Triathlon Event Distance Specialization: Training and Injury Effects

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Abstract

Vleck, VE, Bentley, DJ, Millet, GP, and Cochrane, T. Triathlon event distance specialization: training and injury effects. *J Strength Cond Res* 24(1): 30–36, 2010—We conducted a preliminary, questionnaire-based, retrospective analysis of training and injury in British National Squad Olympic distance (OD) and Ironman distance (IR) triathletes. The main outcome measures were training duration and training frequency and injury frequency and severity. The number of overuse injuries sustained over a 5-year period did not differ between OD and IR. However, the proportions of OD and IR athletes who were affected by injury to particular anatomical sites differed ($p < 0.05$). Also, fewer OD athletes (16.7 vs. 36.8%, $p < 0.05$) reported that their injury recurred. Although OD sustained fewer running injuries than IR (1.6 ± 0.5 vs. 1.9 ± 0.3, $p < 0.05$), more subsequently stopped running (41.7 vs. 15.8%) and for longer (33.5 ± 43.0 vs. 16.7 ± 16.6 days, $p < 0.01$). In OD, the number of overuse injuries sustained inversely correlated with percentage training time, and number of sessions, doing bike hill repetitions ($r = -0.44$ and -0.39, respectively, both $p < 0.05$). The IR overuse injury number correlated with the amount of intensive sessions done ($r = 0.67$, $p < 0.01$ and $r = 0.56$, $p < 0.05$ for duration of "speed run" and "speed bike" sessions). Coaches should note that training differences between triathletes who specialize in OD or IR competition may lead to their exhibiting differential risk for injury to specific anatomical sites. It is also important to note that cycle and run training may have a "cumulative stress" influence on injury risk. Therefore, the tendency of some triathletes to modify rather than stop training when injured—usually by increasing load in another discipline from that in which the injury first occurred—may increase both their risk of injury recurrence and time to full rehabilitation.

Key Words triathlon, training, cumulative stress, event distance

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Introduction

Triathletes mainly train for either Olympic distance (OD) (1.5-km swim, 40-km cycle, 10-km run) or Ironman distance (IR) (3.8-km swim, 180-km cycle, 42.2-km run) competition (1). Up to 60% of "elite" OD and 75% of IR athletes have been reported to be affected by injury—that is, "any musculoskeletal problem causing the athlete to stop training for at least one day, reduce mileage, take medicine, or seek medical aid" over varying time periods (4,5,15,20). Most such injuries are "overuse injuries…caused by repetitive movements" (19).

It has been suggested that the balance of training emphasis differs between OD and IR triathletes (6,22) and, therefore, that the relative influence of putative training-related risk factors for injury might vary with event distance. However, no one has published work comparing injury occurrence across *national*-level triathletes specializing in 1 or the other event, although various authors (5,20) have suggested that the extent, severity, and risk factors for injury are influenced by triathlete ability level. No one has published a comparative investigation of impact of the different *types* of training sessions that OD and IR athletes undergo on injury risk, examining whether, for example, IR do more low-intensity training and are more vulnerable to injury, or whether OD do more high-intensity training and are equally vulnerable to injury.

The aim of this study, therefore, was to conduct a preliminary retrospective investigation into the effect of event distance specialization on training load and injury occurrence in triathletes.

Methods

Experimental Approach to the Problem

The study involved the collection of (a) demographic information, (b) information relating to both intrinsic and extrinsic risk (particularly training-related) factors for injury, and (c) injury data for British Senior National Squad OD and IR athletes. The retrospective questionnaire that was used for the study was developed in conjunction with the National Squad coaches and was first piloted on 5 members of the National Squad, none of whom suggested any changes to it.

Subjects

Informed consent forms and, once these had been returned, the training and injury questionnaire, were distributed to all 35 male triathletes within the 1994 Great Britain Senior National OD and IR Triathlon Squads. Returns were then encouraged by personal contact, a second questionnaire, and telephone calls. Both the British Triathlon Federation and the local University Ethics committee approved the study.

Procedures

Injury Occurrence, Distribution, and Severity. Injury was defined in the questionnaires as "any musculoskeletal problem causing cessation of training for at least one day, a reduction of training mileage, or taking of medicine" (4,10,20). Retrospective details were requested, with dates, of overuse injury sustained to the neck, upper back, hamstrings, calf, Achilles tendon, shoulder, lower back, knees, ankles, or other sites (stating what). Athletes noted to which discipline they attributed their injury; whether swim, bike, or run training was subsequently stopped or modified (and for how long); and whether the injury recurred within a year. They reported traumatic injury, defined as 'that caused by a hazard encounter (such as falling off the bike)" separately from "overuse injury," in a similar manner. Although the athletes' medical records were not available to the first author, 79% of the athletes had kept a detailed training diary over the 5-year period covered by the study and were able to cross-check their reports against it.

Risk. The putative intrinsic injury risk factors that were recorded in the questionnaire included anatomical locations of any previous injury, age, height, and body mass. The athletes' extent of competitive experience (years) and highest competitive level reached in both triathlon (in terms of placing at national, Continental and World Elite, or age-group championships) and its component single sports (i.e., county-, regional-, national-, or international-level representation) were reported. Personal best times for the component disciplines of the triathlon in isolation (i.e., in a pool, during time trial, or on a track) and when combined within the various distances of (wetsuit/non-wetsuit, open water/non-open water) triathlon that are available to the athletes (2) were also assessed.

Additional data were collected within 3 categories of potential extrinsic risk factors for injury–namely, (a) training session type; (b) specificity of training to triathlon, and (c) training equipment (such as bike handlebar position, seat angle, use of clipless pedals, and crank length). Total training data were noted prospectively over the week without taper closest to the respective athletes' OD or IR National Championships. Number and duration of training sessions (± warm-up/warm-down) were recorded for swimming, cycling, and running training overall and for "long," "hill reps," "speed work," and "other" bike and run training. An explanation of the aforesaid terms, as agreed by all the national coaches at the time of the study, is given in Table 1. Subjects also provided a copy of their training diary information for the week in question. Said data were not found to differ significantly from the totals given by the athletes, and the format of recording training frequency and duration information was therefore considered valid for the purposes of the study. In addition, the athletes noted the extent to which the frequency and duration of such sessions normally varied. For example, they noted the minimum, average, and maximum duration of their long runs and the minimum, average, and maximum total time spent in 1 week doing long runs over the year of the study.

Details were additionally obtained of hours trained in other sports, proportion of training accounted for by interval training, "back-to back" run-bike or swim-bike training, and weight training. Subjects noted whether they routinely warmed up, cooled down, and or incorporated stretching before and or after training (and if so, whether it was after warm-up) during the week in question, as well as whether they normally did so or had done so only for that week.

Measures

Data were grouped by OD or IR event specialization before analysis using the Statistical Package for the Social Sciences, version 15.0 (SPSS, High Wycombe, United Kingdom). An injury severity index (i.e., the total time taken off training as the result of injury, by the athletes in either the IR or OD groups, divided by the number of athletes in that group) was also compiled for each anatomical location.

Statistical Analyses

Levene's test for homogeneity of variance was conducted before demographic, injury, and risk factor data for the OD and IR groups were compared using a Student's T-test for independent samples with either equal or unequal variance, as appropriate. Association between occurrence of injury and both potential aetiological factors was tested for using Pearson's product moment correlation on ratio level data and the Chi-squared test on nominal data. Relationships between continuous numerical data and dichotomous category data were assessed by the point biserial correlation coefficient. The 95% confidence level was set as the level of significance.

Results

Completed questionnaires were received from 75% and 95% of the respective OD and IR National Squads at the time of the study (i.e., from 12 OD and 18 IR males). Subject characteristics are shown in Table 2. The athletes were training for 1 or the other competitive distance (rather than both) and had competed over said distance for an average of 7 years. Although all the athletes both finished within the top 50 at their respective OD or IR National Championships and had represented their country at the Elite relevant OD or IR World Championships within 2 years of the study, most were not competing regularly on the International Triathlon

Table 1. Explanation of training-related terms.

	Definition of terms	Example bike sessions	Example run sessions
Long	Low- or moderate-intensity continuous steady training, 1–2 mmol/L below lactate threshold, heart rate below 75% max. Slightly higher intensity than recovery work. Energy source: fat with some carbohydrate contribution.	>1.5 hours of continuous bike riding.	Long, easy runs of >1 hour duration.
Speed work	Hard to very hard work steady or intermittent quality training. Conducted above lactate threshold intensity. Long repeats of 1–1.5 minutes with incomplete recovery, repeats of 3–5 minutes with complete recovery, or repeats of 30–60 seconds with complete recovery. Rest between repeats normally >1 minute. Energy source: carbohydrate with marginal or no fat contribution.	20–60-minute time-trials. Moderate-length intervals with moderate rest (e.g., 6 × 5 minutes w/2 minutes, 3 × 8 minutes w/4 minutes, 8 × 3 minutes w/1 minute up to short intervals with long rests (8 × 1 minute w/2 minutes, 12 × 30 sec w/1 minutes).	20–30-minute continuous runs. Moderate-length intervals with moderate rests (e.g., 5 × 3 minutes w/1.5 minutes, 4 × 4 minutes w/2 minutes, 3 × 8 minutes w/4 minutes). Repeats with long rest (e.g., 8 × 400 m w/2 minutes, 5 × 800 m w/4 minutes, 12 × 200 m w/1 minute).
Hill reps	Low-velocity, high-force work.	Hill repeats using hills that take 2–3 minutes to climb at a fast sustained pace.	Normally 200–400 m but may go up to 800 m.
Other	Isolated leg training. Combined run-bike-run sessions.	Single-leg spinning on indoor training.	–

Table 2. Subject characteristics.

	OD ($n = 12$)	IR ($n = 19$)
Age (years)	27.0 ± 4.7	31.3 ± 3.1
Mass (kg)	69.5 ± 4*	72.6 ± 6.1*
PB 1.5-km swim (hours)	18.98 ± 1.53*	21.4 ± 1.9*
PB 40-km bike (hours)	55.72 ± 1.88	57.2 ± 2.8
PB 10-km run (hours)	31.82 ± 0.87*	33.30 ± 1.5*
Training duration (hours)		
Overall	15.6 ± 3.7	19.5 ± 7.6
Swim	5.6 ± 2.6	6.1 ± 4.5
Bike	6.3 ± 3.0	8.8 ± 4.5
Run	3.7 ± 1.4	3.9 ± 1.7
Training frequency (sessions)		
Overall	12.0 ± 3.0	14.3 ± 3.2
Swim	4.0 ± 1.1	5.1 ± 1.9
Bike	3.8 ± 1.7	4.0 ± 2.2
Run	4.17 ± 2.0	4.6 ± 2.0

PB = personal best time; OD = Olympic distance; IR = Ironman distance.
*$p < 0.05$ for differences between groups.

Union OD World Cup circuit or its Ironman equivalent. We would not, therefore, consider them "World-Ranked Elites."

Comparative Analysis of Risk Factors for Injury

The OD males were faster swimmers and runners than the IR males (Table 2). They had more years of competitive cycling and running experience (4.6 ± 3.8 vs. 3.3 ± 4.2 years and 11.9 ± 5.9 vs. 10.1 ± 7.2 years, respectively, $p < 0.05$) and did more swimming and transition technique analysis than IR males. No OD athletes, but 17.6% of IR athletes, reported "orthopaedic problems." None of the other putative intrinsic injury risk factors that we assessed differed between groups.

Details of the athletes' training are given in Tables 2 and 3. Fewer OD males than IR males did back-to-back swim-cycle (none vs. 13.3%) and cycle-run training (25 vs. 66.7%; data not shown in tables). Far more OD males than IR males did *not* routinely stretch before cycling (91.7 vs. 63.2%) or cool down after cycling (33.3 vs. 5.3%).

Table 3. Overall training duration (hours) and training frequency of male British National Senior Squad triathletes during a typical race training week without taper.

	OD	IR
Duration (hours)		
Long bike	3.2 ± 2.6*	4.7 ± 1.8*
Hill rep bike	0.3 ± 0.7	0.8 ± 0.9
Speed work bike	1.2 ± 0.7	1.1 ± 0.8
Other bike	1.6 ± 1.6	2.4 ± 3.0
Long run	1.3 ± 1.0*	1.6 ± 0.7*
Hill reps run	0.4 ± 0.5	0.8 ± 0.9
Speed run	0.8 ± 0.6	0.9 ± 0.7
Other run	1.2 ± 0.9	0.5 ± 0.4
Session frequency		
Long bike	1.1 ± 1.3	1.5 ±1.5
Hill reps bike	0.3 ± 0.5	0.3 ± 0.5
Speed bike	1.5 ± 1.0	1.5 ± 1.0
Other bike	1.1 ± 1.3	1.5 ±1.5
Long run	0.7 ± 0.5	1.0 ± 0.7
Hill reps run	0.3 ± 0.5	0.3 ± 0.6
Speed run	1.2 ± 0.8	1.1 ± 0.5
Other run	2.0 ± 2.0	2.2 ± 1.7

OD = Olympic distance; IR = Ironman distance.
*$p < 0.01$ for differences between groups.

Occurrence and Severity of Injury

Traumatic injury was sustained by 43.1% and overuse injury by 72.2% of the British Senior Squad as a whole over the 5 years. The mean number of traumatic and overuse injuries that was incurred by each athlete was 0.76 ± 0.98 and 1.96 ± 1.95, respectively. Neither the relative proportion of either the squad affected the relative proportion of the total number of injuries accounted for by either overuse or traumatic injuries, nor the average number of such injuries (overall or within each triathlon discipline), differed between groups. Fewer of the OD than IR triathletes (16.7 vs. 36.8%, $p < 0.05$), however, reported injury recurrence within 1 year.

The OD and IR groups differed significantly for the proportions of each who were affected by overuse injury to particular anatomical sites (Figure 1, $p < 0.05$). For example, a greater proportion of OD than IR males sustained Achilles tendon injury ($p < 0.05$). In addition (data not illustrated), more of the total number of overuse injuries that were sustained by OD athletes occurred to the lower back (17.9%), Achilles tendon (14.3%), and knees (14.2%), whereas most of the injuries that were reported by IR athletes were to the knees (44%), calf (20%), hamstrings (20%), and lower back (20%).

Most overuse injuries were attributed to running (65.2 vs. 60.0%, ns) rather than cycling (26 vs. 32%, ns) or swimming (15.2 vs. 16%, ns). In both groups, hamstring and calf injuries were mainly attributed to running. Knee injuries were attributed to running, cycling, and both disciplines combined, by 44.4, 33.3, and 22.2% of OD males, respectively, and equally to cycling and running by IR males. The equivalent values for Achilles tendon injury were 12.5, 62.5, and 12.5% of OD athletes. However, all the IR athletes thought their Achilles tendon injuries to be nonspecific in origin. Seventy-one percent of OD but only 33.3% of IR lower back injuries were attributed to cycling, with the remainder classed as "of nonspecific origin."

Swimming, cycling, and running training, respectively, was stopped by 16.7, 50.0, and 41.7% of the athletes as a result of injury. However, more time was subsequently lost from training by OD than by IR triathletes (33.5 ± 43.0 vs. 16.7 ± 16.6 days, $p < 0.01$) compared with. none vs. 3.5 ± 5.0 swimming days, 13.4 ± 31.1 vs. 17.5 ± 12.1 cycling days, and 29.3 ± 43.0 vs. 11.7 ± 8.1 running days, respectively. Although the actual time taken off training as a result of

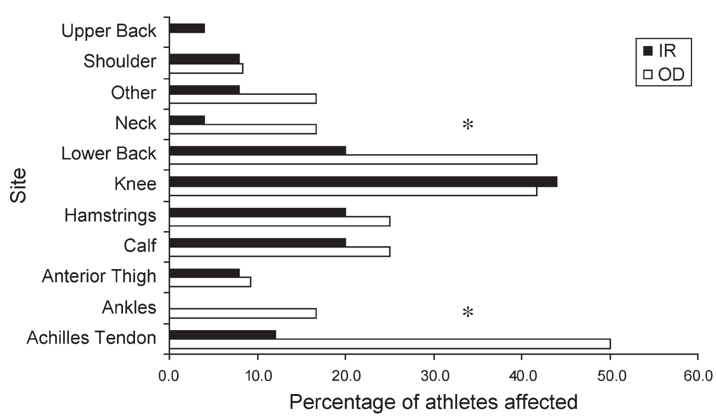

Figure 1. Anatomical distribution of overuse injury in British Senior National Squad male Olympic-distance (OD) and Ironman-distance (IR) triathletes: percentage of the group affected. *$p < 0.05$ for differences between groups.

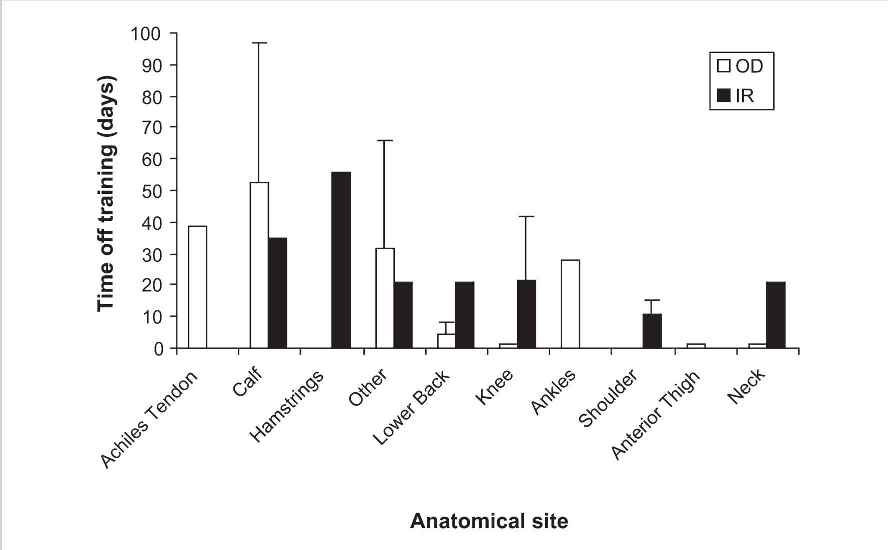

Figure 2. Training days lost as a result of overuse injury in various anatomical sites (mean ± *SD*) over a 5-year period in British Senior National Squad male Olympic distance (OD) and Ironman distance (IR) triathletes.

injury to a particular anatomical site (Figure 2) varied between individual athletes, the anatomical sites that were associated with the most time off overall in each group, for both the OD and IR athletes, were the upper back, Achilles tendon, lower back, and knee. Of note, similar percentages (16 and 16.7%) of OD and IR athletes indicated that they modified rather than stopped their training in response to injury (and that they usually did this by *increasing,* rather than decreasing, training load in the other disciplines from that in which they first noticed the injury).

Observed Links Between Putative Risk Factors and Overuse Injury

No relationship was demonstrated between the potential intrinsic risk factors and overuse injury number; except in IR males to whom where the number of running overuse injuries sustained was linked to competitive running experience ($r = 0.59$, $p < 0.05$).

In the whole group, running injury occurrence also correlated with total run training time ($r = -0.34$, $p < 0.05$). Achilles tendon injury occurrence positively correlated with distance covered doing "run hill reps" ($r = 0.92$, $p < 0.01$) and slightly negatively correlated with time spent doing "long runs" ($r = -0.15$, $p < 0.05$). An association was also seen between lower back injury occurrence and "speed bike" training time ($r = 0.52$, $p < 0.01$). Overuse injury number in OD athletes was linked with percentage of training time spent performing "bike hill reps" ($r = -0.44$, $p < 0.05$) and frequency of both "hill rep" bike sessions ($r = -0.39$, $p < 0.05$) and "other" bike sessions ($r = 0.35$, $p < 0.05$). In IR athletes, overuse injury number was correlated with both the duration of each "speed run" session ($r = 0.56$, $p < 0.05$) and "speed bike" training time ($r = 0.67$, $p < 0.01$).

Discussion

This study is the first to compare injury data between national/international-level OD and IR triathletes. Incidence proportions for injury of 60 and 74.8% of "short distance Elites" and IR athletes have been reported previously (4,5) but over different time frames. Our results, which were also the first to have been obtained using *uniform methods of data definition and collection* for the 2 event distances, suggest that equal proportions of IR and OD specialists may be affected by injury. Migliorini (13,14), who reported clinical data for Italian National Squad triathletes over a similar period, suggested the most frequently affected anatomical site to be the knee in OD athletes. He cited the observations of O'Toole et al. (15) as evidence that the lumbosacral region was more often affected in "long distance" triathletes. Migliorini's own athlete group included 24 OD but only 2 IR specialists–and our results agree with his over the OD. Our IR results, however, support those of Egermann et al. (5), who suggested that the most common overuse injuries in IR triathletes are also knee injuries.

Our investigation also confirmed the generally held view that triathlon running injuries tend to be the most serious triathlon injuries (10), followed by cycling injuries, in terms of time consequently lost from training. We also obtained data to suggest that it could be sensible to prioritize the prevention of injury to the upper back, Achilles tendon, lower back, and knee, and that the recurrence of such injuries may be more of a problem for IR than for OD triathletes.

Additionally, we obtained information regarding the potential relative influence of various putative risk factors on overuse injury occurrence in the 2 athlete groups. Our study may be said to extend on some aspects of that of Migliorini (13,14), who apparently did not undertake statistical analysis of his data. Our finding that previous injury is a major risk factor for injury was as expected. However, we observed no relationship between overuse injury number and triathlon or running experience, except in IR males, in contrast to Williams et al. (21) and Korkia et al. (10). Our athletes were more experienced and therefore may have been less influenced by this potential risk factor. As reported in other studies (10,21), however, a greater proportion of the athletes attributed a greater number of injuries to running than to cycling and swimming. We also found Achilles tendon injury to be more common, more severe, and more often attributed to run training in OD than in IR athletes. This may be linked to OD athletes doing more extensive "run hill" and "speed rep" (etition) work over the training year than IR athletes, as the running literature (18) suggests, although we obtained insufficient depth of training data to judge for sure. Some differences also existed between OD and IR athletes as regards the relative proportion of injuries sustained to a particular anatomical site that were attributed to one or the other triathlon discipline(s).

Our second confirmatory finding was that the triathletes commonly attributed injury in a particular anatomical site *to training in more than one discipline,* supporting the theory (3,20) that, in addition to the usual mechanisms of stress seen in single-sport athletes, engaging in multi-sports puts athletes at risk for *cumulative* stress injuries. O'Toole et al. (17) stated that "when posterior thigh muscles and the Achilles tendon are stressed by excessive plantar flexion during swimming and by repeated force production during cycling, it may take less stress during running to cause an overuse injury in a triathlete than in a single sport runner." They cited evidence of greater occurrence of Achilles tendon injuries in triathletes who do not routinely stretch before cycling (12) to support this premise. Previous work has suggested calf and Achilles tendon injury occurrence to be interrelated (20). In this study, more OD than IR triathletes did *not* routinely stretch before cycling and more OD triathletes reported Achilles tendon injury. Although we found no link between stretching practice and injury occurrence, it was not surprising (19) that the negative correlations that we noted between the use of some specific types of training (such as "long runs") and overuse injury occurrence emphasize the fact that both triathlon coaches and future triathlon injury research *must* take the multimodal nature of training in this sport into account.

Although our study adds new information to the triathlon injury literature, it has several limitations that should be taken into account in the interpretation of our findings. Most of the triathlon injury papers to date share these flaws, and they are discussed in some detail later. First, although we obtained compliance rates of 75 and 95% of the respective OD and IR squads, the very fact that our study participants were National Squad athletes necessarily limited our sample size to one of inadequate statistical power (1). Future research at National Squad or "World-Ranked Elite" level must, necessarily, involve athletes from more than 1 country. This method of increasing the number of participating athletes would go some way toward alleviating the second major problem faced by retrospective work at this athlete ability level–namely, being able to use a more valid recall period (9) (i.e., one of approximately 2 months duration) and, at the same time, collect sufficient injury data for statistical analysis. Second, although our results provide support for much of the data that were collected over similar dates, and by a clinician, for another National Squad (13,14), we were only able to validate them against the athlete's own training diaries, as opposed to against medical records. Nor did we conduct an analysis of either study "nonparticipants" or Squad "drop-outs" (both of whom may have been injured). We stress that both these issues should be addressed by future triathlon injury studies and that the research design of choice for such work must be that of a longitudinal prospective cohort. This would reduce the occurrence of problems with measurement error–because of problems in distinguishing between new and recurring injuries–and with knowing whether the training data obtained relates to before or after the occurrence of injury. However, for prospective multicountry injury studies to occur in triathlon, consensus must first be reached among the researchers and doctors who are involved regarding which injury definition (8) and data collection methods to use in triathlon research, as has been achieved in other sports (6,7).

Both competition *and* training exposure and injury data, however, are needed for top-level triathletes. The third important finding of this study, therefore, relates to the *manner* in which training information in triathletes is recorded in studies looking for possible relationships between training-related factors and injury profiles. Our range data (not shown) indicated that subjective interpretation of the same training session jargon, which is in common use among British triathletes, may differ between OD and IR triathletes. For example, a "long bike" can mean a 2-hour (moderate) intensity session in OD triathletes or a 6-hour, lower-intensity session in IR triathletes. Training information should be recorded in a more objective manner (e.g., in terms of work:rest ratios) and over longer time periods in the future. We further suggest that future research concentrate particularly on the influence of cycle and run training sessions that clearly differ between OD and IR specialists (i.e., "long bike" and "long run" sessions and, potentially, cycle-run transition training) on injury risk.

Despite our data having been collected some time ago, this paper remains the first to provide comparative training and injury data for OD and IR triathletes at the national/international level. The continued dearth of detailed, long-term data investigating links between training and maladaptation in top triathletes in the academic literature (8) is clearly a problem to be urgently addressed. Fortunately, the increasing use at National Squad level both of new tools for measuring training, such as Schoberer Radmesstechnik GmbH (SRM) systems, and of generic (and, sometimes, compulsory) prospective longitudinal training diaries should allow for more detailed investigation into the relationships between swim, cycle, and run training and overuse injury occurrence in the future. Alignment of the injury definitions and data collection procedures that are used within training studies of National Squad triathletes with those that are implemented within international competition by the World Governing Body shall potentially allow for greater understanding of the influence of cross-training on the extent and risks of both injury, and its recurrence, to specific anatomical sites.

To summarize, our preliminary data indicated which training-related factors may be worth following up within future prospective longitudinal investigation of the links between training and injury distribution or recurrence in OD and IR triathletes. We have also highlighted several methodological issues to be taken into account for future investigations into the extent to which training affects differences in injury profiles between OD and IR triathlon specialists to be effective.

Practical Applications

Triathletes are notorious for their reluctance to stop training when injured, with many, instead, preferring to increase their training within the other disciplines to that in which the injury occurred. It is important that both they and their coaches note that cross-training (16) does not necessarily reduce the absolute likelihood of overuse injuries (22) and that they take any potential cumulative effects of cycle and run training (e.g., to the knee and lower back) on injury risk into account. Those who train higher ability OD triathletes should also be particularly aware of the potential links between excessive use of hill repetition run work and the occurrence of Achilles tendon injury. We further stress to the injured athlete and his or her coach that it is in their best interest–in terms of learning what caused an injury, recovering from it as quickly as possible, and minimizing the extent to which it might recur–to see a clinician as soon as possible for specialist diagnosis and support.

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References

1. Bahr, R and Holme, I. Risk factors for sports injuries–A methodological approach. *Br J Sports Med* 37: 394–392, 2003.
2. Bentley, DJ, Millet, GP, Vleck, VE, and McNaughton, L. Specific aspects of contemporary triathlon: Implications for physiological analysis and performance. *Sports Med* 32: 345–359, 2002.
3. Cipriani, DJ, Swartz, JD, and Hodgson, CM. Triathlon and the multisport athlete. *J Orthop Sports Phys Ther* 27: 42–50, 1998.
4. Collins, K, Wagner, M, Peterson, KP, and Storey, M. Overuse injuries in triathletes: A study of the 1986 Seafair Triathlon. *Am J Sports Med* 17: 675–680, 1989.
5. Egermann, M, Brocai, D, Lill, CA, and Schmitt, H. Analysis of injuries in long-distance triathletes. *Int J Sports Med* 24: 271–276, 2003.
6. Fuller, CW, Ekstrand, J, Junge, A, Andersen, TE, Bahr, R, Dvorak, J, Hägglund, M, McCrory, P, and Meeuwisse, WH. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Clin J Sports Med* 16: 97–106, 2006.
7. Fuller, CW, Molloy, MG, Bagate, C, Bahr, R, Brooks, JHM, Danson, H, Kemp, SPT, McCrory, P, Mcintosh, AS, Meeuwisse, WH, Quarrie, KL, Raftery, M, and Wiley P. Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *Br J Sports Med* 41: 328–331, 2007.
8. Gregory, PL. Overuse injury–An overused term? *Br J Sports Med* 36: 82–83, 2002.
9. Jenkins, P, Earle-Richardson, G, Slingerland, DT, and May, J. Time dependent memory decay. *Am J Ind Med* 41: 98–101, 2002.
10. Korkia, PK, Tunstall-Pedoe, DS, and Maffuli, N. An epidemiological investigation of training and injury patterns in British triathletes. *Br J Sports Med* 28: 191–196, 1994.
11. Manninen, JSO and Kallinen, M. Lower back pain and other overuse injuries in a group of Japanese triathletes. *Br J Sports Med* 30: 134–139, 1996.
12. Massimino, FA, Armstrong, MA, O'Toole, M, and Hiller, WDB. Common triathlon injuries: Special considerations for multisport training. *Ann Sport Med* 4: 82–86, 1988.
13. Migliorini, S. An epidemiological study of overuse injuries in Italian national triathletes in the period 1987–1990. *J Sports Traumatol Rel Res* 13: 197–206, 1991.
14. Migliorini, S. The triathlon: Acute and overuse injuries. *J Sports Traumatol Rel Res* 22: 186–195, 2000.
15. O'Toole, ML, Hillier, DB, Smith, RA, and Sisk, TD. Overuse injuries in ultraendurance triathletes. *Am J Sports Med* 17: 514–518, 1989.
16. Millet, GP, Vleck, VE, and Bentley, DJ. Physiological differences between cycling and running: Lessons from triathletes. *Sports Med* 39: 179–206, 2009.
17. O'Toole, ML, Miller, TK, and Hiller, WDB. Triathlon. In: Fu, FH and Stone, DA, (eds.). *Sports Injuries.* Philadelphia: Lippincott Williams and Wilkins, 2001. Chapter 42.
18. Sallade, JR and Koch, S. Training errors in long distance running. *J Athl Train* 27: 51–53, 1992.
19. Thacker, SB, Gilchrist, J, Stroup, DF, and Kimsey, CD. The impact of stretching on sports injury risk: A systematic review of the literature. *Med Sci Sports Exerc* 36: 371–378, 2004.
20. Vleck, VE and Garbutt, G. Injury and training characteristics of male elite, development squad and club triathletes. *Int J Sports Med* 19: 38–42, 1998.
21. Williams, MM, Hawley, JA, Black, R, Freke, M, and Simms, K. Injuries amongst competitive triathletes. *NZ J Sports Med* March: 2–6, 1988.
22. Zupan, MF and Petosa, PS. Aerobic and resistance cross-training for peak triathlon performance. *Strength Cond* 7–12, October 1995.