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Physical recovery, mental detachment and sleep as predictors of injury and mental energy

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Abstract

Although sports activities are generally considered beneficial to people's health and well-being, they can cause injuries and increased fatigue. Guided by the Demand-Induced Strain Compensation Recovery Model, this study hypothesized that physical recovery and mental detachment from sport-related activities would prevent injury and enhance mental energy. A cross-sectional survey study was conducted among 161 recreational athletes. Structural equation modelling analyses showed that mental detachment was negatively associated with injury and positively associated with mental energy. Sleep deprivation partially mediated the relation between mental detachment and mental energy. These findings imply an important role for mental detachment in maintaining people's health and well-being.

Keywords

exercise, health, recovery, sleep, well-being

Demands placed on employees are on the rise, due to a 24/7 economy, intensified international competition and advancements in technology (Geurts, 2014). In light of these developments, both physical and mental recovery from work-related effort are considered important in protecting employees' health and well-being (Geurts and Sonnentag, 2006; Meijman and Mulder, 1998; Sonnentag and Fritz, 2007, 2014). A large body of research has since demonstrated that recovery is hampered by prolonged exposure to work-related demands, both physically and mentally, and by stressor-related thoughts (Geurts, 2014). In contrast, recovery may be *facilitated* by recovery experiences such as psychological or mental detachment, relaxation, mastery and behavioural control (Sonnentag and

Fritz, 2007). One type of behavioural activity that seems to enhance such recovery experiences is engaging in sports (Ten Brummelhuis and Bakker, 2012). Recreational sport activities are commonly considered to be beneficial to

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one's health and well-being (Penedo and Dahn, 2005). A recreational athlete is 'a person who is physically active but who does not train for competition at the same level of intensity and focus as a competitive athlete' (Laquale, 2009: 12). However, there may be a negative side to recreational sports in which insufficient physical and mental recovery from sport activities could also be harmful, potentially resulting in injury (Wilber et al., 1995), mental fatigue (Kaplan, 2001) and impaired sleep (Yang et al., 2010). Moreover, about 1–3 per cent of US adults compress their weekly activity into 1 or 2 days, the so-called 'weekend warriors' (Kruger et al., 2007), which likely increases their risk of injury due as a result of higher intensity and total duration of physical activity (Lee et al., 2004). Injuries among recreational athletes are also associated with significant social and economic costs (Shephard, 2003). Thus, although sport-related activities are usually considered as beneficial for recovery from work (e.g. Oerlemans and Bakker, 2014; Ten Brummelhuis and Bakker, 2012), physical and mental recovery from sport-related activities itself may also be important to prevent negative consequences of sport participation. The first aim of this study was therefore to investigate the role of physical recovery and mental recovery (i.e. mental detachment) from sport-activities in predicting people's physical health (i.e. injury) and mental well-being (i.e. mental energy). The second aim was to explore the mediating role of sleep between both physical and mental forms of recovery, and injury and mental energy.

Physical and mental recovery

Physical recovery primarily entails normalization of physiological functions (e.g. blood pressure, cardiac cycle) and the restoration of energy stores (e.g. blood glucose and muscle glycogen; Jeffreys, 2005). The Effort-Recovery (E-R) Model (Meijman and Mulder, 1998) specifically states that one prerequisite for optimal recovery is that the functional systems that have been taxed during work are no longer strained. Accordingly, physical recovery is

normally achieved through deliberate rest, combined with hydration and nutrition (Hauswirth and Mujika, 2013). The importance of physical recovery in sport is evident, and since it has been linked to lower injury rates (Weerapong et al., 2005), we aim to replicate this finding.

Mental recovery concerns the return to baseline levels of mental abilities (e.g. concentration, decision-making). Research among employees has shown that mental detachment from work is a powerful recovery experience underlying recovery (Sonnentag and Fritz, 2014). Translated to the sport setting, mental detachment refers to an individual's sense of being away from (the demands of) training or competition. This implies that people have stopped thinking about sport-related issues or problems (Sonntag and Fritz, 2007). Mental detachment benefits physical health and mental well-being as it helps to restore resources that were taxed during effort expenditure (Demerouti et al., 2009). It is negatively associated with vigour (Demerouti et al., 2012), anxiety (Flaxman et al., 2012) and psychological strain (Moreno-Jiménez et al., 2009). However, the role of mental detachment from sport activities in relation to health and well-being of recreational athletes has received little attention in the literature (Beckmann and Kellmann, 2004). This study includes mental energy as an indicator of mental well-being, which is characterized by the ability to concentrate well, make decisions and feeling energetic (Kellmann and Kallus, 2001).

Matching recovery

Recovery can thus be considered as a multidimensional construct (Jeffreys, 2005) and it is important to take these dimensions into account when considering relations between recovery experiences and outcomes. According to the matching-principle of the Demand-Induced Strain Compensation Recovery (DISC-R) Model (De Jonge and Dormann, 2003, 2006; De Jonge et al., 2012), the strongest effects of recovery experiences on health

outcomes will be found when these are based on identical dimensions (De Jonge and Dormann, 2006). Consequently, based on the matching-principle of the DISC-R Model and its empirical evidence (Van den Tooren et al., 2011), we expect physical recovery to be negatively related to injury. Likewise, we expect mental detachment to be positively related to mental energy. Note that although the DISC-R Model expects a stronger association between physical demands, physical recovery, and physical health, it does not a priori rule out positive associations between demands, recovery and well-being outcomes that are dissimilar (e.g. physical recovery – mental well-being, mental recovery – physical well-being). For instance, feeling physically fit likely benefits one's cognitive functioning (Hillman et al., 2008). Thus, we also hypothesized that physical recovery would be associated with higher levels of mental energy, and that higher levels of mental detachment would be associated with lower levels of injury. However, in line with the matching-principle of the DISC-R Model, we expect the relation between recovery and health and well-being indicators of the matching kind (physical recovery and injury; mental detachment and mental energy) to be stronger compared to the relation between recovery and health and well-being indicators of the non-matching kind.

The mediating role of sleep

Adequate physical recovery is consistently associated with improved sleep in clinical, general, as well as athletic populations (Beckmann and Elbe, 2015). Moreover, just one night of sleep deprivation can increase biomarkers of muscle damage (e.g. Mejrj et al., 2015; myoglobin), which increases the risk of getting injured. Therefore, we hypothesized that physical recovery will be positively related to sleep quality and negatively related to sleep deprivation. Similarly, cognitive arousal prior to sleep, resulting, for instance, from low mental detachment, has been shown to affect sleep quality and sleep loss (Cropley and Millward, 2009;

Yang et al., 2010). Furthermore, adequate sleep benefits cognitive functioning, whereas sleep deprivation has been consistently associated with reduced cognitive functioning (Fullagar et al., 2015). Hence, we hypothesized that mental detachment will be positively related to sleep quality and negatively related to sleep deprivation. In turn, we expect sleep quality to be positively related to mental energy and negatively related to injury, where we expect sleep deprivation to be positively related to injury and negatively related to mental energy. Finally, we expect both sleep quality and sleep deprivation to serve as the underlying mechanisms linking physical recovery and mental detachment to injury and mental energy (see Supplemental Figure 1).

Method

Procedure and participants

A cross-sectional survey was administered to 161 recreational athletes (96 males, 65 females, $M_{\text{age}}=27.1$, standard deviation (SD)=13.6, range: 14–68) who, on average, engaged in sports 5.3 hours a week (SD=3.4). The most often cited sports these participants engaged in were football (17%), fitness (17%), athletics (12%), cycling (9%) and tennis (4%). Moreover, the majority of the participants in this study took part in occasional competitions (20%) or scheduled competitions (33%). We included all participants who reported that they spend 30 minutes or more being physically active each day (including cycling to work, walking, engaging in sports, etc.). This is indicative of people with a healthy and active lifestyle (Haskell et al., 2007; O'Donovan et al., 2017). A total of 54 per cent of the participants engaged in physical activity between 30 and 60 minutes a day, 37% between 1 and 2 hours a day and 9% more than 2 hours a day. Prior to participant recruitment, the study received institutional ethical approval. Participants were recruited by bachelor students of Eindhoven University of Technology as part of a BA course on sport psychology.

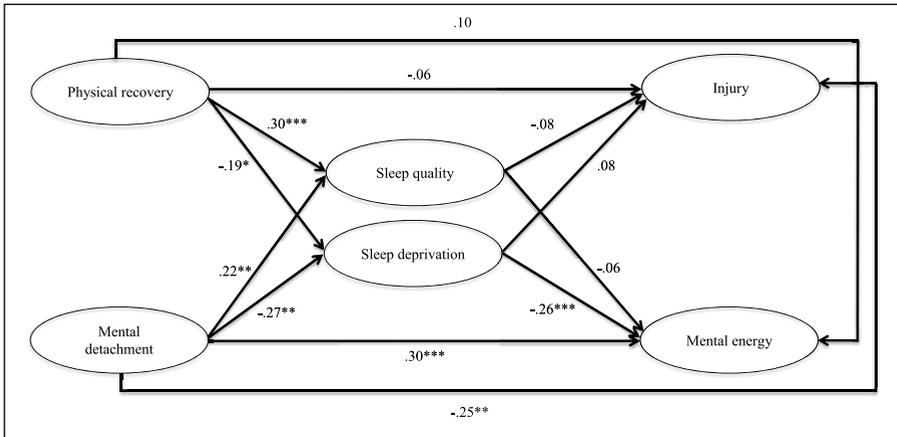


Figure 1. Structural model of the relations between physical recovery, mental detachment, sleep, injury and mental energy. Coefficients represent standardized estimates. For reasons of parsimony control variables are not displayed, as they did not affect the pattern of significant findings. * $p < .05$; ** $p < .01$; and *** $p < .001$.

Measures

The survey contained several scales and subscales of the Recovery-Stress Questionnaire for Athletes (Kellmann and Kallus, 2001; RESTQ-Sport). The RESTQ-Sport is a validated questionnaire developed to assess the amount of physical and mental stress arising from sport-related activities and to what extent people engage in recovery-enhancing strategies (Kellmann and Kallus, 2001). The RESTQ-Sport assesses what happened within the sport domain during the 3 days/nights prior to assessment and has been used among both amateur (e.g. Di Fronso et al., 2013) and elite athletes (e.g. Kellmann and Günther, 2000). Each item is rated according to its frequency on a 7-point Likert-scale ranging from 0 (never) to 6 (always). Missing values (2.6%) were replaced using mean-substitution of non-missing items from the relevant subscale in each individual case (see Graham et al., 2003).

We measured *mental detachment* as a subscale consisting of two items from the Pressure scale, namely, ‘I worried about unresolved problems’ and ‘I couldn’t switch my mind off’. All items were recoded so that higher scores reflect a higher ability to mentally detach. We measured *physical recovery* using the four

items of the Fitness scale (e.g. ‘I recovered well physically’; ‘I was in a good condition physically’; $\alpha = .73$). We measured *injury* using four items of the Injury scale (e.g. ‘Parts of my body were aching’; ‘I had muscle pain after performance’; $\alpha = .68$). We measured *mental energy* using four items of the Lack of Mental Energy scale (e.g. ‘I was unable to concentrate well’; ‘I put off making decisions’; $\alpha = .75$). All items were recoded so that higher scores reflected more perceived mental energy. *Sleep quality* was measured using four items of the Sleep Quality scale (e.g. ‘I fell asleep satisfied and relaxed’; ‘My sleep was interrupted easily’; $\alpha = .75$). The latter item was recoded so that higher scores reflected better sleep quality. *Sleep deprivation* was measured using one item: ‘I did not get enough sleep’.

Control variables

As previous research has indicated the important role of age and gender with regard to recovery and sleep (e.g. Huang et al., 2002; Sonnentag, 2003), both factors were included as control variables. Moreover, since the importance of physical recovery and mental detachment may differ as a function of load, we also included the average number of hours per week

participants engaged in sport as a control variable.

Analytical strategy

The hypothesised model was tested using a path analysis in Mplus (Muthén and Muthén, 2010; version 7.31) with maximum likelihood estimation since all variables were multinormally distributed. Paths were specified according to the proposed model (Supplemental Figure 1). Model fit was evaluated using the following model fit indices and cut-off values (Hair et al., 2010): the Comparative Fit Index (CFI; $\geq .90$), the Tucker-Lewis Index (TLI; $\geq .90$), the standardized root mean square residual (SRMR; $\leq .08$) and the root mean square error of approximation (RMSEA; $\leq .06$). Bootstrapping (1000) was applied to calculate the 95% confidence interval (CI) around the estimates of the indirect effects. Mplus can calculate the effect of multiple mediators and provides estimates and significance tests of indirect effects (Muthén, 2011).

Results

Mean values, standard deviations, Cronbach's alphas and Pearson zero-order correlations for the different variables are displayed in Table 1. The fit indices of the hypothesized model revealed a satisfactory fit of the model to the data ($\chi^2=4.36$, degrees of freedom (df)=3, $p=.23$, CFI=.99, TLI=.92, SRMR=.02, RMSEA=.05 (.00; .15)), indicating support for the hypothesised model. This model explained 16% of the variance in injury and 38% of the variance in mental energy.

As depicted in Figure 1, results from structural equation modelling showed that physical recovery was not related to injury or mental energy, whereas mental detachment was related to lower injury ($\beta=-.25$) and positively to mental energy ($\beta=.30$). Thus, an increase in mental detachment is associated with less injuries and more mental energy. These findings reject our hypotheses that physical recovery would be negatively related to injury and positively

Table 1. Mean values, standard deviations, internal consistencies, and correlations between the study variables (N = 161).

Measure	M	SD	1	2	3	4	5	6	7	8	9
1. Gender	.40	.49									
2. Age (years)	27.13	13.58	-.06								
3. Average sports training hours per week	5.29	3.36	-.11	-.23**							
4. Physical recovery (0-6)	3.48	1.14	-.16*	.18*	.18*	.82					
5. Mental detachment (0-6)	3.70	1.35	-.06	.21**	-.11	.13	.72				
6. Sleep quality (0-6)	4.00	1.17	-.10	.13	.06	.35***	.27**	.76			
7. Sleep deprivation (0-6)	2.53	1.64	-.04	-.17*	.09	-.21**	-.31***	-.48***	N/A		
8. Injury (0-6)	2.09	1.16	.08	-.17*	.22**	-.11	-.29***	-.22**	.21**	.68	
9. Mental energy (0-6)	3.74	1.10	-.02	.39***	-.18	.21**	.44***	.25**	-.43***	-.43***	.75

SD: standard deviation. Cronbach's alphas are on diagonal. Gender was coded as 0= male; 1 = female. * $p < .05$ (two-tailed); ** $p < .01$ (two-tailed); and *** $p < .001$ (two-tailed).

related to mental energy, while our hypotheses that mental detachment would be negatively related to injury and positively related to mental energy are supported. Moreover, a comparison of both beta coefficients indicated that mental detachment was more strongly related to mental energy than to injury, as would be expected based on the matching-principle of the DISC-R Model.

Physical recovery was related to both sleep quality ($\beta = .30$) and sleep deprivation ($\beta = -.19$). Feeling more physically recovered is thus associated with both better sleep quality and less sleep deprivation. Mental detachment was also related to sleep quality ($\beta = .22$) and sleep deprivation ($\beta = -.27$), indicating that more mental detachment is also associated with both better sleep and sufficient sleep. In turn, sleep quality was not related to injury or mental energy, whereas sleep deprivation was only related to mental energy ($\beta = -.26$).

Mediation analyses

To test the mediating effect of sleep deprivation between mental detachment and mental energy, we used the respective commands in Mplus (Muthén and Muthén, 2010). Results indicated that sleep deprivation partially mediated the effect of mental detachment ($\beta = .07$, $z = 2.48$, $p = .013$, 95% CI = .02–.12) on mental energy. Thus, higher mental detachment is associated with less sleep deprivation (i.e. longer sleep duration), which in turn is associated with more mental energy.

Discussion

Although sport-related activities are usually viewed as being beneficial for recovery from work-related effort, sport activities in itself are also demanding and – without adequate recovery – may lead to negative consequences such as injury or increased fatigue. Using the DISC-R Model as our explanatory theoretical framework, this study aimed to increase our understanding of both physical and mental recovery (i.e. mental detachment) as predictors of physical injury and

mental well-being among individuals regularly engaging in sport. The results showed that mental detachment was related to both physical health and mental well-being. That is, the more these recreational athletes were able to mentally detach from sport-related issues, the less they suffered from injuries and the more mental energy they reported. This study thus provides preliminary evidence that mentally distancing oneself from the demands of sport is important in preventing potential negative consequences of sport participation. Physical recovery was not related to either injury or mental energy. This was unexpected, given the widely recognized importance of physical recovery in relation to physical fatigue and injury (Weerapong et al., 2005).

As mental detachment was more strongly related to mental energy than to injury, the results provide partial support for the matching-principle in the sport domain, as proposed by the DISC-R Model (De Jonge and Dormann, 2003, 2006) and empirically validated in the work domain. Moreover, this study provides valuable insight into the role of mental recovery as a predictor of health and well-being of recreational athletes, as it is one of the first studies to include both physical and mental recovery simultaneously in a research model.

With regard to the mediating role of sleep quality and quantity, the results indicated that, in line with our expectations, mental detachment was positively related to sleep quality and negatively related to sleep deprivation. Furthermore, we found that sleep deprivation partially mediated the relation between mental detachment and mental energy. This suggests that higher levels of mental detachment are related to a more adequate amount of sleep, which in turn is related to more mental energy. Although there was no relation between physical recovery and either injury or mental energy, physical recovery was positively related to sleep quality and negatively related to sleep deprivation. Thus, taken together, these findings are in line with the idea that physical and mental recovery has a positive effect on sleep (Beckmann and Elbe, 2015; Cropley and

Millward, 2009) and that reduced sleep leads to inferior mental states (Fullagar et al., 2015).

Contrary to our expectations, we did not find a main effect of sleep quality on both injury and mental energy. This is in contrast with the notion that sleep quality is more important for recovery compared to sleep deprivation (Pilcher et al., 1997). We also did not find a main effect of sleep deprivation on injury. Research findings on the relation between sleep loss or sleep deprivation and injury are mixed at best (Fullagar et al., 2015), and some evidence even suggests that sleep deprivation may result in altered mental functioning, which may affect attention and decision-making, potentially resulting in an increase in injury risk (Nédélec et al., 2015). The findings from this study are more in line with the idea that a lack of sleep (i.e. sleep deprivation) is an important contributor to impaired health and well-being among recreational athletes (Fullagar et al., 2015; Nédélec et al., 2015).

To our knowledge, this is the first study to explicitly investigate the role of mental detachment (i.e. not thinking about sport-related activities) in relation to health and well-being among a sample of recreational athletes, using a valid theoretical framework, with a relatively large and diverse sample, including both younger and older recreational athletes engaging in a variety of sports.

Practical implications

As recreational sport participation may yield negative consequences for individual health and well-being, as well as for society at large (Shephard, 2003), our findings also have practical implications. Recreational athletes who lack adequate knowledge about training principles often rapidly accelerate their schedule and do not think about appropriate recovery (Pearce, 2002), resulting in a higher susceptibility to injury (Wilber et al., 1995) and overtraining (Meeusen et al., 2013). Training plans that are often used by recreational athletes, which are widely available and usually not adapted to the specific individual, should take into account and plan 'mental breaks' from the schedule.

Moreover, recreational athletes should be educated about proper sleep routines and how to cope with sleep problems (Bird, 2013). Mobile apps that help people practice mindfulness skills, for instance, might prove to be effective in enhancing mental recovery (Birrer et al., 2012). Mindfulness prevents individuals from dwelling on the past or worrying about the future and therefore likely promotes mental detachment (Hülshager et al., 2014). Finally, balancing different domains such as work, sports and family is a challenge for the general population as well (Guest, 2002) and substantiates the need for effective work–life balance policies (Poelmans et al., 2009) in order for people to experience optimal health and well-being across a variety of domains.

The role of mental detachment might potentially go beyond being just an effective recovery strategy, since it can also prevent people from becoming obsessed with their recreational sport. This is termed obsessive passion (Vallerand et al., 2003), which leads people to experience an uncontrollable urge to engage in an activity and ultimately results in poor health (e.g. injury; Rip et al., 2006) and well-being (e.g. burnout; Lalande et al., 2017).

Limitations and future research directions

This study is not without limitations. First, we only relied on self-report measures, which may result in an overestimation of the associations among variables due to common method variance (Podsakoff et al., 2012). Future studies could include, for example, observer-ratings or more objective indicators of health, well-being and sleep. For instance, rather than asking people about muscle pain and injuries, future studies could include data on injuries from medical archives. This being said, our study was focused on short-term consequences of recovery and associated sleep, health and well-being outcomes for only 3 days/nights. Chronic injuries usually take a much longer time period to develop. A related limitation is that we measured sleep deprivation using a single item, as

this could jeopardize construct validity. Hence, future studies could include more comprehensive measures of sleep and appropriate cut-off scores for determining sleep deprivation to further explore the role of sleep deprivation in the recovery process.

Second, the design of our study does not permit us to draw any inferences about causality since all variables were assessed in one single questionnaire in one moment in time. Although alternative models tested yielded lower fit indices, future research could aim to replicate the present findings by using, for instance, longitudinal or experimental designs.

Third, mental detachment is likely not the only form of detachment that is related to health and well-being. Future studies could investigate the effect of other forms of detachment, such as emotional detachment (i.e. putting emotions arising from sport aside) in preserving athletic well-being. As this study only focused on the physical and mental aspect of recovery, future studies could also investigate emotional recovery since it has been suggested that one's emotional state is also related to sport-specific health and well-being (Lundqvist and Kenttä, 2010).

Finally, although this study illustrates the importance of recovery for people's health and well-being, its ensuing effects on employment are still unclear. Therefore, further research might explore how (insufficient) recovery from sport-related activities affects employability and productivity. For instance, weekend warriors (Kruger et al., 2007) might deplete their physical and mental resources enormously during the weekend, causing them to feel overly tired when returning to work.

Conclusion

This study is one of the first to investigate the relations between physical and mental aspects of recovery from sport-related activities, on one hand, and physical health and mental well-being, on the other hand, among recreational athletes. Mental detachment was found to be positively related to health and well-being of

recreational athletes, providing novel and promising insights into the role of mental detachment in preventing negative consequences of sport participation. Moreover, although more detailed measurements are needed, the results suggest that sleep deprivation partially mediated the positive relationship between mental detachment and mental energy. Taken together, these results signify that careful consideration of appropriate physical and mental recovery from sport-related activities will likely benefit people's health, well-being and sleep.

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