Article

Athletic Performance and Recovery-Stress Factors in Cycling: An Ever Changing Balance

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Abstract

We sought to examine whether the relationship between recovery-stress factors and performance would differ at the beginning (Stage 1) and the end (Final Stage) of a multi-stage cycling competition. Sixty-seven cyclists with a mean age of 21.90 years (*SD* = 1.60) and extensive international experience participated in the study. The cyclists responded to the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport) and rated their performance (1 = *extremely poor* to 10 = *excellent*) in respect to the first and last stage. Two step-down multiple regression models were used to estimate the relationship among recovery (nine factors; e.g., *Physical Recovery*, *Sleep Quality*) and stress factors (10 factors; e.g., *Lack of Energy*, *Physical Complaints*), as assessed by the RESTQ and in relation to performance. Model-1 pertained to Stage 1, whereas Model-2 used data from the Final Stage. The final Model-1 revealed that *Physical Recovery* (β = .46, p = .01), *Injury* (β = -.31, p = .01) and *General Well-being* (β = -.26, p = .04) predicted performance in Stage 1 (R^2 = .21). The final Model-2 revealed a different relationship between recovery-stress factors and performance. Specifically, being a *climber* (β = .28, p = .01), *Conflicts/Pressure* (β = .33, p = .01), and *Lack of Energy* (β = -.37, p = .01) were associated with performance at the Final Stage (R^2 = .19). Collectively, these results suggest that the relationship among recovery and stress factors changes greatly over a relatively short period of time, and dynamically influences performance in multi-stage competitions.

Key words: Recovery-Stress Balance, Cycling, RESTQ-Sport.

Athletic Performance and Recovery-Stress Factors in Cycling: An Ever Changing Balance

The ability to balance recovery demands and stress stimuli is essential for the development and maintenance of skilled performance in sports (Kellmann, 2010; Meeusen et al., 2013). Chronic underrecovery may lead to non-functional overreaching and, ultimately, to overtraining and burnout (Meeusen et al., 2013). Accordingly, monitoring recovery-stress balance is crucial to sport scientists and professionals (Di Fronso, Nakamura, Bortoli, Robazza, & Bertollo, 2013; Kellmann, 2002). Previous studies on recovery-stress balance have been based primarily on pre-post mean comparison designs, thus capturing changes in recovery and stress but failing to assess the relationship among various recovery (e.g., sleep quality, social relaxation) and stress factors (e.g., emotional, social). However, the relationship among bio-psycho-social variables and performance outcomes should not be drawn on a one-to-one basis (Cacioppo, Tassinary, & Berntson, 2007), but rather on a one-to-many basis, in the sense that performance is usually influenced by multiple bio-psycho-social factors (Edmonds & Tenenbaum, 2012).

Within the sport and exercise psychology domain, the importance of concurrently assessing various recovery and stress factors is presented in Kellmann's (2002) Model of the Interrelation between Stress States and Recovery Demands. In theory, Kellmann posits that the interrelation among recovery demands and stress states should be balanced if athletes aim to perform optimally during competitions. In practice, it means that upon an increase in stressors throughout the season (e.g., social stress such as pressure from coaches and media), athletes should counterbalance by engaging in various forms of passive (e.g., sleeping in), active (e.g., stretching) and pro-active (e.g., travelling to visit family and friends) recovery activities. When unable to balance recovery demands and stress states (i.e., high stress/low recovery; low stress/high recovery), athletes are more likely to perform poorly.

Kellmann's Model of the Interrelation between Stress States and Recovery Demands has been psychometrically operationalized through the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport; for a review Kellmann & Kallus, 2001). This questionnaire is composed of general stress (e.g., Physical Complaints) and recovery scales (e.g., Physical Recovery), as well as sport specific stress (e.g., Injury) and recovery (e.g., Self-Efficacy) scales. The RESTQ-Sport was designed to target athletes', rather than coaches', subjective perception of recovery factors and stress states. This is particularly important because athletes' and coaches' assessment of training load tends to differ (Ardua & Márquez, 2007). Furthermore, the RESTQ-Sport has been used by sport scientists and practitioners, as it allows for the establishment of a multilayered recovery-stress profile (Davis, Orzeck, & Keelan, 2007; Di Fronso et al., 2013; Lombardi et al., 2013).

Previous research on recovery-stress balance in sports has focused on comparing recovery-stress scores (pre-post designs) across different training periods (e.g., pre-season, in-season, post-season). Overall, results suggest that recovery and stress scores fluctuate greatly throughout the competitive season (Brink, Visscher, Coutts, & Lemmink, 2012; Di Fronso et al., 2013; Kellmann, Altenburg, Lormes, & Steinacker, 2001). In regards to elite cyclists, underrecovery has been found to be negatively related to performance and perception of effort (Halson et al., 2002). Furthermore, recovery-stress unbalance has been found to have a strong negative effect on Olympic cyclists' performance (Gould & Dieffenbach, 2002).

Maintaining a healthy recovery-stress balance is paramount in multi-stage competitions, when athletes are exposed to high-stress demands over extensive periods of time (Filho et al., 2013; Lombardi et al., 2013). In particular, cyclists' performance and perceived bio-psycho-social states have been found to vary greatly over multi-stage competitions (Filho et al., 2013). Moreover, the different environmental characteristics proper to each competition stage have been shown to influence athletes' overall performance capability (Lombardi et al., 2013). In this context, we aimed to explore the relationship between cyclists' bio-psycho-social states and performance in a multi-stage cycling competition. Specifically, we aimed at addressing the question: "Does the relationship among several perceived recovery-stress states and performance outcomes change in a multi-stage cycling competition?" More specifically, we sought to examine whether the relationship among recovery-stress factors and performance would differ at the beginning (i.e., stage 1) and end (i.e., final stage) of the Girobio, an international multi-stage cycling competition. Given the exploratory nature of our study, we refrained from proposing specific hypotheses. We expected that the final regression models for the first and last stages would differ akin to the overarching theoretical notion that recovery-stress factors are dynamic and tend to change greatly over time (Kellmann, 2010).

Methods

Participants

Institutional ethical approval was obtained prior to the commencement of the study, and in agreement with the Helsinki Declaration. All athletes participating in the Girobio-2012 were briefed on the purposes of the study during the technical meeting preceding the start of the race. Cyclists interested in the study received further information about its objectives and procedures, and signed an informed consent sheet. Of the 170 cyclists who entered the Girobio-2012, 78 finished the race and agreed to complete the two administrations of the RESTQ-Sport. On average, the cyclists had 11.23 years of cycling experience (*SD* = 5.90) and were approximately 22 years of age (*M* = 21.90, *SD* = 1.60). The cyclists were from four different countries (i.e., Italy, Netherlands, Switzerland, and United States) and represented 25 different racing teams. The majority of the cyclists who participated in the study were *puncheurs* (n = 38, 48.7%), followed by *all-rounders* (n = 13, 16.7%), *climbers* (n = 12, 15.4%) and *sprinters* (n = 3, 3.8%). Twelve cyclists (15.4%) did not report their riding specialty.

Measures

Demographic survey. Demographic information about the athletes' *age*, *nationality*, and *team affiliation* was collected. Athletes were also asked to indicate what *type of cyclists* (*all-rounder*, *climber*, *puncheur*, or *sprinter*) they considered themselves to be.

RESTQ-Sport (Kellmann & Kallus, 2001). The RESTQ-Sport was designed to measure the frequency that athletes experience stress states as well as recovery-related activities and contains 77 items pertaining to 19 scales. Specifically, the RESTQ-Sport consists of (a) seven general stress scales (i.e., *General Stress, Emotional Stress, Social Stress, Conflicts/Pressure, Fatigue, Lack of Energy, Physical Complaints*), (b) five general recovery scales (i.e., *Success, Social Recovery, Physical Recovery, General Well-being, Sleep-Quality*), (c) three stress sport-specific scales (i.e., *Disturbed Breaks*, *Emotional Exhaustion*, *Injury*), and (d) four sport-specific recovery scales (i.e., *Being in Shape, Personal Accomplishment, Self-Efficacy, Self-Regulation*). Each scale contains four items, measured using a Likert-type scale with anchors 0 (*never*) and 6 (*always*). All items were preceded by the stem "in the past 3 days/nights…", and worded in simple language aimed at facilitating grammatical understanding. Sample items include: "I was angry with someone" (*Social Stress*), and "I had a good time with my friends" (*Social Recovery*). Previous psychometric assessments have supported the factorial structure (i.e., recovery and stress), internal consistency, and test-retest reliability of the RESTQ-Sport (Davis et al., 2007;

Kellmann & Kallus, 2001). Moreover, the questionnaire has high face and predictive validity in regards to underrecovery and overtraining states in sports (Kellmann & Kallus, 2001).

Performance. Subjective performance represented the dependent variable in the step-down regression analysis adopted in this study. After the completion of the first and final stage, the athletes were asked to report their perceived performance on a Likert scale ranging from 1 (*extremely poor*) to 10 (*excellent*). It is important to note that subjective reports may better represent athletes' performance experiences in some sports (Chelladurai, 2007). Purely objective scores do not account for myriad situational factors, such as outstanding performance from peers and opponents, bad weather, and stage conditions (e.g., flat, low-mountain, and high-mountain). In the present study, final ranking was negatively correlated with subjective performance for both Stage 1 (Spearman's r = -.33) and Stage 2 (Spearman's r = -.39), corroborating the notion that objective and subjective performance are not positively related constructs, and dependent on individuals' role within a team.

Procedures

Data were collected during the Girobio-2012. The race included nine stages of various lengths and diverse topographies, and covered approximately 1,300 kilometers (for a review see Lombardi et al., 2013). The stages varied in length and involved flat (Stages 1, 2 and 7), low-mountain (Stages 3, 4, 5 and 6), and high-mountain (Stages 8 and 9) terrains. Specifically, the stages ranged from 75.6 km to 193.3 km in length (M = 148.82, SD = 33.67), and from 642 m to 5190 m in elevation (M = 2617.78, SD = 1576.93). The first assessment of the athletes' RESTQ-Sport (Stage 1), as well as the administration of the demographic survey, occurred one day prior to the first stage of the race. The second assessment (Final Stage) occurred one day prior to the last stage. Whereas RESTQ-Sport data was collected prior to the race, performance data was collected immediately following the first and last stage in congruence with the notion that athletes' subjective reports tend to be more reliable when reported closely after performance (Tenenbaum, Lloyd, Pretty, & Hanin, 2002). During all data collections the cyclists were instructed to be serious and truthful in their responses. Two trained scholars administered the questionnaires in a quiet environment. Coaches and journalists were not allowed in the room during the data collection to ensure the comfort and privacy of the participants. The interval between stages was 10 days. This time frame was deemed appropriate as the RESTQ-Sport is a state-oriented measure aimed at capturing recovery and stress states over a period of approximately three days or nights (see Kellmann & Kallus, 2001).

Results

Descriptive and Correlational Analyses

Means, standard deviations, and correlation coefficients for all recovery and stress factors are given in Table 2 (Stage 1) and Table 3 (Final Stage). Overall, correlation coefficients among stress related factors (general and sport specific) were higher than coefficients among stress and recovery factors. Similarly, coefficients among recovery factors (general and sport specific) were higher among themselves, than in comparison to scores among recovery and stress related factors. Specifically, significant correlations among general stress scales ranged from .31 (*Social Stress* and *Fatigue*) to .70 (*General Stress* and *Social Stress*) for Stage 1, and from .28 (*Social Stress* and *Fatigue*) to .69 (*Emotional Stress* and *Lack of Energy*) for the Final Stage. Correlation coefficients for sport-specific stress scales were between .39 (*Emotional Exhaustion* and *Injury*) and .47 (*Disturbed Breaks* and *Emotional Exhaustion*) for Stage 1, and between .45 (*Disturbed Breaks* and *Injury*) to .60 (*Emotional Exhaustion* and *Injury*) for the Final Stage. Correlation coefficients among general recovery scales ranged from .33 (*Social Recovery* and *Physical*

Recovery) to .58 (*Physical Recovery* and *General Well-being*) for Stage 1, and from .39 (*Success* and *Social Recovery*) to .68 (*Social Recovery* and *General Well-being*) for the Final Stage. Lastly, correlation coefficients for sport-specific stress scales were between .65 (*Being in Shape* and *Self-Efficacy*) and .71 (*Being in Shape* and *Self-Regulation*) for Stage 1, and .58 (*Being in Shape* and *Personal Accomplishment*) to .75 (*Being in Shape* and *Self-Regulation*) for the Final Stage. Altogether, these findings indicate that the relationship among recovery and stress factors is subject to change over time. To examine how such a relationship could have a varying degree of influence on performance from Stage 1 to the Final Stage, we performed a series of step-down multiple regression analyses.

Regression Analyses

We adopted a step-down regression analysis, which is considered a robust procedure as it combines theory and data driven approaches (Cohen, Cohen, West, & Aiken, 2002). Foremost, this analytical approach is consistent with the importance of exploring the dynamic balance involving recovery and stress factors, in respect to performance in sports (Filho et al., 2013; Kellmann, 2010; Meeusen et al., 2013; Shrier & Hallé, 2011).

All assumptions were checked prior to running the regression analysis. Residuals were randomly dispersed around the independent variables. The outcome variables were relatively normally distributed with skewness and kurtosis values of -.29 and -.47 for Stage 1, and .64 and .33 for the Final Stage. As presented in Tables 2 and 3, correlation among variables was below the cutoff point of .80 (r = -.69 to .46), suggesting that multicollinearity was not a major concern. Estimates of internal consistency were also computed for each scale in regards to Stage 1 and the Final Stage. Scales with poor internal consistency (i.e., $\alpha \leq .60$) were not entered in the regression models to prevent biases due to large measurement error (Cohen et al., 2002).

Specifically, the scales *Success*, *Physical Complaints* and *Personal Accomplishment* were not included in the analysis for Stage 1, whereas *Physical Complaints* and *Sleep Quality* were not considered in the analysis for the Final Stage.

For both stages, demographic variables were entered in the first exploratory model (Model 1) to control for and assess the influence of *age* and *type of cyclist*. Whereas *age* is a continuous variable, *type of cyclists* was sub-divided and dummy coded for *all-rounders* (0 = no, 1 = yes), *climbers* (0 = no, 1 = yes), *puncheurs* (0 = no, 1 = yes), and *sprinters* (0 = no, 1 = yes). Any variable that reached marginal significance was retained in the exploratory Model 2, which also included all recovery and stress related factors. Subsequently, all significant predictors of performance, as well as variables with marginal significance, $.05 \leq p \geq .15$, were further tested in Model 3 akin to previous research in the sport literature (Umbach, Palmer, Kuh, & Hannah, 2006). Congruent with guidelines on parsimonious statistical modeling (Cohen et al., 2002), Final Model 4 contained only significant predictors contributing to explained variance and overall model fit.

Stage 1. Model 1 included demographic variables only, precisely *age* and *type of cyclists*. Model 1 did not reach statistical significance, F (5, 69) = 1.93, p = .10. However, the dummy variable *sprinter* (β = -.23, p = .07) approached significance and was retained and included in Model 2 along with all recovery and stress factors. Although Model 2 reached statistical significance, F (17, 60) = 1.79, p = .05, the variable *sprinter* and the majority of the recovery and stress factors were not statistically related to performance (see Table 4). In adopting a conservative approach, we kept all predictors with $p \leq .15$ in Model 3, due to the fact that the partial correlation among predictors may change as variables are eliminated from the regression model (Cohen et al., 2002). Although Model 3 was statistically significant, F (5, 72) = 4.66, p =

.01, *Conflicts/Pressure*, and *Fatigue* were still not found to predict performance for $p \leq .05$. Accordingly, we retained only significant predictors in Model 4, F (3, 74) = 6.43, p = .01. Specifically, *Physical Recovery* (β = .44, p = .01), *Injury* (β = -.31, p = .01), and *General Well-being* (β = -.26, p = .04), were found to significantly predict 21% of the variance in subjective performance for Stage 1 (see Table 4). Tolerance and variance inflation values were below 1.0 and 2.0, respectively, further suggesting that multicollinearity was not an issue.

Final Stage. We adopted the same rationale for regressing demographic variables and recovery-stress factors onto performance scores. Although Model 1 reached statistical significance, F (5, 69) = 2.43, p = .04, only the dummy variable *climber* was statistically related to performance. Accordingly, in Model 2 we retained *climber* while adding all recovery and stress factors to the regression equation. Model 2 did not converge to a reliable solution, F (18, 59) = 1.48, p = .13. In Model 3 we maintained all predictors that had approached significance (i.e., $p \leq .15$) in Model 2. Specifically, Model 3 included *climber*, *Conflicts/Pressure*, *Lack of Energy* and *Self-Efficacy*. Although Model 3 was statistically significant, F (4, 73) = 4.63, p = .01, *Self-Efficacy* failed to reach significant results and was excluded from the Final Model 4, F (3, 74) = 5.87, p = .01. Only *climber* (β = .28, p = .01), *Conflicts/Pressure* (β = .33, p = .01), and *Lack of Energy* (β = -.37, p = .01) were found to predict performance for the Final Stage. The total explained variance was 19% (see Table 4). Tolerance and variance inflation values were .64 and 1.57, respectively, and thus multicollinearity was not an issue.

Discussion

We examined whether the relationship between recovery-stress factors and performance would differ at the beginning and end of a multi-stage cycling competition. Initial correlational analyses suggested that the relationship among recovery and stress factors changed over time. Overall, the correlation pattern across recovery and stress factors was unique for Stage 1 and the

Final Stage. However, the association between *Being in Shape* and *Self-Regulation* was of strong magnitude ($r \leq .70$) for both Stage 1 and the Final Stage. In fact, the ability to self-regulate is essential to enable individuals to stay physically and mentally fit (Filho et al., 2013; Robazza, Pellizzari, & Hanin, 2004). Therefore, future studies should further examine the direction of this relationship to determine whether self-regulation enables *Being in Shape* or vice-versa. Step-down multiple regression models further indicated that the relationship among recovery and stress factors changed greatly from the first to the last stage of the race.

Stage 1

For Stage 1, *Physical Recovery* ($\beta = .44$) was the most important predictor of performance, followed by *Injury* ($\beta = -.31$) and *General Well-being* ($\beta = -.26$). To this extent, it is well-established that athletes should be (and feel) physically recovered in the competitive phase of the periodization cycle; this being the reason why tapering occurs prior to major competitions (Di Fronso et al., 2013; Gould & Dieffenbach, 2002; Kellmann, 2010). It has also been empirically established that athletes without injuries usually outperform their opponents (Meeusen et al., 2013; Shrier & Hallé, 2011).

The negative relationship between *General Well-being* and performance, a seemly counterintuitive relationship, may be a result of the four items of this scale ("I was in good spirits"; "I was in a good mood"; "I felt happy"; and "I felt content") measuring affective states rather than general bio-psycho-social health status. In this regard, extant research on the Individual Zones of Optimal Functioning framework suggests that athletes are able to perform optimally even under unpleasant affective states (Hanin, 2007). From an applied standpoint, this finding reinforces the notion that sport practitioners should help athletes to identify their idiosyncratic affective profile, as pleasant emotions are not always linked to optimal performance. In fact, recent research in sport psychology suggests that athletes should have multi-action plans in order to cope with unpleasant states while sustaining exertion in endurance cycling (Comani et al., 2014).

Final Stage

For the Final Stage, *climber* was found to be positively related to performance. It is understandable that climbers perceived performance differently than other types of riders, given that the final stage was a high-mountain stage, where climbers would likely perform well. Overall, it is noteworthy that different types of cyclists may perceive performance differently and that these differences are likely related to contextual factors (i.e., type of stage, such as flat, low-mountain, and high-mountain). In fact, there is empirical evidence across sports that one's role within a team influences subjective performance ratings (Carron, Eys, & Burke, 2007; Filho, Gershgoren, Basevitch, & Tenenbaum, 2014). Accordingly, both researchers and practitioners should consider self-perceived subjective ratings in designing research and operationalizing periodization cycles in sports.

For the Final Stage, *Lack of Energy* and *Conflicts/Pressure* were found to be negatively and positively related to performance, respectively. Thus, the ability to mobilize all available mental and physical energy resources is crucial for optimal performance at the end of the race. Mental skills regimens, in particular relaxation routines and attention control training (see Orlick, 2008), may help athletes replenish energy prior to the final stage, and save energy during the race by focusing on certain cues. The positive relationship between *Conflicts/Pressure* and performance has ample support in both classic and contemporary sport psychology literature (Eklund & Tenenbaum, 2013; Jones, Swain, & Hardy, 1993). Sport psychologists have long argued that pressure to perform ("fight or flight") may be facilitative rather than debilitative to athletic performance, particularly among elite athletes participating in high-stakes competition (Fletcher & Hanton, 2001; Swain & Jones, 1996). Cyclists that made it to the last stage may have adopted a positive frame of mind, choosing to embrace the pressure and stay committed to the race (mindfulness-acceptance approach; see Gardner & Moore, 2004), rather than abandoning the stage.

Generally, findings from this study suggest that the linkage between recovery-stress factors and performance is dynamic in nature, an ever-changing balance. These findings corroborate the notion that athletes' performance in multi-stage competitions are partially dependent on their self-perceived bio-psycho-social states (Di Fronso et al., 2013; Filho et al., 2013). During multi-stage competitions athletes are exposed to different challenges (e.g., different terrains and temperatures) that influence their ability to consistently obtain peak performance while maintaining a healthy recovery-stress balance. Thus, coaches and sport practitioners should closely monitor how changes in athletes' bio-psycho-social profile influence performance in multi-stage competitions. Athletes with little competitive experience and minimal coping skills may benefit greatly from receiving specific feedback about how to balance recovery and stress during extensive multi-stage competitions.

Limitations, Implications and Future Directions

This study is not without limitations. First, we were unable to collect additional psychological and physiological data, as time with the athletes was limited. Second, the relatively small sample size might have interfered with the reliability of a few RESTQ-Sport scales, as previously detailed. We adopted a convenience sample strategy by collecting data in situ. Ideally, future studies should be based on larger sample sizes defined through a priori power analysis. Notwithstanding, the complexity of a field study with elite cyclists during an extended, multi-stage competition made it difficult to collect data for a larger number of athletes while including multiple methodological controls.

Despite these limitations, our study advanced research in sport and exercise psychology by looking at the relationship of recovery-stress factors rather than focusing primarily on mean comparison. From a theoretical standpoint, our findings reinforce the notion that performance is influenced by myriad recovery-stress factors that are not stable, but rather change dynamically over relatively short periods of time (Kellmann, 2002, 2010; Kellmann & Kallus, 2001). It is particularly noteworthy that general recovery factors explained most of the variance of performance in the First Stage, whereas general stress factors were more relevant in the Final Stage. From an applied standpoint, these findings highlight the importance of considering the interaction of recovery-stress factors when developing periodization programs in sports. It is important to ensure that athletes are fully recovered prior to competition in agreement with the overarching notion of training periodization. Moreover, coping skills might be particularly important in multi-day competitions, especially during the final stages.

In addition to targeting larger samples and implementing multiple psycho-physiological controls, future studies should consider mid-race assessments that can be statistically integrated with pre- and post-assessments through longitudinal growth models. Researchers should also compare top to bottom cyclists' objective performance markers (i.e., time, final rank) in order to advance the knowledge of recovery and stress factors as predictors of expert performance in cycling. Moreover, additional studies comparing the bio-psycho-social profile of the different types of cyclists may advance specific performance psychology guidelines applied to *all-rounders*, *climbers*, *puncheurs*, and *sprinters*. Specifically, scholars could examine whether different types of cyclists favor different recovery strategies (i.e., active, passive, pro-active).

The inclusion of other psychological measures, such as rating of perceived exertion, and physiological assessments may help to form a more complete understanding of recovery-stress balance in endurance sports. Finally, investigating the relationship of recovery-stress factors with group-related constructs (e.g., cohesion in cycling teams) and objective performance may advance our knowledge on the profile of high-performing teams in endurance sports.

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Table 1

Descriptive and Correlational Matrix of Stress and Recovery Factors, Girobio Stage 1

Stress / Recovery	M	SD	1	2	3	4	5	6	7‡	8	9	10	11‡	12	13	14	15	16	17‡	18	19	20
General Stress																						
1. General Stress	0.89	0.92	1	.60*	.62*	.55*	.49*	.57*		.45*	.69*	.21		-.22	-.28*	-.42*	-.26*	-.23*		-.14	-.17	-.11
2. Emotional Stress	1.17	0.94		1	.70*	.40*	.41*	.62*		.32*	.54*	.29*		-.24*	-.17	-.45*	-.39*	-.10		-.08	-0.2	.02
3. Social Stress	1.10	1.10			1	.34*	.31*	.63*		.36*	.58*	.13		-.09	-.16	-.35*	-.28*	-.13		.07	-.09	-.02
4. Conflicts/Pressure	2.07	1.11				1	.41*	.42*		.42*	.30*	.24*		-.06	-.01	-.17	-.25*	.06		-.06	.04	-.14
5. Fatigue	1.44	0.96					1	.36*		.44*	.57*	.50*		-.04	-.25*	-.20	-.43*	-.12		-.09	.03	-.12
6. Lack of Energy	1.09	0.80						1		.37*	.55*	.36*		-.11	-19	-.36*	-.26*	-.12		-.05	-.10	-.08
7. Physical Complaints†																						
Sport Specific Stress																						
8. Disturbed Breaks	1.27	0.92								1	.47*	.40*		-.02	-.09	-.24*	-.28*	-.19		-.08	-.16	-.23*
9. Emotional Exhaustion	1.22	0.97									1	.39*		-.09	-.24*	-.25*	-.31*	-.13		-.03	-.03	-.22*
10. Injury	1.84	0.78										1		.15	.01	.01	-.19	.19		.15	.25*	-.28*
General Recovery																						
11. Success†																						
12. Social Recovery	3.55	1.26												1	.33*	.49*	.11	.28*		.10	.32*	-.03
13. Physical Recovery	3.03	0.93													1	.58*	.46*	.68*		.61*	.64*	.27*
14. General Well-being	3.54	1.12														1	.44*	.68*		.61*	.64*	-.01
15. Sleep Quality	3.94	0.89															1	.39*		.35*	.24*	.17
Sport Specific Recovery																						
16. Being in Shape	3.22	1.14																1		.65*	.79*	.17
17. Personal Accomplishment†																						
18. Self-Efficacy	2.86	1.07																		1	.73*	.18
19. Self-Regulation	3.10	1.12																			1	.16
20. Performance	5.82	2.27																				1

*p < .05; **p < .01

Note. †These scales were not considered in the analysis of Stage 1 due to low internal consistency (i.e., $\alpha \leq .60$).

Table 2

Descriptive and Correlational Matrix of Stress and Recovery Factors, Final Stage

Stress / Recovery	M	SD	1	2	3	4	5	6	7†	8	9	10	11	12	13	14	15†	16	17	18	19	20
General Stress																						
1. General Stress	1.82	1.29	1	.63*	.45*	.56*	.49*	.60*		.47*	.68*	.47*	.12	-.17	-.18	-.41*		-.15	.06	.00	-.07	-06
2. Emotional Stress	1.76	1.19		1	.65*	.60*	.38*	.69*		.42*	.53*	.34*	.24*	-.12	-.06	-.34*		-.02	.12	.09	.04	-.06
3. Social Stress	1.88	1.47			1	.42*	.28*	.67*		.22	.44*	.24*	.23*	.01	.01	-.11		.06	.07	.11	.04	-.14
4. Conflicts/Pressure	2.12	1.09				1	.41*	.60*		.37*	.49*	.34*	.48*	.25*	.11	-.07		.19	.27*	.25*	.26*	.14
5. Fatigue	2.90	1.46					1	.30*		.61*	.55*	.64*	.28*	.13	-.08	-.02		.02	.31*	.28*	.21	-.08
6. Lack of Energy	1.48	0.95						1		.37*	.50*	.28*	.35*	-.05	-.04	-.16		.07	.08	.14	.03	-.17
7. Physical Complaints†																						
Sport Specific Stress																						
8. Disturbed Breaks	2.41	1.40								1	.46*	.45*	.20	.12	-.04	-.11		.04	.28*	.28*	.20	-.11
9. Emotional Exhaustion	1.98	1.18									1	.60*	.11	-.07	-.20	-.22		.01	.01	.05	-.07	-.14
10. Injury	2.64	1.23										1	.16	.20	-.07	.06		-.05	.22	.19	.11	-.17
General Recovery																						
11. Success	2.17	1.13											1	.39*	.54*	.43*		.59*	.56*	.67*	.62*	.10
12. Social Recovery	3.18	1.35												1	.48*	.68*		.53*	.62*	.49*	.56*	.15
13. Physical Recovery	2.42	0.93													1	.58*		.66*	.44*	.56*	.61*	.09
14. General Well-being	2.91	1.20														1		.59*	.43*	.41*	.52*	.15
15. Sleep Quality†																						
Sport Specific Recovery																						
16. Being in Shape	2.57	1.18																1	.58*	.73*	.75*	.11
17. Personal Accomplishment	2.46	1.16																	1	.64*	.71*	.15
18. Self-Efficacy	2.52	1.14																		1	.74*	-.09
19. Self-Regulation	2.70	1.20																			1	.14
20. Performance	6.42	1.60																				1

*$p < .05$; **$p < .01$

Note. †These scales were not considered in the analysis of the Final Stage due to low internal consistency (i.e., $\alpha \leq .60$).

Table 3

Regression Analysis of Stress and Recovery Factors on Cycling Performance, Stage 1

Variables	Model 1			Model 2			Model 3			Model 4 (Final)		
	B	β	*p*	B	B	*p*	B	β	*p*	B	β	*p*
Demographics												
Age	.13	.10	.43									
All-rounder	-1.19	-.19	.19									
Climber	1.03	.17	.26									
Puncheur	-.18	-.04	.82									
Sprinter	-3.21	-.23	.07	.22	.02	.88						
General Stress												
General Stress				.14	.06	.77						
Emotional Stress				.29	.12	.52						
Social Stress				-.05	-.02	.89						
Conflicts/Pressure				-.53	-.26	.10	-.36	-.18	.12			
Fatigue				.70	.30	.06	.49	.21	.12			
Lack of Energy				.30	.10	.52						
Phys. Complaints†												
Sport-Specific Stress												
Disturbed Breaks				-.11	-.04	.76						
Emot. Exhaustion				-.58	-.25	.18						
Injury				-1.23	-.42	.01	-1.10	-.37	.01	-.89	-.31	.01
General Recovery												
Success†												
Social Recovery				.06	.04	.79						
Phys. Recovery				.82	.33	.06	1.24	.51	.01	1.07	.44	.01
Gen. Well-being				-.89	-.44	.03	-.58	-.29	.03	-.52	-.26	.04
Sleep Quality				.20	.08	.58						
Sport-Specific Recovery												
Being in Shape				.54	.27	.22						
Person. Accomp.†												
Self-Efficacy				-.17	-.08	.66						
Self-Regulation				.30	.15	.52						
R^2		.12			.34*			.24**			.21**	

$^{*}p < .05$; $^{**}p < .01$

Note. †These scales were not considered in the analysis of Stage 1 due to low internal consistency values.

Table 4

Regression Analysis of Recovery and Stress Factors on Cycling Performance, Final Stage

Variables	Model 1			Model 2			Model 3			Model 4 (Final)		
	B	β	*p*	B	B	*p*	B	β	*p*	B	β	*p*
Demographics												
Age	.03	.04	.76									
All-rounder	.14	.03	.83									
Climber	1.16	.38	.01	1.0	.23	.09	1.16	.26	.01	1.22	.28	.01
Puncheur	.37	.11	.49									
Sprinter	-1.52	-.15	.21									
General Stress												
General Stress				.21	.17	.38						
Emotional Stress				.02	.01	.94						
Social Stress				-.09	-.08	.61						
Conflicts/Pressure				.48	.33	.09	.53	.36	.01	.48	.33	.01
Fatigue				.07	.06	.72						
Lack of Energy				-.50	-.30	.14	-.62	-.37	.01	-.62	-.37	.01
Phys. Complaints[†]												
Sport-Specific Stress												
Disturbed Breaks				-.05	-.05	.75						
Emot. Exhaustion				-.11	-.08	.66						
Injury				-.20	-.15	.38						
General Recovery												
Success				.03	.02	.91						
Social Recovery				-.08	-.07	.74						
Phy. Recovery				-.05	-0.3	.85						
Gen. Well-being				.27	.20	.36						
Sleep Quality[†]												
Sport Specific Recovery												
Being in Shape				.17	.12	.56						
Person. Accomp.				.33	.24	.21						
Self-Efficacy				-.55	-.39	.08	-.15	-.10	.34			
Self-Regulation				.05	.04	.87						
R^2		.15			.31			.20**			.19**	

$^{*}p < .05$; $^{**}p < .01$

Note. [†]These scales were not considered in the analysis of the Final-Stage due to low internal consistency values.