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Algorithmic Management as a Double-Edged Form of Digital Work Design: Job Demands, Autonomy and Employee Outcomes across 35 European Countries

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Abstract

Computer-based managerial systems are part of the digital infrastructure of work, with potential implications for employee demands and discretion. Drawing on Job Demands-Resources theory, this study examines task allocation, work scheduling and performance monitoring as distinct functions and their parallel indirect associations with engagement and intention to quit through work intensity and autonomy. Weighted least squares mean- and variance-adjusted structural equation models were estimated for 26,504 employees in 35 European countries using the 2024 European Working Conditions Survey. The measures capture reported computer involvement rather than verified artificial intelligence capabilities. Engagement and autonomy were modelled as latent factors, and quit intention as an ordinal outcome. All three practices were positively associated with work intensity. Task allocation was positively associated with autonomy, whereas monitoring was negatively associated with autonomy; scheduling's negative autonomy association was less robust to contextual fixed effects. Task allocation showed opposing indirect engagement associations through intensity and autonomy, whereas monitoring showed negative associations through both pathways. Intensity-related indirect associations with quit intention were consistently positive, while autonomy-related indirect associations were not statistically significant in the primary or fixed-effects models. Sensitivity analyses supported the main directional patterns, while exploratory country diagnostics indicated incomplete measurement invariance and heterogeneous slopes. The findings inform the evaluation of digital management by distinguishing functions associated with greater demands and greater autonomy from those associated with greater demands and reduced autonomy. The cross-sectional design does not establish causal mediation or uniform cross-country relationships.

1. Introduction

Digital technologies increasingly perform or assist managerial tasks once coordinated chiefly by supervisors. Computers assign work, align staffing with fluctuating demand, capture indicators of performance and communicate instructions in real time. This development has stimulated research on algorithmic management (AM), understood as the organisation and control of work through data-driven and computational systems [1, 2, 3]. Its importance is not solely technical: when managerial functions are mediated by software, the organisation of employees' daily effort and their opportunities to exercise discretion can change together [4, 5].

From a social informatics perspective, computer-based management involves the interaction of information systems with organisational arrangements and everyday work practices. Its evaluation therefore requires attention to employees' working conditions alongside technical functionality and operational performance. Algorithmic management research highlights how technological infrastructures interact with organisational choices and existing relationships, while work-design research identifies demands and discretion as important dimensions of employees' experience of digital technologies [3. 5]. Distinguishing allocation, scheduling and monitoring provides a practical basis for

examining these relationships without assuming that all computer-based managerial functions have equivalent implications for workers.

Much early evidence emerged from platform labour, where task matching, performance ratings and information asymmetries often operate as an integrated control architecture [6, 7, 8, 9]. This scholarship challenged the assumption that platform flexibility necessarily means worker autonomy. Yet it also highlighted the possibility that computational coordination reduces uncertainty and supports task execution. Recent reviews and conceptual discussions accordingly caution against treating algorithmic management as uniformly beneficial or uniformly coercive; outcomes differ according to the managerial function, design characteristics and context of implementation [10, 11, 12].

The setting is no longer confined to gig platforms. Algorithmically mediated and computer-based management practices are present in conventional employment, where systems are embedded within existing supervisory relationships, employment contracts and organisational routines [13, 14, 15]. Data from the European Working Conditions Survey (EWCS) 2024 reveal distinct computer-based managerial functions across heterogeneous European occupations and countries [16, 17]. These survey items provide evidence of computer involvement in task allocation, scheduling and monitoring, but do not establish whether every underlying system uses artificial intelligence or independently exercises decision authority. We therefore study employee-reported computer-based managerial practices that are relevant to algorithmic management rather than claiming to identify fully autonomous AI management systems.

The central question is not simply whether computer-based management exists but whether different managerial functions are associated with different configurations of job demands and resources. Task allocation organises assignments, scheduling structures labour time, and monitoring renders performance visible. Each can affect the continuity and evaluation of work without necessarily changing employees' discretion in the same direction. This functional distinction matters because a system that allocates tasks efficiently may leave methods of execution open, whereas continuous monitoring can be experienced as a narrower latitude for working independently [2, 4, 11]. These are contextual interpretations, rather than properties directly observed in the EWCS measures.

Job Demands-Resources (JD-R) theory offers a means of separating two parallel work-design pathways. Work intensity expresses the sustained quantitative and temporal effort required in a job; heightened intensity can deplete energy and promote unfavourable attitudes [18, 19]. Job autonomy, by contrast, denotes employees’ discretion over task ordering, work methods and work speed—a resource that can support self-direction, engagement and effective goal pursuit [20,21] same computer-based practice might therefore be associated with greater demands and greater resources, while another practice might combine greater demands with fewer resources. Recent AM research already addresses demands and resources jointly, including evidence on time pressure, overload, role clarity and feedback in delivery work [22]. The contribution must consequently be more specific than merely introducing JD-R theory to AM.

We develop a function-specific dual-path account, examining three managerial practices simultaneously and comparing their relationships with work intensity and autonomy. We then trace the associated indirect relationships to two distinct employee outcomes: work engagement, a motivational state involving vigour, enthusiasm and absorption [23, 24], and intention to quit, a withdrawal-oriented evaluation of the employment relationship [25, 26]. These outcomes should not be assumed to respond identically to demands and resources. For example, an employee may remain motivated because of increased decision latitude even while facing higher pace demands; withdrawal cognitions may still be more closely associated with sustained intensity.

The analysis uses the 2024 EWCS data for 26,504 employees in 35 European countries. It combines weighted WLSMV structural equation modelling—with latent autonomy and engagement and ordinal intention to quit—with country, occupation and sector fixed effects, design-based observed-variable regressions and a narrower quantitative-demands-only sensitivity test. We also compare the original one-path specification with the dual-path model on the same analytic sample. The added autonomy pathway is a theory-guided exploratory extension developed after examination of earlier work-intensity models; its results are not represented as independent, preregistered confirmation. The cross-sectional design permits conditional direct and indirect associations, not causal identification of intervening mechanisms.

This study contributes to research on digital work design in three ways. First, it distinguishes the demand-resource configurations associated with computer-based allocation, scheduling and monitoring within a common analytical framework. Second, it examines whether these configurations relate differently to motivational engagement and withdrawal intention, including potentially offsetting indirect associations that aggregate measures may obscure. Third, it evaluates the stability and limits of pooled findings through contextual controls, survey-design checks and exploratory cross-country diagnostics. For informatics research, the contribution is empirical evidence on how distinct managerial uses of computer systems are associated with working conditions and employee outcomes across a large, heterogeneous employee sample.

2. Theoretical Background and Hypothesis Development

2.1. Algorithmic management as function-specific work organisation

Algorithmic management is best approached here as a set of managerial functions rather than a single undifferentiated psychological exposure. Control research describes how algorithmic systems shape work through direction, evaluation and incentives [2]. Work-design research adds that the same arrangements can alter decision latitude, task interdependence, feedback, workloads and social support [4, 5]. Such perspectives are complementary: computational control changes worker experience precisely by reorganising everyday working conditions.

The present study distinguishes automated or computer-supported allocation of tasks, scheduling of working time, and monitoring of performance. These are not interchangeable acts of management. Assignment decisions affect task flow; scheduling affects when and for how long work must be performed; monitoring affects the visibility and scrutiny of work outputs. The functions can coexist, but high exposure to one does not logically require high exposure to the others. Accordingly, three observed predictors are retained rather than combined into a reflective AM factor [10, 11].

2.2. Work intensity as a job-demand pathway

Work intensity reflects the effort and temporal pressure associated with accomplishing tasks within the workday. The literature on intensification links rising productivity expectations, faster pace, tight deadlines and reduced slack to greater demands on workers [18, 27]. Reviews find that sustained intensification can undermine employee functioning and well-being [19, 28]. Within JD-R theory, such demands can consume energetic resources and activate health-impairment processes, even when employees also possess motivating resources [21, 29].

Computer-based task allocation may increase the continuity of assignments: faster matching and more efficient queues can reduce coordination delays but can also narrow intervals between tasks. Computer-based scheduling may align labour to demand peaks and create more intensive temporal organisation. European research links employer-directed schedules and non-standard working-time arrangements to intensity, while recent scholarship discusses the temporal restructuring accomplished by algorithmic coordination [30, 31]. Performance monitoring can make pace, output and inactivity continuously observable; electronic-monitoring reviews and meta-analyses highlight potential strain and surveillance pressures, notwithstanding substantial context dependence [32, 33, 34, 35]. Monitoring is therefore particularly salient as a possible source of evaluative pressure, although greater estimated coefficients do not establish statistically significant differences between coefficients without direct tests.

H1a-H1c. Computer-based task allocation (H1a), work scheduling (H1b) and performance monitoring (H1c) are each positively associated with work intensity.

2.3. Job autonomy as a resource pathway

Job autonomy represents discretion over the sequence, methods and pace of work. It is a core work resource because it permits workers to adapt their approach to task demands and exercise agency in goal accomplishment [29, 5]. Algorithmic management does not necessarily reduce this resource in every form. Allocation systems may reduce uncertainty over what should be done while leaving workers discretion over how, when or in what order to execute allocated tasks. In contrast, scheduling systems may establish time slots or availability requirements that limit latitude, and monitoring may make employees more reluctant to deviate from measured routines [4, 9].

The expected autonomy associations are therefore function-specific. Task allocation may be positively associated with autonomy when it facilitates organisation without prescribing execution. Scheduling and monitoring could be negatively related to autonomy to the extent that the timing and conduct of work are

externally constrained. These arguments are conditional: a rigid assignment engine could diminish autonomy, whereas participatory scheduling or informative monitoring could support it. The autonomy paths are analysed as theory-guided exploratory extensions rather than retrospectively presented as preregistered hypotheses. We examine the signed associations of each of the three functions with latent autonomy and test their robustness to contextual fixed effects.

2.4. Work intensity, autonomy and employee outcomes

Work engagement is a positive, fulfilling relationship with work encompassing energy, dedication and absorption [23, 36]. JD-R theory anticipates that sustained and insufficiently buffered demands erode energy, while resources support motivational functioning [20, 29]. Challenge-hindrance research complicates any assumption that every job demand must reduce engagement; some effortful requirements may also be appraised as opportunities [37, 38]. The intensity captured here, however, emphasises rapid pace, time pressure and interdependent pace determinants and is consequently expected to show an overall negative relationship with engagement [19].

Intention to quit is conceptually different: it expresses an evaluation of the desirability or likelihood of leaving employment, not simply the absence of engagement. Persistent high effort requirements may make continued employment more costly and contribute to withdrawal cognitions, consistent with turnover theory and cumulative meta-analytic findings [25, 26]. The combination of lower engagement and greater withdrawal intention is therefore plausible under a sustained demand pathway, although cross-sectional associations cannot demonstrate that intensity precedes either outcome.

H2. Work intensity is negatively associated with work engagement.

H3. Work intensity is positively associated with intention to quit.

Autonomy is theoretically distinct from intensity. Its resource value lies in enabling workers to make meaningful choices about how work is undertaken. Greater autonomy should generally coincide with higher engagement, as discretion can contribute to involvement and self-directed goal accomplishment [5, 29]. A negative association between autonomy and intention to quit is also plausible, but not inevitable: turnover cognitions may be influenced more strongly by work pressure, contractual arrangements and external alternatives, and autonomy may not by itself offset these conditions [25, 26]. The two autonomy-to-outcome paths are therefore examined separately as exploratory resource-related predictions, not assumed to be symmetric across outcomes.

2.5. Parallel indirect associations and potentially competing pathways

Taken together, the original demand-path account implies that computer-based managerial functions can be indirectly associated with lower engagement and higher intention to quit through work intensity. This framing concerns model-implied products of associations, not counterfactual mediation effects. The extension adds a resource-related indirect pathway through autonomy. Because AM functions may

combine increased intensity with either expanded or constrained autonomy, their two indirect associations with engagement can have opposing or reinforcing signs.

The distinction is especially relevant for allocation and monitoring. Where task allocation coexists with greater intensity and greater autonomy, its negative demand-related and positive resource-related indirect associations could offset one another, potentially concealing distinct associations in a net summary. Where monitoring coexists with greater intensity and less autonomy, both pathways could point to lower engagement. Scheduling may resemble the latter pattern, but its autonomy relationship could depend heavily on occupational and institutional context. Such patterns help explain why simple direct AM-outcome regressions may understate heterogeneous associations [3, 10, 22].

The original work-intensity hypotheses were specified for the demand-only analysis and retained in the dual-path model. Because the autonomy extension followed examination of the earlier demand-path results, its resource-path expectations and cross-path comparisons are treated as theory-guided exploratory analyses rather than prospectively confirmed hypotheses. This separation keeps theory, timing of model development and strength of inference aligned.

H4a-H4c. Task allocation (H4a), work scheduling (H4b) and performance monitoring (H4c) are each indirectly associated with lower work engagement through greater work intensity.

H5a-H5c. Task allocation (H5a), work scheduling (H5b) and performance monitoring (H5c) are each indirectly associated with stronger intention to quit through greater work intensity.

Exploratory resource-path expectations: task allocation is expected to be positively associated with autonomy and, through autonomy, with engagement; monitoring and scheduling may display negative autonomy-related engagement paths. Autonomy-related indirect associations with quit intention are assessed without assuming that they will mirror the engagement findings.

3. Methodology

3.1. Research design, sampling and analytical sample

This analysis uses employee-level data from the European Working Conditions Survey 2024, UK Data Service Study 9511, second edition [16]. The full release contains 36,644 records; 30,570 respondents are classified as employees. The dual-path sample consists of 26,504 employees with valid focal variables, seven groups of controls and a positive final calibration weight, implying the removal of 4,066 employee records (13.3%). The sample covers 35 European countries represented in the original single-mediator baseline analysis. This sample differs from the original 26,673-person work-intensity-only sample solely because valid autonomy indicators are additionally required. All comparisons between the single-mediator baseline model and the dual-path model re-estimate both specifications on the same 26,504 observations.

The data were collected at one point in time and are observational. The theoretical model orders computer-based management before work characteristics and worker attitudes, but measurement does not establish temporal precedence, rule out reverse or reciprocal associations, or identify causality. Throughout the manuscript, 'pathway' denotes a theoretically organised set of simultaneous conditional associations; 'indirect association' denotes a model-implied coefficient product.

3.2. Measures

3.2.1. Computer-based managerial practices

Employees rated the extent to which computer systems allocate their tasks (tech_task_alloc), determine working hours or schedules (tech_hours), and monitor performance (tech_monitor_perf). The original four-category items run from 1 (to a large extent) to 4 (not at all); responses were reversed so that higher scores indicate greater computer-based involvement. All three items were retained as distinct observed variables and standardised in the final analytical sample. The items do not identify algorithmic complexity, machine-learning use, decision autonomy or specific implementation characteristics.

3.2.2. Work intensity (job demand)

The demand pathway uses the official EWCS Work Intensity Job Quality Index (JQ_work_intensity), which encompasses quantitative demands, multiple determinants of work pace and emotional demands. Its original index is higher when job quality is better and work intensity lower; we reverse the sign prior to standardisation so that higher structural scores denote greater intensity. For descriptive interpretation, 1 minus the original 0–1 index gives the equivalent positively oriented intensity metric. Importantly, the three computer-based management items are not components of this index, although the pace determinants include machinery or automatic systems. A sensitivity model therefore uses a more restricted quantitative-demands operationalisation excluding that potential conceptual overlap.

3.2.3. Job autonomy (job resource)

Autonomy is modelled as a three-indicator latent variable using EWCS items on discretion over the order of tasks (autonomy_order), work methods (autonomy_methods) and work speed (autonomy_speed). The original five-category responses were reversed so that larger values represent greater autonomy. Treating the construct as latent models the common dimension while accounting for measurement error. Standardised factor loadings and reliability estimates are reported, but pooled fit does not establish measurement invariance across countries.

3.2.4. Employee outcomes

Work engagement was specified as a latent factor indicated by feeling energetic at work (eng_energy), being enthusiastic about work (eng_enthusiastic) and experiencing time passing quickly while working (eng_timeflies). The five-category items were reversed so larger values denote greater engagement. Intention to quit (quit_job) was reverse-coded so larger ordinal categories denote stronger reported intention to leave and was specified as an ordered outcome rather than a continuous variable.

3.3. Controls and survey-code audit

Models adjust for age, sex, ISCED educational attainment, workplace size, usual weekly working hours, organisational seniority and employment-contract type. Age, hours and seniority enter continuously; sex, education, workplace size and contract type are represented by categorical dummy variables. Seniority code − 555 signifies less than one year and is recoded to 0.5 years, rather than treated as a negative duration. For monthly-hours respondents routed through code − 994 on the weekly item, valid monthly hours are divided by 4.345; other non-substantive negative survey codes are excluded. The additional contextual specification includes country, one-digit ISCO occupation and top-level NACE sector fixed effects. These controls cannot eliminate unmeasured confounding or resolve country-specific measurement non-equivalence.

3.4. Weighted WLSMV structural equations and analysis strategy

The primary SEM uses R/lavaan [39], weighted least squares mean- and variance-adjusted estimation (WLSMV, with DWLS parameter estimation), theta parameterisation and the final EWCS calibration weight (CALWEIGH). Three engagement indicators, three autonomy indicators and the quit item were specified as ordered. The three management predictors enter simultaneously in the work-intensity and autonomy equations; both work characteristics predict both outcomes, with direct practice-to-outcome paths retained. A residual association between work intensity and autonomy was freely estimated. All observed focal predictors and the intensity index were standardised after sample selection. The analysis distinguishes 12 component indirect associations, corresponding to three managerial practices, two work characteristics and two employee outcomes. For each practice–outcome pair, the two component products are summed to obtain the combined indirect association. Standardised point estimates are presented on the lavaan Std.all scale, with p values from the corresponding WLSMV model output. The primary SEM incorporates calibration weights; clustering and stratification are addressed separately in the observed-variable robustness analyses.

The single-mediator baseline model (work intensity only) was re-estimated on the dual-path model sample for a transparent same-N descriptive comparison. Because the expanded model adds a latent construct and changes the measurement/structural parameterisation, differences in global indices alone do not prove substantive superiority. Results are interpreted primarily through the additional identified work-design relationships and the consistency of the demand paths.

3.5. Robustness and sensitivity analyses

Robustness analyses addressed functional form, context and the measurement of work intensity. The same N = 26,504 sample was used for the baseline demand-only and dual-path WLSMV specifications; fixed-effects WLSMV added country, ISCO-1 occupation and NACE-1 sector indicators. An alternative quantitative-demands mediator comprised high-speed work, tight deadlines, insufficient time and disruptive interruptions (N = 26,080), excluding technology-related pace-determinant and emotional-

demand components of the broader index. This was estimated with the same latent autonomy and engagement factors, ordinal quit outcome and both primary and contextual fixed-effects specifications.

A separate design-based observed-variable regression check used CALWEIGH, 3,547 primary sampling units and 486 strata (3,061 design degrees of freedom). It tests the robustness of the focal associations under survey clustering and stratification but is not equivalent to a survey-design-adjusted latent/ordinal SEM. Additional supplementary analyses assessed ordinal measurement structure across the 35 countries and observed-score cross-country slope heterogeneity. For the ordinal CFA, a globally consistent four-category recode of the engagement enthusiasm item combined its two lowest categories to resolve one empty country-category cell; no such recoding was applied to the principal SEM. Country-by-slope and leave-one-country-out checks used weighted observed-variable regressions with country, occupation and sector controls and PSU-clustered standard errors, not multi-group latent SEM. These extensions are explicitly exploratory and are interpreted separately from the primary structural model. Additional reporting and coding details are provided in Supplementary Information, Appendix A; exploratory cross-national diagnostics are described in Appendix B.

4. Results

4.1. Weighted descriptive statistics and correlations

Weighted descriptive statistics were computed on the exact 26,504-person dual-path analytical sample using the supplied calibration weight, CALWEIGH [40]. Observed-variable associations were summarised using weighted Pearson correlations (Table 1) [41]. The three computer-based management items were moderately correlated (r = .472–.548). Work intensity was positively correlated with performance monitoring (r = .222), task allocation (r = .200), and scheduling (r = .177); it was negatively correlated with engagement (r = − .158) and positively correlated with quit intention (r = .170). Job autonomy was positively correlated with engagement (r = .160), whereas its bivariate correlation with quit intention was small and negative (r = − .040). These correlations describe unadjusted associations between observed scores and should not be interpreted as equivalent to covariate-adjusted structural paths involving latent variables, which additionally depend on the specified measurement and structural models [42].

Table 1
Weighted descriptive statistics and correlations (N = 26,504)

Variable	M	SD	1	2	3	4	5	6	7
1. Task allocation	1.567	0.954	1.000	—	—	—	—	—	—
2. Work scheduling	1.332	0.770	0.548	1.000	—	—	—	—	—
3. Performance monitoring	1.561	0.974	0.476	0.472	1.000	—	—	—	—
4. Work intensity	0.349	0.189	0.200	0.177	0.222	1.000	—	—	—
5. Job autonomy	3.325	1.103	0.054	-0.024	-0.028	-0.039	1.000	—	—
6. Work engagement	3.829	0.737	0.005	-0.026	-0.047	-0.158	0.160	1.000	—
7. Intention to quit	1.947	1.300	0.040	0.055	0.042	0.170	-0.040	-0.237	1.000

Note. CALWEIGH-weighted means, population-form weighted SDs, and Pearson correlations. Engagement and autonomy are three-item observed composites in this table; the structural model estimates them as latent ordinal factors. The reversed work-intensity index is reported on a 0–1 scale. All higher scores indicate more of the named construct.

4.2. Analytic sample and model adequacy

The employee sample decreased from 30,570 to 26,504 after the dual-path variable and control restrictions; the original 26,673-person single-mediator baseline sample is not used for the direct comparison. Table 2 reports overall fit for the same-N baseline and dual-path models, as well as for the two narrower demand models. The primary dual-path model achieved scaled $\chi^2(124) = 473.282$, CFI=.988, TLI=.997, RMSEA=.010 and SRMR=.021. The corresponding country-occupation-sector fixed-effects model achieved scaled $\chi^2(376) = 1598.366$, CFI=.955, TLI=.997, RMSEA=.011 and SRMR=.015. Following the fit-evaluation guidance of Schermelleh-Engel et al. [43], approximate fit is satisfactory in all specifications, and the significant large-sample χ^2 statistics do not, by themselves, undermine this assessment.

Table 2
Model fit across same-sample and sensitivity specifications

Specification	N	Scaled χ^2 (df)	CFI	TLI	RMSEA	SRMR
Single-mediator baseline / primary	26,504	248.89 (58)	0.982	0.997	0.011	0.019
Single-mediator baseline / FE	26,504	609.05 (184)	0.961	0.998	0.009	0.012
Dual-path model / primary	26,504	473.28 (124)	0.988	0.997	0.010	0.021
Dual-path model / FE	26,504	1598.37 (376)	0.955	0.997	0.011	0.015
Dual-path QD / primary	26,080	443.90 (124)	0.988	0.997	0.010	0.021
Dual-path QD / FE	26,080	1528.05 (376)	0.957	0.997	0.011	0.014

Note. QD = quantitative demands; FE = country, ISCO-1 occupation and NACE-1 sector fixed effects. These models have different measurement structures; fit indices are descriptive, not a formal non-nested model superiority test.

4.3. Latent-variable measurement

Both three-indicator factors displayed substantively meaningful loadings (Table 3). In the primary model, engagement loadings ranged from .642 to .840, while autonomy loadings ranged from .768 to .877. The three autonomy items showed internal consistency (Cronbach's α = .830). An ordinal latent-response approximation to composite reliability was ω = .867 and average variance extracted was AVE=.685 in the primary specification. These values support internal consistency and convergent measurement within the pooled model [44], while not establishing metric or scalar invariance among 35 countries [45].

Table 3
Standardised measurement loadings

Indicator	Latent factor	Primary	FE
Energy at work	Engagement	0.760	0.785
Enthusiasm	Engagement	0.840	0.845
Time passes quickly	Engagement	0.642	0.646
Control over task order	Autonomy	0.835	0.853
Control over methods	Autonomy	0.877	0.890
Control over speed	Autonomy	0.768	0.749

Note. All shown loadings are statistically significant at $p < .001$ in their respective WLSMV models. Composite reliability and AVE are approximate latent-response quantities.

Within-country, unweighted three-item Cronbach alpha coefficients showed a median of .818 for autonomy (range .649-.922; one country below .70) and .734 for engagement (range .645-.855; 12 countries below .70). Because alpha does not establish equivalence of latent-response thresholds or loadings, we also estimated exploratory multi-group ordinal CFAs over 35 countries. Their results, presented in Section 4.11, indicate a well-fitting configural structure but do not establish full cross-country measurement equivalence. Thus, the pooled measurement model is informative, while strong latent mean equivalence across countries remains unsupported.

4.4. Associations with job demand and job resource

All three management practices showed positive associations with work intensity in the primary model: task allocation β = .081, scheduling β = .058 and monitoring β = .138 (all p<.001). The associations persisted after adding country, occupation and sector fixed effects (β = .084, .052 and .144, respectively). Monitoring had the largest point estimate across these models, but a direct statistical comparison of the coefficients was not conducted.

The autonomy equation differentiated the three functions (Table 4). Task allocation was positively associated with autonomy in the primary model (β = .097, p<.001) and FE model (β = .045, p=.007). Monitoring was negatively associated with autonomy (β=−.060, p<.001; FE β=−.038, p=.014). Scheduling was negatively associated with autonomy in the primary model (β=−.048, p=.004) but not conventionally significant with contextual fixed effects (β=−.027, p=.086). Thus, the two more stable autonomy patterns concern task allocation and monitoring; the scheduling result is context-sensitive.

Table 4
Primary and fixed-effects focal structural relationships

Structural relationship	Primary β	p	FE β	p
Task allocation → Work intensity	+ 0.081	< .001	+ 0.084	< .001
Scheduling → Work intensity	+ 0.058	< .001	+ 0.052	< .001
Monitoring → Work intensity	+ 0.138	< .001	+ 0.144	< .001
Task allocation → Job autonomy	+ 0.097	< .001	+ 0.045	0.007
Scheduling → Job autonomy	-0.048	0.004	-0.027	0.086
Monitoring → Job autonomy	-0.060	< .001	-0.038	0.014
Work intensity → Engagement	-0.196	< .001	-0.200	< .001
Job autonomy → Engagement	+ 0.185	< .001	+ 0.172	< .001
Work intensity → Quit intention	+ 0.207	< .001	+ 0.200	< .001
Job autonomy → Quit intention	-0.015	0.369	-0.044	0.008

Note. β denotes Std.all. p values derive from WLSMV estimation with CALWEIGH. Associations are conditional on the other focal predictors and coded controls; FE columns additionally include country, occupation and sector indicators.

4.5. Work characteristics and employee outcomes

Work intensity was negatively associated with work engagement (primary β=−.196; FE β=−.200, both p<.001) and positively associated with intention to quit (β = .207 and .200, both p<.001). In contrast, autonomy was positively associated with engagement (β = .185; FE β = .172; both p<.001). The autonomy-quit path was not significant in the primary model (β=−.015, p=.369), becoming negative and statistically significant only after contextual fixed effects (β=−.044, p=.008). Accordingly, evidence for the autonomy resource pathway is more consistent across specifications for engagement than for withdrawal intention.

Direct practice-to-outcome paths were relatively small. Task allocation retained a positive direct association with engagement (β = .044, p=.022; FE β = .038, p=.048). Scheduling and monitoring had no significant direct engagement paths in the main dual-path model specifications. The primary direct quit paths were non-significant; scheduling was weakly positively associated with quit intention only in the FE model (β = .033, p=.047). These discrepancies discourage interpretations based solely on direct practice-to-outcome associations.

4.6. Parallel indirect associations with engagement

Table 5 separates the demand-related and autonomy-related engagement pathways. All three work-intensity paths were negative and statistically significant in both models. Through autonomy, task allocation had a positive indirect association with engagement (primary β = .018, p<.001; FE β = .008,

p=.010). Monitoring had a negative autonomy-related indirect association (β=−.011, p<.001; FE β=−.007, p=.015). Scheduling's negative autonomy-related pathway was significant in the primary model but not the FE model (p=.092).

Crucially, task allocation was associated with engagement through two opposing work characteristics: a negative intensity path and a positive autonomy path. In the primary model their combined indirect association was near zero and not significant (β = .002, p=.645); in the FE model the net indirect association was slightly negative (β=−.009, p=.048). The change in the net estimate highlights why pathway-specific and combined coefficients must be presented together. Monitoring's two negative engagement paths instead reinforced each other, yielding significant combined indirect associations in both specifications (primary β=−.038; FE β=−.035). The scheduling combined association was negative in both models, largely because of the robust intensity pathway.

Table 5
Engagement: pathway-specific and combined indirect associations

Practice	Pathway	Primary β	p	FE β	p
Task	via intensity	-0.016	< .001	-0.017	< .001
Task	via autonomy	+ 0.018	< .001	+ 0.008	0.010
Task	combined indirect	+ 0.002	0.645	-0.009	0.048
Scheduling	via intensity	-0.011	< .001	-0.010	< .001
Scheduling	via autonomy	-0.009	0.005	-0.005	0.092
Scheduling	combined indirect	-0.020	< .001	-0.015	< .001
Monitoring	via intensity	-0.027	< .001	-0.029	< .001
Monitoring	via autonomy	-0.011	< .001	-0.007	0.015
Monitoring	combined indirect	-0.038	< .001	-0.035	< .001

Note. Defined parameters are products or sums of WLSMV regression coefficients. Significant component paths do not imply a significant combined indirect association; no causal mediation is identified.

4.7. Parallel indirect associations with intention to quit

In both primary and FE models, the work-intensity route linked each AM function with stronger reported intention to quit (Table 6). Standardised demand-related indirect coefficients were small and positive: roughly .010-.029 across function and specification. By contrast, none of the three autonomy-related indirect paths to quit intention reached the conventional 5% significance threshold in either principal dual-path model specification. Combining the two pathways therefore yielded positive total indirect associations to quit intention that were largely attributable to work intensity. This pattern suggests that

the evidence for autonomy-related indirect associations is more consistent for engagement than for quit intention.

Table 6
Quit intention: pathway-specific and combined indirect associations

Practice	Pathway	Primary β	p	FE β	p
Task	via intensity	+ 0.017	< .001	+ 0.017	< .001
Task	via autonomy	-0.001	0.377	-0.002	0.059
Task	combined indirect	+ 0.015	< .001	+ 0.015	< .001
Scheduling	via intensity	+ 0.012	< .001	+ 0.010	< .001
Scheduling	via autonomy	+ 0.001	0.393	+ 0.001	0.152
Scheduling	combined indirect	+ 0.013	< .001	+ 0.012	< .001
Monitoring	via intensity	+ 0.029	< .001	+ 0.029	< .001
Monitoring	via autonomy	+ 0.001	0.375	+ 0.002	0.063
Monitoring	combined indirect	+ 0.029	< .001	+ 0.030	< .001

Note. The quit variable is ordinal in WLSMV. Standardised model-implied indirect associations should not be interpreted as probability changes or causal effects.

4.8. Same-sample comparison of the single-mediator baseline and dual-path models

When the original work-intensity-only model was re-estimated on the identical 26,504-person sample, its main demand-path coefficients remained closely aligned with those of the dual-path model. Using the same analytical sample allows the baseline and dual-path estimates to be compared without confounding model specification with the exclusion of 169 additional observations. The expanded model changes the direct engagement association for task allocation and separates part of the variation in engagement into a positive autonomy-associated path. Although the dual-path model reports a higher primary CFI than the one-path model (Table 2), the theoretical value of the extension is not the model-fit difference by itself; it is the observed distinction between demand and resource configurations. Given the non-identical measurement structures, no claim of formal overall model superiority is made.

4.9. Quantitative-demands-only robustness

Replacing the broader work-intensity index with the four-component quantitative-demands measure reduced the analytic sample to 26,080. The quantitative-demand paths remained positive for all three managerial functions (primary β = .066, .038 and .105; FE β = .070, .034 and .112; Table 7). Quantitative demands were negatively associated with engagement and positively associated with intention to quit. All six quantitative-demand indirect associations were significant in both primary and FE sensitivity

models, with generally smaller magnitudes than those in the broader-index models. Most importantly for the resource extension, the task allocation-autonomy-engagement association remained positive (QD primary β = .018, p<.001; QD FE β = .008, p=.014), while the monitoring-autonomy-engagement association remained negative (β=−.012, p<.001; FE β=−.007, p=.013). Scheduling's autonomy-related engagement pathway again lost conventional significance under FE.

The narrow-demand results support the interpretation that the primary demand-related patterns are not solely an artefact of the official intensity index's machinery-related pace determinant or its emotional-demand component. Nonetheless, the narrow measure is conceptually narrower and the complete-case sample differs; the two approaches should not be regarded as numerically equivalent measurement forms.

Table 7
Narrow quantitative-demands sensitivity: selected structural and indirect associations

Association	Primary β	p	FE β	p
Task → quantitative demands	+ 0.066	< .001	+ 0.070	< .001
Scheduling → quantitative demands	+ 0.038	0.017	+ 0.034	0.029
Monitoring → quantitative demands	+ 0.105	< .001	+ 0.112	< .001
QD → engagement	-0.112	< .001	-0.112	< .001
QD → quit intention	+ 0.162	< .001	+ 0.148	< .001
Task → autonomy → engagement	+ 0.018	< .001	+ 0.008	0.014
Monitoring → autonomy → engagement	-0.012	< .001	-0.007	0.013
Task → QD → engagement	-0.007	< .001	-0.008	< .001
Scheduling → QD → engagement	-0.004	0.022	-0.004	0.036
Monitoring → QD → engagement	-0.012	< .001	-0.013	< .001
Task → QD → quit	+ 0.011	< .001	+ 0.010	< .001
Scheduling → QD → quit	+ 0.006	0.019	+ 0.005	0.032
Monitoring → QD → quit	+ 0.017	< .001	+ 0.017	< .001

Note. N = 26,080 in both QD models. The full 12 QD/autonomy products are retained in the underlying output CSVs; table prioritises the demand-path tests and two robust autonomy-engagement products. QD models retain latent autonomy and engagement and ordinal quit.

4.10. Complex-survey design-based checks

Design-based survey regressions accounting for calibration weights, 3,547 PSUs and 486 strata preserved the main directional patterns using observed-variable outcomes (Table 8) [40]. In the intensity

regression, task allocation (.088), scheduling (.056) and monitoring (.150) were positively associated with intensity. In the autonomy regression, task allocation was positively associated with the observed autonomy composite (b=.0465, p=.002) and monitoring negatively associated (b = − .0349, p=.026); scheduling's negative coefficient was not significant. Work intensity was negatively associated with observed engagement and positively associated with observed quit intention. The autonomy composite was positively associated with engagement, while its quit association was less conclusive (p=.055). These are not tests of model-implied indirect effects or substitutes for latent/ordinal estimation.

Table 8
Design-based observed-variable regression checks

Association	Coefficient	SE	p
Task → intensity	+ 0.0878	0.0178	< .001
Scheduling → intensity	+ 0.0557	0.0176	0.002
Monitoring → intensity	+ 0.1497	0.0163	< .001
Task → autonomy	+ 0.0465	0.0151	0.002
Scheduling → autonomy	-0.0271	0.0160	0.089
Monitoring → autonomy	-0.0349	0.0156	0.026
Intensity → engagement	-0.1632	0.0154	< .001
Autonomy → engagement	+ 0.1231	0.0176	< .001
Intensity → quit	+ 0.1743	0.0149	< .001
Autonomy → quit	-0.0276	0.0144	0.055

Note. Country, occupation and sector included as fixed effects along with cleaned employee controls. Design-based regression coefficients are not directly comparable with WLSMV Std.all. These estimates do not test the structural model’s indirect associations.

4.11. Cross-national measurement and structural heterogeneity

The 35-country design warrants explicit assessment of whether ordinal engagement and autonomy items function comparably across survey contexts. An unweighted multi-group WLSMV CFA, using the ordinal identification approach of Wu and Estabrook [46], used the same 26,504 observations as the principal dual-path model. Because one country had an empty response cell for work enthusiasm, only the CFA sensitivity analysis combined its two lowest response categories identically in every country. The configural model converged with strong global fit (CFI=.997, RMSEA=.049; Table 9); full threshold equality, however, produced a larger deterioration (CFI=.987, RMSEA=.066). A post-hoc, one-item-per-factor release of the threshold vectors for task-order autonomy and work enthusiasm improved fit (CFI=.991, RMSEA=.060). Adding loading equality constraints to the partial-threshold model yielded

CFI=.987 and RMSEA=.064, representing a modest deterioration relative to the partial-threshold model (ΔCFI = − .004; ΔRMSEA = + .004). These exploratory diagnostics suggest a common configural structure but departures from full threshold invariance; the post-hoc partial-threshold results should be interpreted cautiously and do not establish full cross-country measurement equivalence.

Table 9
Exploratory multi-group ordinal measurement-invariance diagnostics

Specification	CFI	RMSEA	ΔCFI vs configural	ΔRMSEA vs configural
Configural	0.997	0.049	0.000	0.000
Full thresholds	0.987	0.066	−0.010	+ 0.017
Full thresholds + loadings	0.985	0.065	−0.012	+ 0.016
Partial thresholds[1]	0.991	0.060	−0.006	+ 0.011
Partial thresholds + loadings[1]	0.987	0.064	−0.010	+ 0.016

Note. [1]Threshold vectors were freed across countries for auto_order and eng_enth, chosen exploratorily from one-item-release comparisons. The enthusiasm item was collapsed to four response categories for CFA only. All models converged. These are unweighted, non-design-adjusted models; differences are descriptive fit-index changes, not formal evidence that all latent scores are comparable.

Country-by-slope tests in a separate weighted observed-score regression framework were significant jointly for work intensity (Wald $\chi^2(102) = 263.25$), autonomy ($\chi^2(102) = 217.37$), engagement ($\chi^2(68) = 234.10$) and quit intention ($\chi^2(68) = 149.71$), with Holm-adjusted $p<.001$ in every case [47]. At the individual-path level, task allocation-autonomy showed no detected country interaction ($p=.139$); monitoring-autonomy was nominally heterogeneous ($p=.038$) but not after Holm correction of ten focal tests ($p=.075$). Importantly, in 35 leave-one-country-out refits, the pooled coefficients of all ten focal relationships retained their signs. This supports the robustness of the pooled association directions to the exclusion of any single country, while the significant interaction tests indicate cross-country heterogeneity and some country-specific point estimates have opposite signs. All country tests used observed composites rather than latent SEM and remain supplementary. Further details of category handling, exploratory threshold releases and leave-one-country-out coefficient ranges are provided in Supplementary Information, Appendix B.

5. Discussion

The empirical evidence supports a function-specific work-design account of computer-based managerial practices. All three practices were positively associated with work intensity, but their relationships with autonomy differed. Task allocation combined a positive intensity relationship with a positive autonomy relationship; performance monitoring combined greater intensity with lower autonomy. This distinction offers a more precise interpretation of algorithmic management than a single average measure of

technological involvement. It also specifies what a 'double-edged' managerial practice entails: not necessarily uniformly opposite employee outcomes, but two simultaneous work-design associations that can contribute opposing indirect paths to engagement.

The findings integrate, rather than displace, the control and work-design literatures. Platform studies have documented efficiency, flexibility and control within the same algorithmic work systems [7, 9], and scholarship on work design emphasises both demand and resource changes [4, 5]. The positive allocation-autonomy association is compatible with systems that coordinate what needs doing while allowing discretion over execution; the negative monitoring-autonomy association is compatible with evaluative visibility constraining experienced discretion [2, 33]. Neither explanation is directly measured: the EWCS does not record task clarity, system architecture, AI autonomy, supervisor intervention, or the monitoring regime's stated purpose. The empirical contribution is the distinct sign pattern, not proof of these organizational mechanisms.

The demand pathway remained more general across functions and outcomes. Regardless of the management practice, greater work intensity was associated with lower engagement and greater quit intention, and all six demand-related indirect associations remained statistically significant in the primary and fixed-effects models and in the corresponding narrow-demand sensitivity models. This consistency gives work intensity a relatively stable role in interpreting demand-related employee experiences, consistent with JD-R research on the health-impairment process and the work-intensification literature [19, 29]. It does not imply that heightened intensity invariably causes withdrawal: the design remains cross-sectional and unmeasured characteristics may jointly shape computer use, work demands and attitudes. Cross-sectional indirect associations should not be interpreted as evidence of longitudinal mediation processes [48].

The autonomy pathway was not equally general. It was positively associated with engagement in both primary and FE models, but the autonomy-quit association was evident only in FE-adjusted models, and the three AM-to-quit indirect associations through autonomy were not significant in the principal models. This asymmetry is compatible with a more consistent association between autonomy and engagement, whereas quit intention may also reflect contractual security, occupational opportunity structures and broader employment circumstances [25, 26]. These are interpretive possibilities rather than directly observed explanations.

The task-allocation engagement result deserves careful interpretation. Its negative intensity-related indirect association was nearly counterbalanced by its positive autonomy-related association in the primary model; their combined estimate was not significant. Following contextual fixed effects, the autonomy-related path remained positive but smaller, leaving a slightly negative combined indirect estimate at the conventional significance boundary. Reporting only the two significant component paths would exaggerate the net contribution. The theoretically significant observation is that the two work-design routes differ in sign, not that the combined indirect association with engagement is necessarily

large or stable. Monitoring, by contrast, exhibited negative indirect associations through both intensity and autonomy, resulting in a more consistently negative combined estimate.

Recent research has already examined opposing demand- and resource-related pathways between algorithmic control and employee well-being. For example, Zhang et al. [22] examined time pressure and work overload alongside feedback quality and role clarity, with job satisfaction and emotional exhaustion as outcomes. Nor is the prevalence of computer-based management across Europe new evidence in itself [17]. The narrower contribution of this analysis is to differentiate allocation, scheduling and monitoring in the same multi-country employee data, estimate their parallel demand- and autonomy-related engagement pathways, and show that the resource pathway is less consistently related to quitting. The magnitude of the indirect estimates is modest; the analysis therefore clarifies how associations are organised without claiming that the estimated associations are large or universal.

5.1. Theoretical contributions

First, the results refine the unit of theorising: algorithmic management is better distinguished by managerial function when the object of interest is work design. Allocation and monitoring have different autonomy signs even though both are positively associated with intensity. These findings support analysing managerial functions separately when examining work-design associations; they do not by themselves establish whether a common reflective measurement model is appropriate. Function specificity does not deny common organisational features; it identifies the level at which distinct work characteristics can be compared [4, 11].

Second, the results distinguish resource-related and demand-related indirect associations in a way a single-mediator account cannot. The task-allocation engagement association comprises a negative intensity component and a positive autonomy component; their combined indirect association is near zero in the primary model. Monitoring's two engagement components are instead both negative. This countervailing-versus-reinforcing distinction is the central theoretical result. Because the model is cross-sectional and the autonomy extension exploratory, these are model-implied associative configurations rather than verified processes through which algorithms cause subsequent changes in employee attitudes.

Third, the resource pathway is outcome-specific. Autonomy is consistently positively related to engagement, but the three autonomy-related indirect associations with quit intention are not significant in the main models. In contrast, work-intensity indirect associations retain their signs and significance across both outcomes. The distinction discourages equating motivational engagement with withdrawal intentions and suggests that labour-market opportunities, contracts and other omitted influences may shape quitting judgments [25, 26]. Such influences were not directly tested as competing pathways.

Fourth, the geographic scope is a strength with limits. The principal allocation and monitoring patterns were supported across contextual fixed-effects models, narrow-demand sensitivity checks and complex-survey observed-score regressions. In the observed-score framework, all ten focal pooled coefficients

retained their signs when countries were excluded one at a time. At the same time, country-by-slope tests indicate heterogeneity, and multi-group ordinal CFA supports a common configural structure but does not establish full cross-country measurement equivalence. The pooled association directions are therefore robust to the exclusion of any single country, but this does not imply identical structural coefficients or response thresholds across all 35 countries.

5.2. Practical implications

For organisations implementing digital management systems, the findings suggest evaluating allocation, scheduling and monitoring separately. The positive allocation–autonomy association indicates that computer involvement in assigning work can coexist with discretion over execution; however, allocation was also associated with greater work intensity. Monitoring combined greater intensity with lower autonomy. Evaluation should therefore consider employee-reported demands and discretion alongside operational indicators, with attention to how the pattern differs across managerial functions.

Relevant evaluation questions include whether allocation systems concentrate assignments, whether scheduling arrangements permit employee input, and whether performance monitoring accommodates contextual explanations and human review. These questions concern system configuration and organisational governance, rather than the presence of computerisation alone. The present data do not establish the effectiveness of transparency, human oversight or participatory design. Such features should be examined in longitudinal or intervention studies that assess changes in work intensity, autonomy, engagement and withdrawal intention.

6. Limitations and Future Research

Several limitations constrain interpretation. Most importantly, the EWCS is cross-sectional and based on employee reports. The ordered statistical model follows a plausible work-design theory, but it cannot establish that computer-based practices precede changes in demands or resources. Reverse associations are possible: workplaces with intensive work may adopt more monitoring, and employees in highly autonomous roles may be more likely to receive digitally assigned tasks. Common-source measurement can also contribute to observed covariation. Longitudinal designs, implementation discontinuities, organisational records and multi-source studies are needed to test temporal ordering and rival explanations.

Measurement scope is a second limitation. The management items capture employees' reported computer involvement in allocating, scheduling and monitoring, not the exact degree of algorithmic autonomy, AI use, opacity or managerial power. The autonomy items measure order, method and speed discretion and do not exhaust the broader spectrum of worker control. The official intensity index includes multiple pace determinants and emotional demands, potentially raising conceptual-overlap concerns even though the focal AM items are distinct. The narrower quantitative-demands model reduces this concern but cannot solve all common-method or construct-validity issues.

Third, measurement comparability across countries is incomplete. In an unweighted ordinal multi-group CFA, the configural model fitted well (CFI=.997, RMSEA=.049), but full threshold equality worsened fit (ΔCFI = − .010, ΔRMSEA=.017). Releasing the threshold vectors for task-order autonomy and work enthusiasm improved fit relative to the fully threshold-constrained model. Adding loading equality constraints to the partial-threshold model produced a modest further deterioration (ΔCFI = − .004, ΔRMSEA = + .004 relative to the partial-threshold model). These data-driven item releases, the global recoding of enthusiasm solely for CFA and the absence of survey-design adjustment limit conclusions. Full cross-national measurement equivalence and latent-mean comparability are not established.

Fourth, complete-case estimation excludes 4,066 employees relative to the initial employee sample. The sensitivity analysis requires 424 additional omissions. Nonrandom missingness can influence estimates, and future analyses could examine excluded-versus-retained profiles or use survey-compatible missing-data approaches. The final calibration weight supports pooled population inference under the supplied design assumptions but does not by itself eliminate item nonresponse bias.

Fifth, primary latent/ordinal WLSMV models incorporate calibration weights, whereas stratified clustered variance estimation was assessed separately in observed-score regressions. Country-interaction analyses are also based on observed scores, and their test statistics do not demonstrate equivalent latent structural parameters. Although leave-one-country-out estimates retained signs, individual country slopes sometimes differed in direction; significant omnibus heterogeneity argues against uniform country effects. More comprehensive multigroup SEM with defensible partial measurement constraints and survey-design features would strengthen this inference.

Sixth, the autonomy extension arose through theory-guided exploration after examination of the original demand-path results. Its associations should be independently replicated before strong confirmatory claims. Country-level measurement diagnostics and the item releases used for partial threshold invariance are likewise exploratory and susceptible to specification search. Future longitudinal and multi-source work should distinguish task coordination from evaluative control, measure mechanisms such as clarity and feedback directly and test the boundary conditions of work-design pathways.

7. Conclusion

Using weighted EWCS 2024 data for 26,504 employees in 35 European countries, this study found that computer-based allocation, scheduling and monitoring were each positively associated with work intensity, but their relationships with job autonomy diverged. Allocation was positively related to autonomy and displayed opposing indirect engagement associations through intensity and autonomy; monitoring was negatively related to autonomy and displayed reinforcing negative engagement pathways. Demand-related indirect associations were stable for both engagement and quit intention, whereas autonomy-related indirect associations were clearer for engagement than for quitting.

For informatics research and practice, these findings indicate the value of evaluating digital management at the level of specific managerial functions and associated working conditions. Pooled

associations were stable in direction across several checks, but their modest magnitudes, cross-country heterogeneity and incomplete measurement equivalence limit generalisation. Longitudinal studies with direct measures of system capabilities and implementation practices are needed to establish temporal relationships and test whether changes in digital management design improve employee outcomes.

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Competing interests

There are no competing interests to declare.

Author contributions

All authors contributed to the study and preparation of the manuscript, with FAA making the leading contribution. MAA and MS contributed to the development and revision of the manuscript. MAA serves as the corresponding author.

Ethics approval and consent to participate

This study involved secondary analysis of anonymised European Working Conditions Survey 2024 data obtained through the UK Data Service. No participants were recruited or contacted for the present analysis. Additional ethics approval and informed consent were not required for this secondary analysis.

Consent for publication

Not applicable. The manuscript does not report identifiable individual-level information.

Code availability

The analysis scripts and supporting outputs are available from the corresponding author upon reasonable request.

Use of AI-assisted tools

AI-assisted tools were used for language editing, proofreading, manuscript organisation and methodological clarification. The authors reviewed and verified all content and take full responsibility for the final manuscript.

Data availability and analytical transparency

The data analysed in this study are from the European Working Conditions Survey 2024, second edition, distributed by the UK Data Service (Study Number 9511; https://doi.org/10.5255/UKDA-SN-9511-2). The data are available to registered users subject to the UK Data Service End User Licence Agreement. Access requests should be made through the UK Data Service.

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