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Psychometric item evaluations of the Recovery-Stress Questionnaire for athletes

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Abstract

Objectives: Using an item-based analysis, the factor structure of the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport) [Kellmann, M., & Kallus, K.W. (2001). *Recovery-Stress Questionnaire for Athletes: User manual*. Champaign, IL: Human Kinetics] was assessed as a test of its validity. The RESTQ-Sport is a 76-item questionnaire that was developed to assess the physical and mental impact of training stress and to facilitate the formulation of strategies for the enhancement of recovery. According to [Kellmann, M., & Kallus, K.W. (2001). *Recovery-Stress Questionnaire for Athletes: User manual*. Champaign, IL: Human Kinetics], two factors: Recovery and Stress, comprised the 12 General subscales and seven Sport subscales of the RESTQ-Sport.
Methods: A total of 585 male and female athletes who train at a Canadian national sport center were recruited to complete the RESTQ-Sport. Maximum likelihood factor analyses were performed.
Results: The results confirmed the two-factor structure proposed by Kellmann and Kallus for the Sport-Recovery/Stress Scale but disconfirmed this structure for the General-Recovery/Stress Scale. Item analysis further disconfirmed the two-factor structure for the General Scale and failed to confirm the 19 Subscales proposed by the authors on both of the General and Sport Scales.

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Conclusions: These results are interpreted to suggest that while the questionnaire should not be considered to be a *diagnostic* tool for under-recovery states, the RESTQ-Sport does, nonetheless, still measure general parameters of training stress which can be tracked in recovery planning.

Keywords: Recovery; Stress; Athlete RESTQ

Introduction

A major component of peak performance in athletics is specialized training but Kellmann (2002) states that another key component is proper recovery from the stress of training. Gould and Dieffenbach (2002) found that failure to properly recover from the stress of training produces a state of overtraining, under-recovery, and burnout. According to Silva (1990), under-recovery falls on the lower end of a continuum and burn-out falls on the higher end. There are physiological and psychological consequences to under-recovery (e.g., Budgett, 1998; Kellmann & Gunther, 2000) which, themselves, are believed to result in poor performance (Budgett).

The Recovery-Stress Questionnaire for Athletes [RESTQ-Sport] is a questionnaire reported to identify the extent to which athletes are physically or mentally stressed and their current capabilities towards recovery (Kellmann & Kallus, 2000, 2001). It has been distributed to well over 500 individuals and organizations throughout the world and can therefore be reasonably estimated to have been used on at least several thousand high-performance athletes as a diagnostic tool to detect under-recovery states and to plan recovery practices (Human Kinetics Publishers, personal communication, November 16, 2005). Prominent users include the United States Olympic Committee and the Canadian Sport Centers. The forerunner of this instrument was a General Recovery-Stress Questionnaire (Kallus, 1995) formulated on the idea that people will respond differently to physiological and psychological demands depending on how well-rested they are when faced with these demands (e.g., someone who has just returned from a vacation may perform more effectively at work than someone who has not had a vacation in a long time). In turn, the RESTQ-Sport was constructed based on the notion that an athlete who has proper recovery may perform better than one who is under-recovered. However, theoretical and practical concerns governed the methods used to determine the 19 subscales of the RESTQ-Sport. Kellmann and Kallus (2000, 2001) used an a priori method of identifying each of the subscales, combining to form several scales that reflect various aspects of stress and recovery. Although measuring recovery and stress by using these scales and subscales appears to be "face valid", the scales may be criticized from an empirically based standpoint since the individual items comprising the subscales were not verified for their utility.

The RESTQ-Sport was developed through continuous bio-psychological research in the area of stress for the General Scale, and the Sport Scale was comprised of items observed to coincide with stress or recovery states in athletes (Kellmann & Kallus, 2001). Recovery involves undertaking behaviors that affect physiological, psychological, behavioral, social, and environmental needs subsequent to a training load (Kallus & Kellmann, 2000). Physiological aspects of recovery include restoring resources such as food, water, and minerals (Kentta & Hassmen, 1998) along with recovery from injuries and the restorative hormonal and biological processes that occur

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during sleep (Hellman & Hettinger, 2000; Savis, 1994). As indicated in the REST-Q user manual, psychological recovery connotes the restoration of relaxation and mood to homeostasis and equilibrium. Behaviors that facilitate recovery are diverse and span the gamut from cross-training to leisure activity. Social recovery efforts might include a focus on family meals as well as on interpersonal contact with friends or intimate relationship partners away from the training venue (Kellmann & Kallus, 2001).

Fundamental to the issue of recovery in sport is identifying appropriate interventions with athletes who show symptoms of under-recovery. Davis, Botterill, and MacNeill (2002) outlined an intervention model focusing on changes in mood and self-regulation which occur in the under-recovered state. The model posits two processes resulting from under-recovery: (1) fatigue from under-recovery directly leads to poor self-regulation of one's recovery needs; (2) fatigue and neuro-chemical responses to stress and fatigue lead to three forms of mood disturbance—low positive affect (depression, helplessness, and low self-efficacy), anxiety, and fear. This link between under-recovery and mood states has been demonstrated empirically (Kellmann & Kallus, 2001).

Coinciding with theoretical advances in the concept of recovery have been developments in measurement methodology. Researchers, for example, have recently developed instruments to measure fundamental aspects of recovery/under-recovery in athletes. Raedeke and Smith (2001) constructed the Athlete Burnout Measure which they administered to a sample of competitive swimmers. Exploratory factor analysis performed by these authors determined burnout, associated with under-recovery states, as three dimensions consisting of emotional/physical exhaustion, reduced sense of accomplishment, and swimming devaluation. This three-factor model was supported in subsequent research with swimmers along with college athletes from a variety of other sports. Construct validity for the burnout measure was also obtained in the form of positive correlations of the scale with stress, trait anxiety, and amotivation in addition to negative correlations with coping, social support, enjoyment, commitment, and intrinsic motivation.

Perhaps the most significant methodological development in research on recovery in sport was the introduction of the multidimensional RESTQ-Sport questionnaire (Kellmann & Kallus, 2000, 2001). Validation studies included several with German and American athletes revealing high correlations between RESTQ-Sport and Profile of Mood States (POMS) scales (Birrer, Seiler, Binggeli, & Vogel, 2001; Kellmann, Fritzenberg, & Beckmann, 2000; Kellmann & Gunther, 2000). The POMS scales measuring tension, depression, anger, fatigue, and confusion correlate negatively with the recovery-related scales whereas "vigor" on the POMS correlates positively with these scales. The stress-related RESTQ-Sport scales show a positive correlation between stress and the POMS scales for tension, depression, anger, fatigue, and confusion as well as a negative correlation with vigor.

Several studies demonstrating the application of the RESTQ-Sport to training have also been conducted. For example, use of the scale has been found effective in monitoring individuals and/or groups in micro-cycles during training camps (Hogg, 2000; Kellmann, Altenburg, Lormes, & Steinacker, 2001; Kellmann & Gunther, 2000) and over an entire season (Ferger, 1998a, b). Jürimäe, Mäestu, Purge, Jürimäe, and Sööt (2002) indicated that among rowers in heavy training, cortisol levels correlated meaningfully and in expected directions with RESTQ-Sport scale changes. When recovery assessment is carefully planned, the effects of a yearly training schedule

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can also be evaluated (Kellmann & Altenburg, 2000). The RESTQ-Sport can also contribute to developing concrete recommendations for intervention (Kellmann & Gunther, 2000; Kellmann & Kallus, 1999; Kellmann, Kallus, Gunther, Lormes, & Steinacher, 1997).

To determine the factor structure of each of the major General and Sport Scales, Kellmann and Kallus (2001) conducted a principal components factor analysis on the 12 General *subscales*, rather than the items, and on the seven Sport-specific subscales. From this method, these authors found that the RESTQ-Sport measures two factors which they labeled "Stress" and "Recovery". The analysis was performed separately for the General and Sport-specific scales since the Sport scale was attached as an addendum, similar to attachments developed within other subject groups, such as the RESTQ-Work (Kallus, 1995) and RESTQ-Coach (Kallus & Kellmann, 1995; Kallus, Kellmann, Eberspacher, & Hermann, 1996). Kellmann and Kallus (2001) found that the same two factors were replicated for each of the two sections of their test: (1) General-Recovery and Stress factors and (2) Sport-specific Recovery and Stress factors.

However, an a priori method of identifying the number of subscales or factors which describe the RESTQ-Sport was employed by Kellmann and Kallus (2000, 2001). These authors did not use an analysis that would be empirically driven by the *items* comprising the subscales. Empirical methods for normative sample data analysis include factor analysis and principal-components analysis on the items. The results from these methods may then be used to suggest the number of scales for a questionnaire. It is common for analyses using these methods to identify a smaller number of scales than when using a priori methods.

The present study used an empirically derived method to determine the critical components of the RESTQ-Sport. Following the process used by Kellmann and Kallus (2000, 2001) to determine their initial factor structure, data was analyzed using a factor analysis, although in our study the factor numbers were fixed to determine (1) if the two-factor structure of "Stress" and "Recovery" proposed by Kellmann and Kallus (2001) can be confirmed for each of the General and Sport-specific scales, and (2) if the 19 subscales can be confirmed from item analyses.

The present study differed from the previous factor analytic research by performing a maximum likelihood factor analysis on all test items taken as one set to test for confirmation or disconfirmation of the 19 subscales. Since Kellmann and Kallus (2001) had divided the items into 19 sets of subscales based on face validity before performing their analysis on the scale scores with 12 subscales used to measure general stress and seven subscales used to measure sport-specific stress, it is still unknown what the factor structure might be for the subscales when items themselves form the basis of the analysis. The present study fills gaps in the published research by using item analyses for confirming or disconfirming the two factors (Stress and Recovery) and the 19 subscales previously hypothesized by Kellmann and Kallus, which has to-date only applied principal components analysis to the *Scales* of the RESTQ-Sport.

Method

Participants

Participants were 585 athletes who were in training at a Canadian national sport center; these included 187 long-track speed skaters, 99 short-track speed skaters, and 133 swimmers. The rest of

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the sample included divers, cyclists, ski jumpers and gymnasts. The athletes ranged in age between 13 and 34 ($M = 21.63$, SD $= 4.16$). There were 300 female and 285 male participants in the study. The RESTQ-Sport was administered in the training environment during the preparation phase of an athlete's competitive season as a regular procedure for checking recovery from training stress. Our data is derived from the collection of this recovery monitoring.

Measures

RESTQ-Sport consists of 12 General Stress and Recovery scales along with seven Sport-specific Stress and Recovery scales (Kellmann & Kallus, 2001). The General Stress component includes three scales which measure general stress, emotional stress, and social stress along with their consequences. Three General Stress Scales are concerned with performance aspects (scales measuring conflicts/pressure, fatigue, and lack of energy). The scale, "physical complaints", measures the physical aspects of stress. Other General Stress scales measure different aspects of recovery. Three scales measure the basic aspects of recovery including social recovery, physical recovery, and general well-being. An additional recovery scale assesses sleep quality. Finally, a General Stress scale labeled "success", measures performance outside of sport.

The seven Sport-specific scales of the RESTQ-Sport focus on aspects of recovery related to sport (Kellmann & Kallus, 2001). The scale "disturbed breaks" refers to events which interrupt the athletes during the recovery process. "Burnout/emotional exhaustion" focuses on the athlete's desire to give up or quit the sport. "Fitness/injury" relates to the athlete dealing with injuries or being vulnerable to them so that physical strength is hampered. "Fitness/being in shape" measures subjective feelings about performance ability and competence, perceived fitness, and vitality. "Burnout/personal accomplishment" asks about appreciation and empathy within the team and the realization of personal goals in sports. "Self-efficacy" measures the level of expectation and competence regarding an optimal performance preparation in practice. "Self-regulation" refers to the availability and use of psychological skills when preparing for performance (e.g., goal setting, mental training, motivation).

Internal consistency reliability has been demonstrated with a Canadian sample, with Cronbach-α values for each of the 19 separate subscales, comprised of hypothesized items, ranging from .72 to .93 (Kellmann & Kallus, 2001). Test–retest reliability of the individual Subscales, rather than the questionnaire as a whole, has been found to be highly stable after 24 h, achieving correlational values above 0.79, and maintaining relative stability for 3 days, with increased decline in stability over subsequent days (Kellmann & Kallus, 2000, 2001).

Athletes responded to each item on a self-rated seven-point Likert scale according to how well the item was deemed to be self-descriptive for the previous 3 days and nights. The actual 76 items were the basis for statistical analysis of the subscales. Items that corresponded to 'a prior' subscales suggested Kellmann and Kallus (2001) were combined to find the mean subscale scores (see Appendix A for subscales and corresponding items) and also used in the factor analysis for the two factor solution. The sleep quality items 36 and 46 were reversed score to compensate for the opposite meaning of these items on the more positive, recovery oriented subscale. Mean subscale scores were calculated for the two-factor General Scale and Sport Scale by taking the average scores for each of the 12 general subscale and seven sport subscales.

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Statistical analysis

The standard form of the 76-item RESTQ-Sport (Kellmann & Kallus, 2001) as described above, was used for a maximum likelihood factor analysis with oblique (promax) rotation. Maximum likelihood was used to test if the hypothesized construct factors do reproduce the data (Gorusch, 1983; Stevens, 2002) with a Kappa value of 2 to create a large enough difference between the large loadings and the small-moderate loadings (Gorusch, 1983). Promax uses the varimax solution as the basis for the ideal solution (Hendrickson & White, 1964). Since Kellmann and Kallus used varimax principal components originally, promax was then used as a basis to alter the orthogonal rotation to the oblique. Additionally, since the stress and recovery factors are correlated, as demonstrated by previous research (Kellmann & Kallus), and within this study, an oblique rotation was used (Gorusch, 1983; Stevens, 2002).

Maximum likelihood factor analysis was chosen as the most appropriate method due to the absence in previous research of statistics on the items for the hypothesized subscales provided by Kellmann and Kallus (2001). Structural equation modeling (SEM) would be inappropriate in this case, since (a) strong previous empirical work has not been done and (b) the theoretical utility of the factors and items suggested for inclusion was not firmly established a priori (Bollen & Long, 1993; Gorusch, 1983; Stevens, 2002). Given these deficits, a model cannot be extracted from previous work (Kellmann & Kallus) without retaining inappropriate items and thus skewing the results. Keeping poor items forces the utilization of post hoc model modification strategies for correcting errors that should always be prevented or corrected for before performing confirmatory factor analyses with SEM. As Bollen (1989) indicates, under-identification of a model will ultimately occur when factor loadings or correlations have the opposite sign, are much smaller or larger in magnitude, and parameter estimates are out of range. Often, researchers set the model up incorrectly by insufficient prior study of the items that comprise a specific factor or items that fit a given theory. Exploratory factor analyses (EFA) is one tool that can ascertain the best model alternatives prior to SEM testing (Bollen, 1989; Bollen & Long, 1993; Stevens, 2002). For overcoming insufficiency of prior analysis, exploratory types of factor analyses are suggested (Gorusch, 1983). However, when a number of factors can be hypothesized a priori, then analyses with some confirmatory types of features, such as the maximum likelihood variation, can be used (Stevens, 2002).

Last, initial empirical work on factor items is suggested to ensure that the items are relatively pure measures of the underlying constructs; this prevents misspecifications of any new model that might arise (Bollen, 1989; Stevens, 2002). Performing adequate exploratory analyses before model testing is also recommended by MacCallum, Roznowski, and Necowitz (1992) in order to minimize chance factors, model instability and un-likeliness for cross-validation through post-hoc model modification. Cudeck and Browne (1983) extend this point by encouraging exploratory analyses to allow for the construction of alternative models so that less error will develop from chance when forcing only one model.

The present study, then, addresses these concerns by performing the factor analyses on all items to determine, empirically, the subscales that can be later tested by SEM models, and by attempting to confirm or disconfirm the overall General and Sport Scales that have received some previous empirical attention. Gorusch (2003) states that the most impressive confirmation of factors (those originally derived in an EFA study) comes via their replication in subsequent

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"follow-up" EFA studies using new data from independent samples. In this way, the 'factor composition' is confirmed and validated.

According to Gorusch (1983), maximum likelihood factor analysis tests hypotheses that a specific amount of variables legitimately define a pre-specified factor and that large sample sizes will increase the probability that the sample equals the (athletic) population. Hakistan, Rogers, and Cattell (1982) specify that for samples with a large n (greater than 200) and high communalities (averaging above 0.6), the scree plot or eigenvalues are equally acceptable methods for extracting meaningful factors. They further state that the Kaiser rule is much more credible than the scree rule when the Q/P ratio is less than .30 (Q is the number of factors; P is the number of variables). In the present study, a Q/P ratio of 0.25 was found for each of the General and Sport Scales. Items were checked for homogeneity and were found to be acceptable (i.e. not significantly skewed).

The maximum likelihood procedure selected the factors for the number of subscales previously indicated as meaningful by previous authors (Kellmann & Kallus, 2001). In this paper, two major analyses were conducted: a replication study, and an item analysis study. The replication study tested the two-factor solution (Recovery vs. Stress) for each major scale (General, Sport) as was previously tested by Kellmann and Kallus. The General and Sport Scales were tested separately since these scales were originally developed at different times and previously tested separately. The item analysis study tested the factor structure of the items incorporated into the 12 separate subscales suggested for the General Scale, and the seven subscales suggested for the Sport Scale.

Results

Replication study

Maximum likelihood factor analysis: the general scales and the sport scales

The Bartlett test of sphericity (χ^2 (66, $N = 585$) = 4601.49, $p < .0001$) for the General Scale and (χ^2 (21, $N = 585$) = 1883.21, $p < .0001$) for the Sport scale indicated that the scales were correlated, warranting a factor analysis for the data (see Tables 1a and 2a). Previous research also found that each of the scales were either negatively or positively correlated with one another and specified two factors in previous factor analyses (Kellmann & Kallus, 2001). Communalities were greater than 0.45 for the General scale and they ranged from 0.28 to 0.70 for the Sport scales. A maximum likelihood confirmatory factor analysis with oblique rotation was performed on the 12 mean subscale scores for the previously categorized General factor, and on the seven mean subscale scores for the Sport-specific factor. This model and rotation provided a robust test to adequately separate the scales due to the high correlations of both the scales and factors found by previous researchers (Gorusch, 1983; Stevens, 2002). Based on the Cliff and Hamburger (1967) studies, critical values for acceptance of factor loadings should be tested at an alpha of .01 and adjusted for various sizes of N. For our study, the critical value for an N close to 600 is .210 (Stevens, p. 394), setting the minimum value for statistical acceptance of items loading on specific factors.

Results of the factor analysis disconfirmed the same Recovery and Stress, two-factor structure, previously found by Kellmann and Kallus (2001) for the General Scales. Although

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Table 1

(a) *Factor correlations: General-Recovery/Stress*

Factor	1	2
1	1.000	—
2	−0.586	1.000

(b) *Maximum likelihood factor analysis of mean subscale scores for General-Recovery/Stress*

RESTQ scales	Factor 1	Factor 2
Scale 1: General Stress	0.739	
Scale 2: Emotional Stress	0.844	
Scale 3: Social Stress	0.768	
Scale 4: Conflicts/Pressure	0.820	
Scale 5: Fatigue	0.769	
Scale 6: Lack of Energy	0.631	
Scale 7: Somatic Complaints	0.751	
Scale 8: Success		0.733
Scale 9: Social Relaxation		0.864
Scale 10: Somatic Relaxation		0.626
Scale 11: General Well-being		0.881
Scale 12: Sleep Quality	−0.501	
Variance	50.97%	14.64%
Eigenvalue	6.12	1.76

Table 2

(a) *Factor correlations: Sport-Recovery/Stress*

Factor	1	2
1	1.000	—
2	−0.297	1.000

(b) *Maximum likelihood factor analysis of mean subscale scores for Sport-Recovery/Stress*

RESTQ scales	Factor 1	Factor 2
Scale 13: Disturbed Breaks		0.758
Scale 14: Burnout/Emotional Exhaustion		0.707
Scale 15: Fitness/Injury		0.628
Scale 16: Fitness/Being in Shape	0.783	
Scale 17: Burnout/Personal Accomplish.	0.758	
Scale 18: Self-Efficacy	0.877	
Scale 19: Self-Regulation	0.851	
Variance	46.50%	25.50%
Eigenvalue	3.25	1.78

the General-Stress related factor did confirm with all seven scales loading on the Factor 1, accounting for 51% of the variance, only four of the five subscales for the General-Recovery factor loaded on Factor 2, accounting for 15% of the variance. Specifically, the Sleep Quality Scale did not load on Factor 2: General-Recovery but instead, loaded negatively on Factor 1: General-Stress. Results of the present study did, however, confirm the two-factor structure previously found for the Sport Scales (Kellmann & Kallus). Factor 1 accounted for 47% of the variance of the Sport-Stress Scale, and Factor 2 of the Sport-Recovery Scale accounted for 26% of the variance. Tables 1 and 2 lists the items with the highest loadings on each factor and also lists the loadings, eigenvalues and percentages of variance accounted for in the final rotated factor solution.

The reliability of the General Scale (Recovery and Stress) was $\alpha = 0.40$ and the Sport Scale (Recovery and Stress) was $\alpha = 0.58$. The item-total correlation for Subscale 12: Sleep quality was $r = -.17$ and was the only item negatively related to the entire questionnaire, resulting in a lower Cronbach α.

Item analysis study

Maximum likelihood factor analysis: General-Recovery/Stress items

Results of the present study disconfirmed both of the Recovery and Stress, two-factor structure of the General Scale, as well as its 12 subscales when individual items were analyzed via a maximum likelihood factor analysis. Bartlett's test of sphericity was significant (χ^2 (1128, $N = 585$) = 17899.82, $p < .0001$) for the two-factor structure of the General scale and the 12 subscales, indicating that the recovery and stress factors were correlated (see Tables 3a and 4a) Communalities ranged from 0.267 to 0.823. Means and standard deviations for the 19 subscales are found in Appendix A.

Factor 1: General-Stress was confirmed for the seven subscales when individual items were analyzed, accounting for 33% of the variance. Factor 2: General-Recovery, accounting for 9.4% of the variance was not confirmed for the five subscales. Items #36 and #46 did not load on Factor 2 but did load negatively on Factor 1. These items were reversed scored, as suggested by Kellmann and Kallus (2001) to match the other items that are positively phrased for the General-Recovery scale. Table 3b lists the highest loading factors for the General-Recovery/Stress items.

The factor analysis for the 12 subscales of the General Scale also disconfirmed previous findings. Factor 1 [re-named Social/Emotional Well-being], accounting for 33% of the variance (eigenvalue = 15.9), was found to include items that previously comprised subscale 10: Social Relaxation and subscale 11: General Well-being. It also included item 29, "I felt physically fit". Factor 2 [Social/Emotional Distress], accounting for 9.4% of the variance (eigenvalue 4.5), included items from subscale 3: Social stress and Items #5, 8 and 37 associated with the previous subscale 2: Emotional stress. Factor 3 [Sleep], accounted for 5.3% of the variance (eigenvalue 2.54) and included all of the subscale 12: Sleep quality items with a negative loading, in addition to items #18, "I couldn't switch my mind off" (previously on subscale 4: conflicts/pressure), and item #2, "I did not get enough sleep" (previously on subscale 5: fatigue). Factor 4 [Fatigue], accounted for 3.9% of the variance (eigenvalue = 1.86) and included the remaining 3 items from the previous subscale 5: Fatigue, in addition to two items, #7, "I felt physically bad" and #42, "I felt physically exhausted" from subscale 7: Somatic complaints. Factor 5 [External anxiety], accounting for

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Table 3

(a) *Factor correlations: General-Recovery/Stress items*

Factor	1	2
1	1.000	—
2	−0.589	1.000

(b) *Maximum likelihood factor analysis of General-Recovery/Stress items*

RESTQ Items	Factor 1	Factor 2
Item 22	0.564	
Item 24	0.595	
Item 30	0.631	
Item 45	0.669	
Item 05	0.685	
Item 08	0.593	
Item 28	0.544	
Item 37	0.711	
Item 21	0.713	
Item 26	0.724	
Item 39	0.620	
Item 48	0.588	
Item 12	0.589	
Item 18	0.592	
Item 32	0.599	
Item 44	0.661	
Item 02	0.582	
Item 16	0.616	
Item 25	0.620	
Item 35	0.695	
Item 04	0.499	
Item 11	0.558	
Item 31	0.398	
Item 40	0.351	
Item 07	0.594	
Item 15	0.352	
Item 20	0.638	
Item 42	0.630	
Item 03		0.486
Item 17		0.704
Item 41		0.410
Item 49		0.564
Item 06		0.827
Item 14		0.781
Item 23		0.537

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Table 3 (*continued*)

(b) *Maximum likelihood factor analysis of General-Recovery/Stress items*

RESTQ Items	Factor 1	Factor 2
Item 33		0.893
Item 09		0.389
Item 13		0.549
Item 29		0.564
Item 38		0.440
Item 10		0.850
Item 34		0.833
Item 43		0.885
Item 47		0.661
Item 19		0.436
Item 27		0.283
Item 36	−0.558	
Item 46	−0.566	
Variance	33.0%	9.4%
Eigenvalue	15.9	4.5

3.7% of the variance (eigenvalue = 1.76) was found to include items from subscale 4: Conflicts/pressure and item #28, ''I felt anxious of inhibited''. Factor 6 [Concentration/moody] accounted for 2.8% of the variance (eigenvalue = 1.34) and included items from subscale 6: Lack of energy and two previous emotional stress items from subscale 2. Factor 7 [Depressive symptoms/Coping], accounting for 2.6% of the variance (eigenvalue = 1.22) was comprised of all items from the previous subscale 1: General stress, in addition to Item #31, ''I was lethargic'' and item #20, ''I felt uncomfortable. Item #39, ''I was upset'' also loaded highly on this factor. Factor 8 [Task completion], accounting for 2.4% of the variance (eigenvalue = 1.15) included all items from subscale 8: Success, in addition to item #38, ''I felt as if I could get everything done''. The items with high loadings for Factor 9 also loaded on Factor 1 and were combined with this factor for theoretical meaning. The two items, #9, ''I felt physically relaxed'', and #13, ''I felt at ease'', related to subscale 10: Somatic relaxation. Factors 10, 11 and 12 did not result in a sufficient number of meaningful items or loaded on other factors with greater theoretical meaning. These last three factors also had eigenvalues < 1.0. Table 4b lists the highest item factor loadings for the eight meaningful General subscales.

Cronbach's α for the General Scale (Recovery and Stress) items was 0.76. Item #19, ''I fell asleep satisfied and relaxed'' had a negative item–total correlation, in addition to all of the Sleep quality items, #27, I had a satisfying sleep'', item #36, ''I slept restlessly'', item #46, ''my sleep was interrupted easily'', and item #38, ''I felt as if I could get everything done''.

Maximum likelihood factor analysis: Sport-Recovery/Stress items

Results of the present study confirmed both of the two-factor structure of the Sport-specific Scale, but disconfirmed the seven subscales of this scale when individual items were analyzed via a

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Table 4

(a) *Factor Correlations: General-Recovery/Stress Subscale items*

Factor	1	2	3	4	5	6	7	8
1	1.000							
2	−0.522	1.000						
3	−0.434	0.446	1.000					
4	−0.164	0.366	0.404	1.000				
5	−0.212	0.446	0.472	0.382	1.000			
6	−0.494	0.554	0.537	0.331	0.467	1.000		
7	−0.567	0.674	0.500	0.365	0.500	0.559	1.000	
8	0.303	−.045	−0.090	0.060	0.018	−0.033	−0.162	1.000

(b) *Maximum likelihood factor analysis of mean subscale items for General-Recovery/Stress*

RESTQ Items*	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Item 22							0.762	
Item 24							0.842	
Item 30							0.325	
Item 45							0.288	
Item 05						0.337		
Item 08						0.375		
Item 28					0.359			
Item 37		0.800						
Item 21		0.964						
Item 26		0.951						
Item 39							0.601	
Item 48		0.790						
Item 12					0.417			
Item 18			0.383					
Item 32					0.673			
Item 44					0.806			
Item 02			0.511					
Item 16				0.819				
Item 25				0.837				
Item 35				0.492				
Item 04						0.829		
Item 11						0.846		
Item 31							0.312	
Item 40						0.217		
Item 07				0.215				
Item 15								
Item 20							0.324	
Item 42				0.568				
Item 03								0.658
Item 17								0.230

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Table 4 (*continued*)

(b) *Maximum likelihood factor analysis of mean subscale items for General-Recovery/Stress*

RESTQ Items*	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Item 41								0.590
Item 49								0.357
Item 06	0.798							
Item 14	0.419							
Item 23	0.281							
Item 33	0.817							
Item 09								
Item 13								
Item 29	0.404							
Item 38								0.466
Item 10	0.780							
Item 34	1.014							
Item 43	0.892							
Item 47	0.574							
Item 19			−0.497					
Item 27			−0.714					
Item 36			−0.948					
Item 46			−0.894					
Variance	33.0%	9.4%	5.3%	3.9%	3.7%	2.8%	2.6%	2.4%
Eigenvalue	15.9	4.5	2.5	1.9	1.8	1.3	1.2	1.2

**Note*: each set of four items represent the previous factors 1–12 for the General Scale (see Appendix A for Factor names).

maximum likelihood factor analysis. Bartlett's test of sphericity was significant (χ^2 (378, $N = 585$) = 8889.84, $p < .0001$) for the two-factor structure of the Sport-specific scale and for the seven subscales, indicating that the recovery and stress factors are correlated (see Tables 5a and 6a). Communalities ranged from 0.334 to 0.714.

Factor 1 accounted for 30.8% of the variance (eigenvalue = 8.6) and included the same three Sport-Stress subscales as previously found by Kellmann and Kallus (2001). Factor 2, accounting for 16.1% of the variance (eigenvalue = 4.5), included the four Sport-Recovery subscales as previously found. Table 5b lists the highest factor loadings for the Sport-Recovery/Stress items.

However, results analyzing the factor structure of the seven subscales did not confirm previous findings. Factor 1 [Physical & Sport Efficacy], accounted for 30.8% of the variance (eigenvalue = 8.6), and included all items from subscale 16: Fitness/being in shape, all items from subscale 18: Self-efficacy, items #56, "I prepared myself mentally for performance" and item #62, "I pushed myself during performance" from subscale 19: Self-regulation, in addition to item #55, "I accomplished many worthwhile things in my sport". Factor 2 [Injury], accounted for 16.1% of the variance (eigenvalue = 4.5), and included all items from subscale 15: Fitness/injury.

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Table 5

(a) *Factor correlations: Sport-Recovery/Stress items*

Factor	1	2
1	1.000	—
2	−0.277	1.000

(b) *Maximum likelihood factor analysis of Sport-Recovery/Stress Items*

RESTQ Items	Factor 1	Factor 2
Item 51		0.551
Item 58		0.648
Item 66		0.587
Item 72		0.552
Item 54		0.658
Item 63		0.644
Item 68		0.446
Item 76		0.514
Item 50		0.627
Item 57		0.645
Item 64		0.679
Item 73		0.482
Item 53	0.521	
Item 61	0.731	
Item 69	0.669	
Item 75	0.784	
Item 55	0.706	
Item 60	0.458	
Item 70	0.435	
Item 77	0.509	
Item 52	0.744	
Item 59	0.712	
Item 65	0.804	
Item 71	0.784	
Item 56	0.716	
Item 62	0.739	
Item 67	0.722	
Item 74	0.684	
Variance	30.8%	16.1%
Eigenvalue	8.6	4.5

Factor 3 [Breaks], accounted for 6.6% of the variance (eigenvalue = 1.86) and include all items from subscale 13: Disturbed breaks. Factor 4 [Burn-out], accounted for 4.98% of the variance (eigenvalue = 1.39) and included all items from subscale 14: Burnout/emotional exhaustion.

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Table 6

(a) *Factor correlations: Sport-Recovery/Stress Subscale items*

Factor	1	2	3	4	5	6	7
1	1.000						
2	−0.249	1.000					
3	−0.251	0.494	1.000				
4	−0.380	0.413	0.486	1.000			
5	0.536	−0.384	−0.192	−0.263	1.000		
6	0.424	0.224	0.173	0.084	0.176	1.000	
7	−0.215	0.417	0.360	0.284	−0.381	0.086	1.000

(b) *Maximum likelihood factor analysis of mean subscale scores for Sport-Recovery/Stress*

RESTQ Items*	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Item 51			0.228				
Item 58			0.661				
Item 66			0.806				
Item 72			0.768				
Item 54				0.596			
Item 63				0.407			
Item 68				0.707			
Item 76				0.663			
Item 50		0.832					
Item 57		0.761					
Item 64		0.892					
Item 73		0.657					
Item 53	0.624						
Item 61	0.907						
Item 69	0.637						
Item 75	0.873						
Item 55	0.745						
Item 60					0.640		
Item 70					0.636		
Item 77					0.357		
Item 52	0.846						
Item 59	0.652						
Item 65	0.860						
Item 71	0.630						
Item 56	0.445						
Item 62	0.588						
Item 67						0.655	
Item 74						0.609	
Variance	30.8%	16.1%	6.7%	5.0%	4.2%	3.7%	3.0%
Eigenvalue	8.60	4.50	1.86	1.39	1.19	1.03	0.83

**Note*: each set of four items represent the previous factors 1–7 for the Sport Scale (see Appendix A for Factor names).

Factor 5 [Dealing with adversity], accounting for 4.23% of the variance (eigenvalue = 1.19) included the remaining three items from subscale 17: Burnout/Personal Accomplishments. Factor 6 [Self-regulation] accounted for 3.67% of the variance (eigenvalue = 1.03) and included only items #67, "I psyched myself up before performance" and item #74, "I set definite goals for myself during performance". The two items with high loadings on Factor 7 loaded on previous factors and did not offer any further meaningfulness (eigenvalue < 1.0). Table 6b lists the highest item factor loadings for the eight meaningful Sport subscales.

Cronbach's α for the 28 Sport scale (recovery and stress) items yielded a value of 0.83. Items #36 and #46 of the Sleep quality factor were found to correlate negatively with the item-total correlations, both before and after reverse scoring.

Discussion

These findings suggest that while the RESTQ-Sport should still be considered a valid general measure of under-recovery, there is a different factor structure for the under-recovery construct than originally outlined by Kellmann and Kallus (2001). Many of the individual items combine to form different subscales than those formulated by Kellmann and Kallus (2001). In particular, the very important Sleep Quality subscale was shown, in the present study, to be both unreliable and lacking validity when examining its individual items. It is suggested that, pending confirmation of our own results, this subscale should be re-developed. Overall, the test appears to best measure social relaxation and general well-being together with perceived fitness and self-efficacy.

The item analysis showed the 12 General subscale factors and seven Sport subscale factors to significantly differ from the structure suggested by previous authors (Kellmann & Kallus, 2001). In particular, items from the social relaxation and general well-being subscales were shown to represent the greatest variance; these two loaded on the same factor of the General subscale. These findings indicate that a large proportion of stress-recovery depends on the items corresponding to good social and emotional well-being. Similar items, some from other subscales indicating social and emotional stress, combined to form Factor 2, further suggesting that the social and emotional stress items may be measuring the overall effect of stress and recovery in athletes. Other factors did not correspond to previous findings or a prior subscale hypotheses and suggested that only eight subscales are interpretable. Most of these differences from previous research (Kellmann & Kallus, 2001) are likely due to the fact that the original items were not empirically verified.

The sport item analysis suggested that only six factors were interpreted by this scale. The first factor combined items from physical fitness and self-efficacy in sport. This suggests that athletes might depend on both mental and physical indicators for potential under-recovery. Subsequent factors were represented by either stress or recovery indices but these factors did not fit the structure previously found by Kellmann and Kallus (2001). Without an item analysis, the previously confirmed two factor (stress and recovery) structure is misleading, since the results of the item analysis suggest disconfirmation of this structure.

The advantage of using these analyses to determine the number of scales is that this approach employs a more accurate, data-driven technique to identify a small number of critical dimensions which the questionnaire is measuring (Gorusch, 1983). This contrasts with the larger number of

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factors found when using the a priori method previously used by Kellmann and Kallus (2001). The factors identified using this latter method are less accurate reflections of the questionnaire's previously hypothesized components as shown by the empirical method used in this study. Further, several items, notably the Sleep quality items, lacked even face validity and should have been removed. Including such items with a model would, according to Bollen and Long (1993) cause serious misspecifications, and skewed goodness-of-fit tests. An empirically based method, according to MacCallum et al. (1992), minimizes the chance of deriving spurious and inaccurate SEM results when tested in future studies.

The analyses employed in our study have furthered the grounded up model previously suggested and upon which higher level confirmatory factor analyses can now be conducted to test the utility of this or alternative models. This study also helped to confirm previous exploratory analyses on the Recovery and Stress Scales, as a whole, although the specific items of these scales should now be reconsidered due to items found to be unrepresentative of the previously hypothesized Scales by Kellmann and Kallus (2001).

Both exploratory and confirmatory (SEM) factor analysis of the RESTQ items would now be suggested to verify the factor structure for a heterogeneous group of athletes on recovery-stress. Given the lack of item analysis by Kellmann and Kallus (2001), future research could aid by confirming both the factor composition, using a type of exploratory parallel analysis (MacCallum et al., 1992), and the model fit (Bollen, 1989). Ultimately this would specify the number of common subscales that identify the stress or recovery factors for both of the sport and general scales. From the analyses performed in this study, future exploratory factor analysis research can now use our data as a basis for confirming or disconfirming the optimum number of factors and also for confirming the model fit through confirmatory (SEM) analyses while minimizing post-hoc modification errors (Bollen & Long, 1993; Gorusch, 2003; MacCallum et al., 1992).

From the studies referenced in the user manual (Kellmann & Kallus, 2001), it can be accepted that the RESTQ-Sport measures aspects of under-recovery. As indicated by Silva (1990), under-recovery is measured as one end of a continuum that balances with burnout on the other end. The items in the RESTQ do appear to contain items that will tap into many aspects of this continuum. Importantly, under-recovery remediation may be guided by qualitative evaluation of the items for the scale. However, the items that load on different subscales or indices of stress and recovery need to be further analyzed.

The RESTQ authors suggest that if the athlete shows negative shifts in scaled scores on the RESTQ-Sport, then it would be logical to regularly discuss the items that comprise the relevant RESTQ-Sport factors. With regular *quantitative monitoring* it will be possible to design and evaluate under-recovery remediation—both in the training venue and in the recovery setting (Kellmann & Kallus, 2001).

Our results support the published practical applications for using the RESTQ-Sport. Most notably, coaches can monitor their athletes during training with the goal of identifying specific signs of under-recovery which may prove detrimental to performance. Our research suggests that the coach should simply be alerted to the components of under-recovery and use the RESTQ-Sport to guide modifications to the athlete's approach to recovery. That is, a coach who notices that when an athlete (a) lacks aspects of social and emotional well-being or (b) shows signs of decreased self-efficacy and physical fitness, it would be wise to investigate the potential that the athlete is under-recovering.

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The model of Davis et al. (2002) uses a cognitive-behavioral approach in identifying empirically supported techniques to address the self-regulation and mood symptoms observed in under-recovered athletes. The best practice model would be to measure under-recovery with the RESTQ before using intervention techniques. The techniques follow our results and include: (1) self-regulation for promoting physical recovery (through focus on eating, hydration, sleep, and social activities) and general well-being; (2) focus on goal-setting to increase commitment, self-satisfaction, and confidence; (3) relaxation techniques to calm the mind and body, lower the heart rate, and decrease subjective anxiety or perceived stress; (4) imagery training to provide motivation, bolster flagging confidence and self-efficacy; (5) promotion of interpersonal relaxation together with the use of cognitive methods which focus on attentional control, confidence-building, self-reflection and providing perspective and balance.

The results of the present study are limited in generalizability to athletes in the particular sports appearing in the study's Canadian sample. Although there are no apparent reasons for these results not applying to athletes in other sports, future research should include samples of athletes from as many sports as possible. Results consistent with those of the present study would indicate that components of recovery-stress identified in the present study apply to the under-recovery construct continuum.

Finally, it remains for future research to document the relationship between the various recovery and sport subscales, training quality and athletic performance. Based on the results of our study, it would be reasonable to hypothesize that improved training quality and higher competitive performance should be found among athletes who, while in training or while competing would have lower scores for items that represent stress and higher scores on those items that represent recovery. Additionally, an improved understanding of the recovery-stress dynamic will ultimately shed light on how under-recovery serves as a precursor to overtraining and burn-out in athletes. Further research examining the factor structure of the individual items associated with the RESTQ-Sport is warranted.

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Appendix A. Scales & Items of the RESTQ-76 Sport (2001)

Scale 1: General Stress (5.43; 3.96) [1]

(22) I felt down
(24) I felt depressed
(30) I was fed up with everything
(45) Everything was too much for me

[1] *Brackets contain the means and standard deviations for each item (Mean, SD).*

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Scale 2: Emotional Stress (6.69; 3.54)
(5) everything bothered me
(8) I was in a bad mood
(28) I felt anxious or inhibited
(37) I was annoyed
Scale 3: Social Stress (7.83; 3.25)
(21) I was annoyed by others
(26) Other people got on my nerves
(38) I was upset
(48) I was angry with someone
Scale 4: Conflicts/Pressure (9.30; 4.38)
(12) I worried about unresolved problems
(18) I couldn't switch my mind off
(32) I felt I had to perform well in front of others
(44) I felt under pressure
Scale 5: Fatigue (8.57; 4.72)
(2) I did not get enough sleep
(16) I was tired from work
(25) I was dead tired after work
(35) I was overtired
Scale 6: Lack of Energy (7.66; 3.58)
(4) I was unable to concentrate well
(11) I had difficulties in concentrating
(31) I was lethargic
(40) I put off making decisions
Scale 7: Somatic Complaints (7.17; 3.98)
(7) I felt physically bad
(15) I had a headache
(20) I felt uncomfortable
(42) I felt physically exhausted
Scale 8: Success (12.53; 3.65)
(3) I finished important tasks
(17) I was successful in what I did
(41) I made important decisions
(49) I had some good ideas
Scale 9: Social Relaxation (14.35; 4.46)
(6) I laughed
(14) I had a good time with my friends
(23) I visited some close friends
(33) I had fun
Scale 10: Somatic Relaxation (12.17; 4.12)
(9) I felt physically relaxed
(13) I felt at ease
(29) I felt physically fit

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(38) I felt as if I could get everything done

Scale 11: General Well-being (14.59; 4.36)

(10) I was in good spirits
(34) I was in a good mood
(43) I felt happy
(47) I felt content

Scale 12: Sleep Quality (9.87; 2.54)

(19) I fell asleep satisfied and relaxed
(27) I had a satisfying sleep
(36) I slept restlessly
(46) My sleep was interrupted easily

Scale 13: Disturbed Breaks (6.19; 4.25)

(51) I could not get rest during the breaks
(58) I had the impression there were too few breaks
(66) Too much was demanded of me during the breaks
(72) The breaks were not at the right times

Scale 14: Burnout/Emotional Exhaustion (5.68; 4.56)

(54) I felt burned out by my sport
(63) I felt emotionally drained from performance
(68) I felt that I wanted to quit my sport
(76) I felt frustrated by my sport

Scale 15: Fitness/Injury (9.76; 5.34)

(50) Parts of my body were aching
(57) My muscles felt stiff or tense during performance
(64) I had muscle pain after performance
(73) I felt vulnerable to injuries

Scale 16: Fitness/Being in Shape (12.83; 4.55)

(53) I recovered well physically
(61) I was in a good condition physically
(69) I felt very energetic
(75) My body felt strong

Scale 17: Burnout/Personal Accomplishment (12.49; 4.06)

(55) I accomplished many worthwhile things in my sport
(60) I dealt very effectively with my teammates' problems
(70) I easily understood how my teammate felt about things
(77) I dealt with emotional problems in my sport very calmly

Scale 18: Self-Efficacy (13.31; 4.93)

(52) I was convinced I could achieve my set goals during performance
(59) I was convinced that I could achieve my performance at any time
(65) I was convinced that I performed well
(71) I was convinced that I had trained well

Scale 19: Self-Regulation (14.95; 4.86)

(56) I prepared myself mentally for performance
(62) I pushed myself during performance

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(67) I psyched myself up before performance
(74) I set definite goals for myself during performance

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