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A network approach to PhD students' well-being: insights into risk and protective factors

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ABSTRACT

Due to the high demands of doctoral education, concerns have been raised about PhD students' well-being. In addition to the adverse individual impact, poor well-being of PhD students is also problematic for universities, which might lose talented researchers via absenteeism and drop-out. Despite substantial knowledge about factors influencing well-being in academia, we know little about how these factors jointly promote or impede PhD students' well-being. We applied network analysis, alongside regression analysis, to cross-sectional data from 665 PhD students in the Netherlands to explore how PhD students' job demands, job resources, and personal resources are associated with subjective and archival well-being indices. Findings suggest that job demands, job resources, and personal resources influence PhD students' well-being directly and indirectly via associations with other factors. Among job demands, both publication pressure and work-home conflict were associated with higher burnout. Additionally, work-home conflict was associated with higher sickness absenteeism. Psychological capital stood out as the most important resource within the network and was related to lower burnout, higher engagement, and lower sickness absenteeism. By highlighting the importance of personal resources, particularly psychological capital, for PhD students' well-being, this study can guide the development of interventions to promote PhD students' well-being.



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Around the globe, PhD students report high levels of ill-being, including feelings of anxiety, depression, stress, and burnout (Evans et al. 2018; Levecque et al. 2017). In a recent large-scale study among early-career researchers, most of whom were PhD students, reported levels of anxiety, depression, and suicidality were high and could not be explained by pre-existing mental health problems (Berry et al. 2021; see also Hazell et al. 2021). The ill-being of PhD students is also problematic for universities that may

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not only lose research talent due to PhD students dropping out (e.g. Anttila et al. 2015; Hunter and Devine 2016) but are also likely to face substantial costs due to sickness absence and turnover (Cooper and Dewe 2008).

Previous research has produced a long list of factors contributing to PhD students' well-being or lack thereof (see for a review, Schmidt and Hansson 2018). Common risk factors are competing responsibilities and priorities (Martinez et al. 2013), time pressure (Pychyl and Little 1998), publication pressure (Waaiker et al. 2018), and lack of permanent employment and uncertainty about the future (Huisman, de Weert, and Bartelse 2002), including the difficulty to position oneself after obtaining the PhD (Martinez et al. 2013). Important protective factors include support from supervisors and the scholarly community (Cornér et al. 2018), peers (Schmidt and Umans 2014), as well as self-management strategies such as planning (Martinez et al. 2013). While previous studies have mostly considered these factors in isolation (e.g. Caesens, Stinglhamber, and Luypaert 2014) it is unlikely that PhD students' well-being is the product of a single variable. Instead, several factors are likely to shape PhD students' well-being together (Schmidt and Hansson 2018).

In view of this, we apply a network approach to our data, alongside traditional regression analyses, to take a more multidimensional perspective on PhD students' well-being. Specifically, by using a network approach, we can conceptualise and examine PhD students' well-being (and lack thereof) as a system involving multiple factors. While such systems-based approaches are common in other domains of science, it was not until relatively recently that network approaches made their entrance into psychological science. Yet, by allowing researchers to conceptualise and examine psychological health and lack thereof (i.e. mental disorders) in line with its multifactorial nature – e.g. how do various psychological, biological, and social factors interact to cause mental health problems? – network models have gained popularity quickly (Borsboom et al. 2021). Based on the above, we conceptualise PhD students' well-being as an interconnected system of multiple risk and protective factors.

By using network analyses we can investigate not only how risk and protective factors relate to well-being outcomes but also how risk and protective factors and well-being outcomes are mutually interrelated. Having a more comprehensive and fine-grained understanding of these relationships and their underlying structure/pattern can enable us to see how risk and protective factors 'work together' (Isvoranu et al. 2022) to impact PhD students' well-being. Specifically, the network approach can better isolate relationships between constructs by controlling for mutual dependencies of all the relationships within the network. Furthermore, network modelling can help identify constructs that are highly connected within the network and which might, therefore, be especially useful as targets for well-being interventions (Rhemtulla et al. 2016). A final advantage of network modelling is that it allows one to examine whether networks differ across groups or different levels of a moderator (Haslbeck 2022). Taken together, by using a network approach alongside traditional regression, we aim to answer the question of which risk and protective factors determine PhD students' well-being (and lack thereof), which factors are most impactful on PhD students' well-being, and *how* these are interconnected with each other in a broader network.

Theoretical framework – the job demands-resources theory

In line with our objective to study PhD students' well-being from a multidimensional perspective, we use the job demands-resources (JD-R) theory (Bakker, Demerouti, and Sanz-Vergel 2023; Bakker and Demerouti 2014; Demerouti et al. 2001) as our theoretical framework, a common work-stress model that distinguishes between job demands as potential risk factors and both job resources and personal resources as protective factors of employee well-being. We conceptualised PhD students' well-being in terms of two subjective indicators of well-being (i.e. burnout and work engagement) and one archival indicator of well-being (i.e. sickness absenteeism as recorded by the university).

PhD students' job demands

Job demands are 'aspects of the job that require sustained physical and/or psychological effort and are therefore associated with certain physiological and/or psychological costs' (Bakker, Demerouti, and Verbeke 2004, 86). When job demands are not compensated accordingly, they become the driver of a health-impairment or strain process, wherein employees become depleted and ultimately burned out (e.g. Bakker, Demerouti, and Verbeke 2004; Demerouti et al. 2001). We focus on two specific job demands – publication pressure and work-home conflict – which are likely to play a critical role in PhD students' well-being.

For many PhD students, the pressure to produce 'publishable' results is a major source of distress. Indeed, previous research among early career researchers in the Netherlands showed that six in ten PhD students describe the pressure to publish as 'too high' or 'far too high' (Waaiker et al. 2018). According to JD-R theory, high demands are energy-depleting and can result in burnout and sickness if employees cannot recover from the strain of resource depletion (Schaufeli 2017). This is also in line with Conservation of Resources (COR) theory (Hobfoll, 1989, Hobfoll et al. 2018), which suggests that stress and burnout develop when resources are threatened or lost. Publication pressure may also lower PhD students' work engagement if PhD students believe that their efforts will be frustrated or goal attainment is unlikely. For example, PhD students who expect significant obstacles in the review and publishing process might not be motivated to direct sustained efforts toward that goal but might resort to a more passive, disengaging coping style (e.g. withdrawing; Crawford, LePine, and Rich 2010).

Another job demand that PhD students particularly struggle with is work-home conflict (Stubb et al., 2011), which refers to the experience that demands from the work and home domains are incompatible (Greenhaus and Beutell 1985). Specifically, given that there is no ceiling to knowledge and learning, which is the primary aim of a PhD trajectory, PhD students might see it as their responsibility to work extreme hours, including working during evenings and weekends. Consequently, they might compromise their home and family responsibilities, including their leisure time (Sverdluk et al. 2018), which is likely to hurt their recovery and increase their risk of burnout (Peeters et al. 2005) and sickness (De Croon, Sluiter, and Frings-Dresen 2003). Additionally, because PhD students might be in a stage of their life where they consider starting a family, home demands such as household and caring tasks might be increased and could interfere with work, which can result in work-related stress and strain (Peeters et al. 2005) and reduced work engagement (Verweij et al. 2017).

PhD students' job and personal resources

PhD students' job resources. When employees have job resources at their disposal, that is, aspects of the job that help to achieve work goals and stimulate personal growth and development (Bakker, Demerouti, and Verbeke 2004), they are more likely to deal with challenging job demands effectively. Job resources are thus considered important factors in the strain process (Bakker, Demerouti, and Euwema 2005) while simultaneously initiating a motivational process that fosters work engagement (Bakker, Demerouti, and Verbeke 2004). Here, we focus on three categories of job resources (Podsakoff et al. 2000): (1) task characteristics (i.e. autonomy, role clarity), (2) leader characteristics (i.e. supervisor support), and (3) organisational characteristics (i.e. development opportunities, career control).

Concerning task characteristics, we focused on two key aspects: autonomy and role clarity. Autonomy allows PhD students to act on their own ideas and to perceive themselves as self-efficacious (Overall, Deane, and Peterson 2011) on their journey toward becoming 'independent' scientists (Blaney et al. 2022). When PhD students experience high levels of autonomy, they are more intrinsically motivated for the job and perceive themselves as more competent, which aids both work engagement (Black and Deci 2000) and should also prevent stress and burnout (Ljubin-Golub, Rijavec, and Olčar 2020). Additionally, PhD students who experience high autonomy might be less absent from work because they have a greater motivation to attend to their work-related goals.

Another task-related resource that is important for PhD students is role clarity (La Touche 2017; Mackie and Bates 2019). When PhD students know what is expected of them, they are more likely to show engagement in the pursuit of their task goals because they know *what* to do. Having clear goals also fosters PhD students' engagement because it promotes motivation and the efforts made toward goal pursuit (Lunenburg 2011). Additionally, as role clarity may provide PhD students with a sense of control, even under stressful circumstances, it should prevent stress and strain (Bliese and Castro 2000). Indeed, previous research among university faculty showed that role clarity was associated with higher work engagement and lower levels of burnout (Barkhuizen, Rothmann, and Van De Vijver 2014; Záborská et al. 2018). Consequently, role clarity may be associated with higher engagement and lower burnout and sickness absence.

Concerning leadership characteristics, a resource that is considered highly important for PhD students is supervisor support (Caesens, Stinglhamber, and Luypaert 2014; Cornér, Löfström, and Pyhältö 2017). Supervisors provide PhD students with information and feedback, access to resources (e.g. professional network), and emotional support (Vekkaila et al. 2018). Because PhD students who receive support from their supervisors can absorb themselves fully in their research without worrying, they are likely to experience higher levels of work engagement. Indeed, supervisor support has been found to be crucial for PhD students' engagement and for the successful completion of the PhD (Peltonen et al. 2017). Also, because PhD students can rely on their supervisors to help them manage challenges, they are less likely to feel stress and strain in the face of rising demands (Han, Liu, and Wang 2022; Overall, Deane, and Peterson 2011). Consequently, supervisor support should increase PhD students' work engagement and prevent stress-related experiences, such as burnout and sickness.

We furthermore included two organisational resources: development opportunities and career control. Being able to develop oneself at work, such as learning a new skill or updating existing knowledge, is crucial for employee motivation and work engagement because it allows PhD students to achieve their work-related goals (Bakker and Demerouti 2007). At the same time, PhD students might experience less stress and strain when confronted with high demands because they might feel assured that they can develop the skills and competencies needed to master the challenge (Demerouti & Bakker, 2011). Consequently, development opportunities should also be associated with lower burnout and sickness absenteeism.

Career control is defined as the extent to which individuals feel exposed to career uncertainty and their ability to cope with this uncertainty (Ito and Brotheridge 2001). Because most, if not all, PhD students face temporary employment (Huisman, de Weert, and Bartelse 2002), PhD students inevitably face high levels of career uncertainty. When PhD students worry about their future and their ability to find new employment after obtaining the PhD, stress is a likely consequence (Woolston 2017). However, when organizations provide support through clear human resource management policies and procedures, such as training requirements for different positions (i.e. What is required to become an Assistant Professor?), PhD students may be better equipped to plan their careers, which should increase perceptions of career control and subsequently decrease stress and help prevent burnout and illness (Ito and Brotheridge 2001). Because PhD students who experience career control are likely to look beyond uncertain aspects of the job and seek opportunities for growth and advancement, career control should also be associated with more work engagement.

PhD students' personal resources. In addition to resources stemming from the work environment, PhD students may possess individual or personal resources, such as resilience or self-efficacy. Here, we focus on psychological capital (PsyCap), a psychological resource which encompasses the four resources of hope, self-efficacy, resilience, and optimism (Luthans and Youssef-Morgan 2017) and which has been linked to improved well-being in professionals (e.g. university teachers; Li 2018) and both undergraduate (see for a review, Li, Che Hassan, and Saharuddin 2023) and (post)graduate students (Barratt and Duran 2021; Nielsen et al. 2017). Personal resources in general, and PsyCap in particular, are likely to benefit PhD students' well-being because they help PhD students gain control of and impact upon their work environment successfully (Hobfoll et al. 2003). Through PsyCap, PhD students set and pursue challenging goals (i.e. hope), have confidence in their own skills (i.e. self-efficacy), and feel optimistic about their ability to cope with and recover from setbacks (i.e. optimism and resilience). Consequently, PsyCap should foster engagement and reduce exhaustion. Additionally, because individuals high in PsyCap can cope with stressful situations better, they might not only experience fewer episodes of illness but are also more likely to recover and return to work sooner. Consequently, PsyCap should be related to lower sickness absenteeism (Avey, Patera, and West 2006).

In summary, in line with JD-R theory and prior research, we expect that job demands are associated with lower levels of well-being, that is, higher burnout and sickness absenteeism, and lower work engagement (H1), whereas job and personal resources should be associated with higher levels of well-being, that is, lower burnout and sickness absenteeism, and higher work engagement (H2). Furthermore, we use the network approach to

explore the interplay and impact of job demands and job and personal resources on well-being. Given the exploratory nature of the network approach, we do not formulate any additional hypotheses.

Method

PhD students in the Netherlands

Participants were PhD students at a large university in the Netherlands, most of whom were employed by the university and worked full-time (82.7%). Notably, in contrast to other European and particularly non-European countries, it is common for PhD students in the Netherlands to be employed. This means that PhD students in the Netherlands have a full-time working schedule and a stable income, including employment benefits such as paid sickness, vacation, and parental leave. As such, only a few PhD students choose to combine a part-time PhD with paid work in other areas. Another notable difference that distinguishes the Dutch PhD model from other models, such as in the US or Australia, is that coursework is usually limited to few classes. Rather than engaging in substantial coursework in early phases of the PhD trajectory, PhD students in the Netherlands focus on their research from the get-go and select relevant courses or workshops, within or outside of their institution, at different phases of the project based on their needs. PhD students usually work closely together with one or several formal supervisors throughout the whole project. The size of the supervisory team varies but consists of at least one promotor and one co-promotor.

Although a majority of PhD students spend most of their time (about 80%) on research (Rathenau Institute 2021), PhD students can differ considerably in the extent to which they engage in teaching (e.g. giving tutorials and supervising bachelor or master theses). However, PhD students with more substantial teaching roles are usually given more time (e.g. five years instead of four years) to finish the PhD. The final dissertation is composed of multiple empirical or theoretical chapters (it is common to have at least three), an introduction, and a discussion. When it comes to publishing, most PhD students in the Netherlands are not formally required to publish to be granted their PhD, however, it is common to prepare the different chapters of the PhD for publication at some point in the future, especially if the PhD student wants to remain in academia. Therefore, most PhD students – even in the absence of formal publication requirements – aim to publish during their PhD. PhD students are granted their PhD after an expert committee has reviewed and approved the dissertation and the PhD student has publicly defended their dissertation during a formal celebratory event.

Sample and procedure

PhD students were invited via e-mail to take part in a research project aimed at PhD students' well-being. Data for this study was collected as part of a larger project at two time points, between July and August 2020 and between July and August 2022. The surveys assessed a wide array of variables¹ including PhD students' well-being, job demands, job resources, and personal resources. Additionally, we were provided access to records of PhD students' sickness absenteeism, that is, sickness days registered in the academic year following survey completion.

Surveys were distributed via Qualtrics at the beginning of July 2020 and July 2022, respectively. Participants who participated in the first survey could win one of five gift cards worth €20. Participants who participated in the second data collection received a gift card of €5 or could choose to donate the money for aid. Participants were informed that participation in the study was voluntary and that they could withdraw from the study at any time. Participants gave voluntary informed consent to participate in the study. The study was approved by the Faculty's Ethics Review Board in 2020 (2020-WOP-12454) and 2022 (2022-WOP-15336).

Initially, 576 PhD students in the 2020 data collection and 324 PhD students in the 2022 data collection showed interest in completing the survey by clicking the link in the invitation e-mail. Of these, 31 (15) participants did not give consent, and 162 (27) did not (correctly) complete the survey in 2020 (2022) and were therefore excluded. Consequently, we had complete data from 383 (282) PhD students participating in 2020 (2022). Notably, of the 383 PhD students who completed the survey in 2020, consent for use of sickness reports could only be obtained from 79² PhD students. At the time of data collection in 2022, a majority of the 2020 participants had already finished their PhD ($n = 213$), and as such, consent for the use of sickness data could not be obtained from all of the participants in this group.³ Of the 282 PhD students who completed the survey in 2022, 188 (66.67%) gave consent to the use of their sickness reports.

Thus, the final sample consisted of 665 PhD students (73.9% response rate), including 267 PhD students who also gave consent for the use of their sickness records and for whom the sickness records were obtained. On average, PhD students were 29.90 years old ($SD = 7.32$), and approximately two-thirds of participants were in the first (31.7%) or second (30.0%) year of their PhD project. A slight majority was female⁴ (57.6%) and indicated to be an international PhD student (56.4%). While the distribution of gender was not fully representative of the population of PhD students in the Netherlands – in 2022, 49.9% of PhD graduates in the Netherlands were women (Rathenau Instituut 2023) – the number of PhD students coming from abroad was representative of the share of foreign PhD students in the Netherlands (55% in 2022; Rathenau Instituut 2023). Regarding supervision, most PhD students were supervised by two or more supervisors (83.5%) or by a single supervisor (15.5%) on a weekly (61.6%) or monthly basis (21.7%). More details of the sample's demographic characteristics are shown in Table 1.

Measures

Job demands

Publication Pressure was assessed using the six-item stress subscale from the revised version of the Publication Pressure Questionnaire (PPQR; Haven et al. 2019). An example item is: 'I experience stress at the thought of my colleagues' assessment of my publications output' (1 = *totally disagree*, 7 = *totally agree*).

Work-Home Conflict was assessed with four items from the Survey Work-Home Interaction Nijmegen (SWING; Geurts et al. 2005). We slightly adapted the original items by replacing 'work' with 'doctoral studies'. An example item is: 'How often does it happen that you find it difficult to fulfil your personal obligations because you are constantly thinking about your doctoral studies?' (0 = *almost never*, 4 = *almost always*).

Table 1. Sample demographics.

Characteristic	Sample	
	<i>n</i>	%
Gender		
Female	383	57.6
Male	274	41.2
Other/no answer	8	1.2
Relationship status		
Single	205	30.8
Married/partnered	451	67.8
Other	9	1.4
Living with partner/others		
Yes	439	66.0
No	226	34.0
Having children living in the same household		
Yes	57	8.6
No	608	91.4
Faculty affiliation		
Sciences	299	45.0
Social Sciences	165	24.8
Humanities	111	16.7
Economics	61	9.2
Law	28	4.2
Medicine	1	0.2
Employment		
Full-time	550	82.7
Part-time	115	17.3
Funding		
Yes	602	90.5
No	47	7.1
Other	16	2.4

Job and personal resources

Autonomy was measured with a four-item scale from the second version of the Questionnaire on the Experience and Evaluation of Work (QEEW2.0; Van Veldhoven et al. 2015). An example item is: ‘Do you have freedom in carrying out your work activities?’ (1 = *never/hardly ever*, 4 = *always*).

Role Clarity was assessed with three items from the CPSQ (Pejtersen et al. 2010). The items were slightly adapted to fit the context of PhD students. An example item is: ‘Within my PhD project, there are clear objectives’ (1 = *fully disagree*, 7 = *fully agree*).

Supervisor Support was measured with a five-item scale that had been used for PhD students in prior research (Cornér, Löfström, and Pyhältö 2017). An example item is ‘I feel appreciated by my supervisors’ (1 = *fully disagree*, 7 = *fully agree*).

Development Opportunities were assessed with a three-item scale from the QEEW2.0 (Van Veldhoven et al. 2015). We replaced ‘work’ with ‘doctoral studies’. An example item is ‘I learn new things in my doctoral studies’ (1 = *fully disagree*, 7 = *fully agree*).

Career Control was measured with a scale used by Ito and Brotheridge (2001). The scale consists of three items, such as ‘I have sufficient information so that I can plan my career with confidence’ (1 = *fully disagree*, 7 = *fully agree*).

Psychological Capital was measured using 12 items from the Psychological Capital Questionnaire (PCQ; Luthans et al. 2007). Notably, to assess self-efficacy, we used items from the Short Version of the Occupational Self-Efficacy Scale (Rigotti et al., 2008) because the original items were strongly tied to a managerial setting. The 12

items have been proven to be a valid measure in prior research (Solms et al. 2019). Example items are: ‘Right now I see myself as being pretty successful at work’ (Hope), ‘When difficulties arise at work, I know how to solve them’ (Self-efficacy), ‘I can get through difficult times at work because I’ve experienced difficulty before’ (Resiliency), and ‘I always look on the bright side of things regarding my work’ (Optimism; 1 = *strongly disagree*, 5 = *strongly agree*). Since we were not interested in the sub-components but in the overall PsyCap construct, we calculated an overall PsyCap score by taking the mean of the 12 items.

Subjective well-being

Burnout was assessed with a seven-item scale that has been used extensively in research among PhD students (Pyhältö, Stubb, and Lonka 2009). The scale captures the two main components of burnout – emotional exhaustion and cynicism (Schaufeli and Buunk 2003) – with four and three items, respectively. Example items are: ‘I worry about my thesis in my free time’ (Emotional exhaustion) and ‘It is difficult for me to find meaning and purpose in my doctoral studies’ (Cynicism; 1 = *fully disagree*, 7 = *fully agree*).

Work Engagement was assessed with a 9-item scale (Cornér 2020; Löfström and Pyhältö 2020) adapted from the short version of the Utrecht Work Engagement Scale (Schaufeli, Bakker, and Salanova 2006) to speak to the PhD-setting. An example item is: ‘When I conduct my doctoral research, I feel that I am bursting with energy’ (1 = *fully disagree*, 7 = *fully agree*).

All items can be found in the Online Supplement.

Archival well-being

Sickness Absenteeism was assessed as the total number of days participants called in sick in the academic year following data collection. A one-year time interval is common in sickness absence research to cancel out seasonal fluctuations in registered sickness absence (Steel 2003). This means that for PhD students who completed the survey between July and August 2020, sickness data pertains to registered sickness days between September 2020 and August 2021. Likewise, for PhD students who completed the survey between July and August 2022, sickness data pertains to registered sickness days between September 2022 and August 2023. On average, participants reported 14 sickness days in the academic year following data collection. We applied a log10 transformation to the sickness absenteeism measure before including the data in the analysis to reduce skewness (Aiken 1991). After the transformation, the positive skew was reduced to acceptable levels (the skew coefficient went down from 5.02 to 1.81; Hair et al. 2022). Also, the kurtosis was greatly reduced through the transformation (the kurtosis coefficient went down from 27.24 to 2.22), and as such, the data can be considered normally distributed (Byrne 2010)

Statistical analysis

Analyses were performed with IBM SPSS Statistics version 28 and R version 4.2.2 (R Core Team 2013). Specifically, in R, the *bootnet*, *networktools*, *NetworkComparisonTest*, and

qgraph packages were used. First, we conducted regression analyses to investigate the relationships between PhD students' work characteristics and our well-being outcomes. Specifically, we conducted two separate multivariate regression analyses to regress subjective well-being (i.e. burnout and work engagement) on (1) job demands and (2) job/personal resources. We furthermore conducted two univariate regression analyses to regress archival well-being (i.e. sickness absenteeism) on (1) job demands and (2) job/personal resources. Third, to gain a more nuanced understanding of how job and personal characteristics relate to one another and to PhD students' well-being, we applied a network analysis to the data.

Results

Table 2 presents the means, standard deviations, and correlations of the study variables.

Multivariate analyses predicting subjective well-being

Multivariate regression analysis showed that PhD students' subjective well-being (i.e. burnout and work engagement combined) differed as a function of both publication pressure and work-home conflict, $F_s(2,658) \geq 56.98$, $p_s \leq .001$, Wilks' Lambda ≤ 0.852 , $\eta_p^2 \geq .148$. With respect to resources, analyses showed that subjective well-being did not differ as a function of role clarity or supervisor support, $F_s(2,654) \leq 2.27$, $p_s \geq .104$, Wilks' Lambda ≥ 0.993 , $\eta_p^2 \leq .007$, but the remaining job and personal resources did significantly predict subjective well-being, $F_s(2,654) \geq 6.15$, $p_s \leq .002$, Wilks' Lambda ≤ 0.982 , $\eta_p^2 \geq .018$. Notably, psychological capital was found to be by far the strongest predictor, reporting a large effect size ($\eta_p^2 = .204$).

For greater specificity, the univariate results are reported in Table 3. Overall, both publication pressure and work-home conflict were related to more burnout and less work engagement, with publication pressure showing stronger effect sizes than work-home conflict. Furthermore, all job resources – except for role clarity – and the personal resource of PsyCap were associated with lower burnout. Some job resources (i.e. development opportunities and career control) and the personal resource of PsyCap were associated with more work engagement, whereas other job resources (i.e. autonomy, role clarity, supervisor support) were not found to be related to work engagement.⁵

Univariate analyses predicting archival well-being

Applying univariate regression analyses to the subset of our sample that consented to the use of their registered sickness reports ($N = 267$), we found that only work-home conflict, $F(1, 263) = 4.57$, $p = .033$, $\eta_p^2 = .017$, but not publication pressure, $F(1, 263) = 0.37$, $p = .545$, $\eta_p^2 = .001$ was related to (higher) sickness absenteeism. With regard to job and personal resources, we found that only PsyCap, $F(1, 260) = 4.20$, $p = .041$, $\eta_p^2 = .016$ but none of the job resources were related to sickness absenteeism ($F_s \leq 1.98$, $p_s \geq .160$, $\eta_p^2 \leq .008$).

Taken together, our findings provide partial support for our hypotheses. Regarding our first hypothesis (H1) that job demands are associated with lower well-being in terms of higher burnout and sickness absenteeism and lower work engagement, we

Table 2. Means, standard deviations, correlations, and cronbach's alpha (on diagonal) of the key study variables.

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Gender ^a	—	—	—											
2. Publication Pressure	4.34	1.10	-.07	(.79)										
3. Work-Home Conflict	2.07	0.55	-.02	.54**	(.68)									
4. Autonomy	4.14	0.64	.01	-.28**	-.24**	(.85)								
5. Role Clarity	5.01	1.25	-.01	-.39**	-.22**	.29**	(.87)							
6. Supervisor Support	5.48	1.26	-.04	-.29**	-.19**	.35**	.55**	(.91)						
7. Development Opportunities	5.92	0.92	-.04	-.26**	-.24**	.33**	.43**	.43**	(.82)					
8. Career Control	3.74	1.29	.08	-.40**	-.32**	.25**	.39**	.30**	.38**	(.80)				
9. Psychological Capital	3.85	0.72	.07	-.46**	-.42**	.24**	.44**	.38**	.40**	.51**	(.82)			
10. Work Engagement	4.70	1.09	.04	-.26**	-.24**	.17**	.35**	.32**	.48**	.42**	.55**	(.92)		
11. Burnout	3.97	1.15	-.04	.68**	.59**	-.28**	-.38**	-.37**	-.38**	-.46**	-.60**	-.59**	(.85)	
12. Absenteeism	0.35	0.65	-.13*	.14*	.19**	-.08	-.11	-.03	-.12	-.07	-.16**	-.07	-.18**	—

Note. ^aMale = 0, Female = 1, * $p < .05$, ** $p < .01$, N = 657-665. Analyses including absenteeism were based on N = 263-267. Absenteeism data were log 10 transformed.

Table 3. Results of regression analyses.

Outcomes Effect	Multivariate η_p^2	Subjective Well-Being				Archival Well-Being	
		Burnout		Work Engagement		Absenteeism	
		Estimate (SE)	η_p^2	Estimate (SE)	η_p^2	Estimate (SE)	η_p^2
1. Job demands							
Publication pressure	.31	.52 (.03)	.27 [.46; .59]	-.18 (.04)	.02 [-.27; -.09]	.03 (.04)	.001 [-.06; .11]
Work-home conflict	.15	.68 (.07)	.14 [.55; .81]	-.29 (.09)	.016 [-.46; -.12]	.18 (.09)	.02 [.01; .35]
2. Job and personal resources							
Autonomy	.02	-.14 (.06)	.01 [-.25; -.02]	-.10 (.06)	.01 [-.22; .01]	-.05 (.07)	.002 [-.18; .09]
Role clarity	.001	-.04 (.04)	.001 [-.10; .04]	.01 (.03)	.00 [-.05; .08]	-.03 (.05)	.002 [-.13; .06]
Supervisor support	.01	-.07 (.03)	.01 [-.14; -.004]	.03 (.03)	.001 [-.04; .09]	.06 (.05)	.01 [-.03; .15]
Development opportunities	.09	-.10 (.05)	.01 [-.19; -.01]	.34 (.04)	.09 [.26; .43]	-.05 (.05)	.004 [-.15; .05]
Career control	.04	-.14 (.03)	.03 [-.21; -.08]	.09 (.03)	.01 [.03; .16]	.03 (.04)	.003 [-.05; .11]
Psychological capital	.20	-.66 (.06)	.16 [-.78; -.55]	.57 (.06)	.13 [.45; .68]	-.16 (.08)	.02 [-.31; -.01]

Note. $N = 662$ – 663 . Analyses predicting sickness absenteeism were based on a smaller subset of the sample ($N = 266$ – 267). The 95% confidence intervals are reported in square brackets. Unless otherwise stated, the reported effect size (η_p^2) pertains to the univariate analyses. To highlight differences in effect sizes, the effect size for the relationship between work-home conflict and work engagement is not rounded to two decimal places. Significant results are bold.

found that both job demands were related to higher burnout and lower work engagement, however, only work-home conflict but not publication pressure was associated with higher sickness absenteeism. Regarding our second hypothesis (H2) that job and personal resources are associated with higher well-being in terms of lower burnout and sickness absenteeism and higher work engagement, we found that all job resources except for role clarity were associated with lower burnout, whereas comparably fewer job resources (i.e. only development opportunities and career control) were associated with more work engagement. The personal resource of PsyCap was related to lower burnout and higher work engagement and was the only resource related to lower sickness absenteeism.

Network analyses

We conducted an exploratory network analysis (Borsboom 2017) to obtain a more nuanced understanding of how PhD students' job demands and job and personal resources are interconnected and to explore which (combinations of) variables might be most important for PhD students' well-being. Through network analysis, central variables or 'nodes' can be detected, which are variables that are considered most important because they are highly connected within the network (Costantini et al. 2015). Such nodes might be particularly fruitful as target variables for interventions because they can impact change in many other variables (Borsboom and Cramer 2013). Notably, relationships – so-called edges – within the network are based on partial correlations (just as in multiple regression) and thus represent unique relationships between two variables while taking into account all other variables in the network. To make sure that the

network does not contain spurious, small connections, we used a graphical Lasso (glasso) network (Friedman, Hastie, and Tibshirani 2008) which limits the number of edges to the most important ones (i.e. non-zero edges) while dropping edges that are close to zero. The glasso network was estimated using the *bootnet* package in *R* (Epskamp, Borsboom, and Fried 2018). Networks were visualised using the *qgraph* package (Epskamp et al. 2012).

As shown in Figure 1, the network entailed 11 nodes and 38 non-zero edges. As expected, burnout and work engagement were strongly negatively related, as indicated by a thick red edge. Burnout was positively related to sickness absenteeism, but this edge was relatively weak. Furthermore, the network showed two main clusters: job demands and job resources. Job demands, that is, publication pressure and work-home conflict, showed strong positive relationships with burnout. Unexpectedly, publication pressure and work-home conflict were also positively related to work engagement, indicating that certain job demands might not be exclusively harmful but might have a motivating function in our sample. Alternatively, the positive association between job demands and work engagement could also indicate potential costs of work engagement. Work-home conflict but not publication pressure was also positively associated with sickness absenteeism, and this association was stronger than the associations found between burnout and sickness absenteeism.

With regard to job and personal resources, a strong positive edge was found between supervisor support and role clarity, indicating that PhD students who feel supported by

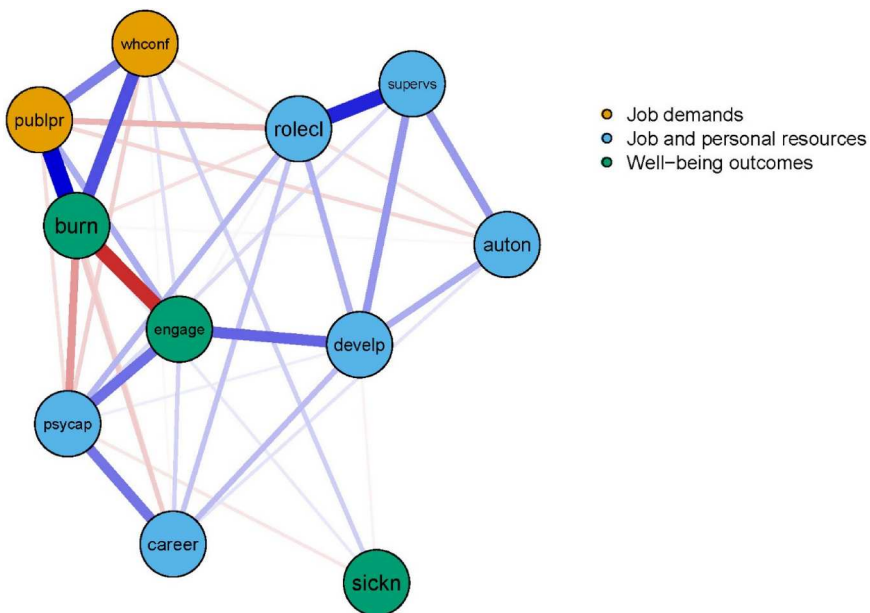


Figure 1. Network of PhD Students' Job Demands, Job Resources, Personal Resource, and Well-Being.

Note. Node descriptions: **Job demands** (yellow/orange): publpr = publication pressure; whconf = work-home conflict; **Job and personal resources** (blue): auton = autonomy; rolecl = role clarity, supervs = supervisor support; develop = development opportunities; career = career control; psychap = psychological capital; **Well-being outcomes** (green): burn = burnout; engage = work engagement, sickn = sickness absenteeism. Blue edges indicate positive relationships between variables, while red edges represent negative relationships. Thicker edges indicate stronger relationships. To facilitate interpretability, we used the colorblind-theme in *qgraph* (Epskamp et al. 2012) and fixed the average layout using the *averageLayout* function.

their supervisors are also more likely to have a clear idea of what is expected of them at work. Although role clarity was not related to burnout and was only weakly related to work engagement, it might influence those outcomes indirectly via positive associations with development opportunities and PsyCap. While both PsyCap and development opportunities were positively associated with work engagement, PsyCap also showed a negative association with burnout. Among the resources cluster, PsyCap had the strongest, albeit small, negative relationship with sickness absenteeism, followed by development opportunities, which was also negatively associated with absenteeism. PsyCap was also negatively related to both publication pressure and work-home conflict, although these edges were relatively small. Interestingly, supervisor support was only weakly related to lower burnout and was not associated with higher work engagement. Yet, it might impact work engagement via its positive association with development opportunities. While career control, in general, appeared to be less interconnected within the network, just as autonomy, it showed a strong positive association with PsyCap and, as such, might still play an important role in PhD students' well-being. For an overview of all edge weights, see Table S1 in the Supplemental Materials. The Supplemental Materials are available on the Open Science Framework at https://osf.io/s8mw4/?view_only=6fa3631b76c143fe8eab3706297e37b6.

Strength centrality analysis

Next, we assessed *strength centrality* to determine how important – or directly connected – a particular node is within the network (Costantini et al. 2015). This coefficient is calculated as the sum of the absolute edge weights between a focal node and all other nodes to which it is connected (Epskamp, Borsboom, and Fried 2018). To obtain the strength centrality estimates, we conducted the routine implemented in the *bootnet* package (Epskamp, Borsboom, and Fried 2018). Further, we used the bootstrapped difference-test in the *bootnet* package to examine differences in centrality (Epskamp, Borsboom, and Fried 2018). Finally, to examine whether certain edges were stronger, a bootstrapped difference-test was used in the *bootnet* package (Epskamp, Borsboom, and Fried 2018). As illustrated in Figure 2, publication pressure appeared to be one of the most central work characteristics within the network and was more central than work-home conflict. Using the *bootstrapped difference-test*, we found that publication pressure was indeed more central than work-home conflict.

Within the resources cluster, PsyCap had the highest strength centrality, however, node strength – or the sum of the absolute edge weights between PsyCap and all other nodes – was not significantly different from those of other nodes, such as development opportunities, role clarity, or supervisor support. Yet, using the *bootstrapped difference-test for edge weights*, we found that PsyCap was more strongly connected to (lower) burnout and absenteeism and (higher) work engagement than most other job resources. Only the edge between development opportunities and work engagement was as strong as the edge between PsyCap and work engagement. Nodes with lower strength centrality were autonomy and career control, indicating that the variable might be less interconnected within the network and, therefore, less important when targeting PhD students' well-being. Overall, centrality indices and edge weights were stable, and, as such, can be interpreted with confidence. Full stability analyses are reported in the Supplemental Materials (Section 2).

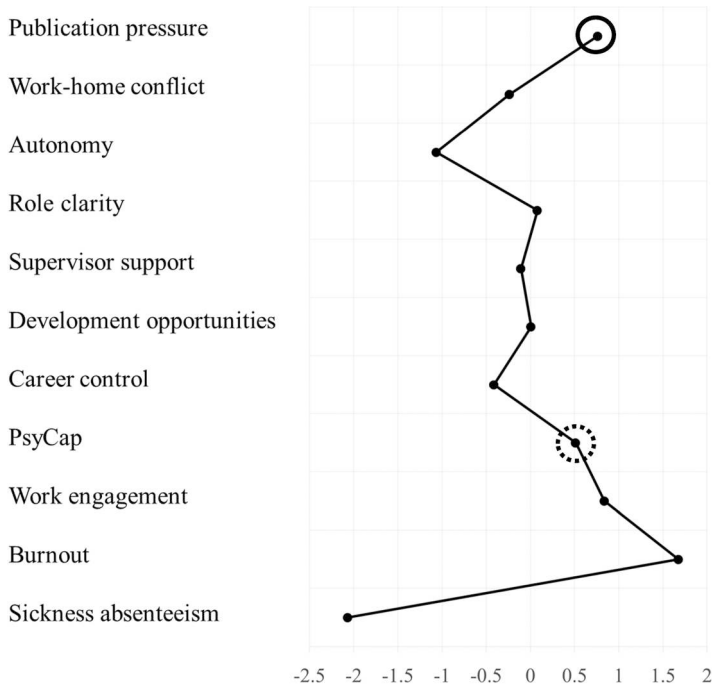


Figure 2. Strength Centrality For Network.

Note. Higher (positive) numbers indicate that the variable is more central to the network; highest values for predictors within the job demands and job/personal resources categories are indicated by a black circle (job demands) or dotted circle (personal resource). Values shown on the x-axis are standardised z-scores.

Additional network analyses

Because PsyCap was among the most central resources in the network, which showed the strongest relations with our two subjective well-being outcomes and was found to predict sickness absenteeism, we conducted an additional network analysis to explore and gain insight into *how* PsyCap may alter the nature of some of the relationships in the network.

To compare the network structure of job demands, job resources, and well-being among PhD students with lower and higher levels of PsyCap, we first created two groups based on a median split.⁶ Participants who fell above the median (≥ 3.917) were assigned to the 'higher PsyCap' group whereas participants who fell below the median (< 3.917), were assigned to the 'lower PsyCap' group (for a similar approach, see DuBois et al. 2017; Smith et al. 2019). To compare the network structure between the two groups, we used the *Network Comparison Test* (NCT; Van Borkulo et al. 2022), which tests if (a) edges between the same nodes are different across networks (i.e. omnibus network structure invariance test) and (b) the sum of all edges is different between the networks (i.e. global strength invariance test). Because the NCT requires non-missing data, we did not include sickness absenteeism in the network. Including absenteeism as a node within the network would mean that the whole network is estimated based on a subset of the sample, which is too small to estimate all parameters.

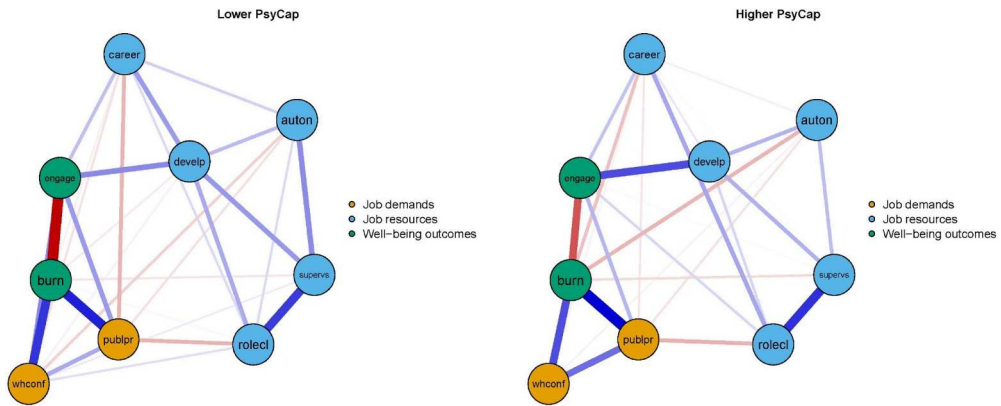


Figure 3. Network of Job Demands, Job Resources, and Subjective Well-Being Outcomes for the Lower PsyCap and Higher PsyCap Group.

Note. Node descriptions: **Job demands** (yellow/orange): publr = publication pressure; whconf = work-home conflict; **Job resources** (blue): auton = autonomy; rolecl = role clarity, supervs = supervisor support; develop = development opportunities; career = career control; **Well-being outcomes** (green): burn = burnout; engage = work engagement. Blue edges indicate positive relationships between variables, while red edges represent negative relationships. Thicker edges indicate stronger relationships. To facilitate interpretability, we used the colorblind-theme in qgraph (Epskamp et al. 2012), and fixed the average layout between the two network plots using the averageLayout function.

As can be seen in Figure 3, the networks look fairly similar with regard to the overall network structure. In line with this observation, the NCT omnibus test of network structure invariance was not significant ($p = .082$). However, the global strength invariance test was different between networks ($S = 0.94$, $p = .022$), indicating that global network strength was significantly lower in the ‘higher PsyCap group’ (3.35) compared to the ‘lower PsyCap group’ (4.29). Therefore, it appears that the network of job demands, job resources, and well-being outcomes was more strongly connected for PhD students with lower PsyCap than the network for PhD students with higher PsyCap.

To explore which individual edges differ across networks, we conducted an individual edge invariance test. The test indicated some differences in edges across networks. Specifically, unlike PhD students with higher levels of PsyCap, PhD students with lower levels of PsyCap did not show a negative edge between autonomy and burnout. Furthermore, there was a negative edge between burnout and work engagement, which was stronger in PhD students with lower PsyCap than PhD students with higher PsyCap. Moreover, there was a positive edge between work-home conflict and work engagement in PhD students with lower levels of PsyCap, which was absent in PhD students with higher levels of PsyCap. Finally, we found that the positive edge between development opportunities and career control was stronger in PhD students with lower levels of PsyCap than those with higher levels of PsyCap.

Discussion

Given the current need to protect and improve PhD students’ well-being, the primary aim of this study was to examine potential risk and protective factors of PhD students’ well-being. To this end, we assessed associations between job demands, job resources, personal resources, and subjective and archival well-being indicators using regression

analysis and network analysis. Below, we summarise our main findings and discuss them in light of theory and previous empirical work.

Generally, our results confirmed premises from JD-R theory, such that job demands were associated with higher burnout levels, whereas job and personal resources were associated with lower levels of burnout and higher work engagement. Interestingly, network analysis indicated that job demands were related to *higher* work engagement, suggesting that PhD students' job demands might be both energy-depleting and stimulating at the same time and, as such, may form 'challenge demands' (Van den Broeck et al. 2010). Alternatively, findings could imply that high work engagement incurs costs and is associated with an increase in job demands (George 2011; Halbesleben, Harvey, and Bolino 2009). Furthermore, publication pressure and work-home conflict differentially predicted well-being. Compared to work-home conflict, publication pressure was more strongly related to higher burnout (and work engagement), whereas only work-home conflict was related to higher sickness absenteeism.

With regard to job and personal resources, psychological capital (PsyCap) – a personal resource consisting of the four psychological resources of hope, self-efficacy, resilience, and optimism – was the only resource that was related to both lower burnout and sickness absenteeism and higher work engagement and was by far the strongest predictor in terms of effect size. Furthermore, PsyCap was one of the most central resources and shared edges with most other resources (e.g. career control and development opportunities), which, in turn, were related to well-being indicators. Therefore, PsyCap appears to be an important resource in its own right and might also increase PhD students' well-being via association with other resources. Additionally, PsyCap was found to alter the connectivity of the network such that PhD students with higher PsyCap levels showed reduced connectivity among variables, whereas PhD students with lower PsyCap showed higher connectivity. These findings might imply that possessing PsyCap makes PhD students less dependent on job resources, whereas those with fewer personal resources might be more reliant on job resources.

Finally, sickness absenteeism (measured with archival data) was found to be the node with the smallest centrality, indicating that sickness absenteeism was only weakly connected within the network. Indeed, across both analyses, only one job demand (i.e. work-home conflict) and a few job/personal resources (i.e. development opportunities, PsyCap) were associated with sickness absenteeism. Also, all relationships were rather weak, suggesting that job demands and job/personal resources might influence PhD students' health status little and less so than their subjective (self-reported) well-being.

Theoretical implications

PhD students' well-being is the product of multiple interconnected factors

While our results clearly show that some demands and resources are more important for PhD students' well-being than others – e.g. PsyCap appeared more important than supervisor support – our findings also suggest that PhD students' well-being is determined by several interconnected factors rather than a single variable alone. As such, although some variables are not directly linked to well-being or only to some outcomes, they might still indirectly influence well-being via associations with other variables. For example, given that supervisor support was linked to development opportunities, which in turn was

associated with work engagement, findings from our network analysis suggest that supervisor support might influence PhD students' work engagement indirectly by influencing their development opportunities.

Job demands are differentially related to subjective and archival well-being

Compared to work-home conflict, publication pressure was more strongly associated with burnout and work engagement. Work-home conflict but not publication pressure was related to higher sickness absenteeism across both analyses. Work-home conflict might be more consequential for employee sickness than publication pressure because it negatively impacts both the work and the home domain (Allen et al. 2000). Specifically, employees who experience work-home conflict might have difficulty recovering when at home, which increases their risk for illness (Moreno-Jiménez et al. 2009). In contrast, the health consequences of experiencing publication pressure might be weaker because stress is induced in one domain only.

Personal rather than job resources are important protective factors

Given that PsyCap was the only resource that was associated with higher work engagement and lower burnout and sickness absenteeism, our findings suggest that personal resources, in particular, are beneficial for PhD students and more so than job resources. This might be because personal resources help employees 'master their working life of constant change and uncertainty' (Toth, Heinänen, and Nisula 2020, 596), and, as such, might outperform job resources in specific work contexts and samples (Bickerton et al. 2014). In the context of PhD education, PsyCap enables PhD students to be self-sufficient and seek the resources they need, thereby making job resources more optional.

Personal resources promote feelings of control regardless of job resources

Supporting our reasoning above, we found that network connectivity, particularly among job resources, was lower in PhD students with higher PsyCap and higher in PhD students with lower PsyCap. These findings suggest that job resources indeed become less tied to one another, likely because PhD students are more capable of creating resources for themselves. For example, because PhD students who possess PsyCap are more likely to feel in control of their work environment (Hobfoll et al. 2003), they might feel capable of influencing the direction of their careers even when uncertainty is high and organisational affordances are lacking. In contrast, PhD students with lower PsyCap might feel that their (future) career might hinge more on other factors, such as the provision of development opportunities. From a COR perspective, reduced connectivity, that is, fewer interconnections among resources, might be the result of a process wherein PhD students value personal resources more and subsequently use job resources less. At the same time, PhD students with lower PsyCap might feel more threatened by the challenges they face. To cope with the threat of resource loss, they might conserve their job resources within a so-called resource caravan (Hobfoll 2014). Future research could assess whether the possession of personal resources, such as PsyCap, can diminish the value of (or reliance on) other resources and if existent (job) resources accumulate when other (personal) resources are lacking.

Strengths, limitations, and future directions

This study has several strengths. First, by studying the well-being of PhD students, this study contributes to our knowledge of (how to support) a particularly vulnerable occupational group in higher education.

Second, this study explored how job demands, job resources, and personal resources are interconnected in predicting PhD students' well-being, which is innovative given that most studies on PhD students' well-being focus on single predictors (Schmidt and Hansson 2018). Such a single-variable approach neglects that most variables do not exist in a vacuum but accumulate and jointly predict specific outcomes, such as well-being (and lack thereof). To that end, we complemented traditional regression analysis with network analysis, which allowed us to estimate relationships within a network of interconnected factors.

Third, in line with previous calls for the inclusion of objective outcomes in research on JD-R theory (Schaufeli and Bakker 2004), we see it as an important strength of our study that we complemented subjective well-being measures (i.e. burnout and work engagement) with an archival measure of PhD students' sickness absence based on organisational records. By including sickness reports, we could examine if results obtained for subjective indicators of well-being, generalise to archival indicators of well-being. For example, while job resources were associated with lower exhaustion, most of these were not associated with sickness absence, indicating that job resources may help to reduce feelings of exhaustion but may be less helpful to fend off sickness.

Our study also has some limitations that should be mentioned. First, because our data was cross-sectional, we cannot make any claims about causation. While we have confidence in the conclusions we draw, given that we used existent theory and previous empirical work to guide the interpretation of our findings and the directionality of the relationships, we recommend that future research considers using longitudinal designs.

Second, given that our sample consisted of PhD students from a single university in the Netherlands – most of whom were employed – PhD students who do not receive funding for their PhD may have additional demands (e.g. financial stress) and may need additional resources that we did not cover in this study, even though we do expect the focal demands and resources examined in the current research to be relevant for all PhD students. To address this limitation, future research should compare perceptions and experiences of different groups of PhD students and take into account financial constraints. Nonetheless, our sample included PhD students from many different disciplinary backgrounds, and as such, results should generalise to PhD students in different research fields. Additionally, because most PhD students in our sample were employed, findings might also generalise to other working professionals, especially those with similar job demands and resources (e.g. medical residents, Solms et al. 2019).

Finally, our measure of sickness absenteeism might be skewed, such that registered sickness days may not represent the actual number of days that participants were sick and did not work. Specifically, PhD students might have been sick and did not work, but some also might not have reported their sickness officially or worked despite being sick (i.e. presenteeism). Although it is common that sickness data is not normally distributed (Steel 2003; see also Schaufeli, Bakker, and Van Rhenen 2009), future research should attempt to obtain sickness data that is a true reflection of the days that employees

did not work due to sickness. To that end, future studies could use supervisor ratings of employee sickness. In these instances, supervisors should rate employee sickness for shorter periods, such as one week or month (Short et al. 2009), to reduce recall bias. Finally, we want to note that sickness absenteeism is not only determined by individual-level factors (e.g. job demands) but also by organisational and context factors (Nowak et al. 2023). For example, if PhD students work in departments that have a strong work ethic, they might be less likely to call in sick and may feel pressure to work despite being sick. In such instances, it might be more informative to assess presenteeism rather than absenteeism as an indicator of PhD students' health status.

Practical implications

Our study has noteworthy practical implications. Specifically, we hope our findings can help inform departments and universities about which factors contribute most to PhD students' well-being and give insight into how to promote it.

First, because job demands were related to higher burnout and sickness absenteeism but also higher work engagement, employing a 'reducing job demands'-strategy might not exclusively benefit PhD students' well-being. Yet, given that publication pressure had a strong influence within the network, that is, publication pressure was not only associated with well-being directly but was also associated with lower job and personal resources, lowering the pressure to publish might generally benefit PhD students' well-being. Departments and universities need to seek ways to motivate PhD students (i.e. offer stimulating demands that help maintain work engagement) without confronting them with demands (i.e. overly high publication requirements) they cannot meet without feeling the need to compromise their well-being.

Second, while we advocate for intervention strategies that take a comprehensive approach – intervention strategies might be most effective when targeting not a single but several influencing factors – we know that resources are often limited, and as such, practitioners might need to select one or few influencing factors as the main target for an intervention. By helping determine which variables are the most central and thus important (i.e. widely connected), network analysis is a valuable tool to inform practitioners. Given that PsyCap was well-connected within the network and was the only resource that was related to all well-being indicators, including sickness absenteeism, we believe that developing PsyCap might be particularly fruitful in improving PhD students' well-being. Having said that, fostering PhD students' personal resources alone is not sufficient, but universities need to create resourceful work environments wherein PhD students can develop and thrive.

Conclusions

By complementing regression analysis with network analyses to examine the risk and protective factors related to PhD students' well-being, this study showed that PhD students' well-being can be best conceptualised and studied as a network of interconnected factors. Nevertheless, our findings show that some demands and resources are more important than others. Specifically, PsyCap appeared to be an important personal resource within the network, as it directly influenced PhD students' well-being and

changed the nature of some of the relationships in the network. Therefore, intervention strategies aimed at promoting PhD students' well-being might do well to focus on increasing PsyCap, in particular.

Notes

1. A full list of variables is available from the authors upon request.
2. Some PhD students completed the questionnaire in 2020 and in 2022 (where we also asked them for their consent regarding access to their absenteeism data), however, for those who participated at both time points ($N = 112$), we only used the data that was collected at the first measurement occasion in 2020.
3. Additionally, 31 participants who participated in the 2020 data collection did not consent to the use of sickness reports, 2 participants did not give consent for the overall research, 6 did not complete the questionnaire, and 52 did not respond to our email invitation.
4. Eight participants indicated not to identify as female or male.
5. Because faculty affiliation was related to our focal variable autonomy, $F(4, 658) = 4.26$; $p = .002$; $\eta_p^2 = .03$, we re-ran the analyses pertaining to autonomy, controlling for faculty affiliation to take into account the potential effects of multilevel characteristics (Bakker, Demerouti, and Sanz-Vergel 2023). Notably, we omitted the only person affiliated with the Faculty of Medicine from these analyses because post-hoc tests cannot be run with groups that contain less than 2 cases. The findings remained largely the same except that the previously non-significant negative relationship between autonomy and work engagement was now significant, $B = -.123$, $t = -2.13$, $p = .034$, 95% CI $[-.236, -.010]$, $\eta_p^2 = .01$. Faculty affiliation was not associated with our outcome measures burnout and work engagement ($ps \geq .292$) or sickness absenteeism ($p = .065$).
6. We acknowledge that a median-split might be seen as problematic by some scholars (DeCoster, Gallucci, and Iselin 2011), however, we deem this an appropriate choice as it is currently the only way to compare networks for participants with higher and lower scores on a continuous variable, as in our case participants who indicate higher versus lower PsyCap (e.g., Smith et al. 2019).

Disclosure statement

This article has been published under the Journal's transparent peer review policy. Anonymised peer review reports of the submitted manuscript can be accessed under supplemental material online at <https://doi.org/10.1080/21568235.2024.2409153>.

Hyperlink the transparent peer review policy highlighted in yellow in the Supplementary footnote and Disclosure statement and that link will need to be taken to <https://www.tandfonline.com/action/authorSubmission?show=instructions&journalCode=rehe20#Transparent%20Peer%20Review>

Author's contribution statement

All authors contributed to the study conception, design, and material preparation. Luisa Solms performed the data collection and analyses. The first draft of the manuscript was written by Luisa Solms and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability statement

The data on which the study is based are not publicly available due to its sensitive nature, but will be available in anonymized form from the corresponding author upon reasonable request.

Ethics approval statement

Data have been collected in accordance with the University of Amsterdam Institutional Review Board (IRB; Ethics Committee FMG, 2020-WOP-12454 and 2022-WOP-15336) and the APA ethical standards.

Materials and code availability statement

The Supplemental Materials are available on the Open Science Framework at https://osf.io/s8mw4/?view_only=6fa3631b76c143fe8eab3706297e37b6 and the analysis code is available upon request from the authors.

Preregistration statement

This study was not preregistered.

Notes on Contributors

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