Article

The training characteristics of recreational-level triathletes: influence on fatigue and health

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Abstract: Little is known about how recreational triathletes prepare for an Olympic distance event. The aim of this study was to identify the training characteristics of recreational-level triathletes within the competition period and assess how their preparation for a triathlon influences their health and their levels of fatigue. During the 6 weeks prior to an Olympic distance triathlon, and the 2 weeks after, 9 recreational athletes (5 males, 4 females) completed a daily training log. Participants answered the Daily Analysis of Life Demands Questionnaire (DALDA), the Training Distress Scale (TDS), and the Alberta Swim Fatigue and Health Questionnaire weekly. The Recovery-Stress Questionnaire (REST-Q) was completed at the beginning of the study, on the day before the competition, and at the end of week 8. Training loads were calculated using session-based rating of perceived exertion (sRPE). The data from every week of training was compared to week 1 to determine how athletes' training and health changed throughout the study. No changes in training loads, duration, or training intensity distribution were seen in the weeks leading up to the competition. Training duration was significantly reduced in week 6 ($p=0.041$, $d = 1.58$, 95% CI = 6.9, 421.9), while the number of sessions was reduced in week 6 ($Z=2.32$, $p=0.02$, ES = 0.88) and week 7 ($Z = 2.31$, $p=0.02$, ES = 0.87). Training was characterized by large weekly variations in training loads and a high training intensity. No significant changes were seen in the DALDA, TDS, or REST-Q questionnaire scores throughout the 8 weeks. Despite large spikes in training load and a high overall training intensity, these recreational-level triathletes were able to maintain their health in the 6 weeks of training prior an Olympic distance triathlon.

Keywords: training loads; monitoring; illness; recovery; triathlon

1. Introduction

Triathlon is a unique sport that requires athletes to excel in swimming, cycling, and running over a variety of distances. Age groupers comprise the majority of triathlon participants with many enrolling in the Olympic distance (1.5km swim, 40km cycle and 10km run) [1]. Success in the sport requires that triathletes possess above average aerobic power and muscular endurance, along with well-developed anaerobic capacities for surges in pace and for the final moments of the race [2-4]. To be able to prepare for the demands of the sport while mastering the three disciplines, age-group triathletes have been reported to train between 8 to 16 hours per week, depending on the race distance [2,5-8].

To maintain this training volume, triathletes may continue to train even when injured, by increasing the training load in another exercise mode to that in which the injury was sustained [4,9,10]. This approach to management of training loads and shifting of training to other modes when injured may put recreational level triathletes at a higher risk for negative training related health outcomes [11]. The intensity at which the training sessions are performed may also be an issue [12]. According to previous research, recreational endurance athletes often perform easy sessions at a pace that is considered too hard [13], whilst not pushing hard enough on the intense training days. This leads to a program with a higher overall intensity, which itself is linked to delayed recovery following training [14], a greater potential for non-functional overreaching [2,13], and potentially a higher likelihood of the occurrence of injuries [4,15]. Too much intense training can also be detrimental to performance. In endurance sports, a polarized approach, with a focus on training at lower intensities (below the lactate threshold), with few key sessions at higher intensities is likely the most effective way to elicit improvements in performance [16,17].

The training frequency of the sport may also lead recreational-level triathletes to experience high levels of stress when attempting to balance training and other life commitments [18]. General life stress can negatively influence athletes' health status [19], blunt the adaptive response to endurance or resistance training programs [20,21], and moderate the relationship between fatigue and recovery [22]. In this context, monitoring athletes' training loads and well-being is important to help balance training and life stress and improve early detection of negative health and performance outcomes [23].

Training loads can be monitored with different methods that are related to changes in performance, health and fatigue [3,15,24]. The session rating of perceived exertion (sRPE) is accepted as a valid measure of training load and might be predictive of illnesses when a spike in training load occurs [24]. Monitoring fatigue levels throughout a training program, however, can be a challenging task. Many physiological measures have been investigated with most showing little validity or practical application [3,15]. In this context, subjective measures (questionnaires on mood and perceived stress, for example) have proven equally or more effective than objective measures (such as blood markers and heart rate responses) [15,23,25,26].

Despite the majority of triathlon participants being recreational athletes [1], little is known about this group's training practices and associated health status as they prepare for competitions. The purpose of this study was to assess the training characteristics of recreational-level triathletes during the competitive season and how the participants' training influenced measures of health and fatigue. As reported with other endurance sports [13], it was hypothesized that athletes would spent too much time training at higher intensities. This would lead the participants to report higher levels of fatigue, stress, and negative health symptoms on a weekly basis.

2. Materials and Methods

The study was approved by a local Research Ethics Board (Pro00082267). Participants were informed of the risks and benefits of the study prior to signing an informed consent document. Recruitment occurred online via social media and the website of the following events: World Triathlon Series (WTS) Edmonton, WTS Montreal, and the Vancouver Triathlon. All the events occurred between July and September of 2018.

2.1 Subjects

The participants were required to have 3 or more years of experience training for and competing in Olympic distance events. Eleven participants (6 males, 5 females), with ages varying between 30 and 47 years old (39.2 ± 5.8, mean ± SD) volunteered for the study and competed in one of the aforementioned events. All the participants were classed as recreational athletes as they were competing in the amateur ("age-group") category, were not part of a regional or national development center and trained and competed in their leisure time [7,8]. None reported training as their main occupation. Olympic distance race times for the participants in this study were slower when compared to well-trained male age-groupers who had similar triathlon training experience [27], corroborating the recreational nature of the participants in the current study.

2.2 Measurements

Participants agreed to record their training programs in the 6 weeks leading to an Olympic distance triathlon that was the key event of their season and the 2 weeks that followed the event. A questionnaire was used to cover participants´ experience in the sport (years of training and competition), and how long they had been training or competing in swimming, cycling, and running. Information on participants' best performance in prior Olympic distance events, age at which they started training and competing in triathlon, and past training practice (hours of training per week, training frequency, longest session in each mode) were also collected. Lastly, participants were asked about how many triathlons (any distance) they enrolled in the current and past years.

2.2.1 Training monitoring

Training was monitored via a customized online training log that was developed for this study. Participants were instructed to maintain their regular training programs while tracking every session. The training log required participants to report their session goal, activity type (e.g., tempo run, intervals), exercise mode and session rating of perceived exertion (sRPE) [24]. The study participants were also asked to report on other types of sessions that they performed and describe what they were.

2.2.2 Training load calculations

External training loads were calculated as the total duration of each session (in minutes) across each week, and separated by mode of training (swimming, cycling, running). The participants' internal loads were calculated using the session rating of perceived exertion method (sRPE) developed by Foster [24], with the duration of each session multiplied by the rate of perceived exertion (1 – 10) that was assigned by the athlete to that session. Training monotony, an index of training variability defined as the daily mean load divided by the standard deviation of the load calculated over a week, was determined for each week [24]. Training strain (the product of training load and monotony) was also reported weekly [24].

2.2.3 Training intensity distribution (TID)

The TID of the athletes was calculated based on the sRPE that was reported for each session. This method was chosen as the researchers did not have data on participants' maximal heart rate, and it allowed for an easier collection of the intensity of the swimming sessions. Nevertheless, there is evidence to support the use of sRPE for assessing training intensity distribution in endurance athletes [16]. Sessions with a RPE of 4 or lower were considered as zone 1, a RPE of 5 and 6 were considered to equate to zone 2, and a RPE of 7 and above was considered as zone 3 [16]. The duration of each session was then assigned to its respective zone (1, 2, or 3) so that the total amount of time within each zone could be calculated for each mode of exercise (swimming, cycling and running).

2.2.4 Self-reported measures of health, fatigue, and illness

At the end of each training week, participants completed three questionnaires: The Daily Analysis of Life Demands (DALDA), the Training Distress Questionnaire, and the Alberta Swim Fatigue and Health Questionnaire. The questionnaires were sent via a digital link and participants were instructed to return them to the researchers within 24 hours. The DALDA [26] consists of 9 questions to assess general stress levels and their source (part A) and another 25 questions to determine symptoms of health and fatigue (part B). The participants were required to rate each variable as either "worse than normal", "normal" or "better than normal". The changes in the numbers of "worse than normal" scores were utilized to assess participants' health across the 8 weeks [5,26].

The Training Distress Scale Questionnaire (TDS) [25] quantifies the psychobiological response to training and helps in identifying athletes who are at risk of training-induced distress. The questionnaire consists of 7 items with participants rating their mood responses using a 5-point Likert scale ranging from "0 – not at all" to "4 – extremely". The sum of the scores was calculated every week, with lower scores meaning the athletes displayed a better mood state. Lastly, the Alberta Swim Fatigue and Health questionnaire [28] was used to determine health and fatigue status as well as general attributes associated with good health on a weekly basis (Appendix A). Aches and soreness were identified as either a headache or general body ache (that was not specific), joint ache or pain, or muscle soreness, which was separated by body segments (e.g., lower back, shoulders, quadriceps, calves, etc.). A niggle was defined as a nagging pain that still allowed participants to train, although could force participants to modify their training. If participants had to modify their training, the extent to which it was modified was also reported (i.e. no modification, to a minor extent, to a moderate extent, to a major extent, cannot participate at all). The Alberta Swim Fatigue and Health questionnaire has been used to evaluate fatigue and health in youth swimmers (Davies et al., 2018) and was considered a valid tool to capture both muscle fatigue status, and respiratory and illness symptoms in endurance athletes.

At baseline, 48 hours prior to the event and 2 weeks post-event, the athletes also completed the Recovery Stress Questionnaire for Athletes (REST-Q). The REST-Q measures the frequency of current stress along with the frequency of recovery associated activities [29]. It consists of 77 items (19 scales with four items each, plus a warm-up item), each with values ranging from 0 (never) to 6 (always), indicating how often the athlete has participated in activities over the past 3 days and nights [29]. Total stress was calculated as the sum of the 10 stress subscales, while total recovery was calculated as the sum of the 9 recovery subscales. The athletes' recovery-stress balance was calculated as the total stress score minus the total recovery score [6]. High scores in stress-associated scales reflect intense subjective strain, while high scores in the recovery associated scales reflect adequate recovery [6,29].

2.3 Data Analysis

Statistical analysis was performed using IBM SPSS® Statistics V.24, with the significance level set at $p \leq 0.05$. Data distribution was checked with the Shapiro-Wilk test. A repeated-measures analysis of variance (ANOVA) was used to compare changes between week 1 and every subsequent week to analyze how training changed over time relative to baseline. Health and fatigue symptoms during the 8 weeks of the study were also compared to week 1. Partial eta square effect sizes are reported (η^2) and interpreted as small (0.01), medium (0.06) and large (0.14). When a main effect of time was found, post-hoc comparisons were performed using the Bonferroni correction, with Cohen's d calculated to report effect sizes (d) of pairwise comparisons between weeks (0 – 0.2 = trivial, 0.2 – 0.6 = small, 0.6 – 1.2 = moderate, 1.2 – 2.0 = large, and > 2 = very large) [30]. To control for alpha level inflation, only pairwise comparisons between week 1 and every subsequent week were performed. When Mauchly's test was significant, a Greenhouse-Geiser adjustment was used to determine the significance level of the test. If the assumption of normality was violated, Friedman's Test was utilized to assess the main effect of time, with Kendall's W used to report effect sizes (*W*). When the main effect of time was significant, the Wilcoxon-Signed Rank test was used to determine differences between weeks, with effect sizes (ES) calculated for each comparison ($r = Z / \sqrt{N}$) and interpreted as 0.10 – small, 0.30 – moderate, and 0.50 – large effect [31]. Correlation analyses between weekly training characteristics (training loads, monotony and strain, and training time at zones 2 and 3) and the "worse than normal" scores on the DALDA questionnaire and the scores on the Training Distress Scale were performed using Spearman's Rank Test.

3. Results

Participants' characteristics are presented in table 1. Two participants (one male and one female) did not have their data included in the study as a result of them not completing the training log or not being able to maintain a training routine. Only 2 participants did not finish in the top-10 of their respective age group, with 2 athletes winning their category. One participant did not finish the race due to injury. According to the training history questionnaire, participants had an average of 5 years of experience in triathlon, and a greater training history in one of the disciplines, with running being the most common. The athletes reported performing more cycling and running sessions in a week than swimming sessions. The number of cycling and running sessions in a week was similar.

Table 1. Participants' self-reported training characteristics.

Characteristics	Mean (range)
Age when started triathlon training (years)	33.6 (19 – 42)
Experience training and competing in triathlon (years)	4.5 (3 – 12)
Swimming Experience (years)	6.5 (3 – 15)
Cycling Experience (years)	7.0 (3 – 15)
Running Experience (years)	14.2 (3 – 30)
Number of triathlons performed last season (any distance)	3.7 (2 – 5)
Training volume in the previous year (hours)#	341 ± 185 (150 – 674)
Number of triathlon specific sessions per week in the past year (overall and per mode)#	7.3 ± 1.5 (5.0 – 9.0)
Swimming#	2.2 ± 1.0 (1.0 – 4.0)
Cycling	3.0 (2.0 – 3.5)
Running#	2.7 ± 0.6 (2.0 – 4.0)
Training volume per week in the past year (hh:mm:ss)	
Overall	08:48:00 (3:30:00 – 13:30:00)
Swimming	2:24:00 (00:30:00 – 05:00:00)
Cycling	03:48:00 (01:12:00 – 06:00:00)
Running	02:24:00 (01:00:00 – 06:00:00)
Longest session (hh:mm:ss) in the past year	
Swimming	01:16:36 (00:50:21 – 02:00:00)
Cycling	03:18:24 (01:30:00 – 07:00:00)
Running	01:52:20 (01:00:00 – 03:00:00)
Average finishing time for Olympic Distance triathlon in week 6 (range) (hh:mm:ss)	02:39:06 (02:25:00 – 02:51:45)
Males	2:36:00 (2:17:12 – 2:58:00)
Females	2:40:48 (2:30:30 – 2:46:00)

Data presented as mean ± standard deviation.

3.1 Training characteristics

3.1.1 Training duration (min) and time spent within each training zone

Total training duration changed significantly over the 8 weeks ($F(7, 56) = 4.126$, $p = 0.014$, $\eta2 = 0.340$). When compared to week 1, total training volume was significantly lower in week 6 ($p = 0.041$, 95% CI = 6.93, 421.95, d =1.58, 414.08 ± 170.5 vs. 199.6 ± 97.6 minutes). Over the 8 weeks of training, no significant changes were seen in the overall time spent in zone 1 ($F(7, 56) = 1.225$, $p = 0.305$, $\eta2 = 0.133$) or zone 2 ($\chi2$ (7) = 9.00, $p = 0.252$, W = 0.143). However, a significant difference for time spent in zone 3 was found ($\chi2$ (7) = 22.56, $p = 0.002$, W = 0.358). Compared to week 1, the time spent in zone 3 was significantly shorter in week 6 (Z = 2.52, $p = 0.012$, ES = 0.95, median = 78 vs. 0 minutes), week 7 (Z = 2.10, $p = 0.036$, ES = 0.79, median = 78 vs. 0 minutes) and week 8 (Z = 1.960, $p = 0.050$, ES = 0.74, median = 78 vs. 40 minutes).

3.1.2 Total time spent swimming, cycling, and running and time spent in zones 1, 2, and 3 for each mode

No significant differences across the 8 weeks were found for total swimming time ($\chi2$ (7) = 10.29, $p = 0.173$, W = 0.163). Total cycling time ($F(7, 56) = 2.483$, $p = 0.027$, $\eta2 = 0.237$) was significantly changed across the 8 weeks, but no differences in relation to week 1 were found. Total running time differed across the 8 weeks ($\chi2$ (7) = 16.39, $p = 0.022$, W = 0.260), with running time in week 6 (Z = 2.54, $p = 0.011$, ES = 0.96, median = 27 vs. 105 minutes) and week 7 (Z = 2.07, $p = 0.038$, ES = 0.78, median = 31 vs. 105 minutes) being lower when compared to week 1. No differences were found for time spent in zones 1 or 2 for swimming, cycling or running. Time spent in zone 3 was significantly different across weeks for swimming ($\chi2$ (7) = 16.21, $p = 0.023$, W = 0.257) and cycling ($\chi2$ (7) = 23.33, $p = 0.001$, W = 0.370). However, post-hoc comparison only showed a significant difference between week 1 and week 6 for cycling in zone 3 (Z = 2.023, $p = 0.043$, ES = 0.76, median = 25 vs. 0 minutes). For running, time spent in zone 3 was significantly different across the 8 weeks ($\chi2$ (7) = 19.52, $p = 0.007$, W = 0.310), with week 6 (Z = 2.36, $p = 0.018$, ES = 0.89, median = 0 vs. 53 minutes) and week 7 (Z = 2.36, $p = 0.018$, ES = 0.89, median = 0 vs. 53 minutes) presenting a significantly lower duration at this intensity compared to week 1.

3.1.3 Number of sessions per week

There was a significant difference in the number of sessions performed each week ($\chi2$ (7) = 19.04, $p = 0.007$, W = 0.308). When compared to week 1, participants maintained their training frequency until week 6, when frequency was reduced (Z = 2.32, $p = 0.02$, ES = 0.88, median = 6.0 vs. 9.0). Training frequency was also reduced the week after the competition, with week 7 being significantly different than week 1 (Z = 2.31, $p = 0.02$, ES = 0.87, median = 5.0 vs. 9.0).

There was no difference in the number of swimming ($\chi2$ (7) = 5.88, $p = 0.553$, W = 0.09) and cycling sessions ($\chi2$ (7) = 10.16, $p = 0.180$, W = 0.16) that were performed over the 8 weeks. However, the number of running sessions changed significantly ($\chi2$ (7) = 16.82, $p = 0.019$, W = 0.26), with a higher number of sessions on week 1 when compared to week 7 (Z = 1.98, $p = 0.048$, ES = 0.75, median = 3.0 vs. 1.0 sessions). The number of other types of sessions performed throughout the 8 weeks did not change ($\chi2$ (7) = 10.92, $p = 0.142$, W = 0.17). Of the other sessions performed, only 1 participant performed some form of cross training, with the rowing and paddling sessions included in the training load calculations. Resistance training and yoga were the only other types of session performed.

3.2 Training load, training monotony, and training strain

Whilst training loads changed significantly over time ($F(7,56) = 3.971$, $p = 0.001$, $\eta2 = 0.332$), no differences were found between week 1 and the other weeks of training. The average training load of the event was 1371.2 ± 248.2 A.U. To assess if the overall load was reduced in the week of the event, the training load for week 6 was calculated with and without the load from the event. Removing the competition load from the training load calculations for week 6 did not lead to a significant difference between week 1 and week 6. Training monotony changed significantly during the 8 weeks ($\chi2$ (7) = 19.07, p = 0.008, W = 0.30), with a significantly lower value for week 6 when compared to week 1 (Z = 2.54, p = 0.011, ES = 0.96, median = 1.0 vs. 0.6). Similarly, significant differences over the 8 weeks were reported for training strain ($\chi2$ (7) = 16.11, p = 0.024, W = 0.25), with pairwise comparisons showing a higher training strain during week 1 when compared to week 6 (Z = 2.42, p = 0.015, ES = 0.91, median = 2322.1 vs. 1403.8).

3.3 Self-reported measures of health, fatigue, and stress

No significant changes were reported for the DALDA questionnaire ($\chi2$ (7) = 12.54, p = 0.084, W = 0.224) and the Training Distress Scale ($\chi2$ (7) = 9.01, p = 0.252, W = 0.16) throughout the 8 weeks. For the REST-Q, no significant differences were found among responses at baseline, 48 hours prior to the event, or two weeks after it (F(2,14) = 0.803, p = 0.46, $\eta2$ = 0.103).

For the Alberta Swim Fatigue and Health Questionnaire, weeks 6 and 7 presented some of the lowest reports of negative health symptoms (i.e. cold, flu, upset stomach, not feeling good overall), muscular aches and soreness and niggles. Symptoms were reported every week by at least 40% of participants, and every week at least 2 participants reported that they had to modify their training (table 2).

Table 2. Descriptive athletes' health status data according to the Alberta Swim Fatigue and Health Questionnaire (n = 9).

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Number of athletes who reported aches and soreness	6	7	5	9	7	5	9	6
Number of athletes who reported niggles	8	7	7	7	6	5	7	6
Number of athletes who modified training	3	5	2	5	3	3	2	3

3.3.1 Correlation analysis between training loads and questionnaire responses

No significant correlations were observed between training loads, monotony, or strain, and participants' responses to the DALDA or Training Distress questionnaire. Similarly, no significant correlation was found between the time spent in either zone 2 or zone 3 and the scores on each questionnaire.

Table 3. Training characteristics of recreational-level triathletes for 8 weeks (data presented as median, 25th percentile, 75th percentile)

Variable	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	p-value	Effect Size
Training Loads sRPE (a.u) [#]	2292.4 ± 1058. 5	1911.2 ± 915.4	2429.7 ± 729.1	2166.7 ± 866.4	1949.9 ± 864.1	2129.6 ± 465.5	968.4 ± 577.3	1665.8 ± 621.3	<0.001	$\eta^2 = 0.447$
Training Duration (hh:mm:ss)	07:43:48 (03:54:12, 09:05:05)	06:52:48 (04:40:12, 08:46:30)	06:49:00 (05:56:36, 08:42:42)	06:37:48 (03:28:12, 07:53:24)	04:54:00 (03:51:36, 07:59:24)	02:58:48 (02:01:12, 04:15:00)[a]	02:39:36 (01:55:12, 06:04:12)	04:56:24 (02:03:36, 07:037:48)	0.014	$\eta^2 = 0.340$
Time in Zone 1 (hh:mm:ss)	02:53:24 (01:45:00, 04:36:00)	02:55:12 (01:27:00, 05:06:00)	02:00:00 (00:00:00, 03:34:12)	02:45:36 (01:05:24, 04:27:00)	01:54:36 (00:34:00, 03:42:00)	02:00:00 (01:02:30, 02:34:48)	02:33:00 (00:45:12, 05:23:24)	02:18:00 (00:37:30, 04:39:00)	0.305	$\eta^2 = 0.133$
Time in Zone 2 (hh:mm:ss)	00:39:00 (00:00:00, 02:24:06)	01:37:12 (00:37:18, 03:46:30)	02:03:00 (00:28:30, 03:00:06)	00:40:00 (00:00:00, 03:01:30)	01:00:00 (00:00:00, 02:09:00)	01:07:00 (00:00:00, 02:34:48)	00:00:00 (00:00:00, 00:43:42)	01:15:00 (00:38:30, 03:31:48)	0.252	$W = 0.143$
Time in Zone 3 (hh:mm:ss)	01:18:00 (00:46:00, 03:00:00)	00:28:00 (00:00:00, 01:42:00)	03:42:36 (00:55:00, 04:28:48)	01:36:00 (00:00:00, 03:24:00)	01:26:00 (00:35:30, 04:09:00)	00:00:00 (00:00:00, 00:55:52)[a]	00:00:00 (00:00:00, 00:40:30)[a]	00:40:00 (00:06:00, 01:09:00)[a]	0.002	$W = 0.358$
Training Monotony (a.u)	1.0 (0.9, 1.3)	1.2 (0.8, 1.3)	0.7 (0.6, 1.5)	1.1 (0.8, 1.4)	0.9 (0.8, 1.4)	0.6 (0.6, 0.8)[a]	0.7 (0.6, 1.3)	0.9 (0.8, 1.2)	0.008	$W = 0.303$
Training Strain (a.u)	2322.1 (1585.5, 2910.4)	2206.0 (1214.8, 3376.8)	1930.9 (1338.1, 3871.0)	2908.6 (1210.6, 3790.4)	1800.9 (1253.1, 3144.3)	1403.8 (1070.5, 1716.3)[a]	601.1 (363.7, 1927.6)	1545.8 (1147.1, 2592.2)	0.024	$W = 0.256$
Number of Sessions per week	9.0 (5.5, 10.5)	7.0 (6.5, 8.0)	8.0 (6.0, 9.5)	7.0 (6.0, 9.0)	6.0 (5.0, 8.0)	6.0 (4.0, 6.5)[a]	5.0 (4.0, 8.0) [a]	7.0 (6.0, 8.5)	0.007	$W = 0.308$
Swimming sessions per week	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	3.0 (2.0, 3.0)	1.0 (1.0, 3.0)	2.0 (1.0, 3.0)	2.0 (1.0, 2.5)	1.0 (1.0, 2.5)	2.0 (0.0, 3.0)	0.553	$W = 0.093$
Cycling sessions per week	2.0 (1.5, 3.5)	3.0 (2.0, 3.0)	3.0 (2.0, 3.0)	2.0 (2.0, 3.0)	3.0 (1.0, 4.0)	2.0 (1.0, 3.0)	1.0 (1.0, 2.5)	1.0 (0.0, 3.5)	0.180	$W = 0.161$
Running sessions per week	3.0 (2.0, 3.5)	2.0 (1.5, 3.0)	2.0 (1.0, 3.0)	2.0 (0.0, 3.5)	2.0 (0.5, 3.0)	2.0 (0.5, 2.0)	1.0 (0,0, 2.0)[a]	3.0 (2.0, 3.0)	0.019	$W = 0.267$
Number of other sessions per week	1.0 (0.0, 2.0)	0.0 (0.0, 1.0)	0.0 (0.0, 1.0)	1.0 (0.0,1.0)	0.0 (0.0, 1.5)	0.0 (0.0, 0.5)[a]	1.0 (0.0, 1.5)	0.0 (0.0, 3.0)	0.142	$W = 0.173$

[a] denotes a significant difference from week 1 ($p < 0.05$); [b] denotes a significant difference from week 1 ($p < 0.01$); [#] data presented as mean ± standard deviation; a.u (arbitrary units)

4. Discussion

This study examined the training characteristics of recreational-level triathletes in the 6 weeks leading up to an Olympic distance triathlon and the 2 weeks after the event. The participants in this study had a training frequency that ranged between 5 and 9 sessions per week. The weekly training duration averaged 6.2 hours per week from weeks 1 to 5, with weeks 7 and 8 showing a decrease in training duration. Not considering the athletes' Olympic distance triathlon, week 6 saw a significant reduction in training duration when compared to week 1, with athletes averaging just under 3 hours of training. These training volumes are below what has been reported for 16 well-trained, but not elite triathletes, who had a minimum weekly training volume of 10 hours [6]. Compared to athletes training for longer distance triathlons, the average weekly training volume was also lower, as previous research has identified that recreational-level Ironman triathletes train on average 14.1 hours per week [7,8]. While these differences can be expected given the duration of the events (Ironman vs. Olympic distance), it must be acknowledged that the difference can be in part explained by the fact that data collected prospectively, such as in this study, can differ from retrospective data, as in the above mentioned study. Nevertheless, training volume in this group of recreational triathletes was still larger than single mode recreational endurance athletes, such as half-marathon and marathon runners [7,32], and cyclists with similar years of experience as the athletes in this study [33].

Despite the importance of monitoring and reporting training volume, training loads are more relevant as these can determine if an athlete is adapting to the training program, assess fatigue and recovery status, and minimize the risks of non-functional overreaching, injury, and illness [15]. The average load (figure 1) in the weeks prior to the competition (2150.01 A. U., from weeks 1 to 5) is slightly higher than the average of 2000 A.U [6] reported by a group of well-trained male triathletes completing a four week progressive, self-prescribed loading regime. While similar, the higher loads in the present study were achieved despite a lower average weekly training volume, indicating that weekly sessions were perceived to be performed at a higher intensity in this group of athletes. In addition, some of the reported loads in the current study were surprisingly high. For example, Coutts et al. [6] put a group of participants through a 4-week period of training overload designed to lead to overreaching. Weekly training loads started at upwards of 3000 A.U, a value that was reached by 5 of the 9 participants in this study at least once during the 8 weeks. One participant in this study also had a weekly load greater than what was reported by Coutts et al. [6] during their second week of overload (3.884 A.U vs. 3.809 A.U).

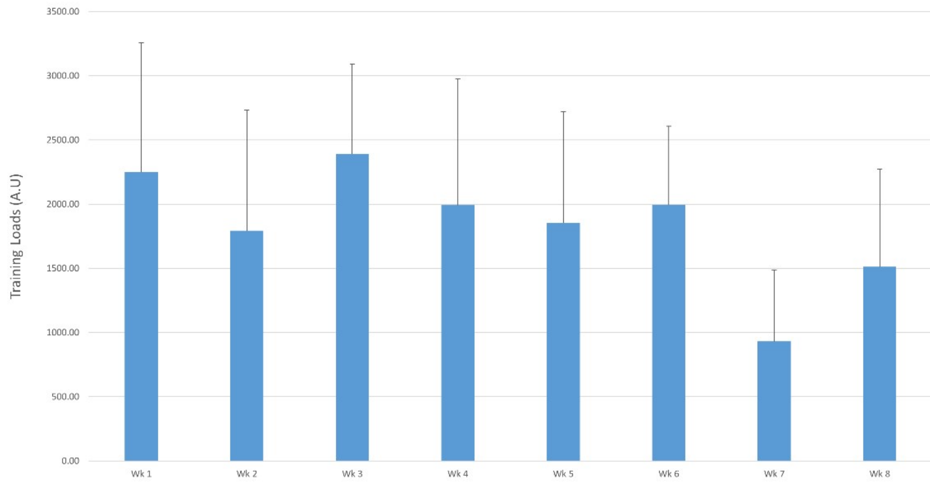
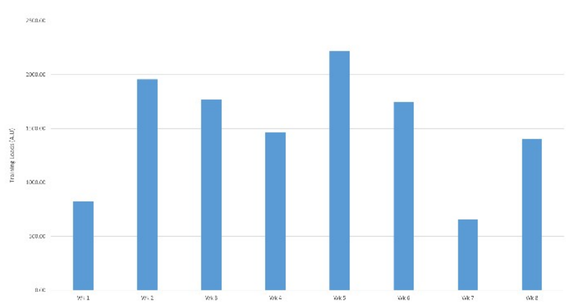


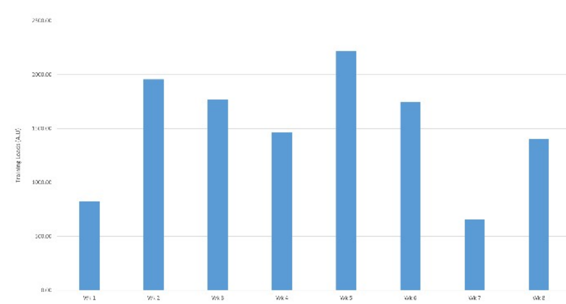
Figure 1. Average training loads (A.U) throughout the 8 weeks of training.

The training loads of the participants in this study were characterized by a high degree of variability throughout the eight weeks, with no discernible pattern in the five weeks leading up to the event. For the whole group, loads were reduced by 17% from week 1 to week 2 (2292.4 vs. 1911.2 A.U), only to increase by 27% (1911.2 vs. 2429.7) in week 3. While loads were reduced by an average of 10% in weeks 4 and 5 (figure 1), an analysis of individual numbers confirms that large spikes in loads between weeks were frequent (figure 2). Indeed, all participants doubled their loads from the previous week at least once throughout the study. As an example, one participant had a reduction in load of 33% in week 3 compared to week 2 (1064.2 A.U and 1603.4 A.U, respectively), followed by an increase of 122% in week 4 (2362.3 A.U), and a reduction of 60% in week 5 (948 A.U). These large variations in training loads can be detrimental to athletes' health. An association between training loads and injuries has been established, with large spikes in loads linked to an increased chance of injury, with the risk potentially remaining elevated for many weeks [34]. These spikes in load could also be related to an increased incidence of banal infections, a potential early sign of non-functional overreaching [24].

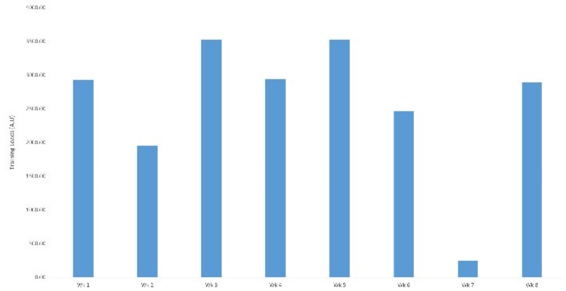
a) Participant 1



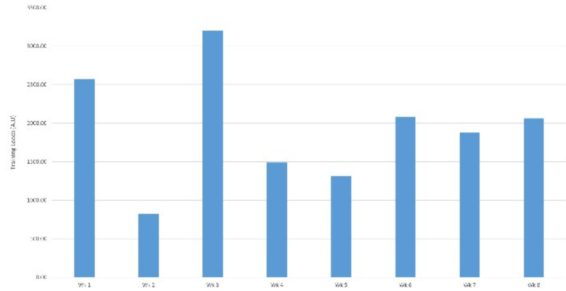
b) Participant 2



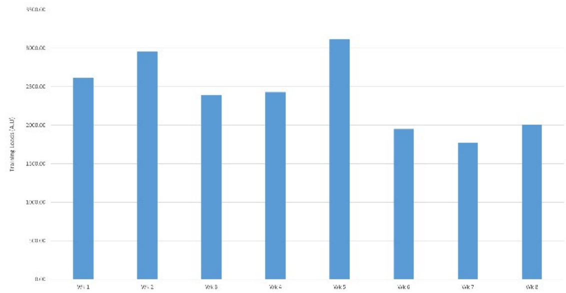
c) Participant 3



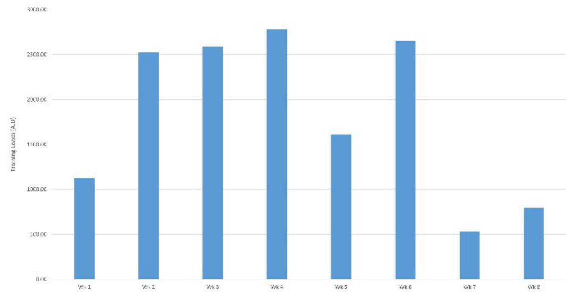
d) Participant 4



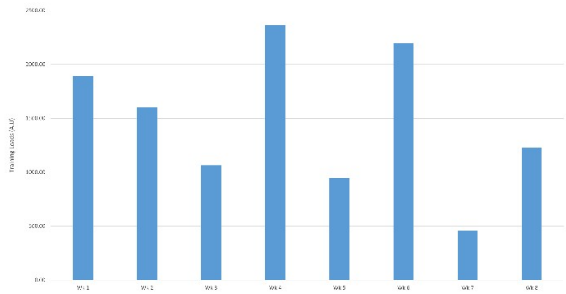
e) Participant 5



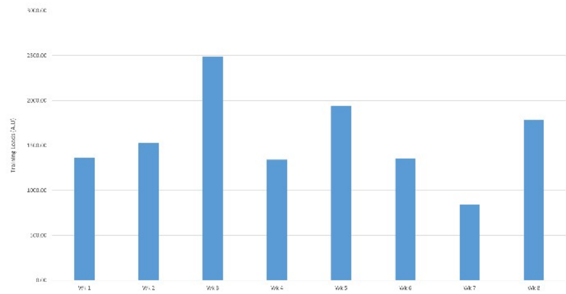
f) Participant 6



g) Participant 7



h) Participant 8



i) Participant 9

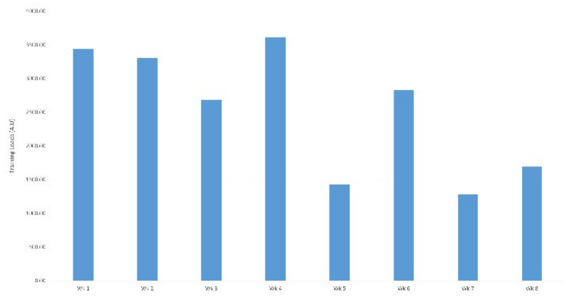
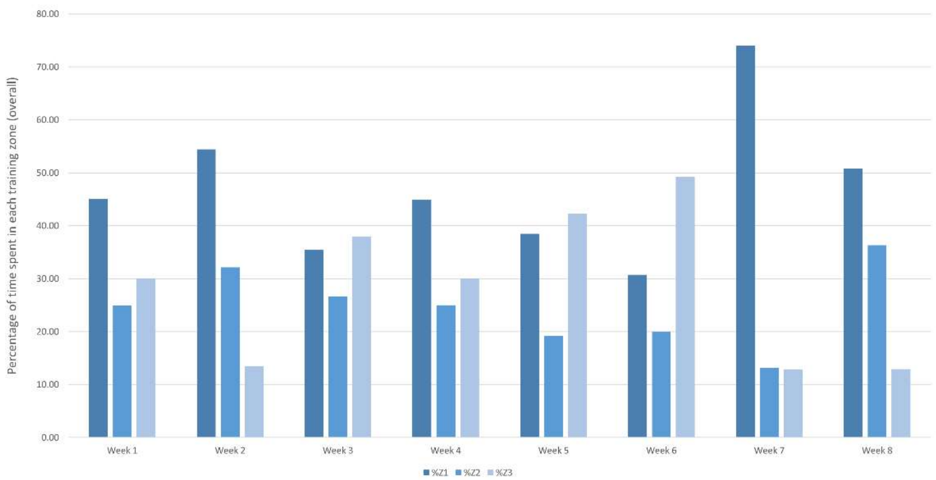


Figure 2. Individual training loads (A.U) for each participant throughout the 8 weeks of training.

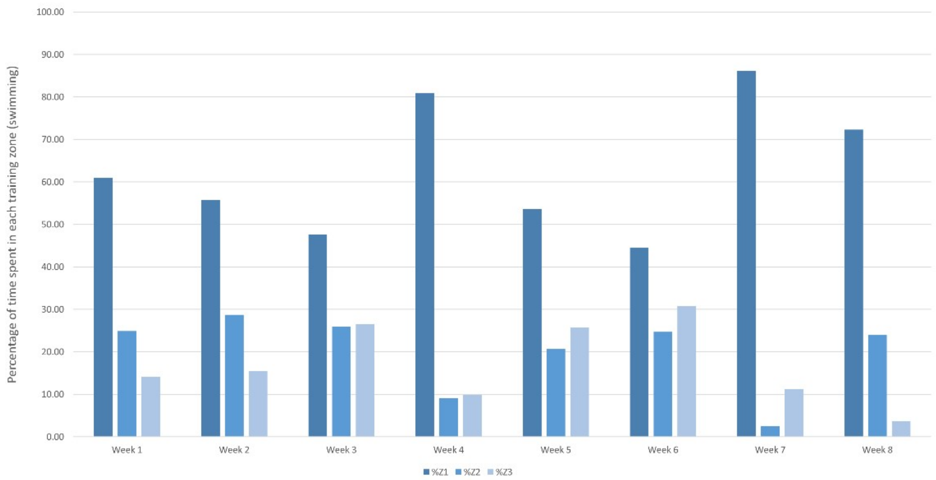
Similar to what occurred with training loads, no pattern was seen in the changes in training intensity distribution throughout the weeks of training (figure 3). A high variability in the percentage of time spent in each training zone throughout the training program was also found. The only difference in TID found throughout the study was in the amount of training that was performed in Zone 3. Due to the competition, the athletes spent a greater amount of time in this intensity zone during week 6, and subsequently reduced the amount of time training in this zone in the two weeks after the competition. In addition, the athletes' training intensity over the 8 weeks confirmed our initial hypothesis, with participants' training intensity distribution favoring higher intensity sessions. Particularly, athletes spent an average of 47% of their training time in zone 1, with more than half of training spent in zones 2 and 3 (25% and 28%, respectively). When the time spent in zones 2 and 3 is considered together, only 2 out of the 8 weeks had a greater amount of time in zone 1 than in zones 2 and 3.

The athletes' TID distribution varied for each discipline, with swimming having a higher percentage of training time in zone 1 when compared to cycling and running. As many overuse injuries in triathlon are associated with cycling and running, particularly with the performance of intense sessions [4], the high volume of training in zones 2 and 3 in these disciplines could be cause for concern. For example, over the 8 weeks of training, the time spent in zone 3 during cycling was higher than that in zone 1 in weeks 3 and 5. Similar results were seen in the TID in running, where the amount of time spent in zone 3 was higher than that in zone 1 in 3 of the 5 weeks prior to the competition.

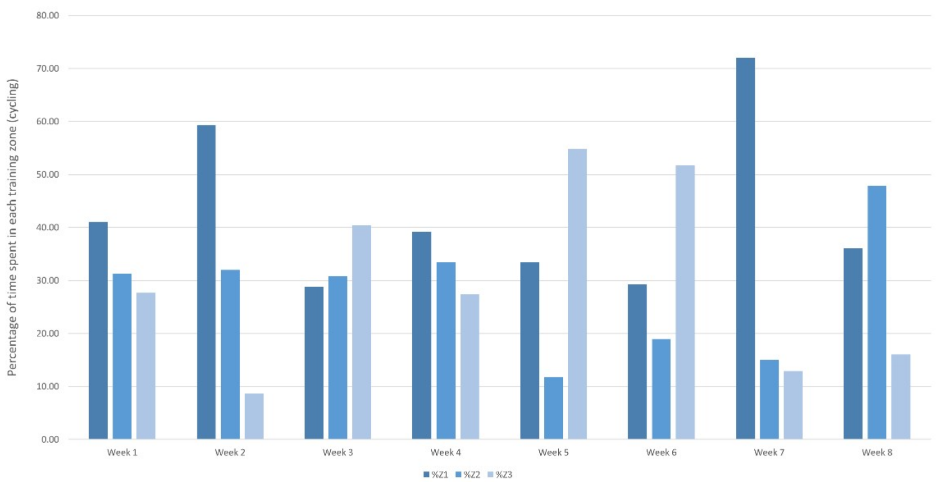
a)



b)


100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Percentage of time spent in each training zone (swimming)
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
%Z1
%Z2
%Z3

c)


80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Percentage of time spent in each training zone (cycling)
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
%Z1
%Z2
%Z3

d)

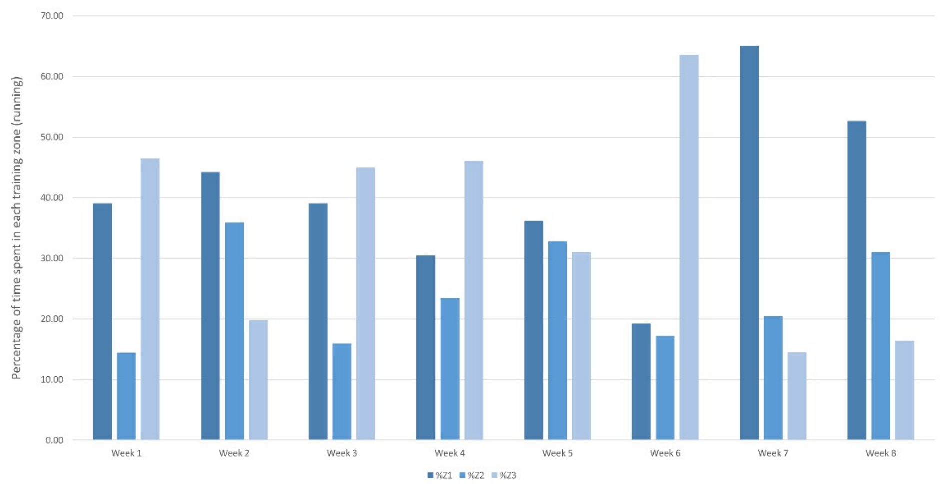


Figure 3. Training intensity distribution based on 3-zone model across the 8 weeks of training. a) overall, b) swimming, c) cycling, d) running.

This high volume of training spent at higher intensities can be detrimental to athletes' performance. Improvements in endurance performance have been shown to be inversely related to the time spent at threshold intensities [2,17], with previous research showing that adaptations to training are related to the time spent in zone 1 (below the first ventilatory threshold) [35]. In addition, too much training time in zone 2 (between the first and second ventilatory thresholds) is also linked to symptoms of non-functional overreaching and a higher incidence of injuries [3,4,13]. Furthermore, Seiler et al. [14] demonstrated that training above the first ventilatory threshold (VT1), which demarcates the upper range of zone 1, can significantly delay recovery. This is particularly troubling for sports where training frequency can be high, such as triathlon, since it is possible that athletes would not be fully recovered prior to the following session.

Nevertheless, despite the large spikes in training loads between weeks and a training intensity distribution that favored higher intensities, contrary to our hypothesis, there were no significant changes in the athletes' fatigue and recovery status based on the questionnaires used. Only 2 injuries were reported, with one being due to a fall from the bike. However, high scores in the questionnaires, indicating a lack of recovery or presence of negative health symptoms were seen even in weeks with lower training loads. As recreational athletes struggle to maintain a balance between training and their regular life commitments [18], it is possible that general stress has an even greater impact on these athletes' self-reported measures of fatigue, illness, and health. Otter et al. [22] reported that in a group of female endurance athletes (including 5 triathletes), recovery was hindered throughout the year of training in moments when general stress was higher. Further evidence also exists to support the notion that amateur triathletes have more difficulty in dealing with stress than those at the elite level [36], and other studies [20,21] have shown that for the general population, a cautious approach would be advisable when engaging in strenuous exercise if under chronic stress.

Even though these athletes were apparently healthy according to standard measures of fatigue, recovery, and health (the DALDA, the TDS, and the REST-Q), signs and symptoms associated with excessive training and not enough recovery were evident. Particularly, muscle soreness, aches, and niggles were reported in the Alberta Swim Fatigue and Health Questionnaire every week by at least 40% of the athletes, with 20% of them having to modify their training on a weekly basis. This modification to training is similar to what has been previously reported in the literature, with athletes often increasing the load in another discipline when necessary [3]. While further research is needed to understand these athletes' approach to training, it is possible that the need to modify their training and the participants' approach to managing their complaints of muscle soreness, niggles, and aches could help in explaining the high variations in weekly training loads.

5. Conclusions

The cohort of age-group triathletes in this study presented a random pattern of training throughout the 6 weeks prior to the competition, with large variations in training loads between weeks, along with several sessions performed at higher intensities (zones 2 and 3). Such approach to training could lead to a greater incidence of injuries, lack of recovery, and reduced performance [2,4,14,24]. Nevertheless, no changes in the participants' fatigue and recovery status were found with the DALDA and TDS questionnaires. Still, this information was captured in the Alberta Swim Fatigue and Health Questionnaire. It is possible that training for a competitive event for some of the recreational athletes in this group was a balancing act between the hours of training and general life. This corroborates a recent study in which recreational endurance athletes, particularly triathletes, reported their struggle to find the time to train [18] and how they felt the need to push beyond their comfort levels to stimulate the desired adaptations. While such behaviors could help explain the results seen in this study, further research should assess the training characteristics of recreational athletes and seek to both understand the reasons behind their training patterns, and how such training patterns impact the athletes' health and performance.

Author Contributions: conceptualization, J.H.F.N and M.D.K.; methodology, J.H.F.N and M.D.K.; formal analysis, J.H.F.N, M.D.K., V.V., and E.P.; investigation, J.H.F.N, V.V., and M.D.K.; data curation, J.H.F.N and E.P.; writing—original draft preparation, J.H.F.N; writing—review and editing, J.H.F.N, M.D.K., V.V., and E.P.; supervision, M.D.K., and E.P.

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Conflicts of Interest: The authors declare no conflict of interest.

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