0
NA.2 Understand why conditioning exercises are important for prevention of running-related injuries.	39	16.9	7	70.0
NA.3 Understand the importance of having contact with health professionals for the prevention of running-related injuries.	31	13.4	8	80.0
NA.4 Express control in keeping the training schedule.	30	13.0	5	50.0
NA.5 Understand when a minor injury may be a matter of concern.	28	12.1	7	70.0
NA.6 Understand that comfort should be the most important factor when choosing running shoes.	28	12.1	7	70.0
NA.7 Understand that there is no right or wrong foot strike pattern.	23	10.0	6	60.0
NA.8 Understand when it is recommended to seek professionals' opinion/help.	6	2.6	2	20.0
NA.9 Understand how to perform conditioning exercises; understand how to incorporate conditioning exercises in a week routine.	5	2.2	3	30.0
NA.10 Be able to perform conditioning exercises; be able to incorporate conditioning exercises in a week routine.	1	0.4	1	10.0
Total	231	100	–	–

*The sum of 'n' and '% of n' equals more than 10 and 100%, respectively, because the participants could report multiple categories.
FET, frequency of emerging themes; n, number of participants; NA, needs assessment.

Step 4: programme production

The first consensus achieved was that running load monitoring is important for running-related injury prevention. Therefore, runners would answer, every 2 weeks, to a questionnaire in order to provide evidence of running load and progression over time (general objective 1). If any symptom related to running practice is detected by the questionnaire, the runners would be directed to an algorithm that would help them in managing their running training volume for the next 2 weeks if they so desire (online supplemental appendix F). At the end of the algorithm, the participants receive: (1) the suggested training volume for the next 2 weeks ranging from 10% to 30% of the volume previously reported at the beginning of the questionnaire; and (2) an infographic with information on how the calculation was done (online supplemental appendix G). To accomplish the general objective 2 related to providing knowledge (specific objective 2.1), self-efficacy (specific objective 2.2) and skills (specific objective 2.3), a website was created in order to communicate information on the topics shown in table 3.

Step 5: adoption and implementation

The delivery strategy would be done through automated tailored online feedback on the severity of symptoms and running load, just after the runners answered the monitoring questionnaire applied every 2 weeks. In addition, the information aimed at providing knowledge and enhancing self-efficacy and skills will be delivered every month through an internet link referring the runners to the RunIn3 website (http://runin3.com.br). A detailed explanation on the implementation process of the RunIn3 prevention programme can be found elsewhere.[33]

Step 6: evaluation planning

The RunIn3 prevention programme will be evaluated through a pragmatic hybrid type 1 randomised controlled trial. The protocol describing the methods in detail can be found elsewhere.[33] The randomised controlled trial has been prospectively registered in ClinicalTrials.gov under the identifier NCT03892239.

DISCUSSION

The prevention programme was developed based on perspectives of behavioural and social science theories. The Integrated Behavioural Model was chosen to guide the development of the RunIn3 prevention programme because this theory covers all determinants that influence preventive behaviours towards running-related injury prevention established through discussions among the participants of this study during the focus group meetings, considering the preferences of the target population: that is, recreational runners. Therefore, the Integrated Behavioural Model was selected *ad hoc* to match with what the participants revealed in the focus groups. The determinants (knowledge, self-efficacy and skills) may influence the preventive behaviours towards running-related injuries presented in table 1. These findings reflect the opinions and beliefs of recreational runners.[45]

Table 2 Methods and applications to the target population

Change objectives per determinant	Method(s)	Application(s)
Knowledge		
To understand when a minor injury may be a matter of concern.	Belief selection	Explain the relation of tissue damage and the thresholds (pain, performance, participation and time loss), types of signs and symptoms of an injury and the difference between delayed-onset muscle soreness (DOMS) and injury.
	Feedback	Provide feedback on OSTRC-BR outcomes.
To understand the importance of having contact with health professionals for the prevention of running-related injuries.	Belief selection	Explain the consequences of not seeking a professional when your symptoms do not go away.
	Persuasive communication	A health professional explaining the importance of having contact with professionals for the prevention of running-related injuries.
	Reinforcement	Reminding the importance of having contact with health professionals.
To understand when it is recommended to seek professionals' opinion/help.	Belief selection	Explain how a running-related injury can impact in runners' health and running practice.
	Persuasive communication	A health professional explaining when it is recommended to seek professionals' opinion/help.
	Feedback	Provide feedback on OSTRC-BR outcomes.
To understand how to get a training schedule.	Belief selection	Explain how and with whom to get a training schedule.
	Persuasive communication	A trainer explaining the importance of having and following a running schedule.
	Reinforcement	Send messages with tips on how to get a proper running schedule.
To understand the consequences of not following the training schedule.	Belief selection	Explain that overtraining and the lack of recovery in appropriate time can lead to injuries.
	Persuasive communication	A physiotherapist/medical doctor explaining the consequences of not following the training schedule.
	Reinforcement	Send messages with examples on the consequences of not following the training schedule.
To understand that comfort should be the most important factor when choosing running shoes.	Belief selection	Explain that comfort should be the most important factor when choosing running shoes.
	Persuasive communication	A trainer/physiotherapist explaining why comfort should be the most important factor when choosing running shoes.
To understand that there is no right or wrong foot strike pattern.	Belief selection	Explain foot strike patterns and state there is no right or wrong pattern with regard to running-related injuries.
	Persuasive communication	A trainer/physiotherapist explaining why there is no right or wrong foot strike pattern with regard to running-related injuries.
To understand why conditioning exercises are important for the prevention of running-related injuries.	Belief selection	Explain the importance of conditioning exercises for running practice.
	Persuasive communication	A trainer explaining the importance of conditioning exercises for running practice.
	Reinforcement	Reminding the runner to perform conditioning exercises on a regular basis.
To understand how to perform conditioning exercises in different contexts.	Belief selection	Explain how to perform conditioning exercises in different contexts.
	Persuasive communication	A trainer explaining how to perform conditioning exercises in different contexts.
Self-efficacy		
To develop self-control in keeping the training schedule.	Goal setting	Establish a goal for each running practice or for each training week that is in line with the running schedule.
	Set graded tasks	Slowly progress the running volume and intensity, with periods of recovery and periodisation.
Skills		
To be able to perform conditioning exercises (eg, at the gym, home or parks).	Facilitation	Instructions and demonstrations on the possibility and how to perform conditioning exercises in different settings/environments.
To be able to incorporate conditioning exercises in a week routine.	Facilitation	Instructions and demonstrations on when to perform conditioning exercises in different settings/environments.

OSTRC-BR: Brazilian-Portuguese version of the Oslo Sports Trauma Research Centre Questionnaire on Health Problems.[50]

Table 3 Full description of the strategies in the RunIn3 programme

Programme component and delivery time point	Description	Strategy
Weekly progression First delivery: week 2 Reinforcement: week 28	Description of weekly progression; discussion of their importance; how to progress weekly volume	Website contains: ► Informative text ► Video with explanation ► Infographic
Warm-up/stretching First delivery: week 4 Reinforcement: week 30	Description of warm-up; discussion of stretching versus warm-up	Website contains: ► Informative text ► Video with explanation
Warm-up/stretching First delivery: week 6 Reinforcement: week 34	How to perform a warm-up (examples)	Website contains: ► Video with examples
Symptoms differentiation—inflammation First delivery: week 10 Reinforcement: week 36	Description of inflammatory symptoms; most common body regions; description of cryotherapy; how to perform cryotherapy; weekly progression reminder; if persists, it's time to seek a professional for help	Website contains: ► Informative text ► Video with explanation ► Video with example of cryotherapy
Symptoms differentiation—delayed-onset muscle soreness (DOMS) First delivery: week 12 Reinforcement: week 40	Description of DOMS symptoms; most common body regions for DOMS; adequacy of weekly progression; performing light exercises	Website contains: ► Informative text ► Video with explanation
Foot strike patterns First delivery: week 16 Reinforcement: week 42	Description of foot strike patterns; explanation of misinterpretation of better/worst foot strike patterns	Website contains: ► Informative text ► Video with explanation ► Video with demonstration of foot strike patterns
Running shoes First delivery: week 18 Reinforcement: week 46	Description of types of running shoes (minimalist/maximalist, antipronation/neutral); explanation of misinterpretation of better/worst running shoes	Website contains: ► Informative text ► Video with explanation
Conditioning exercises First delivery: week 22 Reinforcement: week 48*	Description of exercises; discussion of their importance	Website contains: ► Informative text ► Video with explanation
Conditioning exercises First delivery: week 24 Reinforcement: week 48*	How to perform conditioning exercises (examples)	Website contains: ► Video with examples

*Reinforcement in week 48 contains information of week 22 and week 24.

We have postulated that there are three major concerns regarding running-related injury prevention programmes. First, most running-related injury preventive strategies implemented in practice are not scientific (or evidence) based.[12] Therefore, a strength of this study was to develop an evidence-based running-related injury prevention programme, taking the best scientific knowledge available mixed with the needs and preferences of the target population (ie, recreational runners) and different stakeholders (ie, runners, coaches, running groups, health professionals).

Second, running-related injury preventive strategies are usually based on imposing behaviour changes to runners, such as biomechanical 'corrections' or even replacing running shoes, with no consideration regarding runners' intention to perform such changes.[10 27] Another strength of this study was to develop a running-related injury prevention programme taking into consideration a behaviour model of change (ie, Integrated Behavioural Model) and the determinants (ie, knowledge, self-efficacy and skills) that may influence the runners' intention to perform the behavioural changes that the RunIn3 programme proposes. We believe that this approach will increase the likelihood of runners adopting and sustaining new evidence-based preventive behaviours, or even dropping out old and non-preventive behaviours that are broadcasted in the media nowadays. This is actually the main purpose of social science theories like the Integrated Behavioural Model.[22]

Third, there is a paucity of using implementation science to effectively implement sports injury prevention programmes.[25] For example, the implementation of preventive strategies may present challenges due to lack of financial or technical resources.[46] However, even if the financial and/or technical challenges are overcome, the question remains: would people actually adopt this programme or intervention? Is it feasible to be implemented in the 'real world'? Or even in cases where people are willing to adopt the programme, would its implementation be sustained? All these doubts would

be mitigated if the target population participated in the development process of the programme, providing opinions and suggestions.[17] Therefore, the participatory action approach used in this study may be an important strength, where runners from the community actually commented on their needs, difficulties and preferences towards running-related injury prevention. We believe this approach will increase the likelihood of the programme being implementable in real life.

The low number of participants may be considered a limitation of this study; however, this low number is inherent to the method of choice. Adding more participants increases the likelihood of some people feeling inhibited and, therefore, not participating in the discussions; this may result in divagating discussions that are beyond the control of the focus group moderator; and this may have several unfavourable outcomes such as the inability to transcribe the recorded audios of the meetings due to noise.[47] All these factors being considered, the reduced number of participants in the focus group meetings of this study may have represented a biased view towards running-related injury prevention given the complexity of this matter. To minimise this possible bias, the sample of this study was as heterogeneous as possible in order to gather as much relevant information as possible from different perspectives. The quantitative content analysis approach used in this study may have introduced bias related to personal interpretation and/or deviations from the actual meanings of the transcripts during condensation, coding and/or categorising the qualitative data. However, three researchers were involved in checking and/or reaching a consensus regarding the DP in order to minimise the risk of bias related to personal interpretations.

There is a paucity of effective running-related injury prevention programmes implemented in practice. Therefore, there is a need for the development and evaluation of running-related injury prevention programmes. This might have public health implications, since preventing running-related injuries in large groups (like recreational runners) might improve health, reduce disability, reduce absenteeism from work and reduce costs to the runners and for society.[48 49] Running clubs may benefit from this study in order to rely on the fundamentals of creating evidence-based prevention programmes and not from common sense that has substantial biases. Sports injury researchers might benefit from using and/or adapting the methods applied in this study to other sports in order to increase the body of scientific evidence on the prevention of sports injuries based on behavioural and social science theories. This might increase the number of sports injury prevention programmes proven to be effective and implementable in 'real world'. Furthermore, researchers and/or stakeholders in the field of running-related injury may use the proposed method to support the development of prevention programmes for other populations of runners, such as professional runners.

CONCLUSIONS

A running-related injury prevention programme was developed using the IM framework and a participatory approach. The programme was named 'RunIn3', and it is based on providing feedback on running load and running-related injury risk, as well as providing knowledge, skills and self-efficacy on preventive behaviours towards running-related injury. The programme is aimed to be delivered online through a website.

Author affiliations
[1]Masters and Doctoral Programs in Physical Therapy, Universidade Cidade de São Paulo (UNICID), São Paulo, SP, Brazil
[2]Department of Physical Therapy, Movement and Rehabilitation Sciences, Northeastern University, Boston, MA, USA
[3]Department of Public and Occupational Health (DPOH), Amsterdam Public Health Research Institute (APH), Amsterdam Universities Medical Centers, location VU University Medical Center Amsterdam (VUmc), Amsterdam, The Netherlands
[4]Amsterdam Collaboration on Health and Safety in Sports (ACHSS), Amsterdam Movement Sciences, Amsterdam Universities Medical Centers, location VU University Medical Center Amsterdam (VUmc), Amsterdam, The Netherlands

Twitter Luiz Hespanhol @LucaHespanhol

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ORCID iDs
Caio Sain Vallio http://orcid.org/0000-0002-8599-2680
Gabriela Martins de Oliveira http://orcid.org/0000-0003-1641-3750
Giovana Araujo Kretli Mota http://orcid.org/0000-0001-9723-6594
Alexandre Dias Lopes http://orcid.org/0000-0001-8132-985X
Luiz Hespanhol http://orcid.org/0000-0003-1774-4746

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