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# Moments of exhaustion: An experience sampling study of first semester medical students' mental health during exam preparation

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## Abstract

Exam preparation in medical school is often accompanied by stress and emotional exhaustion. While these experiences may vary across individuals and situations, little is known about their temporal dynamics. This study examines within- and between-student fluctuations in stress, emotional exhaustion, and well-being. We assessed workload and associations of emotional exhaustion with study demands and resources. We conducted an 11-day experience sampling study with 95 medical students during their exam preparation. Three-level random slope models (situations, days, students) were used to examine changes in stress, emotional exhaustion, and well-being, moreover relationships between study demands, resources, and emotional exhaustion. Stress and emotional exhaustion increased within-day, while stress remained stable and emotional exhaustion rose slightly across the 11 days. Well-being declined within-day and over the days, and perceived workload increased as exams approached. Higher workload and performance pressure were linked to more emotional exhaustion, whereas self-confidence was associated with lower emotional exhaustion. Stress, emotional exhaustion, and well-being may fluctuate during exam preparation. Strengthening personal resources, particularly self-confidence, and addressing perceived study demands may help support students during demanding periods of medical education. As the findings propose that mental health indicators vary across individuals and over time, interventions should be tailored to individual needs.

## Introduction

Exam preparation in medical education has been identified as a major contributor to mental health problems among medical students, likely due to the large volume of study material and the high performance pressure they face [1–13]. The first examination period is particularly challenging, as it coincides with the difficulties of starting medical school, such as moving away from home, adapting to a new learning environment and forming a new identity as a higher education student [14–16]. Additionally, new examination formats, such as the Objective Structured Clinical/Practical Examination in which students must demonstrate their competences at various consecutive stations [17], has been shown to be anxiety- and stress-inducing, partly because the students are not yet familiar with it [18]. Combined with the academic and psychological demands of starting medical school, these cumulative pressures may contribute to increased stress, emotional exhaustion, and reduced well-being among students [19–30]. Emotional exhaustion, defined as the depletion of emotional resources, represents a central component of burnout and often arises in the first year of medical school [31–36]. Many studies confirm the associations between stress, emotional exhaustion and well-being [20, 37–40]. For example, stress can be seen as a major contributor to low well-being [37, 41, 42]. Moreover, evidence suggests that stress, emotional exhaustion and well-being are not entirely stable but may fluctuate over time—for example, across employees' workweeks or during university students' exam preparation [43–47]. Understanding these fluctuations is important, as single time-point measurements may mask critical short-term changes, peak levels or recovery processes that could be highly relevant for mental health and the development of burnout. Therefore, cross-sectional and retrospective assessments alone may not be sufficient [40]. Although the first examination preparation is known as a major stressor in medical school [48], to our knowledge, there are only a few studies considering mental health during this period within days and situations. One study about psychology students found that upward comparative thinking during exam preparation was associated with more stress over time at the between-person and within-person levels [47]. Another investigation revealed that problematic smartphone use was associated with depression and social interaction anxiety in university students during examination weeks [49]. Moreover, a study found that the effect of emotion regulation strategies on emotions may depend on whether a situation is exam related or not [50].

The present study aimed to investigate within- and between-student changes in stress, emotional exhaustion and well-being across days and situations during the first exam preparation period in medical school. To better contextualise the exam preparation period and its demands, we also gathered information about students' self-reported daily workload for their studies [1]. To provide recommendations (exemplary for interventions) beyond the daily and situational trends of the variables, another objective of this study was to examine the associations of situational emotional exhaustion with daily demands and resources. Based on the assumptions of the study demands–resources model [31], study demands are associated with increases in emotional exhaustion, whereas resources are linked to decreases in emotional exhaustion. For the present study, we examined the following demands: perceived pressure to perform and perceived amount of study and examination material. We also examined the following resources: self-confidence and perceived social support. Previous studies frequently identified these demands and resources as factors associated with mental health in medical students' examination contexts, and they have been examined within the framework of the study demands–resources model [3, 6, 9, 51, 52].

Experience sampling methodology (ESM) is an effective method for analysing fluctuations in mental health indicators between situations, days and individuals. It allows for precise measurement of changes within a person, detection of within-person associations and conclusions at a person's individual level. Participants answer short questionnaires a few times a day referring to the actual moment at which they are responding. Thus, there is less recall bias than in retrospective surveys [53, 54]. ESM can monitor students' daily experiences during exam preparation, identify early indicators of emotional exhaustion and inform the development of time-specific interventions [40]. Against this background, the following research questions guided our analysis:

RQ1. How do stress, emotional exhaustion and well-being fluctuate within days, across days and between medical students during their first exam preparation period?

RQ2. How does self-reported daily workload develop across days during the first exam preparation period of medical students?

RQ3: How do perceived daily demands (pressure to perform and amount of study and examination material) and daily resources (self-confidence and perceived social support) influence momentary emotional exhaustion during the first exam preparation period of medical students?

## Materials and Methods

# Study design and participants

First semester medical students at the University of Augsburg in Germany were invited via email for an 11-day ESM period (19–30 January 2024), which ended seven days before their first exam in medical school. Participation was voluntary and rewarded with either course credit for participation in research studies as a part of their scientific curriculum or, alternatively, monetary compensation. Those who chose not to participate incurred no penalties. The study followed the principles of the Declaration of Helsinki [55], and written informed consent was obtained in advance. The study was reviewed and deemed unproblematic by the ethics committee of the medical faculty of the Ludwig-Maximilians-University Munich (approval code: 21–0711) on 12 January 2020.

Participants received three prompts per day on a smartphone. These prompts were scheduled within predefined time windows: state 1 (9:30 a.m.–1:00 p.m.), state 2 (2:00–5:30 p.m.) and state 3 (6:00–7:30 p.m.). Within each window, the exact time of the alert was randomised, and the questionnaire remained available 45 minutes after the alarm. At the end of each day, the participants completed an evening questionnaire with questions relating to the whole day. Ninety-five first semester medical students ($N$ = 95) with a mean age of 21.07 years ($SD$ = 2.51) participated and were included in the final analysis. Of these, 72.6% ($N$ = 69) were female, 26.3% ($N$ = 25) were male and 1.1% ($N$ = 1) were nonbinary. The predominance of women in our sample is consistent with the overall gender distribution among medical students in Germany [56]. In summary, we included 940 measurements at the day level and 2465 measurements at the situation level. See Fig. 1 for an overview of the study design and level structure.

## Measurements

# State measurements at Level 1 (time)

To keep the questionnaires brief, single-item measures were employed, which have been shown to provide adequate validity for assessing momentary states in experience sampling research [57] and are common in ESM studies [45, 58, 59].

*Stress* was measured using the item ‘How strongly are you experiencing stress at the moment?’, which was rated on a 7-point Likert scale from 0 (‘not at all’) to 6 (‘completely’). The item was conceptually adapted from the ‘Stress/Strain’ scale of the Freiburg Personality Inventory [60].

*Emotional exhaustion* was assessed adapting an item from the German short version of the Maslach Burnout Inventory for students [61] for the experience sampling context: ‘At the moment, studying is a burden for me’. Responses were measured on a 5-point Likert scale ranging from 0 (‘does not apply’) to 4 (‘applies’).

*Well-being* was measured using two items (‘At the moment, I am very balanced’) and (‘I have got everything under control right now’), rated on a 5-point Likert scale from 0 (‘do not agree’) to 4 (‘agree’). For the present experience sampling study, items were adapted from the psychological aspects portion of the short questionnaire on general habitual well-being (FAHW-12) [62].

## Day measurements at Level 2 (day)

*Workload* in hours was measured with the question ‘How many hours did you devote to your studies today?’, and participants could choose between the categorial response options ‘0 to 4 hours’, ‘5 to 8 hours’ and ‘more than 8 hours’.

The demands were assessed with the question ‘What has been bothering you today?’ Participants rated the severity of the perceived strain caused by the *pressure to perform* and the *amount of study and examination material* on a 5-point Likert scale from 0 (‘no strain’) to 4 (‘large strain’).

The resources were assessed using two conceptually adapted items from the Bochum Resource Questionnaire [63]. *Self-confidence* was assessed using the item ‘I coped with everyday life today by looking optimistically towards the future’, while *social support* was assessed using ‘I coped with everyday life today by having people by my side who supported me’. Both items were rated on a 6-point Likert scale ranging from 0 (‘does not apply at all’) to 5 (‘applies completely’).

# Data analysis

The data were analysed with RStudio (2025) using the lme4 package [64]. A descriptive data analysis was conducted for the main variables of interest, including means, standard deviations, skewness, kurtosis and the Shapiro–Wilk test with .97 as the cut-off value for normality [43]. All

models were estimated via maximum likelihood with robust standard errors due to a missing completely at random (MCAR) structure. All predictors had low variance inflation factor values (range = 1.00–1.12), suggesting that multicollinearity was not a concern.

*Evolvement of stress, emotional exhaustion and well-being within days, across days and between medical students (RQ1)*

Among the tested null models, those that allowed for variation between participants and across days provided the best fit according to the likelihood-ratio test ($\chi^2$ = 87.84–109.19, $p < .001$). For RQ1, we first estimated three-level multilevel regression models with fixed slopes and random intercepts (intermediate model). Subsequently, we extended these models to include random slopes in addition to random intercepts (final model) to account for variability in the trajectories of stress, emotional exhaustion and well-being across days and situations. Only for the well-being item ('At the moment, I am very balanced') did a fixed-slope model fit better (see Appendix 1 for the equations of multilevel models). The predictor variables *situation* (Level 1) and *day* (Level 2) were group-mean centred to separate within- and between-level sources of variance. This centring approach allows the effects of situation and day to reflect within-person (and within-day) fluctuations, independent of between-person or between-day differences. Likelihood-ratio tests indicated that adding quadratic terms for situation and day did not improve model fit ($\chi^2$ (0) = 0, $p$ = 1.0), suggesting that including quadratic terms did not add explanatory value.

# Development of workload (RQ2)

The ordinal outcome variable of daily workload was analysed using a cumulative link mixed model with a logit link function to account for the ordered categorical structure of the data. Model comparisons were conducted between a null model, a model that included day as a fixed effect and a model that additionally included random slopes for day across participants. The model with random slopes provided the best fit.

## Association of daily demands and resources with emotional exhaustion (RQ3)

A multilevel regression model was performed to examine the effects of time (situation and day), study-related perceived demands (pressure to perform and amount of study and examination material) and resources (self-confidence and perceived social support) on emotional exhaustion. To separate within- and between-level sources of variance, predictor variables were group-mean centred within individuals. The final model included a random intercept and random slope (see Appendix 1 for the equation of the multilevel model). There was no significantly better fit for a model with quadratic terms for situation and day ($\chi^2$ (0) = 0, $p$ = 1.0).

The report of methods and results was oriented towards the recommendations of Monsalves et al. for reporting multilevel data analyses [65].

## Results

Most variables showed slight to moderate negative skew, indicating higher-value clustering. Kurtosis values ranged from peaked to flat distributions. Consistent with these patterns, the Shapiro–Wilk test (W) indicated significant nonnormality across variables. Descriptive statistics are presented in Table 1.

Table 1
Descriptive statistics of the main parameters of interest

| Variable | Mean (*SD*) | Range | Skewness | Kurtosis | W (*p* value) |
|---|---|---|---|---|---|
| Stress | 3.76 (1.34) | 0–6 | − .48 | − .18 | .93 (< .01) |
| Emotional exhaustion | 3.01 (.97) | 0–4 | − .88 | .30 | .83 (< .01) |
| Well-being 'inner balance' | 1.89 (1.11) | 0–4 | − .03 | − .79 | .91 (< .01) |
| Well-being 'control' | 1.80 (1.11) | 0–4 | .11 | − .72 | .91 (< .01) |
| Amount of study and examination material | 3.30 (.85) | 0–4 | -1.38 | 2.14 | .76 (< .01) |
| Pressure to perform | 2.49 (1.23) | 0–4 | − .46 | − .81 | .89 (< .01) |
| Self-confidence | 2.44 (1.39) | 0–5 | − .12 | − .85 | .93 (< .01) |
| Social support | 3.09 (1.68) | 0–5 | − .56 | − .89 | .88 (< .01) |

Note: stress, emotional exhaustion and well-being on Level 1 (state measurement), amount of study and examination material, pressure to perform, self-confidence and social support on Level 2 (evening questionnaire); Skewness: Statistical measure of the asymmetry of a distribution (positive values indicate right skew; negative values indicate left skew); Kurtosis: Statistical measure of the peakedness and tail heaviness of a distribution (higher values indicate heavier tails).

Next, we examined the correlations between the Level 1 variables (stress, emotional exhaustion and well-being) and the Level 2 variables (demands, resources and workload) separately (see Table 2).

Table 2
**Correlation matrix of the Level 1 (situation) and Level 2 (day) variables**

| 1. | | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. |
|---|---|---|---|---|---|---|---|---|---|---|
| | ***Emotional exhaustion*** | | | | | | | | | |
| 2. | *Stress* | .451** | | | | | | | | |
| 3. | *Well-being (balance)* | − .374** | − .499** | | | | | | | |
| 4. | *Well-being (control)* | − .369** | − .432** | .677** | | | | | | |
| 5. | Amount of study and examination material | | | | | | | | | |
| 6. | Pressure to perform | | | | | .485** | | | | |
| 7. | Self-confidence | | | | | − .246** | − .254** | | | |
| 8. | Social support | | | | | .010 | − .122** | .263** | | |
| 9. | Workload | | | | | .098** | .088** | .044 | .139** | |

Note: * = p < .05, ** = p < .01, *** = p < .001; Spearman rank correlations were performed for workload due to its ordinal data structure

Emotional exhaustion and stress were moderately positively related, while both were significantly negatively associated with well-being (balance and control). Additionally, pressure to perform was positively related to the amount of study and examination material, whereas self-confidence and social support showed small to moderate associations with stress, well-being and workload.

*Evolvement of stress, emotional exhaustion and well-being within days, across days and between medical students (RQ1)*

Table 3 summarises the multilevel model results, including the estimated effects of situation and day on the Level 1 variables. At baseline (18 days before the first relevant exam), students reported high emotional exhaustion and moderate levels of stress and well-being. These values were comparable to the overall mean levels of these variables (see Table 1). Emotional exhaustion showed small but significant increases both within and between days, whereas well-being dimensions declined slightly over time. Stress rose slightly at the within-day level (situation) but did not change significantly over the 11 days. The negative correlation between intercepts and slopes ($\rho = -0.55$) indicated that the stress of students with higher initial stress tended to remain stable, while those with lower initial stress showed stronger increases. As expressed by the ICC, interindividual differences were substantial for stress, emotional exhaustion and well-being, whereas intraindividual, day-to-day fluctuations were smaller. The situation- and day-level predictors explained only a small proportion of the variance in stress, emotional exhaustion, and well-being (0.2–0.8%). However, when differences between students and fluctuations across days were considered, the explained variance increased substantially, reaching up to 65%. This suggests that much of the variation in these outcomes is related to how students differ from each other and how their experiences change from day to day.

Table 3
Multilevel models of stress, emotional exhaustion and well-being

| Intercept | Stress | Emotional exhaustion | Well-being (balance) | Well-being (control) |
|---|---|---|---|---|
| | **3.75*** (3.54–3.95)** | **2.99*** (2.85–.3.13)** | **1.90*** (1.74–2.05)** | **1.80*** (1.64–1.96)** |
| Situation | .06** (.02–.10) | .04* (.00–.07) | − .08*** (-.11–.04) | − .05** (-.09–.01) |
| Day | .01 (.00–.03) | .02*** (.01–.03) | − .02*** (-.04–.01) | − .02** (-.03–.01) |
| $\sigma^2$ | .65 | .41 | .53 | .52 |
| $\tau_{00}$ | .21 $_{participants:day}$ | .12 $_{participants:day}$ | .14 $_{participants:day}$ | .12 $_{participants:day}$ |
| | .99 $_{participants}$ | .45 $_{participants}$ | .56 $_{participants}$ | .60 $_{participants}$ |
| $\tau_{11}$ | .00 $_{participants:situation}$ | .01 $_{participants:situation}$ | | .00 $_{participants:situation}$ |
| $\rho_{01}$ | − .55 $_{participants}$ | .11 $_{participants}$ | | − .06 $_{participants}$ |
| $ICC_{participants}$ | .53 | .46 | .46 | .48 |
| $ICC_{day}$ | .11 | .12 | .11 | .10 |
| AIC | 6829.3 | 5627.2 | 6210.2 | 6135.6 |
| Marginal $R^2$ / Conditional $R^2$ | .002 / .648 | .005 / .587 | .008 / .573 | .004 / .581 |

Note: * = p < .05, ** = p < .01, *** = p < .001; all models included 2465 observations; 95% confidence interval noted in parentheses; $\sigma^2$: residual (within-level) variance; $\tau_{00}$: random intercept variance; $\tau_{11}$: random slope variance; $\rho_{01}$: covariance between the random intercept and random slope; ICC: intraclass correlation; AIC: Akaike information criterion; $R^2$ (Marginal): explained variance of the predictors (only fixed effects); $R^2$ (Conditional): explained variance of the complete model (including random effects); for well-being (inner balance), a model with fixed slopes fitted best.

## Development of workload (RQ2)

On average, 25% of medical students reported studying 0–4 hours per day, 57% reported 5–8 hours and 18% reported studying more than 8 hours per day. A cumulative link mixed model with random intercepts and random slopes indicated that, as days progressed, the odds of medical students falling into a higher workload category (e.g. from 0–4 h to 5–8 h) increased by 11% per day closer to the exam ($b$ = 1.11, 95% CI [1.06, 1.17], $p$ < .001; $OR$ = 3.03, 95% CI [2.89, 3.22]; $N$ = 940 observations).

## Association of daily demands and resources with emotional exhaustion (RQ3)

Table 4 shows the results of the random slope model, which reveal how perceived demands and resources relate to emotional exhaustion. The model indicates that baseline emotional exhaustion varied only slightly between participants and across days within individuals. Situation, day and study-related demands were associated with higher emotional exhaustion, while resources were linked to lower exhaustion, with self-confidence reaching statistical significance. Removing self-confidence from the model did not change the effect of social support, so a reciprocal suppression effect could be ruled out. Overall, the model explained a substantial portion of the variation in emotional exhaustion, with a marginal $R^2$ of 28.9% (explained variance based on fixed effects only) and a conditional $R^2$ of 57.2% (explained variance with the random effects included). The ICCs showed notable variability, both between participants and across days.

Table 4
Effects of situation, day, daily demands and daily resources on emotional exhaustion

| ***Predictors*** | ***Estimates*** |
|---|---|
| (Intercept) | 3.00*** (2.91–3.09) |
| Situation | .04** (.01–.08) |
| Day | .02** (.01–.03) |
| Amount of study and examination material | .07** (.01–.13) |
| Pressure to perform | .1*** (.05–.15) |
| Self-confidence | − .06** (-.10–.03) |
| Social support | − .02 (-.05–.01) |
| $\sigma^2$ | .41 |
| $\tau_{00}$ | .10 $_{participants:day}$ |
| | .16 $_{participants}$ |
| $\tau_{11}$ | .00 $_{participants:situation}$ |
| $\rho_{01}$ | − .07 $_{participants}$ |
| $ICC_{participants}$ | .24 |
| $ICC_{day}$ | .15 |
| AIC | 5150.9 |
| Observations | 2307 |
| Marginal $R^2$ / Conditional $R^2$ | .289 / .572 |

Note: * = p < .05, ** = p < .01, *** = p < .001; *N* = 2307 observations; $\sigma^2$: residual (within-level) variance; $\tau_{00}$: random intercept variance; $\tau_{11}$: random slope variance; $\rho_{01}$: covariance between the random intercept and random slope; ICC: intraclass correlation; AIC: Akaike information criterion, $R^2$ (Marginal): explained variance of the predictors (only fixed effects), $R^2$ (Conditional): explained variance of the complete model (including random effects).

## Discussion

This study examined how the mental health of medical students developed across the first examination period, with a particular focus on the relationships between perceived demands, perceived resources and emotional exhaustion. The present findings can provide a valuable basis for developing targeted support and intervention strategies for medical students.

# Development of emotional exhaustion, stress, well-being and workload

Our findings may indicate that stress, emotional exhaustion and well-being among medical students are not uniform; instead, they show slight fluctuations depending on proximity to examinations and across the course of the day—patterns that have received little attention in prior research. Our ESM assessment period ended seven days before the first exam. It is therefore possible that stress and emotional exhaustion increased further during this final week beyond the levels observed during the 11 days of the assessment [2]. We deliberately chose to end the assessment one week before the exam to avoid placing an additional burden on students during this particularly demanding period.

The present study suggests that the explained variances in stress, emotional exhaustion and well-being were small when the predictors of situation and day were considered without random effects. This pattern is consistent with findings from studies on working employees, in which time (local clock time, internal time and time since awakening) without random effects accounted for only about 3% of the variance in emotional exhaustion [43]. However, when including random effects, these predictors accounted for a substantial part of the variance (up to 65%).

The variability across individuals may reflect differences in coping strategies, resilience or personal circumstances, suggesting that some students are more vulnerable to examination-related stress than others [8, 66]. The steadily increasing self-reported workload during the 11-day ESM period suggests that medical students intensify their study efforts as the exam approaches, which is consistent with prior findings [67, 68]. Considering the already stressful period at the start of medical studies, this may indicate that as the days towards an exam progress, medical students experience cumulative strains that can lead to lower well-being. A possible step to increase well-being is to investigate the factors associated with emotional exhaustion. The following section discusses some of these factors and their potential impact.

## Associations of emotional exhaustion with perceived demands and resources

In line with the study demands–resources model [31], our findings suggest that students report higher within-day emotional exhaustion in several situations on days when they perceive higher demands and fewer resources, and vice versa. The positive association between emotional exhaustion and daily demands is supported by a diary study [69].

The results highlight self-confidence as a key resource that could help protect against emotional exhaustion. Gottlieb et al. [70] define self-confidence as a person's general trust in their ability to choose appropriate courses of action and to complete them successfully. The authors distinguish between self-confidence, a global belief in one's competences, and self-efficacy, which typically refers to task-specific capability belief. Given that the first exam preparation is highly demanding and that the exams have unfamiliar formats, both self-confidence and self-efficacy may help students perceive this period as more manageable, which could be reflected in lower momentary emotional exhaustion. Regarding previous research [71, 72], at first, it was surprising that there was no significant association between social support and emotional exhaustion. Evidence suggests that social support is not always beneficial and can even be harmful, as shown in a study on unhelpful workplace social support, such as when it conveys the message 'You can't do this on your own' [73]. This indicates that the effects of social support are multidimensional and not universally positive. However, due to the brevity required of ESM questionnaires, social support could not be assessed multidimensionally in this study, which may have affected the results [74].

## Theoretical and practical implications

The findings that stress, emotional exhaustion and well-being fluctuate slightly but significantly between days and situations during exam preparation constitute a first step towards understanding the developmental trajectories of mental health in this context. We recommend that future studies explore the contextual and social determinants of change to advance theories at the intraindividual level. To further investigate interindividual variability in mental health, profile analyses could be conducted to identify potential patterns or subgroups among participants, which may help in the planning of more targeted interventions.

Because both perceived demands and self-confidence explained a notable amount of variance in emotional exhaustion ($R^2$ = .289), it is worth discussing how demands can be reduced and how self-confidence can be bolstered during the first examination preparation in medical school. Interventions to foster medical students' mental health during exam preparation should not only aim to promote general self-confidence and self-efficacy or reduce general performance pressure but also provide resources that take daily fluctuations into account. For example, research has shown that maintaining a success diary, in which students record expressions of gratitude and set personal goals, may enhance their self-efficacy and overall well-being [75]. Since stress, emotional exhaustion and well-being can vary depending on the individual and the situation [76], it seems sensible to develop flexible and customisable steps that help students recognise their own critical situations and apply appropriate coping strategies. Thus, another possible intervention is a transforming stress programme in which students can learn to diminish their own major stressors and develop individual coping strategies [77]. One possibility for building up the self-confidence of medical students is peer-led exam practice [78]. Confidence in one's abilities may lead to perceiving demands less as a burden and more as an opportunity for growth [3, 79]. To address the demands, a recent review showed that medical students with surface-related learning strategies tend to struggle with workload and pressure [80]. Encouraging strategic and deep learning approaches tailored to students' motivation and learning environments could therefore support effective workload management and result in less pressure during exam preparation. This could be achieved by, for example, supporting students in developing awareness of the processes underlying effective learning [80].

## Limitations

Our approach to examining the momentary development of stress, emotional exhaustion and well-being in the first exam preparation of medical students has some limitations. Most importantly, the nonexperimental design of our study allows for correlational but not causal statements about the relationships between the observed variables [81]. Conducted within one medical school, this study offers valuable insights that may also inform other study programmes, but it is possible that other sites will show differences. Therefore, it is necessary to repeat this study with other target groups and in different locations. Because of the time-consuming survey and the fact that participation was voluntary, it is possible that very exhausted students chose not to participate, which could have biased the results [82]. Finally, because our ESM analysis relied on single-item measures, the results may have limited construct coverage, which could reduce reliability [83].

### Conclusions

This study advances our understanding of stress, emotional exhaustion and well-being changes during the first exam preparation in medical school. The results indicate that these factors are not entirely stable but fluctuate both between and within days leading up to the exam, although the overall effect of situation and day was small. Importantly, our findings suggest that variability in emotional exhaustion may be partially accounted for by fluctuations in perceived study demands and available resources. Of these, self-confidence seemed to be particularly helpful in lowering emotional exhaustion. The results highlight the need to consider both personal and situational factors in supporting medical students' mental health and suggest that interventions aimed at enhancing daily resources or managing perceived demands may help buffer emotional exhaustion during exam preparation.

## Declarations

**Author Contributions**

SJ: analysis, data interpretation and drafting the manuscript. AS: conception, funding acquisition, advising and revision. TR: conception, funding acquisition, advising and revision. UN: conception, funding acquisition, advising and revision. NK: data acquisition, advising and revision. TB: data acquisition, advising and revision. MD: conception, funding acquisition and revision. IK: conception, funding acquisition and revision. MK: data interpretation, advising and substantial revision.

All authors have approved the final version for publication and agree to be accountable for all aspects of the work to ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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**Data availability statement**

The data that support the findings of this study are available from the corresponding author [SJ] upon reasonable request. The data are not publicly available because they contain sensitive health-related information and are subject to data protection regulations and institutional data storage requirements.

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**Disclosure of interest statement**

The authors report that there are no competing interests to declare**.**

**Ethics approval and consent to participate**

The study followed the principles of the Declaration of Helsinki [1], and written informed consent was obtained in advance. The study was reviewed and deemed unproblematic by the ethics committee of the medical faculty of the Ludwig-Maximilians-University Munich (approval code: 21–0711) on 12 January 2020.

**Consent to Publish declaration**

Written informed consent for publication was obtained by the participants in advance.

**Declaration of generative AI use**

The authors report generative AI was not used in their research or preparation of this manuscript.

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