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

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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.

INTRODUCTION

Running is an important exercise to stay physically active. The health benefits of running include increasing longevity, cost-effectiveness in preventing cardiovascular diseases and improving health indicators. 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. 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, which is comparable with the summary estimate above mentioned. An important possible consequence of running-related injuries is their negative influence on...
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. The TRIPP framework describes the process to achieve sports injury prevention using the following steps: (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. Nevertheless, there is limited evidence on the effectiveness of running-related injury prevention strategies. Some running-related injury prevention strategies have been implemented in practice without a proper investigation of their effectiveness as suggested by the TRIPP framework. 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. 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. 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.

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. 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 and sports injury prevention programmes.

Behavioural and social science theories

Behavioural and social science theories are being considered essential to develop and implement prevention programmes. 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 has been applied to smoking and cancer 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. The Integrated Behavioural Model is derived from the theory of planned behaviour, which is one of the theories of behaviour change most commonly used in the sports science field. 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, 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’. However, even though the importance of runners’ motivation in running practice. This can lead to a higher probability of dropouts and, in turn, may reduce the beneficial health effects of running.
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. 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. 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. Stage 1 (‘injury surveillance’) and stage 2 (‘establishing aetiology and mechanisms of injury’) were conducted a priori and the results related to these stages can be found elsewhere. 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. 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 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 8. However, our focus group model 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) 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), 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. In this study, the participatory approach directly involved the running community (runners, coaches, health professionals, researchers, stakeholders) in discussions on the entire programme development process and in designing the pragmatic hybrid type 1 randomised controlled trial aimed at addressing step 6 of IM. 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.

Data collection

Focus group was used to collect qualitative data during face-to-face meetings. The 32-item Consolidated Criteria for Reporting Qualitative Research (COREQ) was used to guide the focus group. 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 appendixes 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).1537 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 approach38 39 and it was conducted following a quantitative content analysis orientation based on inductive reasoning.40–42 Another qualitative study43 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:46–42: (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 4 weeks between the meetings. The outcomes elicited during the focus group meetings can be found in online supplemental appendixes 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 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 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. Table 2 describes the methods and applications for the change objectives.
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.

<table>
<thead>
<tr>
<th>Code</th>
<th>FET</th>
<th>FET %</th>
<th>n*</th>
<th>n %*</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA.1</td>
<td>40</td>
<td>17.3</td>
<td>8</td>
<td>80.0</td>
</tr>
<tr>
<td>NA.2</td>
<td>39</td>
<td>16.9</td>
<td>7</td>
<td>70.0</td>
</tr>
<tr>
<td>NA.3</td>
<td>31</td>
<td>13.4</td>
<td>8</td>
<td>80.0</td>
</tr>
<tr>
<td>NA.4</td>
<td>30</td>
<td>13.0</td>
<td>5</td>
<td>50.0</td>
</tr>
<tr>
<td>NA.5</td>
<td>28</td>
<td>12.1</td>
<td>7</td>
<td>70.0</td>
</tr>
<tr>
<td>NA.6</td>
<td>28</td>
<td>12.1</td>
<td>7</td>
<td>70.0</td>
</tr>
<tr>
<td>NA.7</td>
<td>23</td>
<td>10.0</td>
<td>6</td>
<td>60.0</td>
</tr>
<tr>
<td>NA.8</td>
<td>6</td>
<td>2.6</td>
<td>2</td>
<td>20.0</td>
</tr>
<tr>
<td>NA.9</td>
<td>5</td>
<td>2.2</td>
<td>3</td>
<td>30.0</td>
</tr>
<tr>
<td>NA.10</td>
<td>1</td>
<td>0.4</td>
<td>1</td>
<td>10.0</td>
</tr>
<tr>
<td>Total</td>
<td>231</td>
<td>100</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

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

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

### Table 3 Full description of the strategies in the RunIn3 programme

<table>
<thead>
<tr>
<th>Programme component and delivery time point</th>
<th>Description</th>
<th>Strategy</th>
</tr>
</thead>
</table>
| **Weekly progression** | Description of weekly progression; discussion of their importance; how to progress weekly volume | Website contains:  
  ► Informative text  
  ► Video with explanation  
  ► Infographic |
| First delivery: week 2  
Reinforcement: week 28 | | |
| **Warm-up/stretching** | Description of warm-up; discussion of stretching versus warm-up | Website contains:  
  ► Informative text  
  ► Video with explanation |
| First delivery: week 4  
Reinforcement: week 30 | | |
| **Warm-up/stretching** | How to perform a warm-up (examples) | Website contains:  
  ► Video with examples |
| First delivery: week 6  
Reinforcement: week 34 | | |
| **Symptoms differentiation—infarction** | 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 |
| First delivery: week 10  
Reinforcement: week 36 | | |
| **Symptoms differentiation—delayed-onset muscle soreness (DOMS)** | Description of DOMS symptoms; most common body regions for DOMS; adequacy of weekly progression; performing light exercises | Website contains:  
  ► Informative text  
  ► Video with explanation |
| First delivery: week 12  
Reinforcement: week 40 | | |
| **Foot strike patterns** | Description of foot strike patterns; explanation of misinterpretation of better/worst foot strike patterns | Website contains:  
  ► Informative text  
  ► Video with explanation |
| First delivery: week 16  
Reinforcement: week 42 | | |
| **Running shoes** | 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 |
| First delivery: week 18  
Reinforcement: week 46 | | |
| **Conditioning exercises** | Description of exercises; discussion of their importance | Website contains:  
  ► Informative text  
  ► Video with explanation |
| First delivery: week 22  
Reinforcement: week 48* | | |
| **Conditioning exercises** | How to perform conditioning exercises (examples) | Website contains:  
  ► Video with examples |
| First delivery: week 24  
Reinforcement: week 48* | | |

*Reinforcement in week 48 contains information of week 22 and week 24.
be mitigated if the target population participated in the development process of the programme, providing opinions and suggestions.\(^4\) 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 diverging 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.\(^4,7\) 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.\(^4,6\) 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.

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**Contributors** LH conceptualised the study. All authors were involved in designing and conducting the study. CSV, GMO and GAKM cleaned and analysed the data. All authors were involved in interpreting the data. All authors were involved in drafting and revising the entire manuscript for intellectual content, and all approved the final version of the article. All authors had full access to the data (including statistical reports and tables) and can take responsibility for the integrity of the data and the accuracy of the data analysis.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Ethics approval** The study was approved by the Research Ethics Committee of the Universidade Cidade de São Paulo (UNICID)—CAAE 69503717.2.0000.0064.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request to LH (corresponding author). Deidentified participant data might be available after the consent of all authors and the privacy policy of the Universidade Cidade de São Paulo (UNICID).

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RunIn3: The development process of a running-related injury prevention program

Journal: *BMJ Open Sport & Exercise Medicine*

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Electronic Supplementary Material

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## Appendix A

### Definition of terms related to behavioral science

<table>
<thead>
<tr>
<th>Terms</th>
<th>Meaning</th>
</tr>
</thead>
</table>
| Behavioral outcomes              | “The behaviors that influence the risk of the health problem.”
| Determinants of behaviors outcomes | “The personal and environmental determinants that influence behaviors.”
| Performance objectives            | “Performance objectives are statements of what a participant will do or how the individual will modify the environment.”
| Change objectives                 | “Specify what needs to change in the determinants of behavioral outcomes to accomplish the performance objectives, further delineating the logic of change.”
| Focus group                       | “A small set of people, typically 4 to 12 in number, who share characteristics and are selected to discuss a topic of which they have personal experience. A leader conducts the discussion and keeps it on target while also encouraging free-flowing, open-ended debate.”
| Theory of Reasoned Action         | “The theory that attitudes toward a behavior and subjective norms (perceived expectations) regarding a behavior determine a person’s intention to perform that behavior. Intentions are in turn assumed to cause the actual behavior. Also called reasoned action model.”
| Knowledge                         | “The state of being familiar with something or aware of its existence, usually resulting from experience or study.”
| Attitude                          | “Attitudes provide summary evaluations of target objects and are often assumed to be derived from specific beliefs, emotions, and past behaviors associated with those objects.”
| Subjective norm                   | “A perception that an individual has regarding whether people important to that individual believe that he or she should or should not perform a particular behavior.”
| Self-efficacy                     | “An individual’s subjective perception of his or her capability to perform in a given setting or to attain desired results, proposed by Albert Bandura as a primary determinant of emotional and motivational states and behavioral change. Also called perceived self-efficacy.”
| Skills                            | “An ability or proficiency acquired through training and practice. Motor skills are characterized by the ability to perform a complex movement or serial behavior quickly, smoothly, and precisely. Skills in other learned tasks include basic skills, communication skills, and social skills.”

---


Appendix B

Consolidated Criteria for Reporting Qualitative Research (COREQ) 32-item

Domain 1: Research team and reflexivity

Personal Characteristics

1. Interviewer/facilitator: Which author/s conducted the interview or focus group?
   LH was the moderator, CSV was a facilitator, GMO and GAKM were assistants.

2. Credentials: What were the researcher’s credentials?
   LH is a certified physical therapist, and he got his PhD in Public Health. CSV is a certified
   physical therapist and a PhD candidate in Physical Therapy. GMO is a certified
   physical therapist and a candidate to the master’s degree in Physical Therapy. GAKM is a
   undergraduate candidate to the bachelor’s degree in Physical Therapy performing a
   scientific internship within this research project.

3. Occupation: What was their occupation at the time of the study?
   LH is a Full Professor of the Masters and Doctoral Programs in Physical Therapy of the
   Universidade Cidade de São Paulo (UNICID). CSV, GMO and GAKM are PhD, Masters
   and Scientific Initiation candidates under supervision of LH, respectively.

4. Gender: Was the researcher male or female?
   LH and CSV are men, GMO and GAKM are women.

5. Experience and training: What experience or training did the researcher have?
   LH has formal training in Intervention Mapping. LH has formal training in Dissemination
   & Implementation Science. LH conducted a study with similar methods between 2015
   and 2018.
Relationship with participants

6. Relationship established: Was a relationship established prior to study commencement?
   Yes, a relationship was established either by e-mail or text message (smartphone or social media) prior to study commencement. In addition, LH already knew the participants prior to study commencement.

7. Participant knowledge of the interviewer: What did the participants know about the researcher?
   The participants knew LH and he is a researcher in the field of sports injury prevention.

8. Interviewer characteristics: What characteristics were reported about the interviewer/facilitator?
   LH is a researcher in the field of sports injury prevention, and he has experience in running-related injuries and process evaluation.

Domain 2: study design

Theoretical framework

9. Methodological orientation and Theory: What methodological orientation was stated to underpin the study?
   Semantic thematic approach following a quantitative content analysis orientation based on inductive reasoning.

Participant selection

10. Sampling: How were participants selected?
    By convenience.

11. Method of approach: How were participants approached?
    Invitation by e-mail and/or text message (smartphone or social media).
12. Sample size: How many participants were in the study?
   10.

13. Non-participation Setting: How many people refused to participate or dropped out? Reasons?
   5 people refuse the invitation due to conflicting agenda.

14. Setting of data collection: Where was the data collected?
   The data was collected at the Universidade Cidade de São Paulo (UNICID).

15. Presence of non-participants: Was anyone else present besides the participants and researchers?
   No.

16. Description of sample: What are the important characteristics of the sample?
   All participants were located and have been working in the Metropolitan Region of São Paulo, Brazil. They were runners, coaches, health professionals, researchers and stakeholders.

Data collection

17. Interview guide: Were questions, prompts, guides provided by the authors? Was it pilot tested?
   A guide was developed and extensively revised by the research team [Appendix C].

18. Repeat interviews: Were repeat interviews carried out? If yes, how many?
   No.

19. Audio/visual recording: Did the research use audio or visual recording to collect the data?
   We used audio recording to collect the data.

20. Field notes: Were field notes made during and/or after the interview or focus group?
   The facilitator (CSV) carried out the field notes to facilitate the transcriptions.
21. Duration: What was the duration of the interviews or focus group?
   There were conducted 3 meetings with an average duration of 2.5 hours and with an average interval of four weeks between the meetings.

22. Data saturation: Was data saturation discussed?
   Yes, when the topic was saturated, the moderator (LH) changed the content to be discussed.

23. Transcripts returned: Were transcripts returned to participants for comment and/or correction?
   No.

**Domain 3: analysis and findings**

*Data analysis*

24. Number of data coders: How many data coders coded the data?
   2 coders (CSV and GMO) coded the data.

25. Description of the coding tree: Did authors provide a description of the coding tree?
   No.

26. Derivation of themes: Were themes identified in advance or derived from the data?
   The themes were derived from the data.

27. Software: What software, if applicable, was used to manage the data?
   R version 3.3.3 and RQDA package to qualitative data analysis.

28. Participant checking: Did participants provide feedback on the findings?
   Yes, the participants had the opportunity to revise the proposed final product in the last focus group meeting, when the research group presented the prototype of the program to the participants encouraging an open discussion on the matter.
Reporting

29. Quotation presented: Were participant quotations presented to illustrate the themes / findings? Was each quotation identified?

No.

30. Data and findings consistent: Was there consistency between the data presented and the findings?

Extensive discussions were held among the researchers (LH, CSV and GMO) until a consensus was reached. Therefore, yes, we believe that there was consistency between the data presented and the findings.

31. Clarity of major themes: Were major themes clearly presented in the findings?

Yes, major themes were clearly presented in the findings in form of tables.

32. Clarity of minor themes: Is there a description of diverse cases or discussion of minor themes?

Extensive discussions were held among the researchers (LH, CSV and GMO) about minor themes (performance objectives), which were described in Appendix E.

Reference

Appendix C

The semi-structured guide for the focus group meetings

1. **Number of participants:**
   Between 4 and 12 participants.

2. **Duration:**
   Between 1 and 3 hours.

3. **Moderator:**
   LH.

4. **What we want to know?**
   - Risk behaviors towards running-related injuries;
   - Determinants of risk behaviors towards running-related injuries;
   - What changes risk behaviors towards running-related injuries;
   - Preventive behaviors towards running-related injuries;
   - Determinants of preventive behaviors towards running-related injuries;
   - What changes preventive behaviors towards running-related injuries.

5. **Rules and details:**
   Two or more individuals cannot talk at the same time; this makes it difficult to transcribe the audio.

6. **Presentation of evidence:**
   Presentation, in slideshow, of a general and impartial overview about the evidence on the prevention of running-related injuries.
   Ministered by LH.
   Duration (30–45 min).

7. **Questions:**
   Avoid dichotomous questions;
   From 8 to 12 questions.

7.1. **Opening:**
   Promote interaction and encourage everyone to talk.
   a) “Briefly, would you like to introduce yourselves and to tell what you do? (Training, occupation or function that you think relates to injury prevention, running or research)”.


7.2. Introduction:
Introduce the subject to be discussed and get to know the level of understanding of the participants with regard to the previous presentation.
   b) “After the presentation, what do you think about the prevention of running-related injuries?”

7.3. Transition:
Direct to the questions of interest.
   c) “What would be the influence of the runners’ behaviors that could lead to running-related injuries or could protect the runners to develop running-related injuries?”

7.4. Exploratory/key questions:
Questions of Interest.
   d) “What are the behaviors adopted by runners who increase their exposure to risk factors of running-related injuries? That is, risk behavior.”
   e) “What do you think that drives runners to adopt these behaviors?”
   f) “What are the behaviors adopted by runners who reduce their exposure to risk factors of running-related injuries? That is, preventive behavior.”
   g) “What do you think that drives runners to adopt these behaviors?”

7.5. Closure:
Summarize the subject and make sure there are no pending issues.
   h) “How an ideal running-related injury prevention program should look like?”
   i) “Have we forgotten something or would you like to add something?”
Appendix D

Needs assessment PRECEDE logic model
PRECEDE: Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation

RunIn3

RunIn3: Running-related injury prevention program

Behavior-related methods
- Belief selection
- Feedback
- Persuasive communication
- Reinforcement
- Goal setting
- Set graded tasks
- Facilitation

Training-related methods
- Training load monitoring
- Suggestions for safe training load

Personal determinants
- Risk perception
- Lack of knowledge
- Attitude
- Social norms
- Self-efficacy
- Skills

Behavior at risk group
- Not listening to the body
- Not identifying minor symptoms as the beginning of a potential injury
- Not following the training schedule
- Lack of adaptation to running shoes
- Changing shoes/foot strike pattern
- Running technique (biomechanics)
- Social media: 'showing off'
- Social media: doing what famous people say/do
- Being part of a group
- Not performing conditioning exercise
- Not learning how to run before start practicing
- Not seeking professional help/opinion
- Overtraining (beyond limits)

Health problem:
- Running-related injuries

Environmental conditions and behavior of environmental agent
- Not tailoring the training for the runner purpose
- Not tailoring the training for the runner’s needs
- Peers social pressure regarding to performance
- Groups social pressure regarding to 'being cool'

Quality of life
## Appendix E

Matrix of change objectives for behavioral outcomes of at-risk group

<table>
<thead>
<tr>
<th>Performance Objectives</th>
<th>Self-efficacy</th>
<th>Skills</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>To know how to identify minor symptoms in the beginning of a potential injury</td>
<td>–</td>
<td>–</td>
<td>To understand when a minor injury may be a matter of concern</td>
</tr>
<tr>
<td>To establish contact with health professionals</td>
<td>–</td>
<td>–</td>
<td>To understand the importance of having contact with health professionals for the prevention of running-related injuries</td>
</tr>
<tr>
<td>To identify when it is necessary to seek professionals’ opinions/help</td>
<td>–</td>
<td>–</td>
<td>To understand when it is recommended to seek professionals’ opinions/help</td>
</tr>
<tr>
<td>To have a training schedule</td>
<td>–</td>
<td>–</td>
<td>To understand how to get a training schedule</td>
</tr>
<tr>
<td>To know the importance of following and the consequences of not following (more and less) the training schedule</td>
<td>–</td>
<td>–</td>
<td>To understand the consequences of not following the training schedule (e.g., overtraining and lack of recovery in appropriate time can lead to overuse injuries)</td>
</tr>
<tr>
<td>To demonstrate self-control to follow a training schedule</td>
<td>To develop self-control in keeping the training schedule</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>To know that comfort is the most important factor for choosing running shoes</td>
<td>–</td>
<td>–</td>
<td>To understand that comfort should be the most important factor when choosing running shoes</td>
</tr>
<tr>
<td>To know that there is no right foot strike</td>
<td>–</td>
<td>–</td>
<td>To understand that there is no right or wrong foot strike pattern</td>
</tr>
<tr>
<td>To know the importance of performing conditioning exercises</td>
<td>–</td>
<td>–</td>
<td>To understand why conditioning exercises are important for the prevention of running-related injuries</td>
</tr>
<tr>
<td>To know how to perform conditioning exercises</td>
<td>–</td>
<td>To be able to perform conditioning exercises (e.g., at the gym, home or parks)</td>
<td>To understand how to perform conditioning exercises in different contexts</td>
</tr>
<tr>
<td>To incorporate conditioning exercises in the training schedule</td>
<td>–</td>
<td>To be able to incorporate conditioning exercises in a week routine</td>
<td>To understand how to incorporate conditioning exercises in a week routine</td>
</tr>
</tbody>
</table>

*When personal determinants of behavioral outcomes are not defined for performance objectives, the sign “–” is presented.*
Appendix F

Algorithm to help runners in managing their running volume

1. Are you trying to improve your performance?
   - Yes
   - No

2. Are you being advised by a trainer or following a schedule?
   - Yes
   - No

3. Would you like to receive running volume advice?
   - Yes
   - No

4. Would you like a suggestion to discuss with your trainer?
   - Yes
   - No

5. Would you like a suggestion on running volume for the next two weeks?
   - Yes
   - No

6. Suggestion for the next two weeks

7. Infographic on how to improve your running volume

8. End of the questionnaire
Appendix G

Infographic explaining how runners can manage their running volume

**RUNNING VOLUME PROGRESSION**
An acceptable running volume progression is about a 10% increase (km or hours), based on your last week of training, implemented within the next 2-week period. This may reach a maximum of 30%.

This will depend on your fitness level or fatigue!

A simple way to monitor the weekly running volume is by measuring the total distance (km) or duration (hours) of running performed within the last week.

**HOW TO CALCULATE?**
Increase slowly the running distance (km) or duration (hours) within the next 2-week period until you reach the average (10%) or the maximum (30%) progression as calculated below.

**AVERAGE**
Multiply the total distance (km) or duration (hours) of the last week by 0.1.
The result will be a safe progression to the next 2-week period.

**MAXIMUM**
Multiply the total distance (km) or duration (hours) of the last week by 0.3.
The result will be a safe upper limit, that would be recommended not to overtake.