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## **“What a Match!”: The Specific Role of Resources in the Relation Between Demands and Vigour in Elite Sport**

Yannick A. Balk\*

*University of Amsterdam, The Netherlands and Eindhoven University of  
Technology, The Netherlands*

Jan De Jonge

*Eindhoven University of Technology, The Netherlands and University of  
South Australia, Australia*

Wido G.M. Oerlemans

*Eindhoven University of Technology, The Netherlands and HumanTotalCare,  
The Netherlands*

Sabine A.E. Geurts

*Radboud University Nijmegen, The Netherlands*

The triple-match principle, as outlined by the Demand-Induced Strain Compensation (DISC) Model, states that resources are most effective when they match particular demands. The present study investigates the role of match in elite sport with regard to the relation between sport-related demands, sport-related resources, and vigour (i.e., physical strength, cognitive liveliness, and emotional energy). We hypothesised that moderating effects of resources on the relation between demands and vigour are most likely when there is a triple-match between demands, resources and vigour, followed by double-match and non-match. A cross-sectional survey study was conducted among 118 semi-professional and professional athletes (70 females, 48 males,  $M_{\text{age}} = 24.7$ ,  $SD = 6.5$ ). Physical resources moderated (i.e., strengthened) the positive relation between physical demands and physical strength, whereas emotional resources moderated (i.e., buffered) the negative relation between emotional demands and emotional energy. Moderating effects of sport-related resources on the relation between sport-related demands and vigour occurred more often when there was a triple-match compared to when there was less match or no match at all. These findings indicate that, also in the

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\* Address for correspondence: Yannick Balk, Department of Work and Organizational Psychology, University of Amsterdam, PO Box 15919, 1001 NK, Amsterdam, The Netherlands. Email: y.a.balk@uva.nl.

domain of elite sport, resources do not randomly moderate the relation between demands and well-being. Implications and limitations of the study are discussed.

The professional lives of many elite (i.e., semi-professional and professional) athletes have evolved into work-like endeavours (Donnelly, 2016). For instance, elite athletes spend a substantial amount of time and effort on sport and sport-related activities, and are rewarded for their performance (Rigauer, 1981). Moreover, for (semi-)professional athletes sport is their 'job'. In sport science there has been a tendency to focus on the role of individual factors (e.g., physical strength, deliberate practice, mental toughness) in determining sport success—a belief that has been labelled the “myth of individualism” by Wagstaff (2017). However, elite athletes do not operate in a vacuum, but rather in a highly complex social and organisational environment (Hardy, Jones, & Gould, 1996). Hence, similar processes occurring in the workplace may take place in the domain of elite sport as well. Therefore, scholars have started to emphasise the importance of exploring the work and organisational context in which elite sport performers operate (e.g., Fletcher & Wagstaff, 2009). In doing so, theoretical models that have been developed within the context of work have the potential to advance our understanding of health, well-being, and performance in elite athletic populations (DeFreese & Smith, 2013).

Sport organisations impose a variety of physical, cognitive, and emotional demands on elite athletes, but also seek to provide adequate resources for athletes to deal with these demands. However, few studies have addressed the specific role of resources in elite sport. For that very reason, the current study aims to investigate the role of 'job' resources in sport in the relation between 'job' demands in sport and vigour among elite athletes. Vigour can be considered a multidimensional construct representing “individuals' feelings that they possess physical strength, emotional energy and cognitive liveliness” (Shirom, 2003, p. 136), and is positively associated with athletic performance (Beedie, Terry, & Lane, 2000).

## Specific Demands and Resources in Elite Sport

Different theoretical models in the domain of work stress and performance, such as the Demand-Control (DC) Model (Karasek, 1979) and the Job Demands-Resources (JD-R) Model (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001), have tried to explain how occupational stress reactions and performance outcomes can be explained by the interplay between two main job characteristics: job demands and job resources. Job demands can be defined as those properties of the work setting that require immediate

or sustained physical, cognitive, and/or emotional effort. In contrast, job resources can be broadly conceptualised as job-related assets that can be employed when an employee has to deal with demands at work (De Jonge & Dormann, 2017).

In an attempt to further increase our understanding of the interplay between job demands and job resources, De Jonge and Dormann (2003, 2006, 2017) proposed another theoretical framework, the Demand-Induced Strain Compensation (DISC) Model. The DISC Model generally assumes that specific combinations of high job demands and low job resources will increase the risk of poor health, well-being, and performance. Moreover, according to the model's *compensation principle*, adverse effects of high demands on health, well-being, and performance can be counteracted if people have sufficient resources to deal with highly demanding tasks (i.e., stress-buffering mechanism). Second, the *balance principle* of the DISC Model proposes that a balance between high demands and high resources can increase optimal learning, growth, creativity, and performance (i.e., activation-enhancing mechanism). Thus, when high demands are coupled with sufficient resources they can be associated with positive outcomes (De Jonge, Demerouti, & Dormann, 2014). Most importantly, however, the DISC Model proposes that interactions (i.e., stress-buffering or activation-enhancing effects) between job demands and job resources largely depend on the so-called "match" or "fit" between specific types of job demands and job resources (De Jonge & Dormann, 2003, 2006). This idea led to two key principles of the DISC Model: (1) the multidimensionality principle, and (2) the triple-match principle.

First, the multidimensionality principle of the model proposes that demands, resources, and outcomes each consist of a predominantly physical, cognitive, or emotional element (De Jonge & Dormann, 2003, 2006). This principle has been empirically justified in different domains such as health care, technology, education, industry, and services like police (cf. Van den Tooren, De Jonge, & Dormann, 2011), and more recently, also in sport (Balk, De Jonge, Oerlemans, Geurts, Fletcher, & Dormann, 2018). Taking this principle to the sport domain, *physical demands* are those demands primarily associated with the muscular-skeletal system (i.e., sensorimotor and physical aspects of sport behaviour). High physical demands are frequently an innate aspect of engaging in sport. Without stressing the body physically, athletes will likely not develop and maximise their potential for peak performance. That is, tolerable physical demands allow athletes to push themselves further physically by increasing their strength and stamina. In contrast, high physical demands coupled with low resources may lead to negative outcomes such as overtraining, burnout (Raedeke & Smith, 2004; Smith, 1986) and injury (Andersen & Williams, 1988). Second, *cognitive demands* impinge primarily on information processing and complex decision-making (e.g., Hanton,

Fletcher, & Coughlan, 2005). For instance, athletes often have to work precisely and concentrated, and need to retrieve previously stored information about tactics and opponents. Lastly, *emotional demands* are mainly concerned with the effort needed to deal with emotions such as disappointment about one's performance or interpersonal conflict. Like high physical demands, high cognitive and emotional demands in sport have been linked to negative consequences, such as overtraining (e.g., Kuipers & Keizer, 1988) and reduced motivation (Tabei, Fletcher, & Goodger, 2012).

Similar to demands, sport-related resources are also considered to consist of a primarily physical, cognitive, or emotional component (Balk et al., 2018; De Jonge & Dormann, 2006). First, *physical resources* are primarily focused on the opportunity to regulate physical exertion, such as being able to take a physical break or to divide one's training load according to one's current physical capacity. Second, *cognitive resources* are primarily associated with control and informational support. This often comes in the form of the opportunity to determine a variety of training methods, or when athletes have access to knowledge (e.g., through meetings or clinics) to solve challenges. Lastly, *emotional resources* mainly concern the opportunity to freely express emotions or receive emotional support from others (e.g., from a teammate or a coach). Resources by themselves foster growth, learning, and development (Demerouti et al., 2001). However, in addition to having a direct positive effect on athletic health, well-being, and performance, adequate resources can also moderate the impact of high demands on athletes' well-being. Specifically, resources can reduce the perception of demands as stressful or can reduce (stress) reactions associated with specific demands (De Jonge et al., 2014). Both the direct as well as the moderating effect of resources in sport was found by Rees and Hardy (2004), who showed that emotional support directly reduced feeling flat (a negative performance state), but also mitigated the effect of competition pressure on feeling flat.

The second main principle of the DISC Model, the triple-match principle (TMP), pertains to the particular fit between demands and resources as well as outcomes. Specifically, the TMP proposes that the strongest, interactive relations between demands and resources are observed *when* demands, resources, and outcomes are all based on qualitatively identical dimensions. This implies that in sport, for example, emotional support from teammates is most likely to moderate the relation between emotional demands (e.g., an angry and highly frustrated coach) and emotional outcomes (e.g., feelings of emotional exhaustion). So, the TMP suggests not only that demands and resources should match, but also that both demands and resources should match outcomes.

Homeostatic regulation processes are the theoretical basis for the TMP (De Jonge, Dormann & Van den Tooren, 2008; Van den Tooren & De Jonge, 2010). The function of homeostatic regulation processes is to maintain certain critical

parameters within a bounded range, which can be accomplished through the activation of particular resources. In the area of immune functioning, for instance, homeostatic regulation processes are known to cause an activation of internal resources (e.g., T and B cells) when the demands imposed on the human body exceed a certain level (e.g., a virus infection). Through evolutionary processes, the release of functional, matching resources is more likely than the release of dysfunctional, non-matching resources (Lekander, 2002). If we use functional homeostatic regulation processes as a metaphor for athlete self-regulation (cf. Vancouver, 2000), it follows that athlete self-regulation processes may generally cause an activation of functional, matching resources to regulate particular demands (cf. Pomaki & Maes, 2002). In other words, when athletes are faced with a particular type of demand, they will in the first place opt for corresponding types of resources.

Accordingly, the TMP proposes that a match between emotional resources and emotional demands is more functional compared to, for example, an interplay between cognitive resources and emotional demands (De Jonge & Dormann, 2006). However, less or non-matching resources are not dysfunctional by definition (De Jonge & Dormann, 2006; Van den Tooren & De Jonge, 2010). If matching resources are not available or depleted, athletes may activate less or non-matching resources instead. This idea was supported in a vignette study by Van den Tooren and De Jonge (2010), which showed that employees who are faced with a particular type of job demand may take advantage of both matching and non-matching job resources. Therefore, if athletes believe that matching resources are not available in a corresponding demanding situation, they may opt to employ less functional resources that do not correspond to specific demands but might still have a buffering effect (Vohs, Baumeister, & Ciarocco, 2005). This occurs when, for instance, an athlete looks for information about how to deal with disappointment when emotional support from a coach or teammate is not available.

According to the typology of De Jonge and Dormann's (2003, 2006, 2017) DISC Model, different degrees of match can be identified between demands, resources, and the outcome under study. First, a *triple-match* occurs when there is a match between the corresponding types of demands, resources, as well as the outcome (e.g., physical resources may moderate the impact of physical demands on physical strength). Second, a *double-match of common kind* occurs when there is correspondence between demands and resources, regardless of the type of outcome (e.g., emotional resources may counteract the effect of emotional demands on cognitive liveliness). Hence, double-match of common kind is only concerned with the correspondence between specific demands and resources. However, Frese (1999) argued that the outcome component should be considered as a source of match or non-match in the demands–resources–outcomes interaction as well. This is because it is expected that cognitive

demands or cognitive resources will more likely impact cognitive functioning as compared to physical functioning (De Jonge & Dormann, 2006). Hence, when there is a match between either demands or resources on the one hand, and outcome on the other, this is termed a *double match of extended kind*. For instance, emotional resources may counteract the effect of high cognitive demands on cognitive liveliness. Alternatively, emotional resources may also counteract the effect of cognitive demands on emotional energy. In these instances, there is a correspondence between either demands or resources and outcome, as opposed to a direct fit between demands and resources, irrespective of the outcome. Finally, De Jonge and Dormann (2006) identified *non-match* when there is no correspondence between any type of demands, resources, and outcome (e.g., cognitive resources may counteract the effect of physical demands on emotional energy). Accordingly, the DISC Model predicts that the likelihood of interaction effects between demands and resources in the prediction of health, well-being, and performance increases as the degree of match increases (i.e., from non-match, via double-match, to triple-match).

## The Present Study

Research conducted in a variety of work domains has shown that matching specific resources with demands is important in relation to employee health, well-being, and performance (Van den Tooren et al., 2011). However, although similar processes seem to be at play in sport (e.g., Rees & Hardy, 2004), the role of *specific* resources has yet to be thoroughly investigated in the performance domain of elite sport. Identifying how specific sport-related resources interact with sport-related demands, and more importantly, *when* they are most beneficial, is valuable as it may provide clues on how to maintain or improve athletes' health, well-being, and performance. Moreover, while a variety of studies have found support for the DISC Model's compensation principle, studies regarding the balance principle are scarce. Therefore, guided by the DISC Model as our theoretical framework, the present study tested the triple-match principle with regard to sport-related demands, sport-related resources, and vigour (i.e., physical strength, cognitive liveliness, and emotional energy; Shirom, 2003) among elite athletes. The present study adds to the existing literature by testing and extending the DISC Model's propositions (De Jonge & Dormann, 2003, 2006, 2017) to another occupational domain, namely that of elite sport, thereby further discerning *for whom* particular resources are important.

Physical strength is an essential performance-related outcome for the majority of elite athletes. Thus, elite athletes seek to *maximise* their physical strength, at least to a certain extent, by taxing themselves physically. Elite athletes are often also provided with physical resources to manage physical demands, such as being able to take a physical break, having the opportunity to manage one's

training load in line with one's current physical capacity, or technical equipment to accomplish strenuous tasks. When there is a balance between sport-related physical demands and physical resources, physical resources can strengthen the effect of physical demands, which is likely reflected in higher physical strength. The activation-enhancing combination of high physical demands and high physical resources might be particularly relevant in professions such as elite sport. Therefore, we expected physical demands to be positively related to physical strength among elite athletes, leading to the following hypothesis:

*Hypothesis 1:* Higher physical demands are associated with higher physical strength, and this relation is moderated by matching physical resources. More specifically, we expect that the positive relation between physical demands and physical strength is strengthened by physical resources.

Cognitive liveliness and emotional energy are mental capacities that can be drained when dealing with cognitive and emotional demands. Hence, elite athletes seek to *minimise* the depletion of these capacities. Therefore, for cognitive and emotional demands, we expected a negative relation with cognitive liveliness and emotional energy among elite athletes, respectively, leading to the following hypotheses:

*Hypothesis 2:* Higher cognitive demands are associated with lower cognitive liveliness, and this relation is moderated by matching cognitive resources. More specifically, we expect that the negative relation between cognitive demands and cognitive liveliness is weakened by cognitive resources.

*Hypothesis 3:* Higher emotional demands are associated with lower emotional energy, and this relation is moderated by matching emotional resources. More specifically, we expect that the negative relation between emotional demands and emotional energy is weakened by emotional resources.

In line with the propositions of the DISC Model, we expected that moderating effects of resources on the relation between demands and vigour are most likely to be found when there is a triple-match between demands, resources, and vigour, followed by less-matching interactions such as double-match and non-match. This resulted in the following hypothesis:

*Hypothesis 4:* Triple-match interactions between demands, resources, and outcomes are most likely to occur, followed by double-match and non-match interactions, respectively.

Lastly, we compare ratings of demands and resources in elite sport to two previous studies employing the DISC framework in other occupations. The first study, by Bova, De Jonge, and Guglielmi (2013), included 1,629

employees from the human service sector. The second study, by Van de Ven and Vlerick (2013), included 1,533 employees from the technology sector. The comparison with descriptives from previous studies serves two purposes. First, it allows for an assessment of the quality of the current study by comparing, for instance, the standard deviations of the current sample to studies with larger sample sizes. Second, it is informative to compare the domain of elite sport to other occupational domains. Although these comparisons are explorative, we expected that both physical demands and cognitive demands in elite sport would be higher compared to human service work and technology as they can be considered innate aspects of training and competition. For the other types of sport-related demands and resources we did not have specific expectations.

## METHOD

### Design

An online cross-sectional survey study was conducted.

### Procedure and Participants

After receiving institutional ethical approval, athletes were approached through different organisations in The Netherlands, Germany, and the United Kingdom. They were asked to fill out an online survey consisting of questions related to demographic characteristics, demands, resources, and vigour. The final sample consisted of 118 elite athletes (70 females, 48 males,  $M_{\text{age}} = 24.67$ ,  $SD = 6.50$ ) from The Netherlands ( $n = 84$ ), Germany ( $n = 28$ ), the United Kingdom ( $n = 5$ ), and Poland ( $n = 1$ ). Athletes were active in either team or individual sports (48% individual, 52% team) and athletic skill level was categorised as semi-professional ( $n = 53$ ) and professional ( $n = 65$ ). On average, athletes generally spent 18.6 hours per week ( $SD = 9.0$ ) training and competing.

### Measures

Demands and resources in sport were measured using an adapted version of the Demand-Induced Strain Compensation Questionnaire (DISQ; De Jonge, Dormann, Van Vegchel, Von Nordheim, Dollard, Cotton, & Van den Tooren, 2007), which is available in different languages such as Dutch, German, and English. This adapted version is called DISQ-SPORT, and its psychometric properties have recently been published elsewhere (Balk et al., 2018). The sport-related demands scale consisted of 12 items measuring *physical demands* (4 items; e.g., “In my sport, I have to expend a lot of physical effort”), *cognitive demands* (4 items; e.g., “In my sport, I have to

remember many things simultaneously”), and *emotional demands* (4 items; e.g., “In my sport, I have to deal with a negative atmosphere within the group I belong to”). The sport-related resources scale consisted of 9 items measuring *physical resources* (3 items; e.g., “In my sport, I have the opportunity to take a physical break when things get physically strenuous”), *cognitive resources* (3 items; e.g., “In my sport, I have the opportunity to determine my own training method(s)”), and *emotional resources* (3 items; e.g., “In my sport, I can find a listening ear in others (e.g., teammates or coaches) when an upsetting situation has occurred”). For both demands and resources, athletes indicated to what extent their sport requires them to deal with the three types of demands and to what extent they had access to the three types of resources. All items were scored on a 5-point Likert scale, ranging from 1 (*never*) to 5 (*(almost) always*).

Vigour was assessed using the Shirom-Melamed Vigor Measure (Shirom, 2003) that was adapted to the sport setting for the present study. The measure includes a 5-item subscale of *physical strength* (e.g., “I feel I have physical strength”), a 5-item subscale of *cognitive liveliness* (e.g., “I feel I can think rapidly”), and a 4-item subscale of *emotional energy* (e.g., “I feel capable of being sympathetic to others (e.g., teammates or coaches)”). Athletes indicated to what extent they experienced each of the statements using a 7-point, frequency-based Likert scale, ranging from 1 (*not at all*) to 7 (*a lot*).

## Data Analysis

Data were analysed using a series of hierarchical regression analyses in SPSS 24.0. Independent variables involved in interactions were mean-centred in advance to avoid multicollinearity (Aiken & West, 1991). In the first step (Model 1), we entered demographic characteristics such as gender (coded: 1 = male, 2 = female) and age (continuous variable) as control variables. Moreover, different phases before and during a competitive season are often associated with different training loads, a process called training periodisation (Issurin, 2010). Hence, the perception of demands and resources might differ depending on which phase of the competitive season an elite athlete is at. Therefore, we also analysed our data with phase of training periodisation as a single additional control variable (1 = rehabilitation phase, 2 = recovery phase, 3 = general preparation phase, 4 = specific preparation phase, 5 = pre-competition phase, and 6 = competition phase).<sup>1</sup>

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<sup>1</sup> We also analysed our data with phase of training periodisation as a series of dummy variables (with rehabilitation phase as the reference category). As this did not affect the pattern of significant findings, we omitted them from the analyses here for reasons of parsimony and power (i.e., ratio of cases to predictor variables). These additional analyses are available from the first author upon request.

In the second step (Model 2), the centred main terms of characteristics of the sport environment were included (i.e., physical, cognitive, and emotional demands and resources). Finally, in the third step (Model 3), the moderating terms were added to the model using multiplicative terms of demands and resources (e.g., emotional demands  $\times$  emotional resources).

Due to the large number of possible interaction effects and potential collinearity problems, we decided to split the analysis according to our theoretical assumptions, which is in line with previous research (e.g., Chrisopoulos, Dollard, Winefield, & Dormann, 2010; De Jonge & Dormann, 2006; Van de Ven & Vlerick, 2013). Consequently, two hierarchical regression analyses were conducted for each dimension of vigour. The first analysis included all triple-match interactions (e.g., emotional demands  $\times$  emotional resources on emotional energy). We also included the double-match interactions of common kind (e.g., emotional demands  $\times$  emotional detachment on physical strength). As a result, in the first analysis we simultaneously tested three triple matches and six double matches of common kind (i.e., 9 out of 27 possible interaction effects), which are closest to the theoretical assumptions. The second analysis of the data included the remaining double-match of extended kind (e.g., emotional demands  $\times$  cognitive detachment on emotional energy). We also included the non-matching interactions (e.g., emotional demands  $\times$  cognitive resources on physical strength). As a result, in the second analysis we simultaneously tested 12 double matches of extended kind and 6 non-matches (i.e., 18 out of 27 possible interaction effects).

## RESULTS

Means and standard deviations are displayed in Table 1, which also displays the results of ANOVA comparisons with demands and resources scores in other work domains. As expected, results showed that ratings of physical and cognitive demands in sport were significantly higher compared to human service work and technology. In contrast, emotional demands were rated significantly lower in sport compared to both human service work and technology. With regard to resources, ratings of both physical and cognitive resources in sport were significantly lower in the sport domain compared to human service work and technology, whereas emotional resources in sport were rated significantly higher compared to both other work domains. Pearson correlations between the study variables and Cronbach's alphas for the measures are presented in Table 2. As can be seen, physical demands were positively related to physical strength, whereas emotional demands were negatively related to emotional energy. Emotional resources were positively related to all dimensions of vigour. Table 3 displays the regression results obtained from simultaneously testing three possible triple-match

TABLE 1  
Means, Standard Deviations, and ANOVA Comparisons with Previous Studies

	1) Current study ( <i>N</i> = 118) <i>Mean (SD)</i>	2) Bova et al. (2013) ( <i>N</i> = 1629) <i>Mean (SD)</i>	3) Van de Ven & Vlerick (2013) ( <i>N</i> = 1533) <i>Mean (SD)</i>	<i>df (between)</i>	<i>F</i>	<i>Post hoc</i>
1. Age	24.67 (6.50)	40.96 (11.09)	43.18 (10.14)			
2. Gender	1.59 (0.49)	N/A	N/A			
3. Phase in periodisation	3.11 (1.72)	N/A	N/A			
4. Physical demands	3.30 (0.77)	2.17 (1.06)	2.87 (1.16)	2	189.54	1>2, 1>3, 2<3
5. Cognitive demands	4.07 (0.62)	3.67 (0.64)	3.67 (0.64)	2	22.27	1>2, 1>3
6. Emotional demands	2.36 (0.59)	2.69 (0.72)	2.89 (0.72)	2	51.07	1<2, 1<3, 2<3
7. Physical resources	3.14 (0.85)	3.56 (0.91)	3.45 (0.84)	2	16.20	1<2, 1<3, 2>3
8. Cognitive resources	2.76 (0.83)	3.52 (0.66)	3.24 (0.61)	2	128.02	1<2, 1<3, 2>3
9. Emotional resources	3.80 (0.73)	3.60 (0.74)	2.95 (0.76)	2	324.24	1>2, 1>3, 2>3
10. Physical strength	5.48 (0.96)	N/A	N/A			
11. Cognitive liveliness	5.14 (1.05)	N/A	N/A			
12. Emotional energy	5.76 (0.85)	N/A	N/A			

TABLE 2  
Correlations Between the Study Variables ( $N = 118$ )

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	–											
2. Gender	.01	–										
3. Phase in periodisation	–.25	–.11	–									
4. Physical demands	–.17	–.07	–.07	.65								
5. Cognitive demands	.01	–.24	–.24	.02	.71							
6. Emotional demands	.00	–.02	.02	.22	.07	.67						
7. Physical resources	.06	–.06	–.06	–.09	.18	–.05	.62					
8. Cognitive resources	.27	–.11	–.11	–.23	.20	.03	.61	.68				
9. Emotional resources	–.08	–.11	.11	–.02	–.06	–.13	.05	.01	.81			
10. Physical strength	–.05	.07	–.02	.26	–.10	–.17	.06	–.05	.33	.89		
11. Cognitive liveliness	.12	.04	.06	–.04	.04	–.16	.13	.11	.27	.60	.84	
12. Emotional energy	.02	.04	–.08	.07	–.02	–.22	–.01	–.02	.18	.14	.31	.82

Note: Cronbach's alphas are on the diagonal. All correlations  $\geq .18$  are significant at  $p < .05$ ; all correlations  $\geq .27$  are significant at  $p < .01$ ; all correlations  $\geq .60$  are significant at  $p < .001$ .



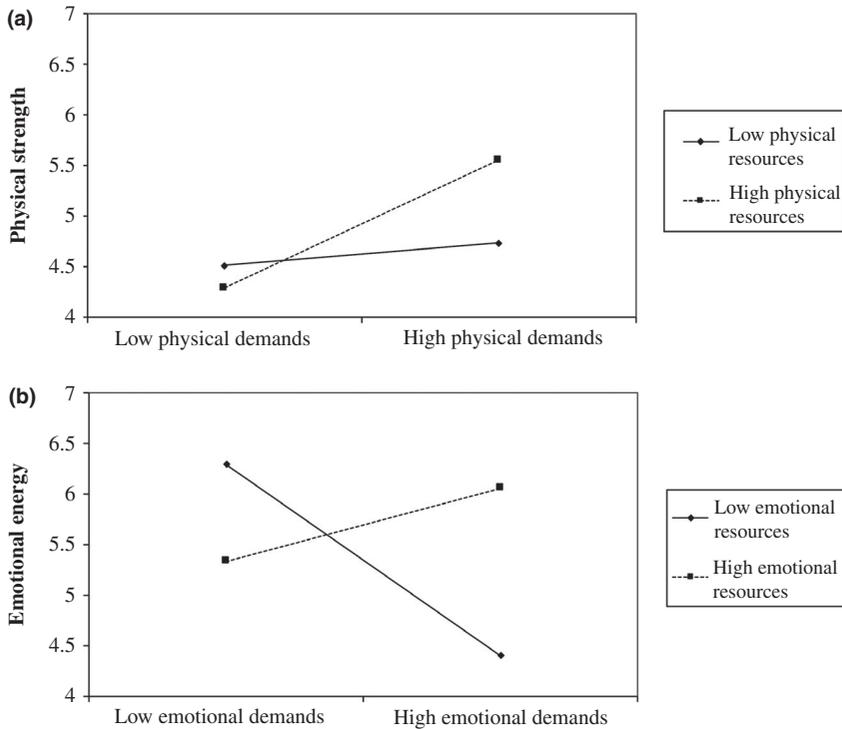


FIGURE 1. Triple-match interactions for physical strength (a) and emotional energy (b).

effects and six possible double-matches of common kind. In the first analytical step, 2 out of 9 possible interactions were significant, both representing triple-match interactions. The triple-match interaction between physical demands, physical resources, and physical strength was significant. To get a grasp of the nature of all interaction effects, we plotted the slopes in accordance with recommendations by Aiken and West (1991), and performed simple slope tests (Preacher, Curran, & Bauer, 2006). As displayed in Figure 1a, simple slope tests revealed that higher physical demands were related to higher physical strength when physical resources were high (+1 SD;  $t = 3.98, p < .001$ ), but not when physical resources were low (-1 SD;  $t = 0.61, p = .546$ ). This provides support for our first hypothesis. No triple-match interaction between cognitive demands, cognitive resources, and cognitive liveliness emerged. Hence, our second hypothesis was not confirmed. The triple-match interaction between emotional demands, emotional resources, and emotional energy was significant. As displayed in Figure 1b, simple

**TABLE 4**  
**Regression Results for Physical Strength, Cognitive Liveliness, and Emotional Energy with Double Match of Extended Kind (De) and Non-Matching (N) Interactions**

	<i>Physical strength</i>		<i>Cognitive liveliness</i>		<i>Emotional energy</i>	
	<i>B (SE)</i>		<i>B (SE)</i>		<i>B (SE)</i>	
<b>Model 1: Control variables (<math>\Delta R^2</math>)</b>						
Age	.01		.02		.01	
Gender <sup>a</sup>	.02 (.02)		.03 (.02)		.00 (.02)	
	.03 (.18)		-.01 (.21)		-.03 (.17)	
Phase in periodisation	.10 (.06)		.15 (.08)		-.03 (.06)	
	.23		.13		.09	
<b>Model 2: Demands and resources (<math>\Delta R^2</math>)</b>						
Physical demands	.30* (.13)		-.01 (.15)		.08 (.12)	
Cognitive demands	-.11 (.14)		.03 (.17)		.13 (.14)	
Emotional demands	-.43** (.14)		-.36* (.17)		-.33* (.14)	
Physical resources	.11 (.12)		.09 (.14)		-.07 (.12)	
Cognitive resources	.16 (.14)		.21 (.17)		.05 (.14)	
Emotional resources	.32** (.12)		.41** (.14)		.26* (.12)	
	.14		.10		.14	
<b>Model 3: Two-way interactions (<math>\Delta R^2</math>)</b>						
Physical demands × Cognitive resources	.31* (.13)	<b>De</b>	-.04 (.16)		.27* (.13)	<b>N</b>
Physical demands × Emotional resources	-.20 (.12)	<b>De</b>	-.03 (.15)		.31* (.12)	<b>De</b>
Cognitive demands × Physical resources	-.22 (.15)	<b>De</b>	-.27 (.17)		-.08 (.14)	<b>N</b>
Cognitive demands × Emotional resources	-.03 (.18)	<b>N</b>	-.20 (.21)		-.36* (.17)	<b>De</b>
Emotional demands × Physical resources	.18 (.21)	<b>De</b>	.48 (.25)		.07 (.20)	<b>De</b>
Emotional demands × Cognitive resources	.31 (.23)	<b>N</b>	.17 (.27)		-.02 (.22)	<b>De</b>
Best-fitting model	$R^2 = .38$		$R^2 = .25$		$R^2 = .24$	
	F(15, 95) = 3.85		F(15, 95) = 2.14		F(15, 95) = 2.02	
	p < .01 (Model 3)		p < .05 (Model 3)		p < .05 (Model 3)	
	Adjusted $R^2 = .28$		Adjusted $R^2 = .13$		Adjusted $R^2 = .12$	

*Note:* Unstandardised coefficients are shown. <sup>a</sup>Gender was coded as 1 = male, 2 = female. \* $p < .05$  (two-tailed), \*\* $p < .01$  (two-tailed).

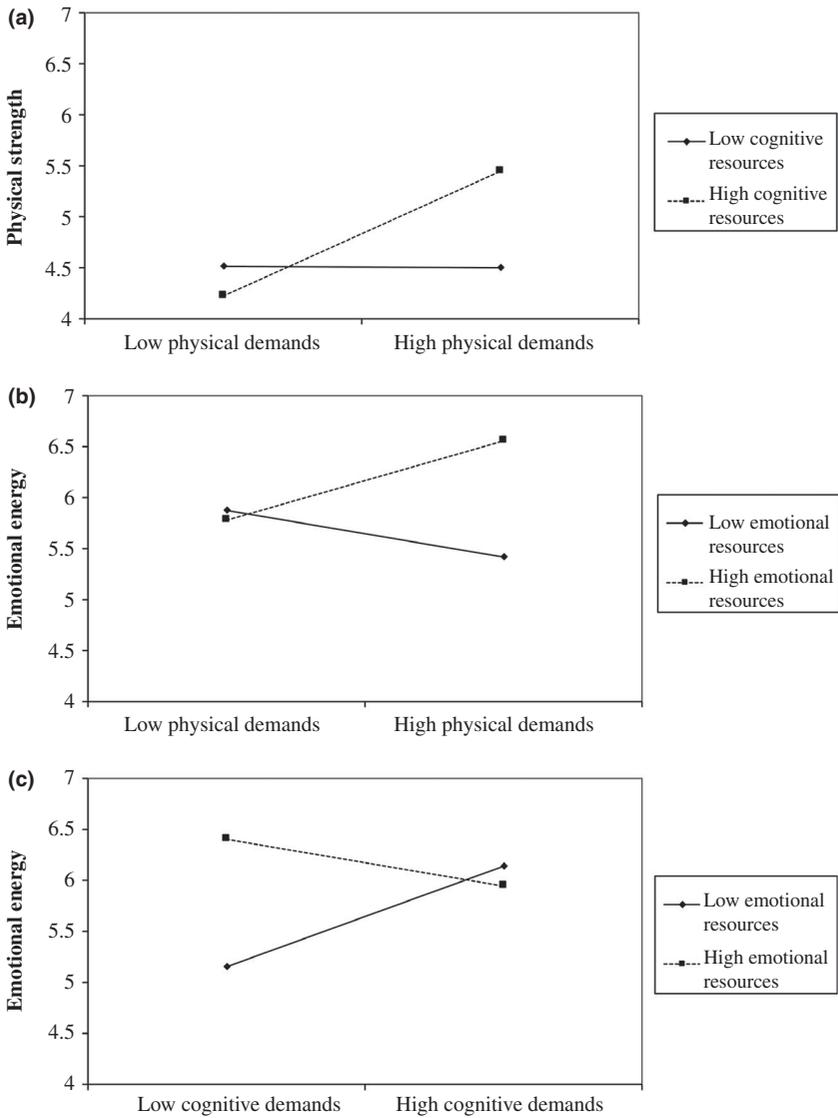


FIGURE 2. Double-match interactions of extended kind for physical strength (a) and emotional energy (b-c).

slope tests revealed that higher emotional demands were related to lower emotional energy when emotional resources were low ( $-1$  SD;  $t = -4.01, p < .001$ ), but not when emotional resources were high ( $+1$  SD;  $t = 1.39, p = .167$ ). Therefore, our third hypothesis that emotional resources will weaken the

negative relation between emotional demands and emotional energy was supported. Altogether, none of the double-match interactions of common kind were significant.

Table 4 shows the regression results extracted from testing the remaining twelve possible double-matches of extended kind and the six possible non-matches. Taken together, four significant interaction effects were found. Three of these interaction effects represent double-matches of extended kind, which are graphically represented in Figures 2a–c. First, the interaction between physical demands and cognitive resources predicted physical strength (Figure 2a). Simple slope tests revealed that higher physical demands were related to higher physical strength when cognitive resources were high (+1 SD;  $t = 4.21, p < .001$ ), but not when cognitive resources were low (−1 SD;  $t = -0.05, p = .962$ ). Second, the interaction between physical demands and emotional resources (Figure 2b) predicted emotional energy. Simple slope tests revealed that higher physical demands were related to higher emotional energy when emotional resources were high (+1 SD;  $t = 2.25, p = .026$ ), but not when emotional resources were low (−1 SD;  $t = -1.43, p = .157$ ). Third, the interaction between cognitive demands and emotional resources (Figure 2c) predicted emotional energy. However, the shape of this interaction effect was against theoretical predictions as the plot shows a reversed effect of emotional resources. More specifically, higher cognitive demands were related to higher emotional energy when emotional resources were low (−1 SD;  $t = 2.09, p = .039$ ), but not when emotional resources were high (+1 SD; simple slope test:  $t = -1.11, p = .270$ ). Finally, we detected only one out of six non-matching interactions (i.e., between physical demands and cognitive resources in the prediction of emotional energy, see Figure 3). Simple slope tests revealed that higher physical demands were related to higher emotional energy when cognitive resources were high (+1 SD; test:  $t = 2.48, p = .015$ ), but not when cognitive resources were low (−1 SD;  $t = -0.91, p = .367$ ).

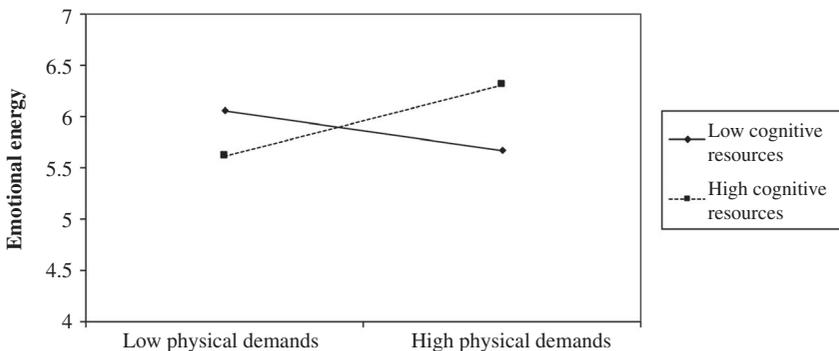


FIGURE 3. Non-matching interaction for emotional energy.

TABLE 5  
Summary of Analyses

<i>Type of interaction</i>	<i>Valid</i>	<i>Reversed</i>	<i>Tested</i>	<i>Ratio valid interaction/ interactions tested</i>
Triple match	2	0	3	66.7%
Double match (both kinds)	2	1	18	11.1%
Non-match	1	0	6	16.7%

Finally, in line with previous DISC research, we investigated whether the likelihood of finding moderating effects of resources in sport is related to the degree of match. Taken together, we found 2 out of 3 tested triple-match interactions (66.7%), 2 out of 18 tested double-match interactions (11.1%), and 1 out of 6 tested non-match interactions (16.7%; see Table 5). These numbers largely support our fourth hypothesis that triple-match interactions are more likely to be found, compared to less-matching (i.e., double-match) and non-match interactions.

## DISCUSSION

Guided by the DISC Model (De Jonge & Dormann, 2003, 2006, 2017) as our theoretical framework, the aim of the current study was to investigate the specific role of sport-related resources in the relation between sport-related demands and vigour in the unique occupational domain of elite sport. The triple-match principle (TMP) of the DISC Model assumes that the strongest, interactive relations between demands and resources will be observed when there is a match between corresponding types of demands, resources, as well as the outcomes under study. In line with our expectations, moderating effects of sport-related resources on the relation between sport-related demands and vigour occurred more often when there was a triple-match compared to when there was less match or no match at all. These findings shed more light on *why* and *when* sport-related resources are most adequate for elite athletes. Based on functional self-regulation theories, athletes will look for functional sport-related resources to mitigate the adverse effects of (high) sport-related demands. This implies that resources in sport are most beneficial when they correspond to specific demands. Furthermore, since we found support for the triple-match principle among a relatively small sample of elite athletes, we believe that the present findings underscore the applicability and strength of the DISC Model for investigating the role

of resources in relation to stress and well-being in different occupational domains.

## Theoretical and Practical Implications

The present findings have several theoretical and practical implications. Sport-related physical resources moderated the relation between sport-related physical demands and physical strength. In line with our expectations based on the DISC Model's balance principle, the combination of high physical demands and high resources in sport showed a strengthening effect on physical strength. Thus, when athletes have the opportunity to match the physical demands they face with adequate physical resources, such as exertion management opportunities, equipment, and the opportunity to decide one's posture, their physical strength will likely increase. This is crucial in sport as athletes seek to improve capacities such as strength, speed, and endurance by taxing their bodies physically.

An interesting finding is that the double-match interaction between physical demands and cognitive resources showed that cognitive resources also moderated (i.e., strengthened) the positive relation between physical demands and physical strength. Cognitive resources are primarily associated with control and informational support and, therefore, could be employed to deal with physical demands such that it allows for optimal effects. For instance, the opportunity to determine training intensity and training methods, as well as having access to information, can have an impact on the physical effort that athletes need to utilise. If certain physical resources are unavailable or inadequate, athletes may opt for less matching resources, such as cognitive resources, to deal with physical demands (De Jonge & Dormann, 2006). Another explanation why athletes may take advantage of less matching or even non-matching resources is that they believe that the mere activation of matching resources is not sufficiently powerful to regulate a corresponding type of demand. If this occasion arises, athletes may activate additional resources to compensate for the lack of fit between capacity and demand (cf. Hobfoll, 2001). In other words, combinations of job resources are sometimes more effective than one singular type. All in all, the present findings suggest that increasing cognitive resources next to physical resources could benefit elite athletes' physical capabilities as well.

As developing capacities such as physical strength is often the foundation of improving athletes' physical capacities and performance, coaches and other staff members should aim to also provide control and informational support. However, cognitive resources were rated lowest of all the sport-related resources and also lower when compared to other occupational domains. An explanation for this finding could be that, in elite sport, coaches primarily

determine the method and intensity of sport-related activities. That is, the elite sport setting does not necessarily promote autonomy or control due to its rigid nature (e.g., inflexible schedules for training and competition) and elite coaches' responsibility for training programmes and competitive strategies (Conroy & Coatsworth, 2007). Although some of the complexity of sport tasks can be outsourced to coaches and other staff members, elite athletes still need to invest effort to deal with cognitive demands. The relatively low level of cognitive resources could also explain why we did not find a triple-match interaction between cognitive demands and cognitive resources in the prediction of cognitive liveliness. As cognitive demands were rated highest of all the sport-related demands, athletes might look for alternative sport-related resources.

While a variety of studies have found support for the DISC Model's compensation principle, empirical evidence for the balance principle of the model is scarce. For instance, Van de Ven, Vlerick, and De Jonge (2008) found a positive relation between cognitive job demands and professional efficacy in a sample of informatics. This positive relation was strengthened by the availability of cognitive job resources. Similar findings were reported by Jonge, Peeters, and Le Blanc (2006) for matching emotional resources in health care. Other studies found no support for the balance principle of the DISC Model (e.g., Van de Ven, De Jonge, & Vlerick, 2014). For this very reason, it has been suggested that matching resources are more functional as stress-buffers than as activation-enhancers (Van den Tooren, Van de Ven, De Jonge, & Vlerick, 2014). However, the current findings among elite athletes suggest that matching physical resources can indeed serve as activation-enhancers. This points to an interesting difference between athletes and non-athletes as studies in other work domains have only found stress-buffering effects of physical job resources on the relation between physical job demands and physical health (e.g., De Jonge & Dormann, 2006; Van de Ven & Vlerick, 2013; Van den Tooren & De Jonge, 2008). This seems to indicate that physical job resources can serve to protect against the negative effect of physical demands in more common work domains, while they can serve as activating resources in the occupational domain of elite sport. However, it is not unreasonable to assume that activation-enhancing effects apply to all occupations, as there is empirical evidence for activation-enhancing effects of matching cognitive resources in informatics (Van de Ven et al., 2008) and for matching emotional resources in health care (Jonge et al., 2006). Whether stress-buffering or activation-enhancing effects of resources are observed is likely dependent on characteristics of the occupation and the outcomes under study, which is an assumption that deserves further attention in future research.

Sport-related emotional resources also moderated the relation between sport-related emotional demands and emotional energy, such that they

weakened the negative relation between emotional demands and emotional energy. Elite athletes in our study reported relatively high levels of emotional resources, which implies that they are relatively accessible. Triple-match interactions between emotional demands, resources and health outcomes are most frequently observed in DISC studies (De Jonge et al., 2008). Thus, also in elite sport, having access to emotional resources seems to be important for preserving emotional capabilities. This is particularly interesting, as some scholars have argued that an athlete's emotional state is the most important health and performance aspect (Botterill & Wilson, 2002). Therefore, it seems vital to provide elite athletes with adequate resources in terms of emotional support from teammates or coaches, as well as a safe social environment in which emotions can be expressed freely.

The finding that both physical and emotional resources are important in dealing with demands is in line with research among populations in the common work domain (cf. De Jonge et al., 2008). For instance, a longitudinal study by De Jonge and Dormann (2006) found a significant interaction between physical job demands and physical job resources in predicting physical health complaints, and between emotional job demands and emotional job resources in predicting emotional exhaustion among health care workers. Taken together, findings across multiple work domains (e.g., health care, technology, informatics, elite sport) suggest that resources are vital in promoting health, well-being, and performance. Moreover, after being successfully applied to different domains, the findings of the present study provide support for the DISC Model as a conceptual framework for the understanding of the nature and interplay between sport-related demands and resources in the prediction of elite athletes' well-being. As a result, this study supports the usefulness of employing work psychology theories and models to investigate health, well-being, and performance in sport, something that has been advocated in recent years (e.g., Wagstaff, 2017).

In addition to the lower ratings of cognitive resources discussed earlier, comparing the ratings of specific demands and resources in elite sport to other work domains resulted in notable differences. First, emotional demands were rated lower in elite sport compared to both human service work and technology. This reflects the assumption that (elite) sport is less concerned with emotional demands than these two other work domains. In addition, in line with our expectations, ratings of physical and cognitive demands in elite sport were significantly higher compared to human service work and technology. So, elite sport is more physically and cognitively demanding than these other work domains. As the first one is quite logical, the second one likely reflects the cognitive effort that athletes employ in competition and through deliberate practice. Deliberate practice is the conscientious, intentional, and repeated application of activities or skills requiring effort and/

or concentration (Ericsson, Krampe, & Tesch-Römer, 1993). According to Ericsson and colleagues (1993) high levels of deliberate practice are necessary to attain expert level performance and are therefore a core element of elite sport.

With regard to resources, ratings of both physical and cognitive resources in sport were significantly lower in the elite sport domain compared to human service work and technology, whereas emotional resources in sport were rated significantly higher compared to both other work domains. The lower rating of physical resources compared to other work domains potentially reflects a core aspect of elite sport: the aim here is to elevate physical demands in such a way that it is beneficial for an elite athletes' (physical) development. This differs from other work domains, as seeking physical challenges or expending physical effort is a goal in itself within the elite sport domain, rather than something that should be minimised or prevented. Moreover, physical resources could be diverse in different work domains. For instance, physical resources in health care are more related to ergonomic devices or a helping hand, whereas physical resources in elite sport are more concerned with economic physical exertion and posture management. Therefore, in other work domains different physical resources might be more accessible or salient, as well as being more often activated.

Coaches, managers, and other staff members strive to provide athletes with abundant emotional resources as well. Hence, elite athletes could find a listening ear or other forms of emotional support in a variety of people closely tied to the sport context. Moreover, elite athletes closely interact with these people on a frequent basis. In addition, individual elite athletes often train (and compete) with other athletes. For instance, track and field athletes, swimmers, or archers can be considered individual athletes, yet they spend a lot of time with "teammates" who are involved in the same sport. They train, eat, and travel together, which can increase perceptions of emotional resources such as emotional support. This highly interpersonal nature of elite sport (Evans, Eys, & Wolf, 2013) can explain the higher rating of emotional resources in elite sport compared to both human service work and technology.

Our findings also have implications for sport organisations. As lowering demands in elite sport may not always be feasible, practical or even desirable, redesigning (i.e., optimising) resources may be a better and more effective approach for preventing negative outcomes of sport participation (DeFreese, Raedeke, & Smith, 2015). This implies that sport organisations need to make sure that athletes have access to adequate resources. For example, when an athlete is confronted with high physical demands, measures can be taken to provide him or her with adequate physical resources. This can come in the form of the opportunity to manage physical exertion and breaks from physical effort. Considering the importance of matching sport-related demands

and resources in relation to elite athletes' well-being can guide coaches, consultants, and sport psychologists in further improving the balance between sport-related demands and resources within sport organisations.

### Study Limitations and Directions for Future Research

Although the results of the present study are promising, there are several limitations that should be noted. A first limitation is the relatively small sample in this study. Small sample size usually affects the power of the study (Maas & Hox, 2005). However, detecting statistically significant moderating effects in a relatively small sample such as ours emphasises the strength of the DISC Model. In addition to this, the TMP is a probabilistic principle (De Jonge & Dormann, 2006). This raises questions of how to determine the distribution of this probabilistic event and whether our results are in line with the theoretical distribution. However, many studies are needed to statistically address this issue (e.g., by means of meta-analysis). Currently, we can only say that the existing evidence clearly favours match in contrast to no match. Notwithstanding the latter, we believe that replication of the current model in larger samples of athletes is necessary.

A second limitation is the cross-sectional design of the study. As such, the study does not allow inferences about the causal relation between demands, resources, and athletic well-being. Future longitudinal studies should investigate these relations across, for instance, a competitive season. In addition, as vigour is related to better performance (Beedie et al., 2000), future research could include performance as an additional outcome to further investigate the interplay between sport-related demands and resources and performance. Also, some of the scales had lower internal consistencies (i.e.,  $\alpha < 0.70$ ), which could make our findings less reliable. However, previous studies provided empirical support for the psychometric properties of the scales (cf. Balk et al., 2018; Bova et al., 2013). Nevertheless, future research is warranted to replicate the current findings.

A third limitation is the reliance on self-report measures, which could result in an overestimation of the associations among variables due to common method variance. However, it can be argued that demands, resources and well-being represent private, individual perceptions that are best rated by the athletes themselves rather than someone else (Podsakoff, MacKenzie, & Podsakoff, 2012). Hence, the use of self-reports can be considered the best way of assessment (Conway & Lance, 2010). A final limitation is that since we only had access to athletes from countries characterised by more individualistic cultures, our findings could not be generalised to countries with more collectivistic cultures. For instance, emotional support might be perceived differently in more collectivistic cultures, where there is a stronger focus on

cohesion and help-seeking (Schinke, Blodgett, McGannon, & Parham, 2014). An interesting avenue for future research is therefore to include cross-cultural investigations regarding demands and resources in elite sport.

## CONCLUSION

To our knowledge, this is the first study to test the triple-match principle of the DISC Model with regard to sport-related demands and resources in a unique sample of elite athletes. Findings provided support for the triple-match principle, as moderating effects of resources on the relation between demands and vigour occurred more often when there was a triple-match compared to when there was less match or no match at all. Hence, also in elite sport, match does matter: resources do not randomly moderate the relation between demands and well-being outcomes. Rather than focusing on individual processes, redesigning the athletic environment in terms of optimising resources might be an additional pathway to improve health, well-being, and ultimately performance, of elite athletes.

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