

Original Research

An Exploratory, Retrospective Study on Injury Occurrence in Triathletes and Marathon Runners

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Background

Injury in populations of runners and triathletes is common. However, while variation in training type and modality is suspected to change the incidence of injury, these factors have not been fully explored.

Purpose

To investigate injury incidence in triathletes and marathon runners to determine which variables are associated with changes in injury reports.

Study Design

Retrospective exploratory analysis.

Methods

Athletes who participated in marathons and triathlons were recruited via social media and endurance athletic groups to participate in a survey on injury history, training history, and training modality. Data were analyzed to assess relationships between factors using Chi-square and regression analysis.

Results

Three hundred and eighty-four marathon runners and triathletes participated (mean age 32; 130 males, 253 females, and one undetermined). There was a positive correlation between increased use of cycling as a training modality and overall injuries ($t = 3.43$, $p = 0.00$) Increased time spent cross training was positively correlated with overall injuries ($t = 2.57$, $p = 0.01$). Volume and frequency of running showed a significant negative correlation with overall injuries ($t = -.12$, $p = 0.02$) as well as a negative correlation between increased weekly swimming time and overall injuries ($t = -3.25$, $p = 0.00$).

Conclusion

Although the number of events and type of event participated in had no statistically significant result on injury rate, the number of hours spent cycling and cross training demonstrated a positive relationship to injury, and number of hours spent swimming and running had a negative relationship on injury rate.

Level of Evidence

Level 3

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INTRODUCTION

Participation in endurance events, such as marathons and triathlons, continues to rise worldwide.¹ A marathon spans 26.2 miles (42.195 km) and a half marathon 13.1 miles (21.098 km),² while an Ironman triathlon includes 2.4 miles (3.86 km) of swimming, 112 miles (180.24 km) of cycling, and a marathon with a half Ironman being half of those distances.³ Injury incidence among endurance athletes has been reported as high as 90%,¹ highlighting the importance of investigating injury occurrence during training.

Overuse injuries result from repetitive stress on tissues.⁴ Risk factors for running-related injuries (RRIs) include years of experience, training volume, and prior injury, though findings remain inconsistent.⁵⁻⁹ While some studies report higher risk among long-term or high-volume runners, others suggest novice runners are more vulnerable. Overall, injury risk is multifactorial, with previous injury consistently noted as an important predictor.

Cross training, defined as exercise modes outside of the primary sport, such as yoga or cycling, has been proposed to reduce injury risk and enhance performance.¹⁰ However, evidence is limited. Voight et al. found cross training common among Boston Marathon qualifiers but not associated with lower injury rates.¹⁰ Similarly, Taunton et al. reported no significant effect of cross training on injury incidence among recreational runners.¹¹ Proposed benefits include reducing impact forces and addressing strength imbalances, though evidence remains inconclusive.¹¹⁻¹³

Training volume also influences injury risk. Rassmussen et al. found that ≥ 30 km/week lowered marathon injury risk,¹⁴ while Kluitenberg et al. and Malisoux et al. observed protective effects of consistent low-intensity running.^{15,16} Conversely, Damsted et al., Winter et al., and Nielsen et al. reported increased injury incidence with mileage increases >20 – 30% .¹⁷⁻¹⁹ Interestingly, Horga et al. found marathon training improved knee joint health in runners with asymptomatic osteoarthritis.²⁰

Cycling and swimming also present mixed associations. Cyclists generally have a low risk of injury, though saddle soreness is common.²¹ Some studies suggest combined cycling and running increases thigh pain and stiffness²² or reduces neuromuscular control,²³ while others report no negative effect on running kinematics.²⁴ Cycling volume has been linked to acute shoulder injuries in triathletes.²⁵

Given conflicting evidence, a gap remains in understanding how training modality and time relate to overuse injuries. The purpose of this study was to investigate injury incidence in triathletes and marathon runners to determine which variables are associated with changes in injury reports. Based on the literature and clinical experience, we hypothesized that: (1) a greater number of completed events would increase injury incidence, (2) cross trainers would report fewer overuse injuries than non-cross trainers, and (3) specific training modalities would be associated with overuse injury occurrence.

METHODS

DESIGN

Retrospective exploratory survey

PARTICIPANTS

A total of 384 participants were recruited, all of whom self-identified as either triathletes (participants in Ironman and half Ironman triathlons) or marathon runners (participants in full and half marathons). All subjects had to be 18 or older and have completed at least one competition (either triathlon, marathon, half-marathon) between October 2017 and October 2018. The sample excluded participants who had injuries at the time the survey was administered, as well as those with any significant surgical history/medical history that affected the musculoskeletal system. The participants were recruited via social media, online forums, and email, using a de-identified link to the online survey instrument.

SURVEY PROCEDURES

Participants were surveyed during a three-week period between October 19th and November 6th, 2018 via an online survey. The survey, developed by the authors did not include a reliability analysis. It consisted of questions regarding demographics, events competed in, history of overuse injuries, hours spent training and/or cross training, average mileage per week, number of days spent running, pace per mile, primary type of running surface, and involvement of a trainer or coach. The survey was sent to five content experts for feedback to achieve content validity. Survey data were collected online using Qualtrics. All responses remained anonymous. IRB approval was granted from the Touro College IRB board.

DATA ANALYSIS

All data were analyzed using SPSS 26. Significance level was set to 0.05 for all tests conducted during the analysis. Cross-tabulations were used to compare marathoners ($n = 184$) and triathletes ($n = 24$) on injury incidence. Correlation analyses were conducted to examine associations between training modalities (running, swimming, cycling, and cross-training) and total number of injuries, identifying both injury-protective and injury-provoking patterns. Training intensity was also examined for correlation with injury incidence. To further evaluate these relationships, regression analyses were performed with training modality and intensity as predictors of total injuries. Correlation strengths were interpreted using Cohen's guidelines ($r = .10$ small, $r = .30$ medium, $r = .50$ large).²⁶

Table 1.

Predictor	B	95% CI (LL, UL)	t	p	Interpretation
Running (hours/wk)	-0.17	(-0.31, -0.03)	-2.44	0.015 *	Small protective effect
Cycling (hours/wk)	0.28	(0.12, 0.45)	3.43	0.001 ***	Positive association
Swimming (hours/wk)	-0.47	(-0.75, -0.19)	-3.25	0.001 ***	Protective effect
Cross training (hours/wk)	0.29	(0.07, 0.51)	2.57	0.010 **	Positive association
Age	ns	-	-	>0.05	Not significant
Gender	ns	-	-	>0.05	Not significant
Body weight	ns	-	-	>0.05	Not significant

*Note. B = unstandardized coefficient. CI = confidence interval. Ns = nonsignificant. *p < .05, **p < .01, ***p < .001. Effect sizes interpreted using Cohen's guidelines (r = .10 small, r = .30 medium, r = .50 large).²⁶

RESULTS

A total of 384 participants were included (mean age = 32 years), consisting of 130 males (33.9%), 253 females (65.9%), and 1 non-response (0.3%).

Weekly mileage was negatively correlated with total number of injuries ($r = -.12$, $p = 0.02$), as were days per week of running ($r = -.11$, $p = 0.04$). Average running pace was not significantly associated with injuries ($r = .05$, $p = 0.35$). Greater number of weekly hours of swimming were significantly protective against injury ($B = -.47$, $t = -3.25$, $p = 0.001$), while more weekly hours of cycling ($B = .28$, $t = 3.43$, $p = 0.001$) and cross-training ($B = .29$, $t = 2.57$, $p = 0.01$) were significantly associated with higher total injury counts.

Running volume alone did not predict injuries. Age, gender, and body weight were not significant covariates. Comparisons between marathon runners ($n = 184$) and triathletes ($n = 24$) showed no significant differences in injury incidence across total injuries or injury categories (all $p > 0.05$). Modality-specific analyses revealed that cycling was positively associated with both upper extremity ($B = .09$, $p = 0.001$) and lower extremity ($B = .13$, $p = 0.025$) injuries, while swimming was negatively associated with lower extremity injuries ($B = -.26$, $p = 0.008$). Cross training was positively associated with upper extremity ($B = .09$, $p = 0.01$) and neck/back injuries ($B = .12$, $p = 0.028$). Results are summarized in [Table 1](#).

DISCUSSION

This study identified several notable associations between training modalities and injury incidence in endurance athletes. Running volume and frequency were negatively correlated with reported injuries, suggesting a potential protective effect of consistent training. These findings align with Rasmussen et al., who reported that higher running volumes were associated with reduced injury risk,¹⁴ though they contrast with reviews suggesting that long-term high-intensity running may increase the risk of osteoarthritis.²⁶ One plausible explanation is that athletes prone to injury may be unable to sustain higher running volumes, while those who tolerate higher mileage may represent a subgroup more resilient to injury. Similar to Alentorn-Geli et al.,²⁶ the current findings suggest that running may have a

protective effect, particularly among those with fewer years of experience.

Unexpectedly, greater time spent cycling was associated with higher reports of upper and lower extremity injuries. These findings are consistent with Schorn et al., who reported a relationship between increased cycling time and shoulder injuries in triathletes.²⁵ Possible explanations include sustained postural demands on the upper body and overuse of the lower extremities, especially if bike fit is sub-optimal.

Cross training was also associated with increased reports of upper extremity and neck/back injuries. This differs from Voight et al., who found no association between cross training and injury rates, possibly due to their smaller sample size.¹⁰ The current results may reflect differences in exercise type or execution, as improper form, inappropriate loading, or poorly matched training programs can increase injury risk. Rather than attributing this to "core weakness," it is more plausible that variability in program design and exercise selection among participants influenced outcomes.

Swimming time was negatively associated with injury incidence, suggesting a protective effect. This finding contrasts with Feijen et al., who observed a positive relationship between swim training volume and shoulder pain.²⁷ A possible explanation is that, in this sample, swimming may have provided complementary conditioning that reduced lower extremity stress. Unlike running or cycling, swimming distributes load differently across muscle groups and may alleviate repetitive impact on weight-bearing structures. However, these findings should be interpreted with caution, as swimming can also contribute to overuse injuries at high training volumes.

Importantly, no significant difference in injury incidence was observed between triathletes and marathon runners. This challenges the assumption that athletes who diversify training through multiple modalities are necessarily less injury-prone. Triathletes typically perform high training volumes across all three sports, which differs from runners who add cross training as a supplemental activity. Thus, injury risk may depend less on whether cross training is performed and more on how each modality is integrated into the overall training load.

Consistent with prior research, the current findings reinforce that running-related injuries are multifactorial.^{7-9, 14,19} Previous injury remains one of the strongest predic-

tors of future injury,¹⁴ while experience also appears to play a role, with novice runners showing higher injury rates than more experienced runners.⁷⁻⁹ Although some literature suggests cross training may be protective by distributing load across tissues,¹⁰ these results indicate that certain modalities may carry specific risks at higher training volumes.

Overall, these findings highlight the complexity of injury prevention in endurance athletes. Rather than assuming that more varied training is inherently protective, coaches and clinicians should consider the specific demands, intensities, and volumes of each modality. Further research is needed to clarify how training distribution across modalities influences injury risk in runners and triathletes.

LIMITATIONS

Limitations of this study include the following: the data were collected via a self-reported questionnaire which risks the validity of the findings due to error or misrepresentation from the respondents due to response or recall bias. Cross-training was defined as any activity other than running, but this is a broad definition that must be investigated more carefully in future studies, as technically those who train for triathlon might not consider their training as “cross training”. This study also did not capture detailed information about injury types and severity, so subjects might have reported injury based on their own conceptions of the term.

FUTURE RESEARCH

Future studies should investigate the difference in injury rate between several cross training modalities including types of weight training and mobility protocols. Future

studies should also have a clear definition as to what an injury is and how to categorize them. Lastly, a randomized controlled trial comparing runners and triathletes who engage in cross training to runners and triathletes who do not in order to determine whether or not cross training aids in the prevention of RRI's is needed.

CONCLUSION

The results of this study indicate that greater participation in running and swimming was associated with fewer reported running-related injuries, whereas increased time spent cycling and cross training was associated with higher injury incidence. No relationship was observed between the number of competitive events per year and injury rates. These findings suggest that not all training modalities confer equal benefits, and that swimming and consistent running may offer protective effects; while cycling and certain forms of cross training may increase risk when performed at higher volumes. Clinicians and coaches should consider modality-specific injury risks when advising endurance athletes on training design and injury prevention strategies.

CONFLICT OF INTEREST STATEMENT

The author(s) declare that they have no conflicts of interest relevant to the content of this manuscript.

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