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THE INFLUENCE OF TRAINING LOAD ON PERFORMANCE AND PSYCHOLOGICAL VARIABLES IN FEMALE COLLEGIATE SWIMMERS

by

JACQUELYN A. NAGLE

(Under the Direction of Jim McMillan)

ABSTRACT

Overtraining has become a very important topic in athletics over the past few decades. Resulting from an imbalance between training stress and recovery, the manifestation of overtraining is unique to each individual, with deviations in physiological, psychological, and performance variables. Regardless of the overwhelming amount of research, there is a lack of any comprehensive studies addressing all components of overtraining. Therefore, the purpose of this study was to describe the effects training load had on performance and psychological variables across a competitive season in collegiate female swimmers. Participants included 19 Division I female swimmers (Age: 19.74±1.19 yrs) who completed 6 tethered swimming tests, yielding the mean force (F_{mean}) produced during a 20 second period, as well as completing 7 Recovery-Stress Questionnaires (RESTQ-76), yielding a Total Recovery-Stress Score (TRSS). RPE scores were also collected for every training session from each athlete. From this, Session RPE was calculated by multiplying RPE by the meters completed in the training session yielding an arbitrary number representative of the individuals' internal training load. Utilizing the Session RPE data across the entire season, the participants were categorized into High, Middle, and Low training load groups (TLG). Analysis revealed no significant interaction between TLG and TRSS, or between TLG and F_{mean}. However, there was a significant time effect for TRSS ($p<0.001$) where there is a significant decreases from the 1st to the 2nd trial ($p=0.006$), and from the 2nd to the 3rd trial ($p=0.05$), and significant increases between the 3rd and 4th trial ($p<0.001$), and between the 5th and 6th trial ($p<0.001$). Similarly, there was a significant time effect for F_{mean} ($p=0.004$) where there is a significant decrease between the 1st and 2nd trial ($p=0.004$), and a significant increase between the 3rd and 4th trial ($p=0.01$). The results of this study indicated that although there was no statistically recognizable difference between groups for performance and psychological variables across a competitive season, there were significant changes that occurred across a season for both variables that have practical significance. For coaches, athletes, and researchers, the application of these tools can be used to monitor training for their athletes in an effort to avoid overtraining and under-recovery.

INDEX WORDS: Overtraining, Underrecovery, Swimming, RESTQ-76, Tethered swimming

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by

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May 2011

DEDICATION

To the 2010-2011 Georgia Southern University Women’s Swimming and Diving Team Coaching Staff and Athletes. Thank you for welcoming me into your family and making this one of the most memorable experiences of my life.

ACKNOWLEDGEMENTS

My deepest and sincerest thanks to those who have helped me through this process. But above all, thank you to my committee, mentors, friends, and fellow coaches. Most importantly, thank you Daddy for always believing in me…I love making you proud.

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CHAPTER 1

INTRODUCTION

Overtraining has become a very important topic in athletics over the past few decades (Budgett, 2000). Because of the increasing participation in sport, as well as the apparent decreasing age of children enrolling in organized athletics and greater need for dedication to the sport, understanding all aspects of performance, including underperformance, has taken center stage. First and foremost, there has been much confusion over terminology throughout the literature, making it difficult to compare results across studies. Recent studies have suggested that overtraining occurs in stages (Hollander & Meyers, 1995; Silva, 1990) where symptoms and fatigue increase with increased intensity and/or volume of training coupled with a lack of recovery (Halson & Jeukendrup , 2004). The first stage, overreaching, is utilized by athletes during a typical training cycle in order to stimulate adaptation and enhance performance. Many sports have come to utilize short periods of higher training loads with unchanged recovery volume, producing a short term performance decline (Coutts, Reaburn, Piva, & Roswell, 2007; Halson & Jeukendrup, 2004). Sometimes this overreaching occurs in the middle of a cycle which is followed by returning to previous training levels and this is also followed by an increase in performance, also known as supercompensation (Budgett, 1990; Halson & Jeukendrup, 2004). Kenttä & Hassmén (1998), describe supercompensation as the breakdown process caused by training, followed by the recovery process, as a result of rest, which results in a rebound in adaptation and performance. Generally, it is understood that the more intense the training, the greater the breakdown therefore demanding higher quality recovery. Consequently, recovery from high intensity training takes place over a longer period of time than low intensity training (Halson & Jeukendrup, 2004; Kenttä & Hassmén, 1998).

Eventually, an athlete who is overreaching and not provided adequate recovery time will experience staleness, the description of which has revealed much conflict in the literature. The conflict presents as to whether staleness is a physiological or psychological condition (here will assume the later), although it is more likely to be a combination of the two. According to Silva, staleness has become known as the psychological antecedent of overtraining (1990) that is typically equated with monotony, too much training, lack of enthusiasm, physical fatigue, and conflict with coaches (Hollander & Meyers, 1995; O'Connor, 2007).

The next phase on the continuum is overtraining, which is simply an extension of overreaching with the defining difference being the amount of time provided for recovery (Gonzalez-Boto, Salguero, Tuero, Gonzalez-Gallego, and & Marquez, 2008; O'Connor, 2007). This decrease in performance is a sport specific and unexplained phenomenon that takes place over a relatively long period of time. As a result of an imbalance between training stress and recovery, this slump in performance is coupled with disturbances in mood state (Booth, Probert, Forbes-Ewan, & Coad, 2006). Although the manifestation of overtraining is unique to each individual, some symptoms include physiological and biological markers such as changes in blood lactate threshold (Urhausen, 2002), psychological markers such as changes in mood and loss of competitive drive (Huddleston, et al., 2002), and performance deterioration (Coutts, Reaburn, et al., 2007; Fry et al., 1994; Halson & Jeukendrup, 2004). It is important to remember however, that athletes suffering from overtraining may be performing the same training volume as their peers and at the same relative intensity. Overtraining is not only sport specific but also individual to the athlete where the individuals do not adapt or recover at the same rate (Budgett, 1990).

Finally, when an overtrained athlete continues to train at high intensities, psychological, emotional, and physical burnout may occur resulting in the athlete withdrawing (voluntarily or involuntarily from injury) from a formerly pursued and enjoyable activity as a result of the excessive stress. Furthermore, burnout is characterized by feelings of carelessness, loss of interest, depersonalization, negative feelings of accomplishment, lower levels of self-esteem, and high levels of depression (Raedeke, 2002).

As previously stated, overtraining is a result of a long term imbalance between stress and recovery. In this case, stress, derived from training, is the destabilization or deviation from the normal state in biological and psychological systems. In contrast, when the psychological and physiological resources are reestablished, recovery occurs (Kellmann & Kallus, 2001), with the basic assumption that increased stress requires increased recovery. When this imbalance occurs it triggers a noticeable decrease in performance accompanied by both physiological and psychological symptoms that are unique to each individual and include but are not limited to symptoms such as loss of competitive drive, upper respiratory tract infections, and reduced VO_2 max (Budgett, 1990; Budgett, 2000; Saremi, 2009).

With an improved understanding of the terminology associated with overtraining, it is better understood that the process of overtraining is fairly common in adult athletes (Hollander & Meyers, 1995). Furthermore, approximately 20% of all athletes may exhibit symptoms of overtraining throughout their career, although variability exists between sports (Budgett, 2000; Mackinnon, 2000). Sports experiencing the symptoms of overtraining most commonly are thought to be high volume sports such as swimming, triathlons, road cycling, and rowing. In each of these sports it is not uncommon to spend between 4 and 6 hours a day, 6 days per week training. Furthermore, the predominantly non-weight bearing mode of the sport makes the athletes less susceptible to acute injury, allowing for an even greater capacity for training volume (Mackinnon, 2000). Furthermore, swimming has been studied most frequently (Kreider, Fry, and O'Toole, 1998) because of the nature of the training which emphasizes high frequency of training sessions for extended durations resulting in a high training volume (Gonzalez-Boto et al., 2008).

With the amount of stress imposed upon a swimmer, the response to the training load may exceed the athlete's adaptation threshold (Hartwig, 2009). Maladaptations such as this can lead to a decrease in performance and other overtraining related symptoms. Therefore, it is very important to coaches, athletes, and exercise physiologists alike to determine a balance between stress and recovery. If this was achieved, it would result in the highest possible training load to produce optimal performance, recovery and possibly identify methods to quantify and monitor individual responses to training in athletes (Hartwig, 2009).

There is a fair amount of literature that identifies symptoms of overtraining syndrome and the consequences it has on athletic performance. However, existent literature maintains a few flaws, making the body of literature incomplete and incomprehensive. For example, it is understood that overtraining takes place over a long period of time and is impossible as well as unethical to induce, especially when working with human subjects (Halson & Jeukendrup, 2004). As a result, most studies include athletes that are simply overreaching rather than overtraining.

Furthermore, few studies observe athletes through an entire season, even though these types of studies would more accurately depict the process of overtraining. Most studies observe athletes through a portion of their season (2 weeks to 6 months), and rarely extend through a complete training cycle (Hooper, MacKinnon, & Hanrahan, 1997; Kreider et al.,1998; O'Connor, Morgan, Raglin, Barksdale, & Kalin, 1989). From a practical perspective, studies that do not accurately illustrate an athletes' experience throughout a whole competitive season are inadequate and not generalizable, and could be deemed relatively useless for coaches and athletes in determining adaptations or maladaptations to training.

Although much of this research has sought to examine the physiological and psychological aspects of overtraining separately by focusing on one specific overtraining response (Kreider et al., 1998), the body of literature focuses mainly on the physiological measures of overtraining although it is inconsistent, whereas psychological measures have been shown to be more reliable if performance is also tested (Gonzalez-Boto et al., 2008). Along the same lines, many studies, especially those utilizing swimmers (O'Connor et al., 1989; Raglin & Mogan, 1994) do not include performance tests, lending the question if the athletes are truly overtrained or not. Because a reduction in performance is the only definitive way to identify overtraining by determining is the athlete is positively or negatively adapting to training, it is vital for studies to include a performance test (Halson & Jeukendrup, 2004). Finally, most studies utilize group means which can misrepresent and mask the true state of the individual (Halson & Jeukendrup, 2004; Hartwig, 2009).

Therefore, the purpose of this study was to determine if there is a significant difference between total training load groups for a performance variable (mean force production during a 30-second tethered swimming test) and psychological variable (Total recovery-stress state as shown in the RESTQ Sport-76) across a competitive season in collegiate female swimmers.

CHAPTER 2

METHODS

Participants

Utilizing a convenience sample, the participants of this study were selected from the Georgia Southern University Women's Swimming Team (N=19) regardless of race, ethnicity, sexual orientation, or religious affiliation. Participation in this study was completely voluntary and the subject was permitted to withdraw from the study at any time without academic or athletic penalty. Recruitment of the participants took place at the first team meeting on August 16, 2010 at 4p.m. on the pool deck. The researchers thoroughly explained the study, including the purpose, procedures, risks, and benefits and those wishing to participate signed an informed consent form approved by the University Institutional Review Board.

Instrumentation

Tethered Swimming Device. Because a decrease in performance has been reported as a strong predictor of overtraining, a performance test was included. This method was chosen for a few reasons, including that the performance test must be sport specific. Previously used tests, such as the Swim Bench and Wingate arm crank tests, can not accurately simulate the proper swim motion (Smith, Norris, & Hogg, 2002) and were shown in previously completed studies to have a low correlation to swimming performance (Shionoya et al., 2001; Vorontsov, Popov, Binevsky, & Dyrko, 2006). Secondly, Halson & Jeukendrup state that the signs and symptoms of overtraining are generally observed in anaerobic tests with a decreased power output (2004). Finally, utilizing swim performance from competition is highly variable because of the inconsistent events swam, pool lengths, and meet formats. The tethered swimming test is a valid and reliable method (Morocuo, Soares, Vilas-Boas, & Fernandes, 2008; Morocuo, 2009; Dopsaj, Matkovic,Thanopoulos, & Okicic, 2003; Kjendlie & Thorsvald, 2006). Dopsaj et al. (2003) tested the validity and reliability of the tethered swimming test, resulting in a high degree on Cronbach's alpha 0.86. With regards to the general reliability, they found that the tethered swimming test shows a high degree on Spearman-Brown r_{tt} 0.97. Furthermore, previously completed studies have shown that pulling force measured during this swim test correlates with swimming performance such that increased pulling force corresponds with increased performance (Vorontsov et al., 2006). However, research states that the reliability of this device is dependent on the subject, and their ability to perform the test maximally every time (Kjendlie & Thorsvald, 2006).

The equipment used for this device included a Futek™ tension and compression load cell, Model LSB302 (Irvine, CA) that was connected to a BioPac™ system, Model MP36RWSW (Aero Camino Goleta, CA) by a BioPac™ custom interface that was calibrated by the manufacturer. Connected to the load cell was a 10 meter non-elastic cable with a swim belt attached to the end. The data acquisition software and collected data was only accessible from the researcher's Dell™ Inspiron 1420 Laptop, Model PP26L(Round Rock, TX) maintaining subject confidentiality. Prior to data collection the calibration of the force data sampling system was tested utilizing a series of known weights. Data was sampled at 1000 Hz.

The protocol of the tethered swimming test was adapted from Morocuo (2009) as follows. Subjects completed a 1000- 1200 yard warm up. The subject then put on the swim belt and adopted a horizontal position in the water with the cable fully extended. The first researcher indicated the start data collection with a hand signal, followed by the second researcher signaling the participant to begin a 30 second maximal freestyle tethered swimming test with an auditory signal (whistle). The end of test was signaled through a second auditory signal (Morocuo, 2009).

Mean force (F_{mean}) was examined because it has been shown to be the best predictor for swimming performance for all competitive techniques and all distances (Morocuo et al., 2008; Morocuo, 2009). To determine F_{mean}, the BioPac™ data acquisition file was first translated into a text file and opened using Excel Spreadsheet software. The first and last peaks were then identified allowing a middle data point to be identified. From this middle data point, a starting data point and ending data point were identified by moving 10,000 data points (10 seconds) to either side of the middle point, resulting in a 20,000 data point (20 second) range. The mean of the inclusive data points was calculated, representing F_{mean}.

Recovery Stress Questionnaire for Sport-76. The RESTQ-Sport is a multidimensional questionnaire that reveals the recovery stress state of the athlete. This questionnaire is based on and is closely correlated to the Profile of Mood State (POMS) which has been used in numerous studies in the past, including those with collegiate swimmers (Morgan, Brown, Raglin, O'Connor, & Ellickson, 1987). However, the RESTQ-Sport has a heavier emphasis on recovery and targets an athletic population. There are 19 sub-scales, including 12 general scales and 7 sport specific examining both the stress state and recovery state of the athlete within the last 3 days. The sub-scales are as follows: 1-7 are life stresses, 8-12 are the temporary or non-specific recovery activities, 13-16 are the sport stresses, and 16-19 are the sport recovery scales. Each question is based on a 7 point Likert scale from 0-6 or never to always and takes approximately 5 minutes to complete.

Utilizing the specific software of the RESTQ-Sport-76, descriptive analysis was completed to determine the levels of stress and recovery. From this, a Total Recovery-Stress State (TRSS) was obtained. This was calculated from the mean scores of the Recovery scales (8-12 and 16-19) minus the mean scores of the Stress scales (1-7 and 13-15).The lower the number, the higher the stress of the individual and the more under-recovered they were. In the manual, Kellmann & Kallus state that the RESTQ-Sport is sufficiently reliable and valid for research purposes (2001). Here it is understood that the RESTQ-Sport scales can be correlated to previously validated scales, such as the POMS and State-Trait-Anxiety Inventory, with positive correlations between related scales and negative correlation between opposite scales (Kellmann & Kallus, 2001). Furthermore, all scales show Cronbach α above 0.7 inferring good internal consistency as well as test-retest reliability within a month (Kellmann & Kallus, 2001).

Session-Ratings of Perceived Exertion (RPE). Session-RPE was calculated for every practice session, including morning and afternoon pool sessions, in order to monitor training load. The types of stress encountered during training are typically defined as either the training volume (external training load), or training intensity (internal training load). In a sport such as swimming, training volume is represented by the amount of yardage completed or minutes swam and the training intensity would be the individual's level of intensity at which the training was performed (Wallace, 2008). Recent research has shown that internal training load determines the stimulus for adaptation, because unlike external training loads such as yardage, internal training load is an individual physiological stress (Wallace, 2008). Furthermore, research has shown that this method of quantifying training load has previously been shown to provide comparable results to that of continuous heart rate monitoring (Foster et al., 2001; Coutts, Slattery, & Wallace, 2007). One simple way to monitor internal training load, and therefore establish the training stress imposed on the swimmer, is with session-RPE, giving a uniform value that covers all of the components contained in a swimming program (Wallace, 2008).

On the first day of practice the researcher had a laminated card with the numbers 0-10 listed with the associated descriptive words, 0 being rest and 10 being maximal. For each practice, the participant was asked to verbally provide a global rating for the previous training session, which was recorded by the researcher in a private, coded notebook to maintain anonymity. Furthermore, collecting session-RPE allowed the researcher to document the subject's internal training load (Wallace, 2008) by multiplying the RPE by the yardage (volume) completed during the session.

Procedure

Data collection took place at least monthly to ensure test-retest reliability. Furthermore, the tests were administered on a Monday. This is because the two measures that were chosen were to be given following a day of rest and in a sport such as swimming, the only day off in the seven day week is Sunday. The testing schedule was created by the researcher and head coach so that the testing dates were strategically placed flanking major training phases as well as major competitions without the testing interfering with the normal practice and competition schedules. Furthermore, the researcher collected the subject's session-RPE following every training session, as well as the yardage completed by each participant to monitor training load throughout the season. The schedule was as follows:

Table 1.

Testing Schedule

	8/16	**9/7**	**10/4**	**11/1**	**11/17**	**11/29**	**1/17**	**2/16**	**2/28**
RESTQ-Sport	*Pre-test*	*T1*	*T2*	*T3*	*T4*	---	*T5*	*T6*	---
Swim Test	---	*T1*	*T2*	*T3*	---	*T4*	*T5*	---	*T6*

Statistical Analysis

Because group means typically utilized in statistical analysis have a tendency to mask the true state of the individual, the present study grouped the athletes on a case by case basis. To group the athletes accurately, Total Training Load (TTL) was determined at the conclusion of testing on February 28, 2011. To calculate the TTL, the researchers collected the session RPE, yardage and calculated the TTL through the following steps:

1. Daily Internal Training Load was calculated (Session-RPE x meters completed)
2. All Daily Internal Training Loads were summed to determine the TTL.
3. The participants were divided into thirds according to their TTL score by identifying natural breaks in the data, with the top third (n=6) representing the “high training load group,” the middle third (n=7) representing the “middle training load group,” and the bottom third (n=6) representing the “low training load group.”

With the 3 training load groups (high, middle, and low) defined, two separate two-way ANOVA with repeated measures were used to analyze the relationship between the training groups and other variables. The independent variable for each statistical test was the training group, consisting of three groups (high, middle and low). The dependent variables for the tests were the tethered swimming test variable (F_{mean}) and the RESTQ-Sport score (Total Recovery-Stress Score). Further statistical analysis of the changes in meters completed prior to each testing point, as well as the general and sport stress and recovery scales was done using a one-way ANOVA with repeated measures. Repeated Measures Contrasts were utilized to determine the significant changes between each trial. When determining statistical significance, the alpha level was set at 0.05.

CHAPTER 3

RESULTS

Participants

Participants included 19 female members of the Georgia Southern University Women's Swimming Team made up of five freshman, four sophomores, four juniors, and six seniors. Basic demographics shown below in Table 2.

Table 2.

Demographic Characteristics of participants (n=19)

Variable	Mean	Standard Deviation
Age (*years*)	19.74	1.195
Height (*cm*)	170.04	7.25
Weight (*kg*)	66.43	7.06

Training Load

Swimming volume (meters) completed during each training session resulted in an average weekly total (30837.59, 9170.13) as well as a season total (678427.04, 26468.61). Session RPE was also collected and TTL was calculated, resulting in an arbitrary number indicative of the sum of all session RPE numbers across the season, and the overall internal training load (3817145, 326819.7). Based on the participants TTL, the three training load groups were established (High, n=6; Middle, n=7; Low, n=6) (Table 3).

Table 3.

Descriptive Statistics by TTL group (n=19)

Variable	Mean	Standard Deviation
Total Swimming Volume *(meters)*		
High	691271.15	13759.07
Middle	669599.18	34164.80
Low	675299.64	25006.15
Total Training Loads *(arbitrary)*		

High	4168033	280176.3
Middle	3806043	63239.1
Low	3479208	127519.0

Tethered Swimming Test

Results revealed no interaction between groups for F_{mean} (p=0.531). Furthermore, no group effect was observed (p = 0.792). However, there was a significant time effect across the season (p = 0.004) for F_{mean}. Repeated contrasts revealed significant differences between Trial 1 and Trial 2 (p = 0.004; ES=0.40), and between Trial 3 and Trial 4 (p = 0.017; ES= -0.14). Descriptive statistics revealed that between Trial 1(84.39N, 13.58N) and Trial 2 (78.90, 15.06) there was a significant decrease in F_{mean}, whereas between Trial 3 (75.62N, 18.79N) and Trial 4 (78.28N, 18.65N) there was a significant increase in F_{mean} (Figure 1).

It should be noted that, due to injuries, only 16 of the 19 participants completed all six trials. Those who did not complete all 6 trials (one from each of the three TTL groups) were removed from the analysis of F_{mean}, resulting in the high training load group n=5, middle training load group n=6, and low training load group n=5.

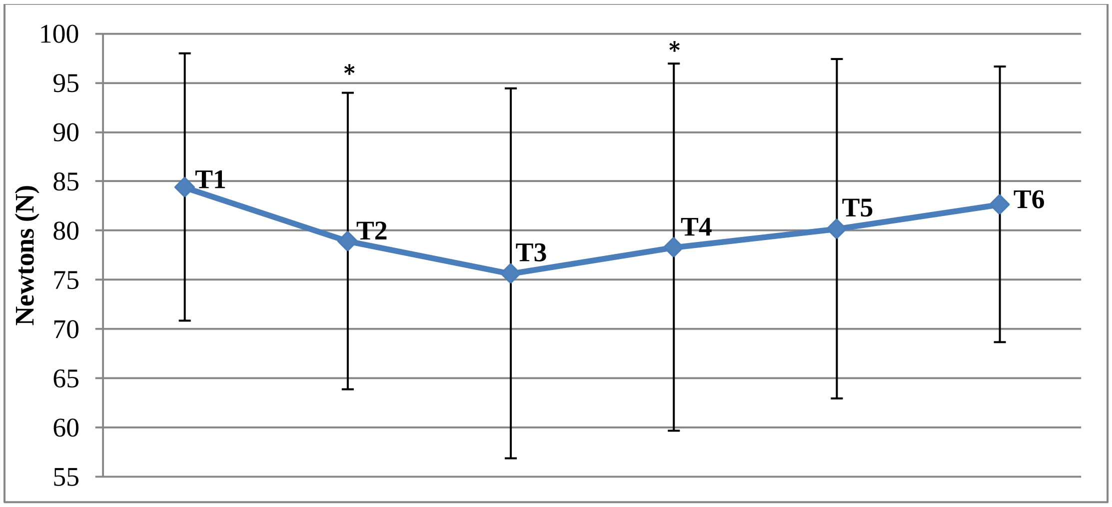

Figure 1. Average Mean Force Production (n=16). *(*)= Significant difference (p<0.05) from previous trial.*

Corresponding with the collection points of F_{mean}, One way ANOVA with Repeated Measures revealed significant changes in the meters completed (Figure 2). Contrasts revealed significant differences between Trial 1 and Trial 2 ($p < 0.001$; ES= -2.10), between Trial 4 and Trial 5 ($p < 0.001$; ES= -0.78), and between Trial 5 and Trial 6 ($p<0.001$; ES= 1.05). Descriptive statistics revealed that between Trial 1(18182.12mtrs, 5560.57mtrs) and Trial 2 (29903.29mtrs, 4013.88mtrs) there was a significant increase in meters completed, and between Trial 4 (29234.33mtrs, 14133.38mtrs) and Trial 5 (40324.08mtrs, 11168.23mtrs) there was a significant increase in meters completed. Finally, between Trial 5 and Trial 6 (28565.37mtrs, 2409.57mtrs) there was a significant decrease in meters completed.

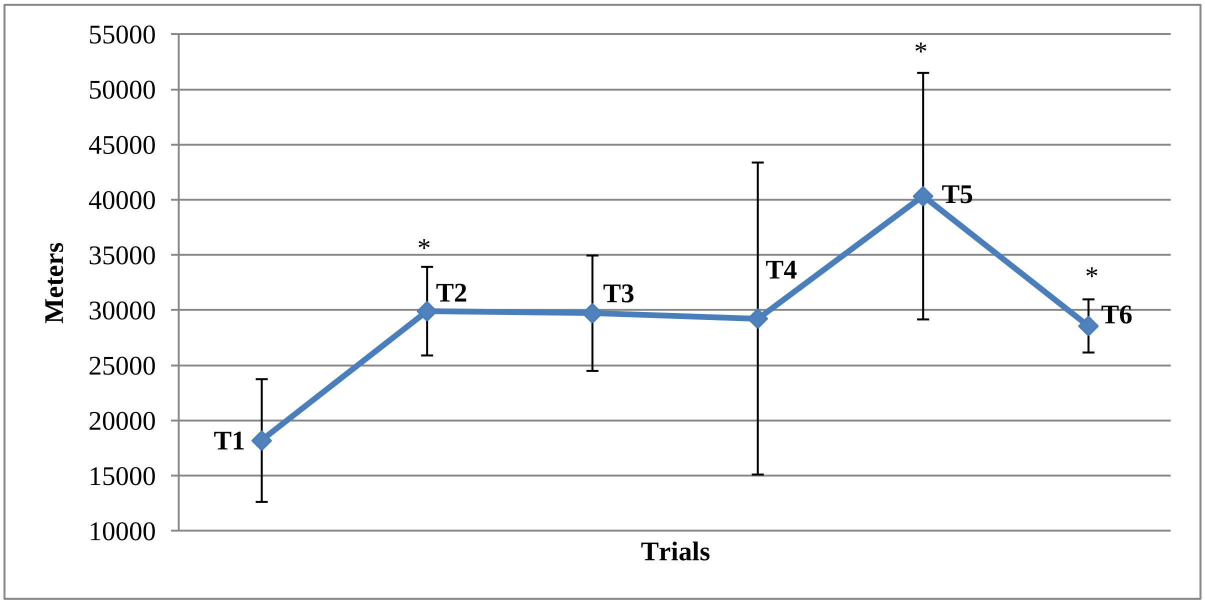

Figure 2. Average Weekly Team Meters Completed Prior to Tethered Swim Test (n=19). (*)= Significant difference ($p<0.05$) from previous trial.

Recovery Stress Questionnaire for Athletes -76

Results revealed no significant interaction between groups for Total Recovery-Stress State (TRSS). Furthermore, no group effect was observed ($p=0.79$). However, there was a significant time effect across the season ($p<0.001$) for TRSS. Contrasts revealed that there was a significant difference between Trial 1 and Trial 2 (p = 0.006; ES= 0.55), Trial 2 and Trial 3 (p=0.05; ES= 0.43), Trial 3 and Trial 4 (p<0.001; ES= -0.65), and between Trial 5 and Trial 6 (p<0.001; ES= -1.41). Descriptive statistics showed that between Trial 1 (9.72, 13.83) and Trial 2 (2.29, 12.89), and between Trial 2 and Trial 3 (-3.37, 13.65), there was a significant decrease. However, from Trial 3 to Trial 4 (5.57, 14.80), there was a significant increase. Finally, from Trial 5 (2.72, 12.67) to Trial 6 (20.68, 10.86), there was also a significant increase in TRSS (Figure 3).

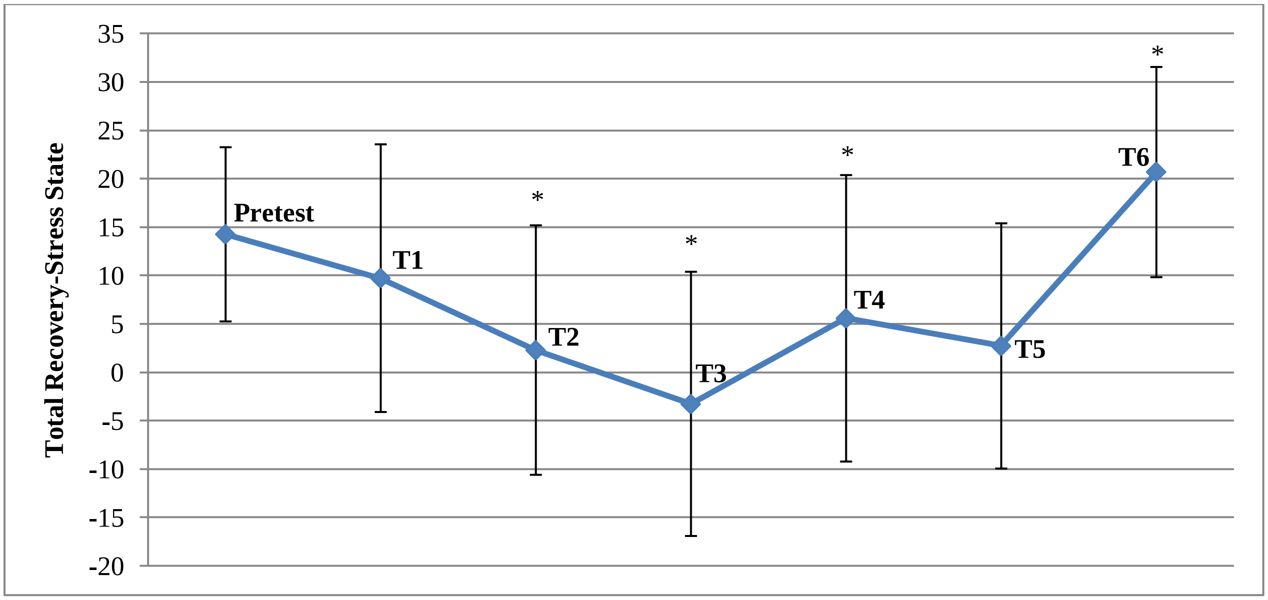

Figure 3. Average Total Recovery-Stress State (n=19). (*)= Significant difference (p<0.05) from previous trial.

Corresponding to the significant changes in TRSS, One way ANOVA with Repeated Measures revealed significant changes in the meters completed in the weeks prior to the Trial (Figure 4). Contrasts revealed significant differences between Trial 1 and Trial 2 (p <0.001; ES= -2.10), between Trial 4 and Trial 5 (p <0.001; ES= -0.64), and between Trial 5 and Trial 6 (p<0.001; ES= 0.88). Descriptive statistics revealed that between Trial 1(18182.12mtrs, 5560.57mtrs) and Trial 2 (29903.29mtrs, 4013.88mtrs) there was a significant increase in meters completed, and between Trial 4 (29234.33mtrs, 14133.38mtrs) and Trial 5 (38386.35mtrs, 11097.71mtrs) there was a significant increase in meters completed. Finally, between Trial 5 and Trial 6 (28521.26mtrs, 2309.53mtrs) there was a significant decrease in meters completed. The pre-test, was not included in the analysis because no meters had been completed prior to the Trial.

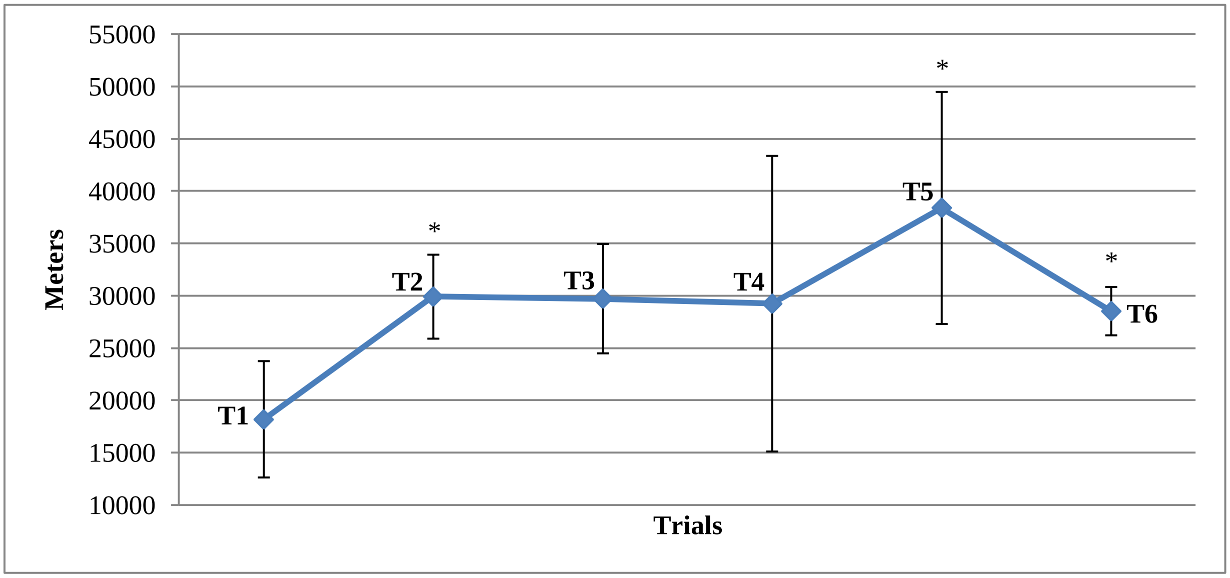

Figure 4. Average Weekly Team Meters Completed Prior to RESTQ-Sport Trial. (*)= Significant difference (p<0.05) from previous trial.

Furthermore, the components of the TRSS (General Stress, General Recovery, Sport Stress, and Sport Recovery) were stratified out and examined across the season for further analysis. See Tables 4a-4d below.

Table 4a.

General Stress Scores

Trial	Mean	SD	Significance	ES
Pretest	10.94	4.21	---	---
Trial 1	13.89	5.56	.022*	-0.70
Trial 2	16.85	5.70	.019*	-0.53
Trial 3	18.80	7.05	.120	---
Trial 4	16.31	5.93	.012*	0.35
Trial 5	15.43	5.93	.414	---
Trial 6	10.98	4.22	.000*	0.75

(*)= Significant difference (p<0.05) from previous trial

Table 4b.

General Recovery Scores

Trial	Mean	SD	Significance	ES
Pretest	18.52	3.86	---	---
Trial 1	17.53	4.92	.347	---
Trial 2	15.88	4.04	.025*	0.27
Trial 3	14.57	3.79	.056	---
Trial 4	16.53	3.92	.007*	-0.51
Trial 5	15.28	3.59	.033*	0.31
Trial 6	18.97	3.66	.000*	-1.02

(*)= Significant difference ($p<0.05$) from previous trial

Table 4c.

Sport Stress Scores

Trial	Mean	SD	Significance	ES
Pretest	3.00	2.14	---	---
Trial 1	7.01	2.44	.000*	-1.87
Trial 2	8.31	2.84	.006*	-0.53
Trial 3	10.03	3.33	.005*	-0.60
Trial 4	7.21	3.35	.000*	0.84
Trial 5	8.52	3.51	.028*	-0.39
Trial 6	2.93	1.95	.000*	1.59

(*)= Significant difference ($p<0.05$) from previous trial

Table 4d.

Sport Recovery Scores

Trial	Mean	SD	Significance	ES
Pretest	9.67	2.38	---	---
Trial 1	13.09	3.45	.001*	-1.43
Trial 2	11.57	2.98	.019*	0.44
Trial 3	11.00	2.44	.406	0.19
Trial 4	12.56	3.47	.015*	-0.63
Trial 5	11.39	2.60	.037*	0.33
Trial 6	15.63	3.23	.000*	-1.63

(*)= Significant difference ($p<0.05$) from previous trial

CHAPTER 4

DISCUSSION

Overtraining is a highly controversial variable of sports training because of its multifactor implications. As a result, research has and will continue to be done with many sports and populations in an effort to better understand the mechanisms of training and recovery for improved sport performance. This study investigated the effect of training load of swimmers across a competitive season on a psychological and performance variable. Results obtained suggest that although there were no significant differences between the training load groups for the aforementioned variables, that there were significant changes across time that aligned with periods of high intensity training and periods of relative rest, as a planned part of the training program.

Tethered Swimming Test

Preliminary observations of resultant data, ranging from 47.8N-119.94N, show consistency of F_{mean} with that of previous studies (Aspenes, Kjendlie, Hoff, & Helgerud, 2009; Dopsaj et al., 2003; Morcouco, 2009; Morocuo et al., 2008) with mean force productions ranging from 61N-121N for both genders. Results of the tethered swimming test did not show significant differences between training groups for F_{mean} across the competitive season. However, the lack of statistical significance thereby assumes practical significance of these findings. With no significant difference between groups, it can be inferred that although the training load varied between groups, there was no difference in mental and physical response to training. Practically, this can be translated to a basic assumption that the athletes were receiving workouts that were individualized and tailored to their needs. As part of the Georgia Southern University Swimming Program, each practice offered at least three different workouts, typically labeled “sprint” “mid-distance” and “distance,” with varying swimming volumes (meters), intervals, and intensities. Athletes moved groups from one workout to the next on a case by case basis to achieve their individual training goals. Results of this study are consistent with existent literature stating that an athlete may be carrying out the same training volume as their peers and at the same relative intensity, but their ability to adapt or recover varies (Booth et al., 2006; Budgett, 1990; Coutts, Reaburn, et al., 2007; Fry, et al., 1994; Halson & Jeukendrup, 2004).

Although no significant interaction was found, data indicated significant time effects across the season for the whole team. As part of a well-planned training program, the temporary decreases and increases in performance, represented by F_{mean}, can be explained with corresponding increases in meters as well as periods of relative rest, respectively. First, results indicated a significant decrease between Trial 1 and Trial 2. When comparing the average weekly meters prior to the testing periods, significant increases in average weekly meters was observed from Trial 1 to Trial 2. In this time period, the athletes increased from a weekly average of 18,181 meters prior to Trial 1 to a weekly average of 29,902 meters prior to Trial 2. Furthermore, a significant increase was observed between Trial 3 and Trial 4 for F_{mean}. Although no statistical significance was found with corresponding meters, anecdotally it can be concluded that the significant increase in performance is due to the week of rest the athletes had due to the University’s Thanksgiving break, in which training was drastically decreased or discontinued. Additionally, through visual assessment of the average force production (Figure 1) in correspondence with the weekly meters (Figure 2), it can be deduced that there is a practical significance to the inverse relationship between work and performance, as well as the effects of rest and performance. When comparing these results to published literature, the inferences that were made align with all basic understandings of training stress and recovery (Kreider et al., 1998).

Furthermore, it should be noted that the timing of the test trials were arranged around the schedules of the athletes and the coaches, sometimes leading to less-than-desirable test dates. For example, the final post-test, representative of when the athlete should be at their peak performance, was completed one week after the conference meet. Although the ideal testing would be the week of the conference meet, when utilizing collegiate athletes, compromises must be made between what is ideal for the researcher and what is ideal for the athlete. Although it was not possible to administer the tethered swimming test prior to the conference meet, anecdotal evidence indicates that the rest period, as shown in the statistically significant decrease in meters completed between trials 5 and 6, was beneficial for performance as indicated in 41 lifetime best times out of possible 61 individual swims of the 19 athletes

Recovery Stress Questionnaire for Athletes-76

Results obtained from the Recovery Stress Questionnaire for Athletes-76, represented by the Total Recovery Stress State (TRSS) did not show significant differences in training load groups across the competitive season. However, similar to the tethered swimming test results, the lack of statistical significance thereby assumes practical significance where it is confirmed that the athletes received training that is individualized to their needs to allow optimal psychological recovery. However, data indicated a significant time effects across the season. Again, much like the results of the tethered swimming test, the temporary changes in TRSS can be explained with corresponding increases in swimming volume as well as periods of relative rest, as a planned part of a well-designed training program.

First, results indicated a significant decrease in TRSS between Trial 1 and Trial 2. When comparing the average weekly meters prior to the testing periods, a corresponding significant increase in average weekly meters was found between Trial 1 and Trial 2. These results are consistent with existent literature, confirming that an increase in training volume induces a significant increase in stress and decrease in recovery, (Budgett, 1990; Jurimae, Maestu, Purge, & Jurimae, 2004; O'Connor et al., 1989) exemplified in a significantly lower TRSS. In two similar studies done with swimmers and rowers (Gonzalez-Boto et al., 2008; Kellmann, Altenburg, Lormes, & Steinacker, 2001), results obtained indicated that the RESTQ-Sport-76 was able to show significant changes concurrently with training load, such that when training volume was increased, TRSS decreased. Similarly, a study done by O'Connor and associates (1989), yielded similar results with swimmers, where a depressed mood state was recognized and correlated to an increase in daily training from 2,000 meters to 12,000 over a 6-month period. In addition, the corresponding dates of the tethered swim test trials (Trial 1to Trial 2) show a significant decrease in F_{mean}. From this, it can be suggested that there is a relationship between performance, psychological variables, and meters completed.

Additionally, a significant decrease was found between Trial 2 and Trial 3. Although no significant differences were detected for meters completed, when the components of the TRSS were stratified out, a significant increase in Sport Stress was detected. Observational data from the coaches confirms these results, with many of the athletes fitting the Sport Stress subscale characteristics including interrupted recovery, stress with teammates and coaches that interrupts periods of rest, feeling burned out, wanting to quit the sport, developing acute injuries and vulnerability to injuries (Kellmann & Kallus, 2001) during this time period from October to November.

The next testing trial took place immediately following a 3-day rest period in preparation for a mid-season taper swimming meet. Results revealed a significant increase in TRSS between Trial 4 and Trial 5 indicating that the temporary rest period had a significant positive impact on the athlete's mood state. These findings are consistent with literature suggesting that tapering, or allowing the athlete a short period of rest and recovery, regularly throughout the season is beneficial (Budgett, 2000). Similarly, the final trial took place prior to the conference meet, following a month long progressive decrease in swimming volume (meters). Resultant data revealed a significant increase in TRSS between Trial 5 and the final collection, Trial 6. The significant increase in TRSS can be explained by comparing the average weekly meters prior to the testing periods, revealing a corresponding significant decrease in average weekly meters was found between Trial 5 and Trial 6. Similar to the findings of Budgett (2000), O'Connor (2007) suggests that reductions in training, or taper, consistently reduce feelings of fatigue as well as increase feelings of energy.

With the resultant data in mind, it is suggested that psychological evaluation is a useful tool in the evaluation of athletes and their susceptibility to becoming overtrained. In association with previously published studies, it is well established that mood profiling , via the monitoring of stress and recovery factors, on a regular basis can be a valuable tool to improve physical and psychological performance of athletes (Gonzalez-Boto et al., 2008; Kellmann & Kallus, 2001; Noce et al., 2008).

Conclusions

Overall, results indicate that although there were no statistically significant differences between training load groups for the performance and psychological variables, there were significant changes across time for both variables. Furthermore, the significant changes detected for both performance and psychological variables corresponded with statistically significant changes in meters completed, revealing an inverse relationship between meters and the aforementioned variables. On the whole, the results of this study have succeeded in filling the current gaps in literature by illustrating a comprehensive picture of the effecting variables across a competitive season for collegiate swimmers. More research is needed to better understand the intricate relationship between training loads and performance and psychological variables.

Finally, it should be noted that results of this study confirmed the claims of previously published studies that psychological measures, when coupled with a valid and reliable performance test, are valuable tools in monitoring stress and recovery of an athlete in an effort to avoid overtraining. Constant monitoring of athletes in such a way, can provide optimal training volumes, and potentially yield the highest possible performances. From a practical perspective, future research should focus on developing minimally invasive and more mainstream ways to monitor these variables for athletes and coaches alike.

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APPENDIX A

RESEARCH QUESTIONS, DELIMITATIONS, LIMITATIONS, ASSUMPTIONS, AND DEFINTIONS

Research Questions

1. Do higher training loads have a significant effect on Fmean across a competitive swimming season?
2. Do higher training loads have a significant effect on Total Recovery-Stress State across a competitive swimming season?

Delimitations

1. This study will focus on NCAA Division I swimmers, ages 18-24, who are members of the Georgia Southern University Swim Team.
2. Only utilizing specific measures from the Recovery Stress Questionnaire for Athletes, Session-RPE, and the Tethered Swimming Device.
3. Only female participants.

Limitations

1. Convenience sampling will be used resulting in a small and non-random sample.
2. The ability to generalize the results to all swimmers may be difficult.
3. Participants may not be familiarized with how to execute a 30-second maximal tethered swimming test.

Assumptions

1. Each participant will take the task seriously and put forth a good effort during the tethered swimming test.
2. Each participant will answer the questionnaire honestly and accurately.

3. Each participant will provide the researchers with an accurate session-RPE score after every training session.

Definitions

1. Overreaching-Purposeful overtraining that is utilized by athletes during a typical training cycle in order to stimulate adaptation and enhance performance. This is followed by a period of relative rest or tapering in order to allow full supercompensation normally within two weeks (Budgett, 1990; Coutts, Reaburn et al., 2007; Halson & Jeukendrup, 2004).
2. Staleness- A psychological or depression-like syndrome that results from overtraining and is not explained by any other medical condition. It is usually equated with monotony, too much training, lack of enthusiasm, physical fatigue, and conflict with coaches (Halson & Jeukendrup, 2004; Hollander & Meyers, 1995; Morgan et al., 1987; O'Connor, 2007; Silva, 1990).
3. Overtraining- A sport specific decrease in performance together with disturbances in mood state resulting from an imbalance between training stress and recovery, despite two weeks of relative rest and ruling out any identifiable medical illness. Although the manifestation of the syndrome is unique to each individual, symptoms are categorized as physiological/biological, psychological, and performance (Booth et al., 2006; Coutts, Reaburn et al., 2007; Fry et al., 1994; Gonzalez-Boto et al., 2008; O'Connor, 2007).
4. Burnout- As a result of overtraining, burnout is the psychological, emotional, and physical withdrawal (voluntarily or involuntarily from injury) from a formerly pursued and enjoyable activity as a result of excessive stress (Hollander & Meyers, 1995; Raedeke, 2002).

APPENDIX B

ANNOTATED BIBLIOGRAPHY

Angeli, A., Minetto, M., Dovio, A., Paccotti, P. (2004). The Overtraining Syndrome in Athletes: A Stress-Related Disorder. *Journal of Endocrinology Investigation*, *27*, 603-612. Retrieved From SPORTDiscus Database.

In this article, the authors summarize current knowledge of Overtraining Syndrome (OTS), and identify the physiological, psychological, immunological, and biological abnormalities associated with it. Major signs and symptoms were identified including physiological alterations (i.e. decreased performance and muscular strength, prolonged recovery, chronic fatigue, sleep-wake cycle, gastrointestinal, sexual, and blood pressure and heart rate changes), psychological symptoms (i.e. depression, apathy, loss of appetite, and fear of competition), immunological dysfunction (i.e. increased susceptibility to infection, decreased immune response), and biochemical alterations (i.e. decreased hemoglobin, serum iron and ferritin, increased urea and uric acid levels, mineral depletion, and low free testosterone). The article also outlines the difference between resistance and endurance athletes re3sponmce of serum IL-6. Finally, the authors state the OTS is characterized by a heterogeneous pattern of abnormalities that progress over time.

Boothe, C.K. Probert, B., Forbes-Ewan, C., Coad, R.A. (2006). Australian Army Recruits in Training Display Symptoms of Overtraining. *Military Medicine*, 171 (11), 1059-1064. Retrieved From SPORTDiscus Database.

In this article, the researchers examine the physiological and psychological effects of training on Australian Army recruits throughout their training course. Based on the theory that physiological stress is exaggerated by psychological stress, the researchers sought to observe the response to intense training using physiological markers (free testosterone/cortisol ration (FTRC), immune testing, and physical fitness measures) and psychological markers (Profile of Mood State). The results infer that mood declined overtime as immune function did. This article provides a general framework for the study I would like to conduct, with minor alterations to the subject pool and testing measures. In comparison to other similar literature, this article reflects many of the same ideas that overtraining is both physiological and psychological in nature and can be tracked with a series of measures. This affirmation solidifies the purpose of my study by laying a foundation in which I intend to extrapolate upon to identify markers that will help predict overtraining in athletes so that it can be avoided.

Budgett, R. (2000). Overtraining and Chronic Fatigue: The Unexplained Underperformance Syndrome (UPS). *International SportMed Journal*, 1 (3). Retrieved From SPORTDiscus Database.

In this article, the author outline overtraining and chronic fatigue under a larger umbrella term called the unexplained underperformance syndrome (UPS), as a result in unclear definitions and diagnosis in the literature. UPS symptoms include history of heavy training and competition, frequent minor infection, unexplained or unusually stiff and/or sore muscles, mood disturbance, change in expected sleep quality, loss of energy, loss of competitive drive, loss of libido, and loss of appetite. Furthermore, the authors outline the pathophysiology of UPS from the psychology to the hormonal changes, as well as outlining management skills. This review of explains that overtraining and chronic fatigue should be grouped together under the title of UPS, proving useful during the review of literature process. Compared to similar articles, this article gives a broad view to overtraining as well as a brief description of the symptoms exhibited. Upon reading this article, the misconceptions about overtraining, burnout, chronic fatigue, and staleness are put to rest because of the concise definitions given.

Budgett, R., Newholme, E., Lehmann, M., Sharp, C., Jones, D., Peto, T., Collins, D., Nerurkar, R., White, P. (2000). Redefining the Overtraining Syndrome as the Unexplained Underperformance Syndrome. *British Journal of Sports Medicine, 34,* 67-68.

In this article, the authors define Underperformance Symdrome (UPS) as a combination of overtraining and chronic fatigue. They define UPS as a persistent unexplained performance deficit despite 2 weeks of relative rest. They also state that endurance athletes present with fatigue and underperformance with secondary changes in mood, where sprinters and power athletes present primarily with changes in mood (burnout and/or staleness) with subsequent changes in performance. This article is an overlap of the previously reviewed Budgett article.

Coutts, A.J., Reaburn, P., Piva,, T.J., Roswell, G.J. (2007). Monitoring for Overreaching in Rugby League Players. *European Journal of Applied Physiology, 90*, 313-324.

In this article, the researchers define the difference between overreaching and overtraining as functional and non-functional overreaching in Rugby players. Non-functional overreaching, or overtraining, occurs when athletes are given inadequate recovery time during periods of intense training. On the contrary, functional overreaching is used deliberately followed by a rest period of recovery to induce supercompensation and a subsequent increase in performance. In this study, 2 groups were used (one completed a normal 6 week program, while the other group was deliberately overreached through intense training. The athletes were performance tested 24 hours before training, following the training, and after a 7 day taper. Results indicate that the IT groups VO2 max and MSFT(multistage fitness test) was significantly reduced over time and condition, indicating overreaching.

Flynn, M.G., Pizza, Boone, J.B., Andres, F.F., Michaud, T.A., Rodriguez-Zayas, J.R. (1994). Indices of Training Stress During Competitive Running and Swimming Seasons. *International Journal of Sports Medicine, 15,* 21-26.

In this article, the researchers tested venous blood samples (cortisol, total testosterone, free testosterone, and creatine kinase), heart rate, and blood pressure of eight male cross country runners, and 5 male swimmers. The tests were conducted for the swimmers after the first 9 weeks of training, after 2 weeks of hard training, after 6 more weeks of hard training, and the week following conference championships. Training volume was also monitored and was broken into high (>100% VO2max velocity) and low intensity training. The results of this study indicated that during the most intense training period, there were significant alterations of FT, TT, and CK. These changes were associated with decrements in performance capacity and increased global mood state.

Fry, R.W., Grove, J.R., Morton, A.R., Zeroni, P.M., Gaudieri, S., Keast, D. (1994). Psychological and Immunological Correlates of acute Overtraining. *British Journal of Sports Medicine, 28,* 241-246.

In this article, the researchers utilized 5 male subjects to monitor the psychological and immunological response to intense training. The subjects underwent 2 intense interval training sessions per day for 10 days and supplied a venous blood sample (and completed a mood state questionnaire (POMS) on days 1, 6, 11 and 16. The results of this study indicate that acute overtraining can also cause imbalances in the immune system as well as psychological disturbances. After a 5 day recovery, performance increased toward baseline, as well as mood state.

Gonzalez-Boto, R., Gonzalez, O.M, Marquez, S. (2008). A New Integrative Model of Overtraining Based on Burnout and Stress-Recovery Psychological Approaches. Ansiedad y Estres, 14(2), 221-237.

In this article, the authors attempt to integrate the difference approaches to overtraining (burnout and recovery-stress relationship). They state that athletic training physically and psychologically stresses athletes and can have both positive and negative effects. Most athletes seek positive adaptation when training, although too much training may lead to negative training responses with individual s progressing to overtraining and ultimately to burnout if the stress due to training is not reduced. They also review the relationship between stress and recovery, and state that high levels of stress will not result in a situation of overtraining as long as adequate recovery is employed. Furthermore, the higher the stress, the more recovery that is needed (Scissor Model, Kellmann, 1991). There is also a difference between Short-term overtraining and Long-term Overtraining in the sense that Short-term OT is utilized in training programs to produce supercompensation, whereas long-term OT is marked by underrecovery and underperformance. Finally, the authors describe that performance is dependent on the balance of stress and recovery.

Gonzalez-Boto, R., Salguero, A., Tuero, C., Gonzalez-Gallego, J., Marquez, S. (2008). Monitoring the Effects of Training Load Changes On Stress and Recovery in Swimmers. *Journal of Physiology Biochemistry,* 64 (1), 19-26.

In this article, the authors examine overtraining using the Recovery Stress Questionnaire for athletes (REST-Q) as well as tracking training load in swimmers. The subjects completed REST-Q 76 four times throughout the season, where each of the 19 scales were analyzed for significant change between measures using a one way ANOVA with repeated measures. The results also showed a correlation between training load and REST-Q 76 scores. The results suggested that as training load, tracked by meters swam, increased so did the REST-Q total recovery stress state. This article is beneficial for my study as it sets a foundation for the use of the REST-Q 76 to effectively measure the stress state of the athlete. In the future, this measure could also be used as a way to prevent overtraining in athletes by tracking the psychological state of the athlete throughout a competitive season.

Halson, S.L., & Jeukendrup, A.E. (2004). Does Overtraining Exist? An Analysis of Overreaching and Overtraining Research. *Sports Med*, 34 (14), 967-981. Retrieved from Academic Search Premier Database.

In this article, the authors question the differences between Overtraining and Overreaching. Although most literature says there is a clear difference between the two, the authors explain that the only difference is the amount of time needed for recovery, and not the symptoms themselves. Additionally, the authors state that most research to date uses athletes who are overreaching, a common training method for athletics also known as 'supercompensation', because inducing overtraining in a laboratory setting is unethical. The author concludes by suggesting that future research include measures of performance and mood state as well as quality and quantity of training and recovery periods to be able to conclusively state that overtraining exists. This source has brought up an interesting question by stating the overt similarities between overreaching and overtraining. In similar literature, it is assumed that athletes exhibiting symptoms of fatigue and underperformance are overtrained, but where is the point where an athlete is not longer overreaching and becomes overtrained? This article describes the differences being in the amount of recovery time needed, which is not a prevalent measure in the concurrent literature. Based on the authors suggestions, I intend to utilize this source to shape my methods section by not only including a psychological measure, but to track the amount of weekly yardage throughout the season to determine recovery time of the athlete to determine if they are simply overreaching or have become overtrained.

Hollander, D.B., Meyers, M.C. (1995). Psychological Factors Associated with Overtraining: Implications for Youth Sport Coaches. *Journal of Sport Behavior*, 18 (1). Retrieved From Academic Search Premier Database.

In this article, the authors use youth sports to outline the physiological symptoms of overtraining, followed by the psychological factors. The authors state that although most literature focuses on the physiological symptoms, the results have more often than not been inconclusive, whereas psychological factors have proven much more reliable. Furthermore, the authors do a nice job of clearing up the hazy terminology, in cases where overtraining, overreaching, and staleness had been used thoughtlessly used interchangeably. This source was one of the most useful in terms of allowing myself to become more familiar with the terminology. Prior to reviewing the literature, I was confused on the uses of the words overtraining, overreaching, and burnout because the athletic world uses there terms to interchangeable, although differences do exist. I do belief however that the authors are bias in their statements that psychological measures of overtraining are more reliable than physiological, considering their sports psych background, and the fact that other literature supports that physiological measures are reliable in predicting overtraining if administered properly. This article has proven helpful in shaping the beginning of my introduction where I will define overtraining and burnout in my terms for the study.

Huddleston, S., Kamphoff, C.S., Suchan, T.M., Mack, M.G., Bian, W., Bush. D., Mintah, J.K., Dutler, K.E., Wee, R.J. (2002). Mood Changes in Collegiate Track and Field Athletes. *International Sports Journal,* 75-83.

In this article, the researchers utilize the Mood Scale, 37-POMS to measure mood state of the athletes over the competitive season. They hypothesized that positive mental health is directly related to higher levels of performance and mood disturbances are associated with poor performance. Therefore, the authors state that a general understanding of mood changes across the athletic season would allow coaches and athletes an opportunity to prevent possible negative performance effects. Previous research has only collected Mood state scores a few times throughout a season, although more frequent monitoring is advised.

Kellmann, M., Altenburg, D., Lormes, W., Steinacker, J.M. (2001). Assessing Stress and Recovery During Preparation for the World Championships in Rowing. *The Sport Psychologist,* 151-167.

In this article, the researchers administered the RESTQ-Sport 6 times during a training camp. They monitored means, standard deviations, and changes in scale scores over time. The results of this study indicate that the RESTQ-Sport is sensitive to life events effecting recovery-stress state, and is a potential alternative to established instruments such as the POMS and the RPE scales. The authors used the RESTQ-Sport to identify why athletes recovery-stress state does not line up with the changes in training, in which case, the training can be altered to avoid overtraining. In conclusion, the authors state that the RESTQ-Sport provides coaches, sport psychologists, and athletes with important information during the process of training, and makes it possible to monitor individuals and groups during the course of a season.

Kjendlie, P-L., Thorsvald, K. A Tethered Swimming Power Test is Highly Reliable. 1-3.

In this article, the authors report the reliability of a tethered swimming test. It was concluded that a tethered swimming power test is highly reliable, assuming that the subject perform maximally and that the protocol consists of three trials.

Lai, C., & Wiggins M.S. (2003). Burnout Perceptions Over Time in NCAA Division I Soccer Players. *International Sports Journal,* 120-127. Retrieved From Academic Search Premier Database.

In this article, the phenomenon of burnout, characterized as physical fatigue, carelessness, and a lack of desire, is studied quantitatively by using a survey (Burnout Inventory for Athletes) to observe burnout over an entire season. The results of this survey were used to find correlations between the demographical information provided by the athlete and the BIA scores throughout the season. The results of the study indicate that although the BIA scores increased over the season, none of the athletes exhibited levels of true burnout. Compared to other sources, this article utilizes a study design and provides empirical evidence supporting the hypothesis that burnout increases over an athletic season. The major distinction of the article is that it describes burnout (psychological measure) over an entire season, whereas similar articles observe changes over a shorter period of time. This is beneficial because overtraining is a phenomenon that takes place over time, which is supported in this article. Furthermore, other similar articles describe overtraining symptoms in athletics, but use non athletes in their sample. The subjects of this study are collegiate athletes, which should have a different response to overtraining and burnout than a person who is not as physically active because of their previous sporting history. This article is easily integrated into my study, because I hope to describe overtraining over a competitive season with real athletes instead of inducing overtraining in a laboratory.

Lehmann, M., Foster, C., Gastmann, U., Keizer, H., Steinacker, J.M. (1999). Definitions, Types, Symptoms, Findings, Underlying Mechanisms, and Frequency of Overtraining and Overtraining Syndrome. *Overload, Performance Incompetence, and Regeneration in Sport*. 1-6.

The authors of this book define overtraining as an imbalance between stress and recovery, where there is more stress and not enough recovery. They define Overtraining Syndrome as an impaired state of health caused by overtraining. Furthermore, short-term overtraining, or overreaching, is utilized in typical training to induce supercompensation and subsequent increases in performance. If overtraining is held for long periods of time, then it becomes burnout and staleness.

Mackinnon, L.T. (2000). Overtraining Effects on Immunity and Performance in Athletes. *Immunology and Cell Biology*, 78, 502-509.

In this article, the authors review literature on overtraining including prevalence, symptoms, and possible prevention strategies. The authors estimate that at any given time, between 7 and 20% of all athletes may exhibit symptoms of overtraining syndrome. The prevalence varies by sport and is thought to be highest in endurance sports requiring high volume intense training such as swimming, triathalon, road cycling, rowing, and distance running. These athletes train 4-6 hours each day, 6 days a week, for several months with no time off. This imbalance of stress and recovery leads to overtraining. It is important to note that the authors state that it is difficult to control for possible confounding variables such as illness, travel, dietary changes, competition stress, and season variability. Finally the authors suggest possible measures to prevent overtraining such as 1. Early identification and monitoring of susceptible athletes, 2. Minimizing known effects such as sudden increases in training load, inadequate dietary intake, and too frequent competitions, 3. Individualized training, 4. Periodized training, 5. Programming recovery training and rest days into training cycle.

Maestu, J., Jurimae, J., Kreegipuu, K., Jurimae, T. (2006). Changes in Perceived Stress and Recovery During Heavy Training in Highly Trained Male Rowers. *The Sport Psychologist, 20,* 24-39.

In this article, the authors manipulated the training volume of 12 elite rowers during a 6 week training period. During this time, they administered the RESTQ-Sport as well as a performance test. The results of this study indicated that as the training load increased the stress scores increased while the recovery scores decreased, indicating a state of underrecovery was being reached. The authors conclude by stating that the RESTQ-Sport questionnaire is a valuable instrument to evaluate the recovery-stress state during high volume and recovery cycles in male rowers.

McGuigan, M.R., Foster, C. (2004). A New Approach to Monitoring Resistance Training. *National Strength and Conditioning Association, 26* (6), 42-47.

In this article, the authors examine how to better monitor training for strength athletes vs. endurance athletes. They explain that strength and power athletes can not use volume of training because it does not address intensity. The authors of this article suggest the use of RPE to monitor intensity of resistance training. Furthermore, session RPE allows the athlete to provide a global rain tog how hard the exercise session was rather than a series of RPE rating throughout the session. Session RPE has been demonstrated to be a valid measure of both aerobic and anaerobic exercise. Upon reviewing literature, session RPE is a valid and reliable indicator of intensity

Morgan, W.P., Brown, D.R., Raglin, J.S., O'Connor P.J., & Ellickson, K.A. (1987). Psychological Monitoring of Overtraining and Staleness. *British Journal of Sports Medicine,* 21 (3), 107-114. Retrieved from Academic Search Premier Database.

In this article, the researchers observed overtraining of swimmers over a ten year period. Because previous literature had indicated that a high percentage (66% of males and 64% of females) of the runners experienced staleness during their athletic career, the researchers sought to observe the effects of overtraining in swimming, a sport known to utilize overtraining as a planned and deliberate part of the training cycle. In using the Profile of Mood State (POMS), ratings of perceived exertion, as well as recording the training load (yardage), the researchers were able to identify the paradigm between physical activity increasing mood and overtraining producing mood disturbance. This source, although somewhat outdated, is a very useful article in that it incorporates swimmers into the study, whereas many current studies have been done in laboratories or with non physically active subjects. Although some techniques may have changed over the years, the basic principles of overtraining utilized in this article are consistent with many newer studies. This article will help shape my argument that swimmers do experience overtraining and their needs to be a set of predictors to help coaches, athletes, and staff members identify it before it's too late. It also validates the need for my study to identify the differences between sprinters and distance swimmers over a competitive season and support it with empirical evidence.

Morouco, P., Soares, S., Vilas-Boas, J.P., Fernandes, R. Association Between 30 Second Maximal Tethered swimming Performance in Front Crawl. *Portuguese Swimming Federation,* 1-2.

In this article, the author analyzes the relationship among forces and velocity produced by the elite swimmers in tethered and free swimming. To do so, they obtained average pulling force in 30 seconds, and average maximum peak force, average minimum force, and average max minus min force. 24 hours later, the swimmers performed a normal swimming test (50m and 200m). The times were then used to calculate velocity. The results of this study indicate that there is an associate between average force and mean velocity in the 50m and 200m events, indicating that the tethered swimming device seems to be a tool for results prediction in front crawl swimming.

Morouco, P. (2009). Force Production in Tethered Swimming and its Relationship with Performance: A New Approach to Evaluate the Anaerobic Capacity of Swimmers? 1- 88.

In this thesis, the author examines the 30 second tethered swimming test as a measure of performance. He discusses the fatigue index as an evaluation parameter, as used in the Wingate test, to evaluate the anaerobic capacity of a swimmer. He discusses that because the force production patterns are so different, that fatigue index may not be a valid parameter in the evaluation of force production. He proposes that the slope between the maxF and minF is a better indication of performance prediction than FI. He goes on to discuss that the tethered swimming test evaluates the swimmers anaerobic potential, giving feedback in real time, with the necessity of using the sophisticated equipment that the invasive tests require. The measures acquired were Maximum force, mean force, fatigue index ([(maximum peak-minimum peak)/maximum peak] x 100), fatigue slope (y=ax+b). The author also states that with the ability to evaluate the individual anaerobic capcity, the coach can better understand the effects of his specific training for swimming distances lower than 200m. he also states that average force is the best predictor for swimming performance, for all competitive techniques, and for all distances tested (50m, 100m, and 200m). Importantly, the author concludes that the fatigue slope may be a suitable approach to evaluate the anaerobic capacity of swimmers.

O'Connor, P.J. (2007). Monitoring and titrating Symptoms: A Science Based Approach to Using Your Brain to Optimise Marathon Running Performance. *Sports Medicine, 37* (4-5), 408-411.

In this article the authors review literature on overtraining including definitions of overtraining, staleness, and burnout in reference to marathon runners. They conclude the article by stating that adequate recovery is needed to optimize performance and avoid overtraining.

Raedeke, T.D. Lunney, K., & Venables, K. (2002). Understanding Athlete Burnout: Coach Perspectives.
Journal of Sport Behavior, 25 (2), 181-206. Retrieved From Academic Search Premier Database.

In this article, the researchers examine the popular concept of burnout from a new and interesting point of view and by unconventional means, by examining coaches' perception of burnout. The results of the survey lends to the fact that coaches' have a good understanding of what burnout is, and also that it is important for themselves and athletes to fully understand to achieve the optimal athletic results. Although this article describes burnout from a perspective different from my own by asking the perspective of the coach, it has proven useful for the purposes of my study. The information however cannot be directly linked to what I am trying to accomplish but it does give validation to my study. This is because overtraining is evident in athletics and who is more involved in the athletes' career than the coach. With coaches admitting that overtraining is a problem, it creates a need for a way to prevent, identify, and alleviate the symptoms of overtraining. With the conduction of my study, I hope to do the aforementioned items so a coach can utilize the techniques with their own athletes.

Raglin, J.S., Koceja, D.M., Stager, J.M., Harms, C.A. (1995). Mood, Neuromuscular Function, and Performance During Training in Female Swimmers. *Medicine and Science in Sport and Exercise,* 372-376.

In this article, the researchers examined the changes in mood (POMS), neuromuscular function (reflex), swimming performance (times), and maximal aerobic power (calorimetry), and anaerobic power (tethered swimming protocol to obtain peak force, mean force, and fatigue index). The tests were given 3 times during the season (baseline, peak training, and taper). The authors concluded that the changes in training load over the 5.5 month period result in changes in mood, anaerobic power, and motorneuron excitability.

Saremi, J. (2009). Overtraining Syndrome. *American Fitness,* 27 (1), 10-16. Retrieved From Academic Search Premier Database.

In this article, the researchers define the overtraining syndrome (OTS), and differentiate it from overreaching based on the amount of time required to recover. Furthermore, the authors, point out some differences in OTS based on the athletes primary training mode; endurance or sprint/power. The authors state that endurance athletes experience fatigue and underperformance (OTS) followed by a change in mood state, whereas sprint athletes demonstrate a feeling of depression which is then followed by underperformance. The article goes on to list the signs and symptoms as well as examine the problems with diagnosis. This article, much like some previous articles, states the difference between the process of becoming overtrained sprint and distance athletes in. Although it is a reliable source of information in which other source can be pulled, it, like many other articles of this topic, lack empirical evidence and are just reviews of literature. I would like to utilize this idea of the differences in sprint and distance athletes, but provide the field with solid evidence of this phenomenon known as overtraining.

Shionoya, A., Shibukura, T., Shimizu, T., Ohba, M., Tachikawa, K., Miyake, H. (2001). Middle Power Measurement in Semi-Tethered Swimming using Ergometer. 83-91.

In this article, the authors suggests that previously used power tests for swimming including swim bench test or the Wingate arm test have a low correlation with swimming performance. However, there is a relationship between STS and swimming performance.

Silva, J.M. (1990). An Analysis of the Training Stress Syndrome in Competitive Athletics. Applied Sport Psychology, 2, 5-20.

In this article the author defines stages of the training stress syndrome including Stress (byproduct created when an organism responds to a demand), Staleness (initial failure to cope with psychophysiological stress from training. If an athlete trains through staleness, it progresses to overtraining), Overtraining (if overtraining is trained through, burnout occurs because the body has exhausted its resources and coping capabilities), and Burnout (exhaustive psychophysiological response resulting in voluntary or involuntary withdrawal from sport).

Smith, D.J., Norris, S.R., Hogg, J.M. (2002). Performance Evaluation of Swimmers: Scientific Tools. *Sports Medicine, 32* (9), 539-554.

In regards to tethered swimming, this article states that since the best swimmers do not necessarily produce the highest swim bench scores, it has been suggested that maximal swimming speed or tethered swimming force could be used to evaluate the balance between technical performance and swimmers' capacity for muscular production in the water. The study they review suggested that the ability to effectively generate power during a partially tethered sprint was a predictor of both sprint and endurance breaststroke performance. This article also mentions the RESTQ-Sport as an appropriate inventory for measuring stress-recovery.

Urhausen, A., & Kindermann, W. (2002). Diagnosis for Overtraining: What Tools Do We Have? *Sports Med,* 32 (2), 95-102. Retrieved from Academic Search Premier Database.

In this article, the authors describe the significant need for a way to diagnose OTS early. The authors then go on to list diagnostic tools at rest (heart rate, mood state and subjective complaints, enzyme activities and metabolic markers in blood, hormones, and immunological parameters) and during exercise (ergometry, blood lactate, ammonia, heart rate, respiratory exchange ratio, perception or effort, and hormones). The author then concludes by saying that future studies should include larger a larger sample size, as well as longer periods of observation. The goal of this article was to provide the reader with information regarding the diagnosis of overtraining, which proves useful for those wanting to complete a study of overtraining. However, the authors of this article list diagnostic tools that have been since said to be unreliable in measuring overtraining such as heart rate and respiratory exchange ratio. This article is extremely important in my study and has helped to outline the procedures I will use in my study. By providing a multitude of possible diagnostic tools, I can now choose from the list based on what is available to me at the university as well as what will be most practically applicable in the future for coaches and athletes alike to prevent overtraining from progressing.

Vorontsov, A., Popov, O., Binevsky, D., Dyrko, V. The Assessment of Specific Strength in Well-Trained Male Athletes During Tethered Swimming in the Swimming Flume. 1-2.

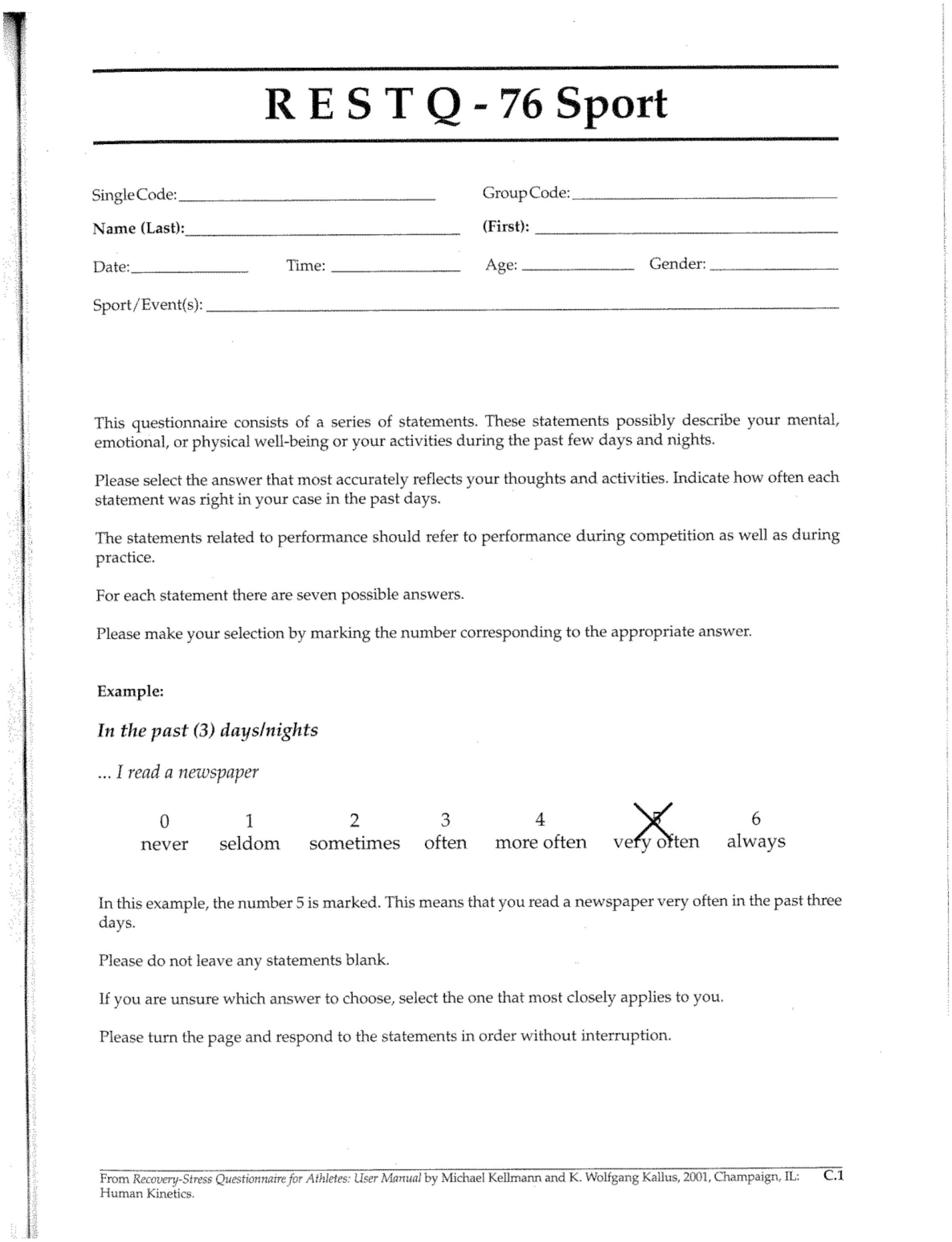
In this article, the authors examine how closely related pulling force to competitive results in swimming in comparison to other specific and non-specific strength tests. The results of this study indicate that peak force can be used for prediction of the performance and assessment of swimming abilities of individuals. Furthermore, it is a reliable criteria of the specific swimming strength, and that the values of the peak force change in accordance with predominant character of training at different stages of a macro-cycle. They fall during periods of extensive aerobic training and grow up again during race-specific training.

Wallace, L., Coutts, A., Bell, J., Simpson, N., Slattery, K. (2008). Using Session-RPE to Monitor Training Load in Swimmers. National Strength and Conditioning Association, 30 (6), 72- 76.

In this article, the authors discuss current methods used in monitoring physical training loads in athletes such as heart rate. However, HR is only applicable to aerobic training and not for high intensity training sessions. Because of this limitation, they suggest an alternative method, session-RPE, which requires athletes to rate the intensity of the session using a rating between 1 and 10. From this, training load can be calculated by multiplying the RPE by the duration in minutes. This can help bridge the gap between coach and athlete in efforts of having recovery days and improving periodization strategies. Finally, the author states that these methods can be used to provide coaches and athletes with instant feedback.

APPENDIX C

RECOVERY-STRESS QUESTIONNAIRE FOR ATHLETES-76



R E S T Q - 76 Sport

Single Code: ____________ Group Code: ____________

Name (Last): ____________ **(First):** ____________

Date: ________ Time: ________ Age: ________ Gender: ________

Sport/Event(s): ____________

This questionnaire consists of a series of statements. These statements possibly describe your mental, emotional, or physical well-being or your activities during the past few days and nights.

Please select the answer that most accurately reflects your thoughts and activities. Indicate how often each statement was right in your case in the past days.

The statements related to performance should refer to performance during competition as well as during practice.

For each statement there are seven possible answers.

Please make your selection by marking the number corresponding to the appropriate answer.

Example:

In the past (3) days/nights

... I read a newspaper

0	1	2	3	4	[✓ 5]	6
never	seldom	sometimes	often	more often	very often	always

In this example, the number 5 is marked. This means that you read a newspaper very often in the past three days.

Please do not leave any statements blank.

If you are unsure which answer to choose, select the one that most closely applies to you.

Please turn the page and respond to the statements in order without interruption.

From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.

C.1

In the past (3) days/nights

1) ... *I watched TV*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

2) ... *I did not get enough sleep*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

3) ... *I finished important tasks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

4) ... *I was unable to concentrate well*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

5) ... *everything bothered me*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

6) ... *I laughed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

7) ... *I felt physically bad*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

8) ... *I was in a bad mood*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

9) ... *I felt physically relaxed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

10) ... *I was in good spirits*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

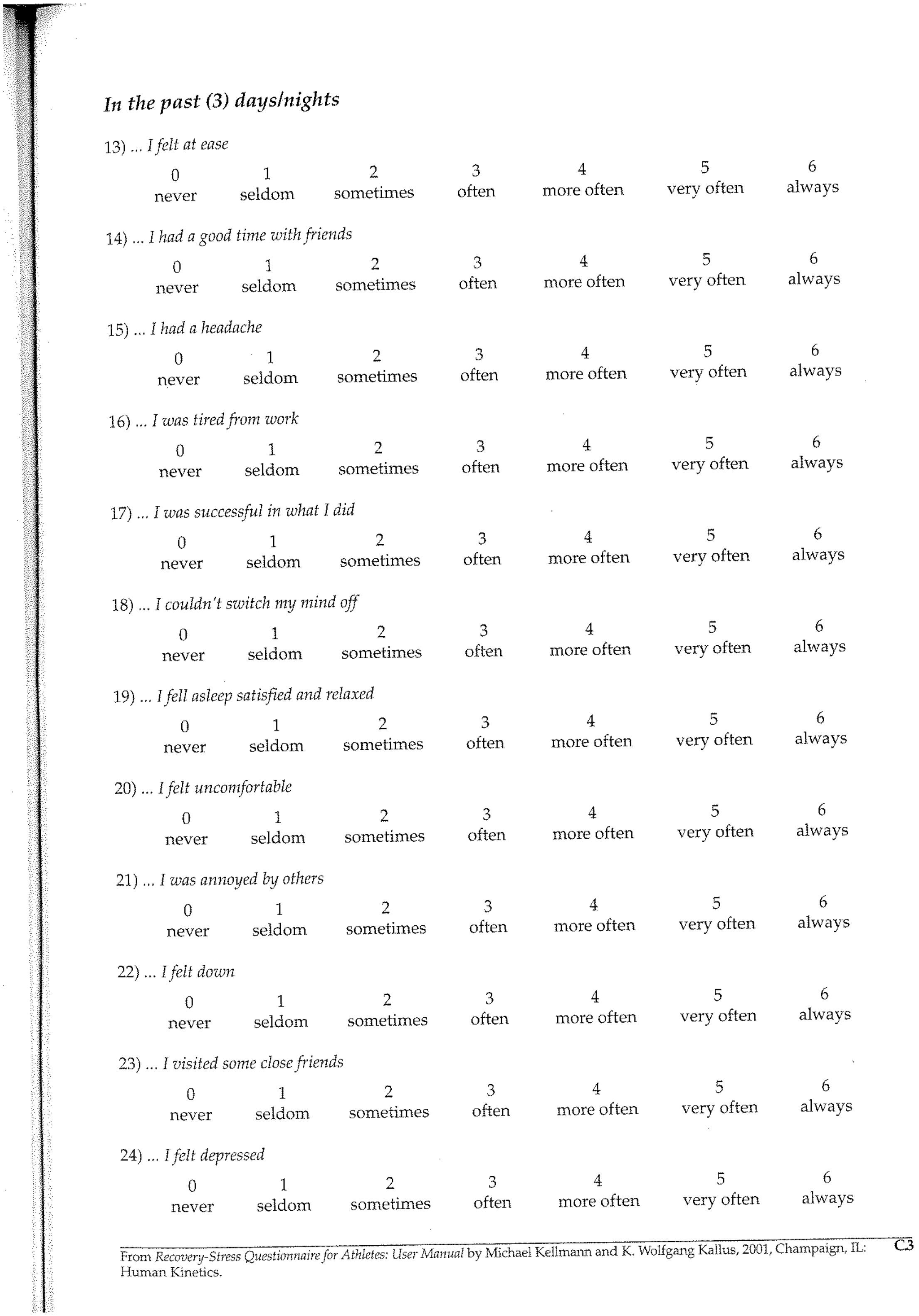
11) ... *I had difficulties in concentrating*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

12) ... *I worried about unresolved problems*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

C.2 From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.



In the past (3) days/nights

13) ... *I felt at ease*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

14) ... *I had a good time with friends*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

15) ... *I had a headache*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

16) ... *I was tired from work*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

17) ... *I was successful in what I did*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

18) ... *I couldn't switch my mind off*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

19) ... *I fell asleep satisfied and relaxed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

20) ... *I felt uncomfortable*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

21) ... *I was annoyed by others*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

22) ... *I felt down*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

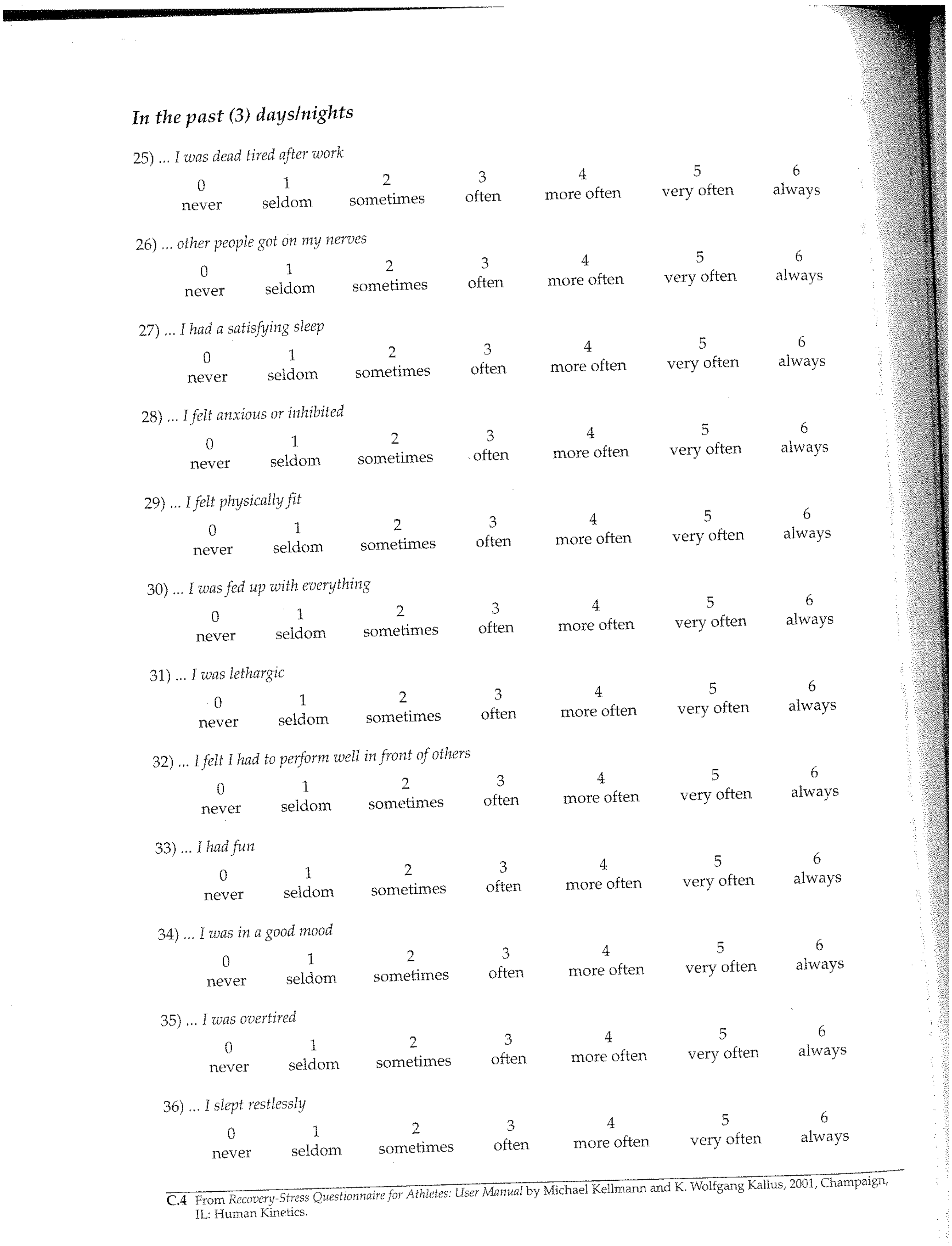
23) ... *I visited some close friends*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

24) ... *I felt depressed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.



In the past (3) days/nights

25) ... *I was dead tired after work*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

26) ... *other people got on my nerves*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

27) ... *I had a satisfying sleep*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

28) ... *I felt anxious or inhibited*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

29) ... *I felt physically fit*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

30) ... *I was fed up with everything*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

31) ... *I was lethargic*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

32) ... *I felt I had to perform well in front of others*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

33) ... *I had fun*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

34) ... *I was in a good mood*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

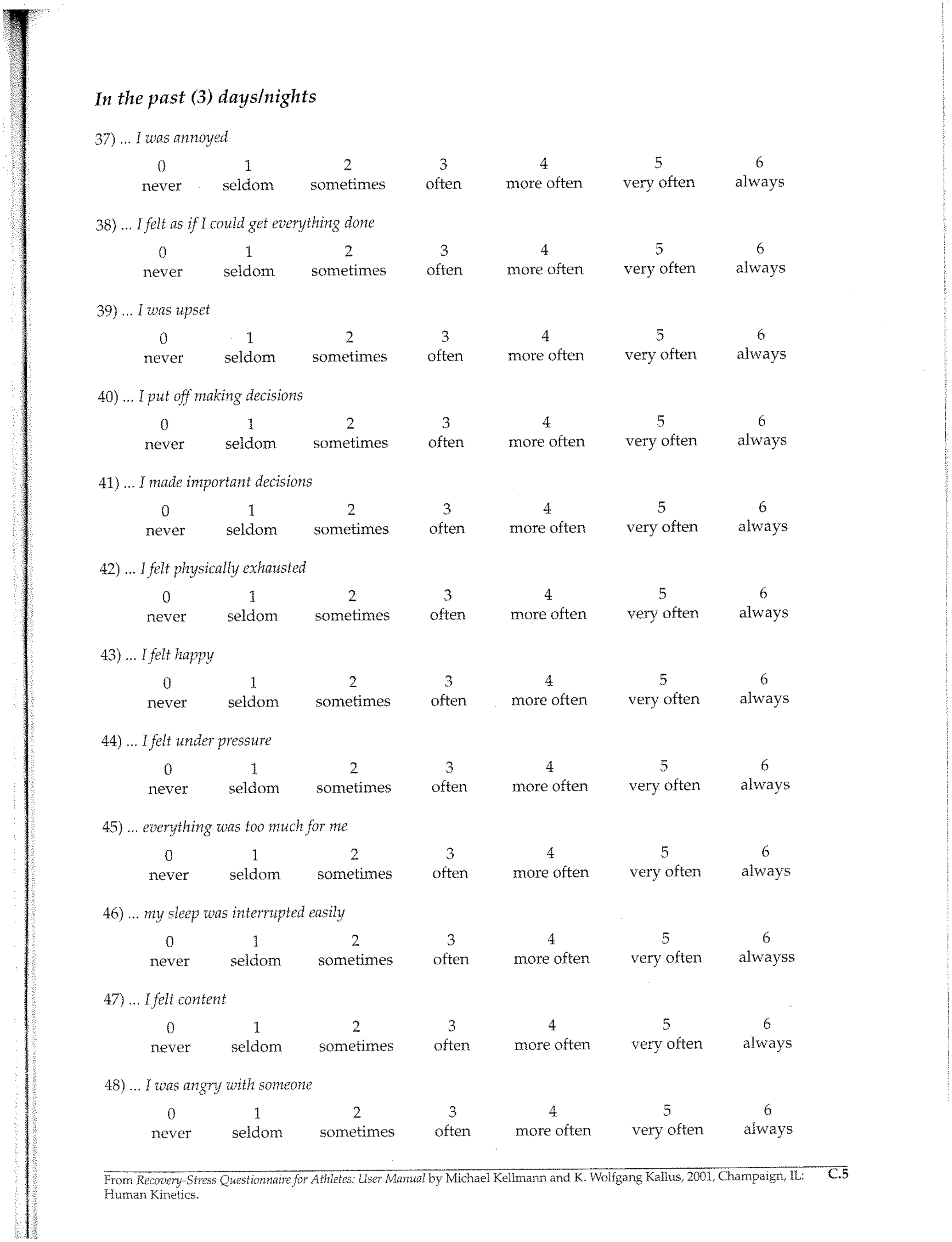
35) ... *I was overtired*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

36) ... *I slept restlessly*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

C.4 From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.



In the past (3) days/nights

37) ... *I was annoyed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

38) ... *I felt as if I could get everything done*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

39) ... *I was upset*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

40) ... *I put off making decisions*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

41) ... *I made important decisions*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

42) ... *I felt physically exhausted*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

43) ... *I felt happy*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

44) ... *I felt under pressure*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

45) ... *everything was too much for me*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

46) ... *my sleep was interrupted easily*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	alwayss

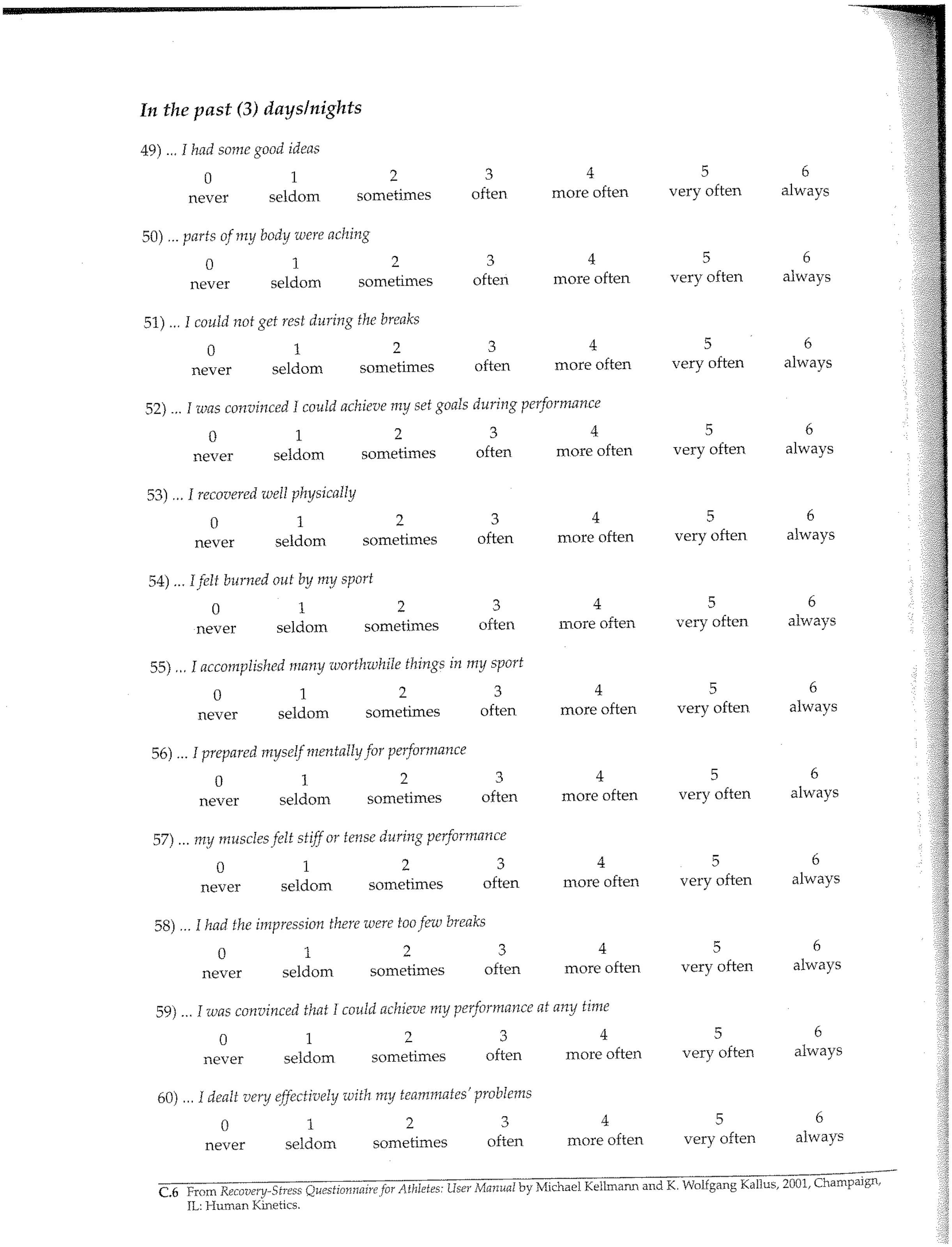
47) ... *I felt content*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

48) ... *I was angry with someone*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.



In the past (3) days/nights

49) ... *I had some good ideas*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

50) ... *parts of my body were aching*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

51) ... *I could not get rest during the breaks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

52) ... *I was convinced I could achieve my set goals during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

53) ... *I recovered well physically*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

54) ... *I felt burned out by my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

55) ... *I accomplished many worthwhile things in my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

56) ... *I prepared myself mentally for performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

57) ... *my muscles felt stiff or tense during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

58) ... *I had the impression there were too few breaks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

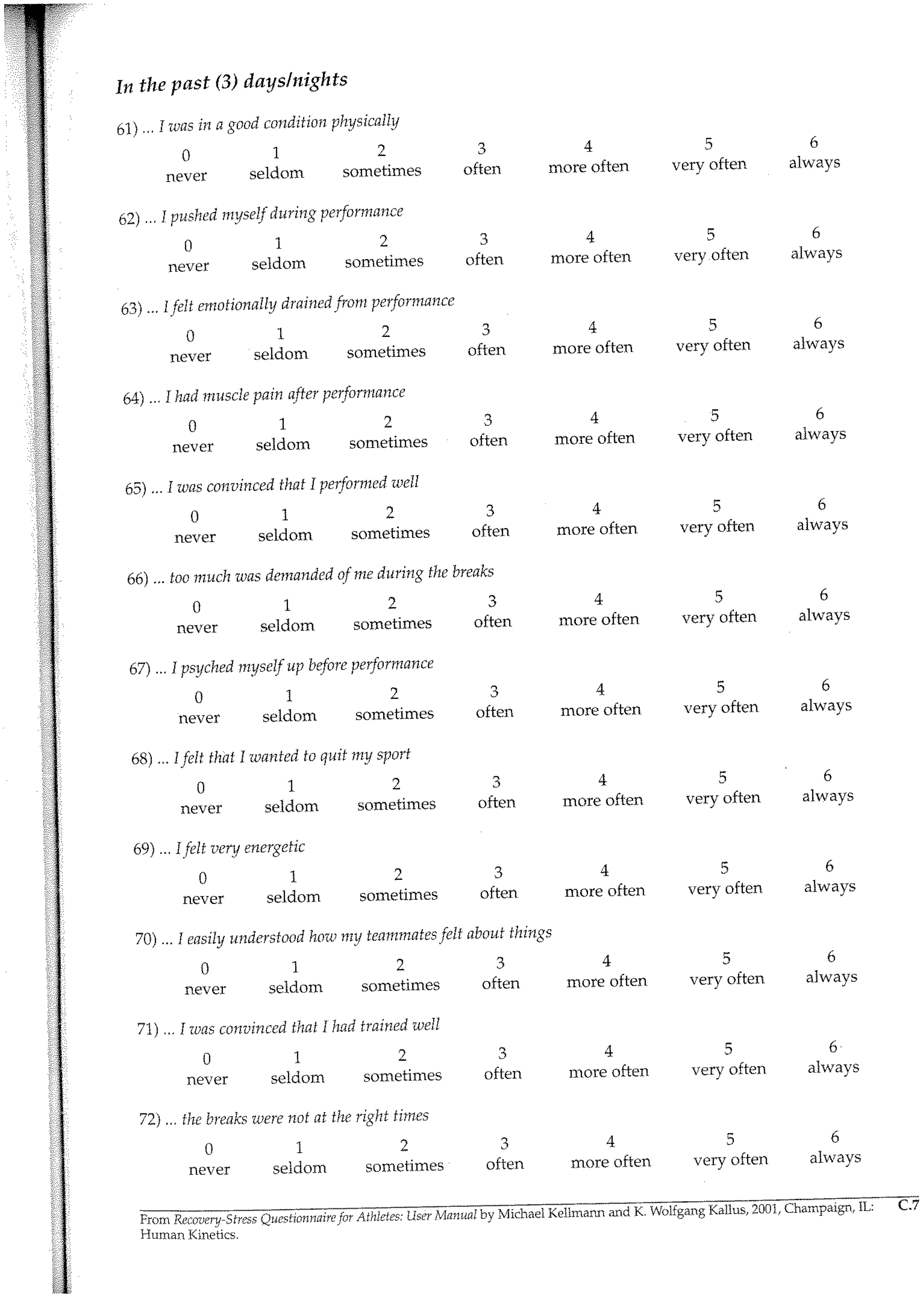
59) ... *I was convinced that I could achieve my performance at any time*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

60) ... *I dealt very effectively with my teammates' problems*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

C.6 From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.



In the past (3) days/nights

61) ... *I was in a good condition physically*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

62) ... *I pushed myself during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

63) ... *I felt emotionally drained from performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

64) ... *I had muscle pain after performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

65) ... *I was convinced that I performed well*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

66) ... *too much was demanded of me during the breaks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

67) ... *I psyched myself up before performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

68) ... *I felt that I wanted to quit my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

69) ... *I felt very energetic*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

70) ... *I easily understood how my teammates felt about things*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

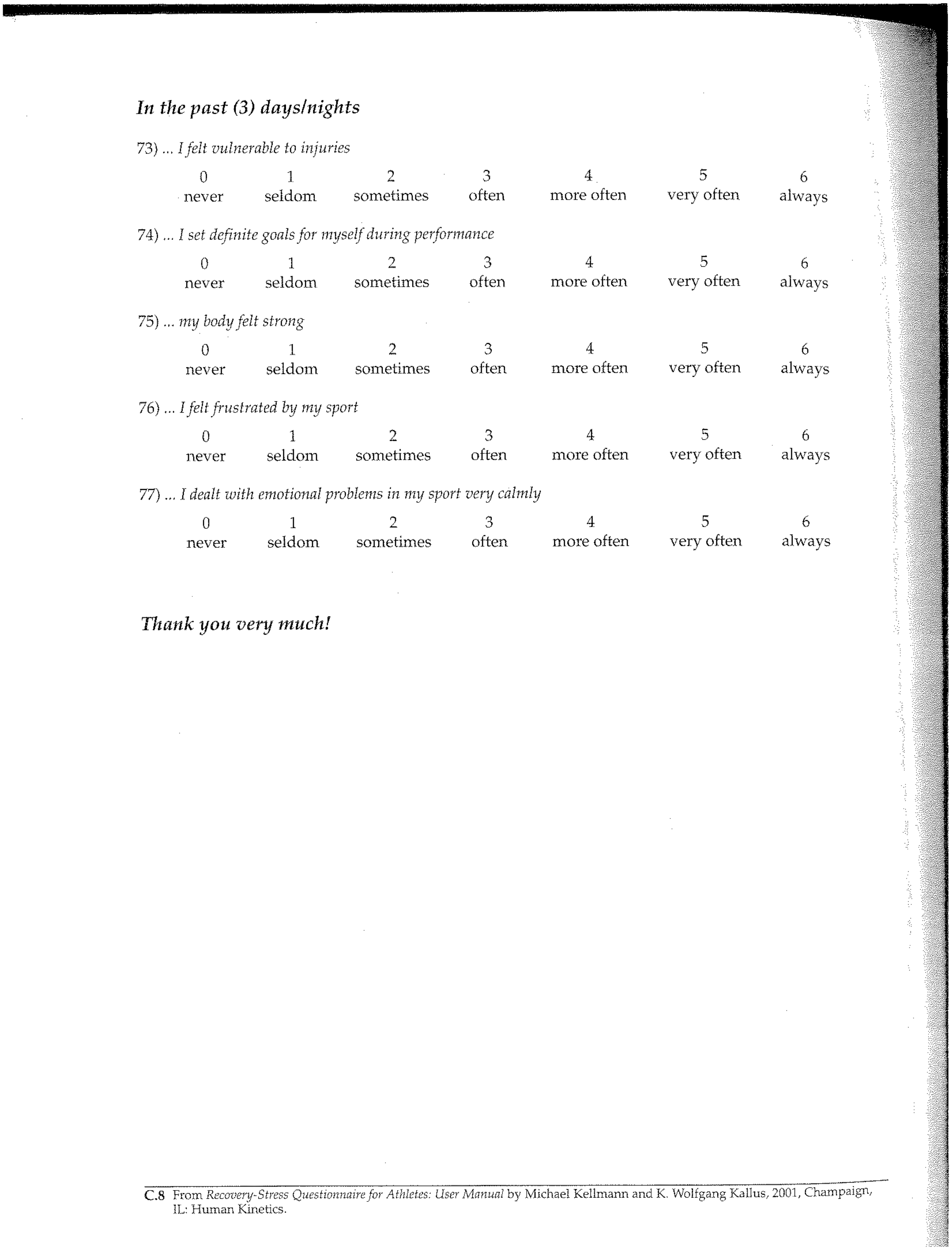
71) ... *I was convinced that I had trained well*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

72) ... *the breaks were not at the right times*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.



In the past (3) days/nights

73) ... *I felt vulnerable to injuries*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

74) ... *I set definite goals for myself during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

75) ... *my body felt strong*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

76) ... *I felt frustrated by my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

77) ... *I dealt with emotional problems in my sport very calmly*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

Thank you very much!

C.8 From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.