Risk factors for knee injuries among recreational runners: a prospective cohort study in the Netherlands

Masterthesis

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“ONDERGETEKENDE

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bevestigt hierbij dat de onderhavige verhandeling mag worden geraadpleegd en vrij mag worden gefotokopieerd. Bij het citeren moet steeds de titel en de auteur van de verhandeling worden vermeld.”

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ABSTRACT

Background: Running is a well-known form of physical activity and is becoming increasingly popular among recreational sports participants in recent years. Nevertheless, running can result in injuries and physical impairments. The most reported running injuries are knee injuries. Risk factors for obtaining a knee injury in recreational runners have not yet been reported.

Aim: The aim of this study was to determine the risk factors for running-related knee injuries and to develop a prediction rule that estimates the probability for knee injuries in recreational runners.

Methods: This study is an observational prospective cohort study and included 3,768 participants. Possible risk factors were obtained one month before the start of a running event. Information on injuries were obtained using a post-race questionnaire one week after the event. The association between potential risk factors and knee injuries was determined using multivariate logistic regression analysis.

Results: In total 2,736 (73.3%) participants responded to the post-race questionnaire of which 163 participants reported a knee injury. The risk model contained four factors. A history of injuries in the previous twelve months (OR=3.29) and a long-distance run during a running event (OR=1.53) increased the risk of a knee injury. Older age (OR=0.97) and more training kilometers per week (OR=0.98) were protective factors. The explained variance of the risk model was 8.6% and the area under the curve was moderate (0.64). We derived a prediction rule from the risk model that calculates the predicted probability that recreational runners can suffer a knee injury.

Conclusion: This study indicates that a previous injury in the past twelve months and a long-distance run during a running event were significantly associated with knee injuries ($p<0.05$) and were therefore risk factors for obtaining a running-related knee injury. The prediction rule can be used to estimate the probability of obtaining a running-related knee injury in recreational runners. Other variables should be evaluated to improve predictive capacity of the model and it should be externally validated.

Implication of key findings: Recreational runners, (para)medical professionals, coaches and trainers could use the present findings to potentially reduce the risk of running-related knee injuries.

Keywords: Running, Running-related injuries, Knee injuries, Risk factors, Risk model

INTRODUCTION

Running is a very well-known form of physical activity and is becoming increasingly popular among recreational sports participants in recent years [1,2]. Running is one of the most accessible and popular sport activities worldwide [3]. Many people start running because it has several health benefits such as weight reduction and it shows improvements in cardio respiratory fitness and mental health [4]. The number of Dutch runners has been constantly increasing in recent years, reaching more than two million runners nowadays [5]. This is about 11% of the total Dutch population. The majority of the runners in the Netherlands are recreational runners [6]. The definition for recreational runners are runners who were not competitive with professional runners [2,6].

Despite the popularity of running it also has some downsides, such as injuries and other physical impairments [7]. This could be a result of overtraining [7,8]. In 2014, runners in the Netherlands suffered from 710,000 running injuries, from which 220,000 were medically treated [5]. This indicates that each year roughly 32% of the runners in the Netherlands will get injured [5]. Depending on the definition of running-related injuries, the type of runner investigated, the observation time and the study design, incidence rates of running-related injuries in general vary between 19.4% and 79.3% [6,8,9]. The most running-related injuries are injuries on the lower extremity and the most common anatomical site of running-related injuries is the knee [5,6,8].

Risk factors for developing running-related injuries in general have been extensively evaluated [10–12]. Risk factors that are associated with a lower extremity running-related injury in half marathon and marathon runners were less than five years of running experience and frequent interval training [6]. Other risk factors that are related to a running-related injury in general in male runners were a history of previous injuries and an increased training volume per week [8,13,14]. Risk factors for lower extremity injuries in male marathon runners are participating more than six times in a race in the previous twelve months and previous running injuries [10]. For other potential risk factors such as age, height, body mass index (BMI), sex, training distance, running experience, type of shoes, use of orthotics, warming-up and cooling-down strategies is conflicting evidence [11,14–17]. Because of the heterogeneity of previous studies (e.g., location of running-related injury, definition of running-related injury, recreational or elite runners, short- or long-distance runners and type of study) no clear overview is available regarding the most important risk factors for a running-related knee injury [1,5,6].

Risk factors for developing a knee injury in recreational runners have not yet been reported, despite that knee injuries were the most common injuries in runners. It might be possible that risk factors for knee injuries differ from other running-related injuries and that there could be a difference between recreational runners and professional runners. The occurrence of knee injuries in a study that investigated risk factors for lower extremity injuries among male marathon runners found that knee injuries were associated with previous running injuries, a running experience of more than fifteen years and a lack of interval training [10]. It is important for clinical practice that we understand how running-related knee injuries occur in recreational runners and how we could prevent them for developing a knee injury. Therefore, the aim of this study is to determine the risk factors for knee injuries in recreational runners. Secondly, we aim to develop a prediction rule that estimates the probability of obtaining a knee injury in recreational runners.

METHODS

Study design

The design of this study is an observational prospective cohort study in recreational runners in the Netherlands. Runners were invited to participate in the study and followed-up by using web-based questionnaires.
The Medical Ethical Committee of the Erasmus Medical Centre Rotterdam (MEC-2009-319), the Netherlands, approved this study.

Study participants

Recreational runners who participated in the Amgen Singelloop Breda (October 4, 2009), the Amgen Singelloop Breda (October 2, 2011), the Lage Landen Marathon Eindhoven (October 14, 2012) and the ABN AMRO Marathon Rotterdam (April 15, 2012) were recruited for this study. The runners could participate in different distances including the marathon (41.195 kilometers), half marathon (21.095 kilometers), 15, 10 and 5 kilometers (km).

Participants (≥16 years) were included if they were recreational runners, they can read and understand the Dutch language and they returned both the baseline questionnaire before the running event and the follow-up questionnaire after the event. Recreational runners are runners who were not competitive participants in these running events. Exclusion criteria were registration ≤4 weeks prior to the start of the event, no email address available, company runners or missing baseline information.

Data collection

Participants received via email of the organization an explanation of the study and an invitation to participate. They received a link to an online baseline questionnaire one month before the event (T0). They were asked to fill in the baseline questionnaire and return it by email before the start of the event. All participants who returned the baseline questionnaire were included and received one week after the event a link by email to fill in the online follow-up questionnaire (T1). Non-responders received a reminder within one week. The questionnaires were developed and used before in the Rotterdam Marathon study [10,19].

At baseline (T0) runners were asked to complete questions about sociodemographic characteristics (age, sex, height, weight and education), training related characteristics (training frequency, training distance, speed during training, type of training, warming-up and cooling-down strategies), years of running experience, lifestyle (other sport activities, smoking, alcohol and overall health) and running injuries during the previous twelve months.

Categorical determinants with the answer options always, often, sometimes, rarely or never were dichotomized into 'often' (always, often) and 'sometimes' (sometimes, rarely, never), conform a previous study [10]. BMI was calculated based on height and weight and kept in the analysis as a continuous variable. The variable 'previous injuries in twelve months preceding the event' was dichotomous (yes/no).

According to the 1 to 10 rule (one determinant per every ten injuries) that is used in the analysis we select the appropriate number of determinants based on the literature [20]. A priori we defined 17 determinants relevant for the analysis: age, gender (male/female), BMI, alcohol use (yes/no), daily smoking (yes/no), education level (high/low), injuries in the previous twelve months (yes/no), running experience (years), weekly training hours, frequency and kilometers, average running speed (km/hour), long distance training (often/sometimes), interval training (often/sometimes), warming-up before (often/sometimes) and cooling-down after the training (often/sometimes) and running distance in the event [1,6,10,13,14].

The follow-up questionnaire (T1) collected information about the running event, new running injuries and pain intensity measured on an 11-point numeric rating scale [21,22]. The participants were also asked to report their warming-up and cooling-down strategy and nutrition intake during the running event [10].

Outcome

The outcome of interest is the presence of new knee injuries during the running events as reported at follow-up (T1). Running-related knee injuries are defined as self-reported complaints of the knee joint or knee tendons caused by running activities which reduced running intensity or running frequency, or medical consultation for a knee complaint was needed [6,19,23].

Statistical analysis

If participants subscribed more than one of the running events (e.g., Singelloop 2009 and 2011) we only included the data of the first running event the participant took part.

Descriptive statistics will be used for the baseline characteristics such as frequencies for categorical variables and means and standard deviations (SD). In case data did not show a normal distribution medians and interquartile ranges (IQR) were calculated for continuous variables [24]. To analyze differences for demographic determinants between responders and non-responders the independent samples T-test is used. Before performing the multivariate logistic regression model multicollinearity between potential determinants is evaluated. If a correlation between two determinants was ≥0.8 only one of the determinants was chosen for the multivariate analysis.

Using self-reported knee injuries after a running event as the dependent variable a multivariate regression analysis was performed on the sociodemographic characteristics, the training related variables, information about the race event, lifestyle and previous running injuries. Odds ratios (OR) are presented with 95% confidence intervals (CI). Backward wald elimination was used for the multivariable logistic analysis of prediction of runners at risk for knee injuries in the total cohort, $p \leq 0.10$ was used as cut-off level for elimination of non-significant predictors from the prognostic model [25]. The prognostic model was finished when all the predictors that are included in the model had a p-value ≤0.10 [24].

Lastly, performance measures were calculated. Calibration of the final logistic model was assessed using the Hosmer-Lemeshow goodness-of-fit-test and the explained variance with the Nagelkerke R^2. The Hosmer-Lemeshow test assesses the overall goodness of fit by comparing the predicted and observed frequencies throughout the deciles of risk [26]. The test results in a p-value that gives an indication of the model fit; a higher p-value represents a better fit and $p < 0.05$ indicates a statistical significant lack of fit [26]. The discrimination of the model was assessed using the area under the curve (AUC) to evaluate how well the model distinguished participants who had a knee injury from those who weren’t injured [24,27]. The AUC ranges from 0.5 (no discrimination) to 1.0 (perfect discrimination). An AUC ≥0.7 is considered as good discrimination, an AUC between 0.6 and 0.7 as moderate discrimination and an AUC <0.6 as poor discrimination [26].

To make a model that is suitable for use in clinical practice, we transformed the logistic regression equitation into a prediction rule with score chart using a nomogram based on logistic regression [28]. The coefficients were multiplied by 25 and rounded to the nearest integer to obtain the score per predictor. Multiplication by 25 was chosen to get the majority of the coefficients close to an integer, thereby minimizing the effects of rounding according to a previous study [29]. The sum of all scores reflects the probability for developing a knee injury in recreational runners.

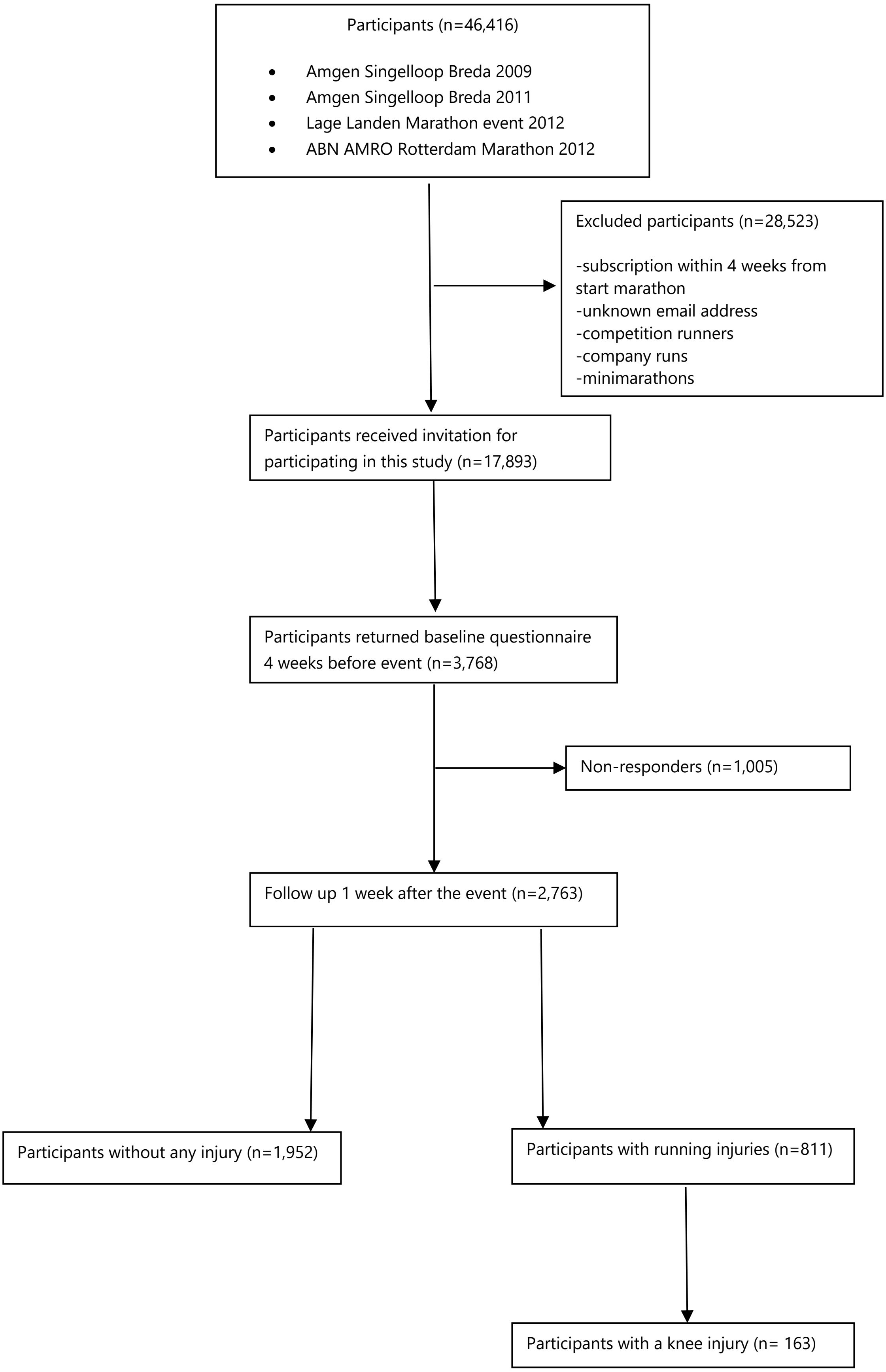
Data were analyzed using the Statistical Package for Social Sciences (IBM SPSS version 24, Inc, Chicago, Illinois).

RESULTS

Participants

A total of 17,891 participants received an invitation by email to participate in this study and a total 3,768 runners (21.1%) returned the baseline questionnaire (figure 1).

Figure 1. *Flowchart*



Baseline characteristics

The mean age of the participants was 42.8 (SD 11.2) years. In total 60.2% of the participants were male and the mean BMI was 23.4 (SD 2.5). More than half of the participants suffered one or more running injuries twelve months preceding the baseline questionnaire (52.2%). Table 1 presents the baseline characteristics of the participants.

Table 1. *Baseline characteristics*

Determinants	**Total n =3,768**
Sociodemographic determinants	
Gender: males (%)	2,270 (60.2)
Age in years: mean (SD), range	42.8 (11.1), 16-77
BMI: mean (SD)	23.4 (2.5)
Education level: higher education (%)	2,875 (76.3)
Daily smoking: yes (%)	161 (4.3)
Alcohol use: yes (%)	3,080 (81.7)
Previous injury ≤12 months: yes (%)	1,967 (52.2)
Training-related determinants	
Training distance, km/week: mean (SD), range	29.8 (18.4), 1-100
Training frequency, times/week: mean (SD) range	2.9 (1.1), 1-12
Training hours, hr/week: mean (SD) range	3.5 (2.0), 1-15
Running speed, km/hr: mean (SD), range	10.4 (1.7), 5-21
Running experience in years: median (IQR), range	5 (11), 0-56
Long-distance training: often (%)	3,430 (91.0)
Interval training: often (%)	1,484 (39.4)
Warming-up before training: often (%)	2,118 (56.2)
Cooling down after training: often (%)	1,427 (37.9)

SD: standard deviation; IQR: interquartile range; BMI: body mass index; kg: kilogram; m: meter; km: kilometers; hr: hour.

Follow-up

One week after the events a follow-up questionnaire was sent to the participants. In total 2,763 runners responded to the follow-up questionnaire (figure 1).

There were significant statistical differences between responders and non-responders at follow-up (table 2). Non-responders were younger, had a higher BMI and ran more often shorter distances in comparison with responders at T1. The differences between the non-responders and responders were nevertheless small.

Table 2. *Characteristics of non-responders versus responders*

	Non-responders	Responders T1
Gender (% male)	572 (56.9%)*	1,698 (61.5%)
Age, mean (SD)	40.8 (11.2)*	43.5 (11.1)
BMI, mean (SD)	23.5 (2.6)*	23.3 (2.4)
Running distance*		
5 km	130 (12.9)	253 (12.9)
10 km	374 (37.2)	1,000 (36.2)
Half marathon	214 (21.3)	713 (25.8)
marathon	275 (28.2)	780 (28.2)

**means statistical significant difference (p <0.05).*

In total 2,566 participants (92.9%) started and finished, 46 participants started their run but did not finish and 151 participants did not start because of injuries or sickness. We received information from 2,763 participants whether they experienced a running-related injury between the baseline questionnaire (T0) and follow-up questionnaire (T1). Overall 811 runners (21.5%) reported one or more running injuries at T1. Of all injured runners, 163 participants (20.1%) reported a knee injury (figure 1). There were no correlations between determinants above 69%, so no determinants were removed from the multivariable regression analysis.

Risk factors

The results of multivariable logistic model for the occurrence of knee injuries are represented in table 3. The multivariate logistic regression analysis resulted in a risk model including four determinants. Two were risk factors and two were protective factors. Risk factors were injuries in the previous twelve months (OR=3.29) and a long-distance run (>15 km) during the event (OR=1.53). Protective factors for the occurrence on knee injuries were an older age (OR=0.97) and a high number of training kilometers (>30 km) per week (OR=0.98). The risk model has an explained variance (Nagelkerke R^2) of 8.6%, an AUC of 0.64 (CI 0.60 – 0.68) and it correctly classifies 91.4% of the runners. The Hosmer-Lemeshow test is not significant (p=0.14), indicating no lack of fit of the model to the data.

Table 3. *Multivariate risk model (backward wald) for incident knee injuries versus no injuries*

Variables	OR (95% CI)
Age	0.97 (0.95 – 0.99)
Weekly training distance (>30 km/week)	0.98 (0.96 – 0.99)
Previous injury (<12 months)	3.29 (2.17 – 5.00)
Running distance during event (>15 km)	1.53 (1.22 – 2.93)
Performance measures	
AUC (95% CI)	0.64 (0.60 – 0.68)
Hosmer-Lemeshow	0.14
Percentage correctly classified	91.4%
Nagelkerke R^2	8.6%

Only entered variables shown; OR, odds ratio; CI, confidence interval; AUC, area under the curve; OR>1.00 is a risk factor; OR<1.00 is a protective factor.

The prediction rule and score chart that we derived from the multivariate risk model is presented in table 4. The weight of an item in the score is based on its related coefficient in the logistic regression equation. The score chart can be used to convert the total score into the predicted probability that recreational runners from ≥16 years can suffer a knee injury. An example of how to calculate the score for an individual recreational runner is presented in the appendix.

Table 4. *Prediction rule & score chart for the probability of obtaining a running-related knee injury*

	Score
Age (≥16 years)*	-2/10 years**
Weekly training distance >30 km/week (yes)	-1
Previous injury past <12 months (yes)	+25
Running distance during an event >15 km (yes)	+22
	Sum of all scores = total score
Total score	**Probability on a knee injury**
<9	0 – 20%
10 – 19	20 – 40%
20 – 29	40 – 60%
30 – 39	60 – 80%
>40	80 – 100%

**The score chart can only be used for runners from 16 years and older.*
***The score decreases with 2 points per 10 years (e.g., a 30-year-old person receives a score of 3 x -2 = -6 points.*

DISCUSSION

This is the first study that assessed the risk factors for running-related knee injuries in recreational runners and derived it into a prediction rule and score chart. This study has identified two risk factors for running-related knee injuries in recreational runners. These two risk factors are a history of injuries in the previous twelve months and a long-distance run during an event. Protective factors are an older age and a high number of training kilometers per week.

Comparison with other studies

In the present study, a history of injuries in the previous twelve months is significantly related with knee injuries shortly before or during a running event ($p<0.05$). This result is supported by previous studies [6,8,10,14]. It could be possible that runners who suffered an earlier injury had an inadequate revalidation, returned to sports to soon or had an insufficient healing process. Eventually this could probably develop a new running-related injury easier or the previous injury is returning. It seems to be important that full recovery have to be taken into account when a runner suffers an injury [6,8,10,14].

Another variable that is associated with the occurrence of knee injuries is the running distance during the event. A distance above 15 km during an event is a risk for a knee injury. This could be explained by the fact that the longer the distance the higher the peak load on muscles and joints is compared to runners who participated on shorter distances [13]. It is also possible that runners who participated on a long-distance run were not prepared enough for running such a long distance. When a runner is insufficiently trained the risk of a running injury during the event is relatively high. The musculoskeletal system can probably not adapt this high impact on the joints and muscles during the run which could lead to overuse running-related injuries [9]. Another explanation for this is that runners on long-distance races are getting more tired during a long race than during their training or compared to runners who participated on shorter distances. Fatigue could probably lead to a different foot strike pattern and step length during the race which will increase the patellofemoral joint pressure during running [30]. Elevated patellofemoral joint kinetics during running could contribute to patellofemoral complaints in runners and can develop knee injuries [31].

This study found two protective factors for the occurrence of running-related knee injuries. One of the protective factors is an older age. This is not in line with previous research where older age was seen as a risk factor for the occurrence of running injuries in general [1,13]. It could be possible that older runners who have more running experience are better trained and prepared for a run than younger runners and were therefore better protected against knee injuries. In addition to this, older runners have a better knowledge of their body so the risk on overuse is less likely to appear compared to younger runners [32]. Another explanation for older age as a protective factor is that older runners have lower peak ground reaction forces (GRF) during running activities [33]. A higher GRF could lead to a higher load on muscles and joints and that could occur running-related injuries [33].

A high number of training kilometers per week (>30 km/week) is also a protective factor for the occurrence of knee injuries in recreational runners. This outcome is contrary to the results of a study that investigated that a high number of weekly training kilometers will contribute to the occurrence of running-related injuries in general [9]. A possible explanation for this is that a high number of weekly training kilometers have positive effects on the musculoskeletal system and anatomical sites [34]. This could prevent a runner from running injuries. It is known that an increased training volume in male runners is a risk factor for running injuries in general, so it should be noted that overuse injuries can occur when a runner is going for an increased amount of training kilometers per week without a well-structured training previously [8,13,14,35].

From a descriptive study about beliefs, opinions and behavior from recreational runners about risk factors for injuries we know that runners think that an excess of training is a risk factor [36]. It is therefore possible that recreational runners do not train the right way so they will not benefit from the protective effects of running enough kilometers per week. This could also explain the risk for developing a knee injury when a runner is participating in a long-distance race during an event. When a runner is insufficiently trained for running such a long-distance because they think that an excess of training is a risk factor it is possible that they are not prepared enough for running such a long distance during an event. This could increase the risk on a knee injury. In summary there is some confusion in runners and they don't know how they should train [36]. It seems to be important for runners that they understand their training and that they know how to train and how to behave to decrease the risk on knee injuries.

Strengths and limitations
The strength of this study is the use of a merged dataset out of four observational prospective cohorts and the large population of runners included [37]. A number of previous studies focused on professional marathon or half-marathon runners. This study focuses on a large amount recreational runners and that made that results could be generalized to a wider population of runners [6,10,12]. Another strength of this study is that we designed a prediction rule with a score chart that can be used in clinical practice. The sum of all scores reflects the probability that recreational runners (≥16 years and older) can suffer a knee injury. The score chart could be used to prevent recreational runners from obtaining a knee injury in the future to minimalize the risks recreational runners could possibly have.

A limitation of this study is that all outcomes and risk factors were self-reported and were therefore not be completely reliable. It should be noted that the definition of injuries used in this study is the same as been used in other studies but there is a new international consensus on defining an injury [2,10,19,38,39]. Differences in understanding the definition of an injury could lead to underestimation of what injuries are and how people interpret injuries. Participants could also apply the criteria for answering the questions differently. This could have led to an overestimation of running-related knee injuries, while complaints for example post-exercise muscle soreness could have been interpret as an injury according to the definition that was used in this study.

Another limitation is that there could be some selection bias in this study. People with an injury could be more motivated to fill in the follow-up questionnaire compared to runners who did not have an injury. We also saw that runners who participated on short distances have responded less to the follow-up questionnaire. It could be possible that these runners are relatively inexperienced and have lower ambitions compared to runners who participated on longer distances. This could interfere with the results of the study. Recall bias could be present at follow-up because participants were asked for a lot of information about their injuries and maybe they could not remember it completely. However, the degree of recall bias is not really high because the participants had the follow-up questionnaire really quickly after the event.

Based on the AUC score, the prediction rule can possibly be improved by adding determinants that we could have missed or determinants that cannot be measured in an observational study. This could be factors such as physical factors or some sociodemographic factors. Factors that are related to knee injuries but we could not measure are muscle strength and some work-related factors [40–42]. Another limitation of the prediction rule is that we do not know the external validation of it. The next step for future research is to externally validate a high-quality prediction model with appropriate performance and discrimination in a new large dataset with more determinants that are possibly related to the occurrence of running-related knee injuries. [43].

Implications

This is the first study that reported the risk factors for a running-related knee injury and derived it into a prediction rule for recreational runners. Despite the limitations of this study the results contribute to the knowledge that describes the need for examining the risks and risk factors for obtaining a running-related knee injury. Recreational runners, (para)medical professionals, coaches and trainers could use the present findings to potentially reduce the risk of running-related knee injuries. Important risk factors for the occurrence of knee injuries are previous injuries and a long-distance run during an event. Furthermore, runners should pay attention at their weekly training distance. A higher weekly training distance seems to be protective for the occurrence of knee injuries. However, caution is required when interpreting and using these results because of the use of self-reported questionnaires, possible bias and that the prediction rule is not externally validated. Further research should be undertaken to investigate the occurrence of knee injuries in large populations and with physical examination tests that will enable to categorize more determinants to investigate possible risk factors for running-related knee injuries. It is also crucial for future research to quantify the external performance of the prediction rule before implementation in clinical practice [43].

Conclusion

This study indicates that a history of injuries in the previous twelve months and a long-distance run during a running event are significantly associated with knee injuries ($p<0.05$) and were therefore risk factors for obtaining a running-related knee injury. We developed a prediction rule with a score chart that estimates the probability that recreational runners can obtain a running-related knee injury. Other variables should be evaluated to improve predictive capacity of the model and it should be externally validated.

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APPENDIX

Practical example prediction rule and score chart

Patient X, a 30-year-old recreational runner wants to know what his expected probability is to obtain a running-related knee injury. He had an injury 6 months ago, his average training distance is about 25 kilometers per week and he is going to run 10 kilometers during an upcoming running event.

	Score	**Score of patient X**
Age (≥16 years)*	-2/10 years**	-6
Weekly training distance >30 km/week (yes)	-1	0
Previous injury past <12 months (yes)	+25	25
Running distance during an event >15 km (yes)	+22	0
	Sum of all scores = total score	19 points
Total score	**Probability on a knee injury**	
<9	0 – 20%	
10 – 19	20 – 40%	
20 – 29	40 – 60%	
30 – 39	60 – 80%	
>40	80 – 100%	

**The score chart can only be used for runners from 16 years and older.*

***The score decreases with 2 points per 10 years (e.g. a 30-year-old person receives a score of 3 x -2 = -6 points.*

The total score of 19 points implies that the expected probability for a running-related knee injury in patient X is 20% to 40%.

SAMENVATTING

Achtergrond: Hardlopen is een populaire vorm van sport en het aantal hardlopers groeit wereldwijd explosief. Ondanks deze populariteit kan hardlopen resulteren in blessures. De meest voorkomende hardloopblessures zijn blessures aan de knie. De risicofactoren op het ontstaan van een knieblessure bij recreatieve hardlopers zijn niet bekend.

Doelstelling: Het doel van deze studie is het weergeven van de risicofactoren op het verkrijgen van een knieblessure bij hardlopers en het ontwikkelen van een predictieregel om de kans op een knieblessure bij recreatieve hardlopers te bepalen.

Methode: Deze studie is een observationele prospectieve cohortstudie. Voor deze studie zijn 3768 recreatieve hardlopers geïncludeerd. Mogelijke risicofactoren en blessures zijn in kaart gebracht een maand vooraf en een week na de start van een hardloopevenement. De associatie tussen mogelijke risicofactoren en knieblessures zijn verkregen doormiddel van multivariate logistische regressieanalyse.

Resultaten: In totaal hebben 2736 (73,3%) hardlopers gereageerd op de vervolg vragenlijst van wie 163 een knieblessure hebben gerapporteerd. Het risicomodel bestaat uit vier factoren. Een blessure in de twaalf voorafgaande maanden (OR=3,29) en het lopen van een lange afstand tijdens een evenement (OR=1,53) zijn risicofactoren voor het ontstaan van een knieblessure. Een oudere leeftijd (OR=0,97) en het lopen van veel trainingskilometers (OR=0,98) zijn beschermende factoren. De verklaarde variantie van het risicomodel was 8,6% en de oppervlakte onder de curve was matig (0,64). Uit het risicomodel is een voorspellingsregel afgeleid dat de kans op een knieblessure berekent bij recreatieve hardlopers.

Conclusie: Deze studie laat zien dat het gehad hebben van een blessure twaalf maanden voorafgaand en het lopen van een lange afstand tijdens een hardloopevenement risicofactoren zijn voor een knieblessure. Daarnaast kan de predictieregel gebruikt worden om te berekenen hoeveel risico een individuele recreatieve hardloper maakt op het verkrijgen van een knieblessure. Andere mogelijke risicofactoren moeten nog in kaart worden gebracht om het predictiemodel te verbeteren en het model moet extern gevalideerd worden.

Klinische relevantie: Recreatieve hardlopers, (para)medische professionals, coaches en trainers kunnen de huidige bevindingen en de risicotabel gebruiken om te kans op het krijgen van een knieblessure te preventief te verminderen.

Sleutelwoorden: Hardlopen, Hardloopblessures, Knieblessures, Risicofactoren, Risicomodel