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Do job demands and resources generalize across academic career stages? Implications for burnout and work engagement

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Objectives: The Job Demands-Resources (JD-R) framework is widely used to explain burnout and work engagement, but its applicability across academic career stages remains unclear. This study examined whether the JD-R framework generalizes across junior and senior researchers.

Methods: This cross-sectional survey collected data from 3,101 researchers across 27 European countries, measuring burnout, work engagement, four job demands (illegitimate tasks, job insecurity, interpersonal conflict, work-family conflict), and four job resources (role clarity, job control, sense of community, predictability). Structural equation modelling (SEM) tested the JD-R framework.

Results: Burnout prevalence was higher among junior (29.5%) than senior (25.1%) researchers. Job demands were associated with burnout, while job resources were associated with work engagement and buffered against burnout. Multigroup SEM did not support measurement invariance across career stages, and separate SEMs showed only moderate-to-poor fit.

Conclusion: These findings suggest that the measurement of job demands and resources, as operationalized here, may not operate equivalently across career stages in this heterogeneous, multi-country sample. Career-stage-specific, longitudinal, and multilevel approaches are needed to establish measurement equivalence before testing the JD-R framework's generalizability in academia.

KEYWORDS

academic researchers, burnout, JD-R framework, structural equation modelling, work engagement

Introduction

Workplace conditions are key determinants of mental health across the global workforce [1]. While moderate stress may be adaptive, prolonged or unmanaged stress can lead to burnout, defined in ICD-11 as an occupational phenomenon resulting from chronic workplace stress and associated with increased risk of depression. Burnout is officially recognized as a compensable occupational disease in several European countries, including Denmark, France, Latvia, Portugal, and Sweden [2–5].

Although academia has traditionally been viewed as a relatively low-stress profession, growing evidence indicates high levels of occupational stress among researchers [6, 7]. A Belgian study on PhD students reported that 32% were at high risk of a common psychiatric disorder, more than twice the rate among comparably highly educated general population (14%) [8]. Early-career researchers are particularly vulnerable due to job insecurity, short-

term contracts, limited funding opportunities, and delayed career stability [7, 9–14]. Across career stages, long working hours, high competition driven by performance metrics, and multiple role demands, including research, teaching, and administrative responsibilities, further contribute to a demanding work environment [15–18]. These structural challenges have prompted calls at the European level for reforms addressing precarious employment and researcher wellbeing [19].

Workplace resources play a critical role in mitigating burnout and promoting wellbeing. Access to autonomy, clear roles, supportive supervision, and a strong sense of community can enhance resilience, job satisfaction, and overall functioning [20–22]. Such resources are central to occupational health interventions aimed at preventing burnout and sustaining workforce capacity [23].

The Job Demands-Resources (JD-R) framework offers a theoretical basis for integrating these observations. The model proposes two distinct but parallel processes [24, 25]: a health-impairment process, in which excessive job demands deplete employees' physical and psychological resources and increase the risk of burnout, and a motivational process, in which job resources foster engagement, motivation, and positive work outcomes, in part by buffering the impact of demands. This dual-process structure is why burnout and work engagement are considered jointly here, rather than as alternative outcomes: they represent the two theoretically distinct pathways the JD-R model predicts, and examining both allows a fuller test of the framework than either outcome alone would provide. The model's core propositions have received substantial meta-analytic support across occupational contexts [26] and have been shown to generalize in direction, if not always in magnitude, across diverse employment sectors [27, 28].

Applied specifically to academia, JD-R research has linked job demands and resources to burnout and engagement among university academics [9, 29–31]. Of particular relevance to the present study, prior work suggests that the relevance of specific demands and resources may shift across career stages which found that different demands were more salient at different points in working life, while resources remained broadly protective throughout [32]. This raises the possibility that a single JD-R measurement model, calibrated without regard to career stage, may not adequately capture the experience of researchers at very different points in their careers from PhD candidates to full professors, who differ markedly in job security, autonomy, and role demands. Applying the Job Demands-Resources (JD-R) framework [24, 25], this study examines whether academic demands (job insecurity, interpersonal conflict, work-family conflict, illegitimate tasks) and resources (job control, predictability at work, role clarity, sense of community) are associated with burnout and work engagement among academic researchers, and whether this association holds equivalently across career stages (PhD candidates to full professors). Consistent with the JD-R framework's dual-process model, we hypothesized that job demands would be positively associated with burnout, while job resources would be negatively associated with burnout and positively associated with work engagement, in both junior and senior researchers.

Methods

Study design and ethical considerations

This study was conducted as part of the Researcher Mental Health Observatory (ReMO), an European Union COST Action (CA19117) which aims to foster mental health and wellbeing within the European research community. The study employed a cross-sectional design.

This study was evaluated by the Ethics Commission of the Leibniz University Hannover and approved under ethics vote EV LUH 04/2023. Participants provided explicit informed consent electronically and confirmed they were ≥ 18 years old before proceeding. The study adheres to the principles of the Declaration of Helsinki. Participation was voluntary and anonymous [33].

Participants and sampling

Participants were researchers working in universities and non-university research organisations across Europe. Eligibility required being ≥ 18 years old and holding an active research position: R1 (PhD candidates), R2 (postdoctoral researchers), R3 (senior researchers), or R4 (full professors). Students and administrative or technical staff were excluded. Recruitment used convenience and snowball sampling via mailing lists (61.2%), social media, and professional groups. Country- and institution-level breakdowns of participants were not available for reporting because the ReMO STAIRCASE data-governance agreement restricts disclosure of participant country and institutional identifiers, in order to protect the anonymity of participating institutions. A conventional response rate could not be computed because participants were recruited through multiple parallel channels (institutional and professional mailing lists, social media, worker representation groups, and word of mouth) for which no common invitation denominator exists.

Data collection

Data were collected via the *Sustainable Working Conditions in Academia (STAIRCASE)* survey using LimeSurvey between September 2023 and August 2024. The questionnaire included five sections: demographics, mental health and wellbeing, working conditions, work environment, and leadership/supervision. For more detailed information, please see the dedicated reports [33, 34].

Constructs considered and instruments used

The study was guided by the JD-R framework [35]. Burnout was measured using the 12-item Burnout Assessment Tool (BAT-12), a well-validated instrument capturing exhaustion, mental distance, and emotional and cognitive impairment [36–38], rated on a five-point frequency scale (1 = “never”, 5 = “always”).

Work engagement was assessed using the UWES-3 [39], a validated measure of vigor, dedication, and absorption, rated on a six-point Likert scale (1 = “never”, 6 = “always”) [40].

Job demands initially included overwork, illegitimate tasks, work-family conflict, interpersonal conflict, and job insecurity. However, overwork was excluded from the final measurement model due to an excessive proportion of missing data (58%); consequently, the final job demands construct comprised illegitimate tasks, work-family conflict, interpersonal conflict, and job insecurity. Illegitimate tasks were measured using the four-item Bern Illegitimate Tasks Scale (BITS), a validated measure of unreasonable tasks [41]. Work-family conflict was assessed using a five-item validated scale capturing interference of work with family responsibilities [42]. Interpersonal conflict was measured using three items from the Knowledge-Intensive Work Environment Survey Target (KIWEST) [43]. Job insecurity was assessed using the four-item Job Insecurity Scale (JIS), validated across European contexts [44]. All job demand items were rated on five-point Likert scales (1 = “fully disagree”, 5 = “fully agree”).

Job resources initially included job control, role clarity, predictability, emotional support, and sense of community. Emotional support was subsequently excluded from the measurement model due to high missingness (42%); all other retained variables exhibited missing data rates below 30%.

Job control was measured with well-validated tool of autonomy and decision-making using three items from the Job Diagnostic Survey (JDS) [45, 46], while the remaining resources were assessed using validated scales from the Copenhagen Psychosocial Questionnaire III [47–49]. All job resource items used five-point Likert scales (1 = “fully disagree”, 5 = “fully agree”).

To characterize the missing-data mechanism for these two indicators, logistic regressions were conducted predicting each item’s missingness from career stage, age category, and gender (Supplementary Table S2). Full-information maximum likelihood (FIML; the mlmv estimator in Stata) was also tested as a sensitivity analysis, retaining both indicators in the measurement model.

Apart from job insecurity, none of the items of the different measures described below were counter indicative. Higher scores on items thus generally reflected higher levels on the construct in question.

Quantitative variables

Age was reported in categories (e.g., 25–27, 28–30) and converted to the midpoint of each interval (e.g., 26 for “25–27”) for use as a continuous covariate. Gender was coded dichotomously (0 = male, 1 = female). Civil status was recorded as a five-category variable: single; in a relationship, co-habiting; in a relationship, not co-habiting; married, co-habiting; and married, not co-habiting. Contract type was recorded as a five-category variable (contract ending within 12 months, 1–2 years, 2–3 years, or >3 years, or permanent contract).

Estimation of burnout point-prevalence

Burnout prevalence was estimated using established BAT cut-offs (Schaufeli et al., 2023): <2.54 no burnout, ≥2.54 at risk, ≥2.96 burnout [50].

Statistical analysis

Structural equation modelling (SEM) was used to examine relationships between job demands, job resources, burnout, and work engagement. Participants were grouped into junior (R1–R2) and senior (R3–R4) researchers.

Burnout and work engagement were modelled as latent constructs. Job demands and resources were also latent constructs represented by factor-score indicators (see Supplementary Table S1 for measurement properties and factor structures). Covariates included age and gender.

To evaluate group equivalence, a multigroup SEM approach tested measurement invariance across academic career stages (configural, metric, and scalar models). Because strict measurement invariance was not supported by the fit indices, direct cross-group parameter comparisons were deemed psychometrically invalid. Consequently, separate single-group SEM models were estimated for junior and senior researchers to allow for a cautious, exploratory examination of structural patterns within each career stage independently. Model fit was evaluated using standard global and incremental fit indices (CFI, TLI, RMSEA, SRMR). Correlated error residuals were added only where theoretically justifiable based on modification indices. Sensitivity analyses examined gender effects.

Results

Sample characteristics and burnout prevalence

Junior and senior researchers differed in demographic and employment characteristics (Table 1). Juniors were predominantly younger (63.1% under 34 years), whereas seniors were mainly aged 40 years and older (83.2%). Women represented the majority in both groups (63.9% juniors; 59.6% seniors). Civil status also differed, with juniors more often single (31.3%) compared to seniors (14.0%), while seniors were predominantly married (59.6% vs. 23.0% among juniors). Burnout prevalence was higher among juniors (29.5%) than seniors (25.1%), with significant group differences ($\chi^2(8) = 38.40$, $p < 0.001$).

Missingness on overwork was significantly associated with career stage (standardized $\beta = 0.39$, $p < 0.001$), whereas missingness on emotional support was not significantly associated with the observed covariates (likelihood-ratio $\chi^2(8) = 10.42$, $p = 0.237$). The FIML specification did not converge to a stable, identified solution (Supplementary Note under Supplementary Table S2). We therefore retained standard ML with listwise deletion as the primary estimator, with overwork and emotional support excluded from the final measurement model.

Multigroup structural equation modelling and measurement invariance

Measurement invariance between junior and senior researchers was examined using a multigroup SEM framework. As detailed in Supplementary Table S3, the configural and metric models showed similar SRMR values (0.071 and 0.075, respectively), although several fit statistics were not reported by the software. In

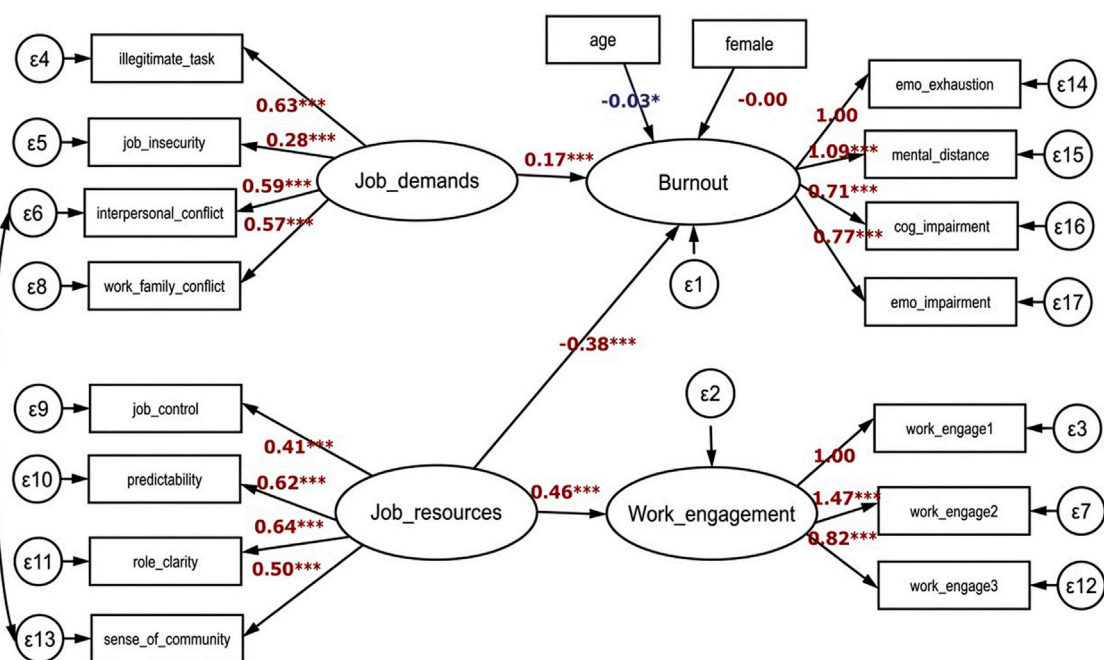


FIGURE 1

Path diagram of the job demands and resources framework among junior researchers (ReMO STAIRCASE survey, 27 European countries, 2023–2024). Note. Values in red represent structural path coefficients and factor loadings and asterisks (*) indicate significant paths. *** $p < 0.001$. Latent variables are represented by ovals and observed variables by rectangles. Single-headed arrows indicate hypothesized regression paths with standardized coefficients, while double-headed arrows indicate covariances.

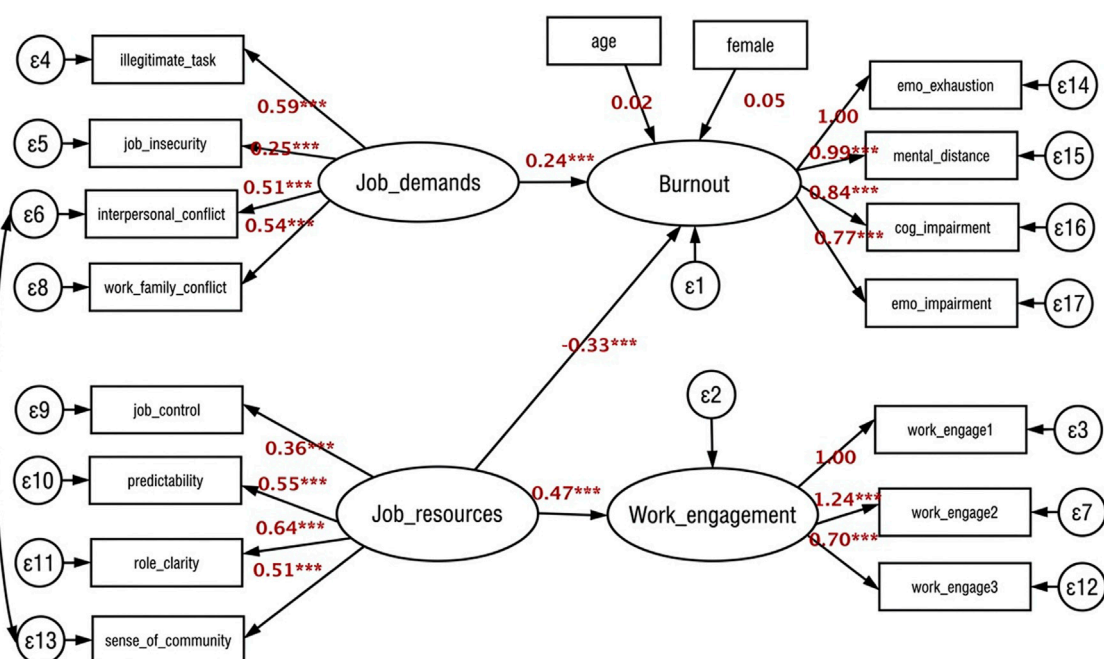


FIGURE 2

Path diagram of the job demands and resources framework among senior researchers (ReMO STAIRCASE survey, 27 European countries, 2023–2024).

TABLE 1 Demographic, professional characteristics, and burnout prevalence among junior and senior researchers (ReMO STAIRCASE survey, 27 European countries, 2023–2024).

Characteristics	Junior researchers (n = 2,705)	Senior researchers (n = 1,321)
Age		
<28	612 (22.6%)	6 (0.5%)
28–33	1,096 (40.5%)	29 (2.2%)
34–39	555 (20.5%)	182 (13.8%)
40–45	259 (9.6%)	341 (25.8%)
46–51	107 (4.0%)	297 (22.5%)
52–57	42 (1.6%)	222 (16.8%)
>57	23 (0.9%)	239 (18.1%)
Missing	11 (0.4%)	5 (0.4%)
Gender		
Female	1,729 (63.9%)	787 (59.6%)
Male	926 (34.2%)	514 (39.0%)
Missing	50 (1.8%)	20 (1.5%)
Civil status		
In a relationship, co-habiting	754 (28.5%)	194 (15.2%)
In a relationship, not co-habiting	409 (15.1%)	81 (6.1%)
Married, co-habiting	623 (23.0%)	787 (59.6%)
Married, not co-habiting	31 (1.1%)	26 (2.0%)
Single	825 (31.3%)	185 (14.0%)
Missing	63 (2.3%)	48 (3.6%)
Contract termination		
Within 12 months	855 (31.6%)	74 (5.6%)
1–2 years	517 (19.1%)	42 (3.2%)
2–3 years	420 (15.5%)	59 (4.5%)
>3 years	146 (5.4%)	60 (4.5%)
Permanent	305 (11.3%)	809 (61.2%)
Missing	462 (17.1%)	277 (21.0%)
Burnout		
No burnout	1,330 (49.2%)	783 (59.3%)
At risk	578 (21.4%)	206 (15.6%)
Burnout	797 (29.5%)	332 (25.1%)

contrast, the scalar invariance model showed poor fit, with $\chi^2(244) = 3,584.47$, $p < 0.001$, RMSEA = 0.101 (90% CI: 0.098–0.104), CFI = 0.770, TLI = 0.746, and SRMR = 0.079. Thus, full scalar measurement invariance was not supported across junior and senior researchers, suggesting that item intercepts were not equivalent across academic career stages. Consequently, direct comparisons of latent factor means across groups were not considered appropriate. To avoid imposing unsupported cross-

group measurement constraints, separate single-group SEMs were subsequently estimated for junior and senior researchers.

Separate structural equation models for junior and senior researchers

Because measurement invariance was not established (Section *Multigroup structural equation modelling and*

TABLE 2 Structural model results and model fit indices for the job demands and resources framework among junior researchers, N = 1,824 (ReMO STAIRCASE survey, 27 European countries, 2023–2024).

Construct	Standardized coefficient (β)	95% CI	p-value
Panel A: Structural model results			
Age $\rightarrow$ burnout	−0.03	[−0.05, −0.01]	<0.05*
Female $\rightarrow$ burnout	−0.00	[−0.05, 0.05]	0.96
Job demand $\rightarrow$ burnout	0.17	[0.07, 0.26]	<0.001***
Job resource $\rightarrow$ burnout	−0.38	[−0.47, −0.29]	<0.001***
Job resource $\rightarrow$ work engagement	0.46	[0.41, 0.50]	<0.001***
Fit index		Value	
Panel B			
χ^2 (df = 109)	1898.45		
p-value	<0.001***		
RMSEA	0.09		
RMSEA (90% CI)	0.09–0.10		
CFI	0.82		
TLI	0.77		
SRMR	0.07		
Coefficient of determination (CD)	0.92		

CI, confidence interval; χ^2 , chi-square statistic; RMSEA, Root Mean Square Error of Approximation; CFI, Comparative Fit Index; TLI, Tucker–Lewis Index; SRMR, Standardized Root Mean Square Residual; CD, Coefficient of Determination. * $p < 0.05$; ** $p < 0.001$.

measurement invariance), separate single-group structural equation models (SEMs) were estimated for junior and senior researchers (Figures 1, 2; Tables 2, 3). Model fit was moderate to poor in both groups (Tables 2, 3). For junior researchers, SRMR = 0.07, CFI = 0.82, TLI = 0.77, and RMSEA = 0.09; corresponding values for senior researchers were 0.07, 0.84, 0.81, and 0.09, respectively. The coefficients of determination were 0.92 for junior researchers and 0.91 for senior researchers.

Among junior researchers, job demands were positively associated with burnout ($\beta = 0.17$, $p < 0.001$), whereas job resources were negatively associated with burnout ($\beta = -0.38$, $p < 0.001$) and positively associated with work engagement ($\beta = 0.46$, $p < 0.001$). Age was negatively associated with burnout ($\beta = -0.03$, $p < 0.05$), whereas female gender was not associated with burnout ($\beta = -0.00$, $p = 0.96$). Standardized factor loadings ranged from 0.38 to 0.63 for job demands and from 0.41 to 0.64 for job resources; all freely estimated loadings for burnout and work engagement were significant (all $p < 0.001$; Supplementary Table S4).

Among senior researchers, job demands were positively associated with burnout ($\beta = 0.24$, $p < 0.001$), whereas job resources were negatively associated with burnout ($\beta = -0.33$, $p < 0.001$) and positively associated with work engagement ($\beta = 0.47$, $p < 0.001$). Neither age ($\beta = 0.02$, $p = 0.223$) nor female gender ($\beta = 0.05$, $p = 0.185$) was associated with burnout. Standardized factor loadings ranged from 0.25 to 0.59 for job demands and from 0.36 to 0.64 for job resources; all freely estimated loadings for

burnout and work engagement were significant (all $p < 0.001$; Supplementary Table S5).

Discussion

This study examined the applicability of a JD-R framework to burnout and work engagement among junior and senior researchers in a heterogeneous sample spanning 27 countries. The findings provide two main observations. First, measurement invariance was not established across career stages, and the separate subgroup SEMs showed moderate-to-poor fit. Second, despite these measurement and model-fit limitations, the estimated structural associations within both groups were broadly consistent with the central propositions of JD-R theory: job demands were positively associated with burnout, whereas job resources were negatively associated with burnout and positively associated with work engagement. These findings should therefore be interpreted cautiously as exploratory evidence regarding the current operationalization of the JD-R framework, rather than as evidence of differences in how the underlying theoretical relationships operate across career stages.

Measurement invariance and multigroup SEM

The multigroup SEM did not support measurement invariance across junior and senior researchers. The configural and metric

TABLE 3 Structural model results of the job demands and resources framework among senior researchers, N = 880 (ReMO STAIRCASE survey, 27 European countries, 2023–2024).

Construct	Standardized coefficient (β)	95% CI	p-value
Panel A			
Age → burnout	0.02	[-0.01, 0.04]	0.223
Female → burnout	0.05	[-0.02, 0.13]	0.185
Job demand → burnout	0.24	[0.12, 0.36]	<0.001***
Job resource → burnout	-0.33	[-0.44, -0.22]	<0.001***
Job resource → work engagement	0.47	[0.39, 0.54]	<0.001***
Fit statistic		Value	
Panel B			
Chi-square (χ^2)	837.85		
Degrees of freedom (df)	109		
RMSEA	0.09		
90% CI for RMSEA	[0.08, 0.09]		
CFI	0.84		
TLI	0.81		
SRMR	0.07		
Coefficient of determination (CD)	0.91		

CI, confidence interval; χ^2 = chi-square statistic; RMSEA, Root Mean Square Error of Approximation; CFI, Comparative Fit Index; TLI, Tucker–Lewis Index; SRMR, Standardized Root Mean Square Residual; CD, Coefficient of Determination. * $p < 0.05$; ** $p < 0.001$.

invariance models did not converge to a stable, identified solution, and only the more constrained scalar model (equal loadings and intercepts) could be estimated, showing poor fit. Thus, the measurement model did not demonstrate equivalence across career stages, limiting the basis for interpreting between-group differences in latent means [51]. Importantly, this finding does not demonstrate that the JD-R framework itself lacks generalizability to academic researchers. Rather, it indicates that the specific operationalization and SEM specification used in the present study did not function equivalently across the two groups. As a complementary strategy that does not depend on measurement invariance, a dominance analysis of the same predictor variables was conducted separately for junior and senior researchers to rank their relative contribution to explained burnout variance [52].

This distinction is important because JD-R theory is deliberately broad and flexible, allowing job demands and resources to be defined according to occupational and organizational context [24, 25, 53]. The flexibility of the framework has contributed to its applicability across diverse occupations and settings. Meta-analytic evidence supports the core JD-R relationships, showing that job demands are positively related to burnout, while job resources are negatively related to burnout and positively related to work engagement [26]. Similarly, a multi-sector study found that although employees across healthcare, industry, service, and public-sector settings differed in their levels of demands, resources, burnout, and engagement, the strength of the relationships between these constructs did not differ significantly

across sectors [27]. Thus, variation in the levels or experience of job demands and resources does not necessarily imply that the underlying JD-R relationships differ across groups.

The lack of full measurement invariance may partly reflect the substantial heterogeneity of the present sample. Researchers were recruited from 27 countries and diverse academic and research contexts, while country-level clustering, institutional characteristics, and disciplinary context were not modelled. Such heterogeneity may influence how specific demands and resources are experienced and interpreted. The present analysis cannot determine whether the lack of invariance was attributable primarily to career stage, national context, institutional setting, discipline, or their combination. Accordingly, the findings are better interpreted as indicating limitations in the cross-group equivalence of the study-specific measurement model than as evidence against the generalizability of the underlying JD-R framework.

Structural associations with burnout and work engagement

Within both career-stage groups, the estimated structural associations were broadly consistent with previous JD-R research. Among junior researchers, job demands were positively associated with burnout ($\beta = 0.17$), whereas job resources were negatively associated with burnout ($\beta = -0.38$) and positively associated with work engagement ($\beta = 0.46$). The corresponding associations among senior researchers were also in the expected direction: job demands

were positively associated with burnout ($\beta = 0.24$), while job resources were negatively associated with burnout ($\beta = -0.33$) and positively associated with work engagement ($\beta = 0.47$).

The positive association between job demands and burnout is consistent with the health-impairment process proposed by JD-R theory and with previous empirical evidence. A meta-analytic test of the JD-R model found a positive association between job demands and burnout, while job resources were negatively associated with burnout; resources were also consistently positively associated with work engagement [26]. Similar findings have been reported specifically among academic staff. In a study of 595 academics in South African higher education institutions, job demands and a lack of job resources were associated with burnout, while job resources were positively associated with work engagement [29]. More recent academic research likewise indicates that psychosocial working conditions are associated with burnout among faculty, with effort increasing burnout and reward reducing it [31]. These findings are therefore broadly consistent with the directional pattern observed in the present study.

The negative association between job resources and burnout and the positive association between resources and work engagement are also consistent with the motivational processes described in JD-R research [35]. Earlier work in higher education has similarly shown that job resources such as autonomy, feedback, and other supportive conditions can play a role in protecting against burnout and supporting positive work-related outcomes. Bakker et al. found among 1,012 employees of a higher-education institution that job resources could buffer the effects of job demands on burnout, although the buffering effect varied across specific demand-resource combinations [54].

The estimated structural associations were broadly similar in direction across the two career-stage groups, consistent with the central propositions of JD-R theory. However, given the lack of full measurement invariance and the poor fit of the subgroup models, the estimates should be interpreted cautiously within each group and should not be used to infer differences in the strength of these associations between junior and senior researchers. Previous research suggests that the relevance of specific job demands and resources may vary across career stages which found that different demands were associated with burnout at different career stages, while job resources were associated with engagement across stages [32]. Although such findings make career-stage variation theoretically plausible, the present study does not provide a formal test of such differences.

Specific job demands in the academic context

The measurement results indicate that several demands contributed to the job demands construct in both groups, including work-family conflict, interpersonal conflict, illegitimate tasks, and job insecurity. These findings are consistent with previous research showing that academic work involves a combination of quantitative, organizational, and work-family demands [30].

Work-family conflict has received particular attention in relation to academic burnout. A study of 2,229 university faculty members in the Czech Republic found that work-family conflict was strongly associated with burnout within a JD-R-based model that also included quantitative demands, job insecurity, and several job

resources [55]. Related research likewise identifies work-family conflict as an important correlate of burnout in academic settings [55–57]. The present findings are consistent with this literature, although the current model treated work-family conflict as an indicator of a broader latent job-demands construct and therefore did not test it as an individual predictor of burnout.

Illegitimate tasks also contributed substantially to job demands in both groups. These refer to duties perceived as unnecessary or unreasonable because they fall outside what an employee believes can legitimately be expected within their professional role [58, 59], and have been linked to burnout and strain, including variance in burnout beyond other workplace stressors [60]. Research among doctoral and postdoctoral researchers has similarly linked illegitimate tasks to burnout [61]. While senior researchers sometimes engage in such tasks, they are also more focused on higher-level responsibilities such as leadership, grant management, and dissemination [62–64].

Interpersonal conflict and job insecurity likewise contributed to the broader job-demands construct and may be particularly salient in academic settings marked by hierarchical relationships, resource competition, and employment uncertainty; 38.1% of junior researchers in the present sample held contracts shorter than 1 year. Prior research links precarious academic employment to reduced autonomy and psychological security [65–67], consistent with broader uncertainty in European research funding [68–70]. Because job insecurity and interpersonal conflict were modelled as indicators rather than separate predictors, however, the present analysis cannot establish their independent associations with burnout.

Specific job resources in the academic context

Role clarity showed a relatively high loading on the job resources construct in both career-stage groups. This is consistent with previous academic research in which role clarity was included as a job resource and was associated with lower burnout among university faculty [55]. The convergence suggests that clarity regarding responsibilities and expectations may be an important component of the psychosocial resource environment in academia. Nevertheless, the loading indicates the contribution of role clarity to the latent job-resources construct; it should not be interpreted as evidence that role clarity itself was a stronger predictor of burnout than the other resources.

Sense of community was also included as an indicator of job resources in the present model. This is consistent with research on academic researchers showing that a sense of belonging to a scholarly or research community is a well-established requirement for researchers' development and wellbeing, with isolation and lack of community linked to greater attrition and disengagement [71]. These findings reinforce the theoretical relevance of a supportive research community as a resource, but they do not allow reliable conclusions about whether sense of community matters more for junior than senior researchers.

Model fit of the separate subgroup SEMs

The separate SEMs showed moderate-to-poor fit in both career-stage groups, indicating that the specified models did not fully reproduce the observed covariance structure. This is consistent

with the sample heterogeneity and framework flexibility discussed in Section *Measurement invariance and multigroup SEM*, which likely contributed to both the lack of measurement invariance and the imperfect fit of the subgroup models.

Model fit may additionally have been influenced by the measurement specification itself. Job demands and job resources were represented using factor-score indicators, whereas burnout and work engagement were modelled using item-level latent indicators. In addition, overwork and emotional support were excluded because of missingness, potentially narrowing the content coverage of the respective constructs.

Importantly, the poor fit of the subgroup models should not be interpreted as evidence that JD-R theory is inadequate for understanding academic wellbeing. A comprehensive review of JD-R research supports the relevance of the framework to burnout and work engagement across diverse occupational settings [28]. Given the poor model fit, the estimated structural associations should be interpreted cautiously, even within each subgroup, and not as evidence of systematic differences between junior and senior researchers.

Limitations and strengths of the study

Several limitations should be considered. First, the cross-sectional design prevents causal inference and cannot rule out reverse causation (e.g., burnout may itself increase perceived demands or reduce access to resources), and self-reported measures may introduce common-method bias. Second, convenience and snowball sampling across 27 countries limits representativeness; country- and institution-level composition could not be reported due to data-governance restrictions, and country, institutional, and disciplinary clustering were not modelled, which may have contributed to the measurement and fit problems observed. Third, as noted above, measurement invariance was not established and the subgroup SEMs showed moderate-to-poor fit, so the structural coefficients remain exploratory. Finally, missingness constrained the operationalization of job demands and resources, including the exclusion of overwork and emotional support; a sensitivity analysis using full-information maximum likelihood did not converge, supporting this exclusion-based approach.

The study also has important strengths. The large sample, cross-national coverage, use of established measures, and explicit evaluation of measurement invariance provide a valuable assessment of the challenges involved in applying the JD-R framework to academic researchers. A further strength was that measurement equivalence across career stages was formally tested rather than assumed. Because full invariance was not established, separate SEMs were estimated for junior and senior researchers without imposing unsupported equality constraints across groups.

Implications for future research

Future research should use longitudinal and multilevel designs to examine variation in JD-R processes across career stages while accounting for country, institutional, disciplinary, and employment contexts. Measurement invariance should be established before making substantive cross-group comparisons, with formal tests of between-group parameter differences conducted where the relevant invariance assumptions are supported. More context-specific

operationalizations of job demands and resources may also be warranted, given evidence that the relevance of particular demands and resources can vary across working life [32]. Such approaches would help distinguish potential career-stage effects from broader contextual heterogeneity. Future research should also examine whether JD-R processes vary by academic discipline, given differing workload structures and funding pressures across fields, and whether socio-demographic factors such as membership in an equity-seeking group moderate relationships between job demands, resources, and burnout; neither could be examined in the present study.

Conclusion

The present study did not establish full scalar measurement invariance across junior and senior researchers, and the separate subgroup models showed moderate-to-poor fit; the structural estimates should therefore be interpreted cautiously and not as evidence of true differences between career stages. Nevertheless, the directions of the estimated associations were consistent with JD-R theory in both groups: job demands were positively associated with burnout, while job resources were negatively associated with burnout and positively associated with work engagement. These findings reflect challenges in applying a common JD-R measurement model to a highly heterogeneous, multi-country sample, rather than evidence that the JD-R framework itself operates differently across career stages, and point to the need for longitudinal, multilevel, context-sensitive research before career-stage differences can be established.

Ethics statement

The studies involving humans were approved by Ethics Commission of Leibniz University Hannover (ethics vote EV LUH 04/2023). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their informed consent electronically before participating in this study.

Author contributions

JL and IG contributed to conceptualization, investigation, methodology, and project administration. MTNN and PW were responsible for data curation, formal analysis, and visualization. MTNN wrote the original draft of the manuscript. JL, IG, PW, and MTNN contributed to review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that they do not have any conflicts of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.ssph-journal.org/articles/10.3389/ijph.2026.1610023/full#supplementary-material>

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