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Author(s): Jõgi, Anna-Liisa; Aulén, Anna-Mari; Pakarinen, Eija; Lerkkanen, Marja-Kristiina

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ARTICLE

Teachers' daily physiological stress and positive affect in relation to their general occupational well-being

Anna-Liisa Jõgi[1,2] | Anna-Mari Aulén[1] | Eija Pakarinen[1] | Marja-Kristiina Lerkkanen[1]

[1]Department of Teacher Education, University of Jyväskylä, Jyväskylä, Finland

[2]School of Educational Sciences, Tallinn University, Tallinn, Estonia

Correspondence

Anna-Liisa Jõgi, School of Educational Sciences, Tallinn University, Narva mnt 25, Tallinn 10120, Estonia.
Email: aljogi@tlu.ee

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Abstract

Background: Teachers' stress, affect and general occupational well-being influence their teaching and their students. However, how teachers' daily physiological stress and positive affect are related in the classroom is unknown. To reduce teachers' stress and enhance their positive affect, it is crucial to understand how occupational well-being relates to stress and affect.

Aim: The aim of the study was to examine the relationships between teachers' daily physiological stress and positive affect in authentic classroom settings and the roles played by teachers' self-efficacy beliefs, perceptions of school climate and burnout symptoms in daily stress and affect.

Sample: The sample consisted of 45 classroom teachers.

Method: Daily physiological stress was assessed by measuring salivary cortisol levels three times in two days. Positive affect was reported by experience sampling at the same time that cortisol was collected. Questionnaires were used to assess self-efficacy beliefs, perceptions of school climate and burnout symptoms. Three-level modelling with random intercepts and slopes was used to analyse the relationships between daily stress and affect and the effect of teachers' general occupational well-being on stress and affect.

Results: No relationships were evident between teachers' physiological stress and positive affect or between daily changes of stress and affect. Self-efficacy beliefs were related to lower stress and higher affect in the middle of the school day. Having sufficient school resources were related to higher positive affect. Teachers' burnout symptoms were associated with lower positive affect.

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Conclusions: We emphasize the potential for self-efficacy and perceptions of school resources as targets for intervening in teachers' stress and affect.

KEYWORDS
classroom teachers, daily assessment, occupational well-being, physiological stress, positive affect

BACKGROUND

Teaching is widely considered as one of the most stressful occupations (Broughton, 2010; Johnson et al., 2005). Teachers' well-being influences their teaching practices, interactions with students and, thus, students' academic and social development (Jennings & Greenberg, 2009; Schussler et al., 2016; Virtanen et al., 2019). In discussions of teachers' well-being, the aspects raised most often are teachers' stress and emotional arousal (Jennings et al., 2013; Lavy & Eshet, 2018). In recent studies of similar stressful occupations, other factors of well-being, such as self-efficacy beliefs, perceived organizational climate and burnout symptoms versus resilience, have been pointed out (Olson et al., 2019; Zeng et al., 2020). These aspects of well-being can be treated as resource gains and resource losses that teachers have or experience while coping with stressful events (Holmgreen et al., 2017). These facets also cover the professional, organizational and workload aspects of well-being, as addressed in previous studies in the school context (Collie et al., 2015; Jennings et al., 2013; van Horn et al., 2004).

Although teachers' stress and well-being in general have been widely studied, questions regarding the ecological validity of measuring well-being, the need for studies to be conducted in natural settings and the use of objective measures along with self-reports have been raised (Francis et al., 2017; Linz et al., 2018). Therefore, our research contributes to this novel and indispensable area by studying teachers' daily physiological stress and emotions in an authentic classroom context and as a response to both resource gains and resource losses and thus as indicators of well-being (see also Collie et al., 2015; Hobfoll, 2010; Holmgreen et al., 2017; Wettstein et al., 2020).

Specifically, we first aimed to study the relationships between teachers' daily physiological stress, as an indicator of physiological well-being and a response to resource loss, and daily positive affect, as an indicator of emotional well-being and a response to resource gain. Our second aim was to investigate the role played by teachers' self-reported individual-level (self-efficacy beliefs) and contextual level resource gains (perceptions of school climate) and individual-level resource losses (burnout symptoms) in relation to stress and positive affect.

Conservation of resources theory on teachers' occupational well-being

According to the Conservation of Resources Theory (COR), the effect of stressful events on teachers' well-being depends on their resilience, specifically on their resource gains and losses (Hobfoll, 2010). As resource gains and losses form a link between stressful events and the outcomes of stress, these are the crucial factors for intervening regarding the effect of a stress causing event (Holmgreen et al., 2017). Compared to the prominent Job Demands and Resources Theory (JDR; Demerouti et al., 2001), the COR is broader and emphasizes strongly individual resources next to the contextual ones and has complemented the understanding of teacher well-being (see Hsieh et al., 2021). In literature, these theories have been used either as hierarchical showing that JDR is a practical and workplace-focused version of COR (Hsieh et al., 2021) or as overlapping one (Bettini et al., 2020).

Teachers' response to the stressful events and, therefore, their well-being depends on both their individual and contextual resources, which are likely to complement each other and accumulate (Holmgreen

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et al., 2017). If teachers have less individual resources in a stressful situation, they seek for more resources from the school environment (Hsieh et al., 2021). Earlier research has further shown that teachers with more resources are more willing to continue their careers at school (Bettini et al., 2020).

Teachers' physiological stress

Teachers' stress is an interplay between personal and environmental factors (Lazarus & Folkman, 1984; Montgomery & Rupp, 2005). Stress is rooted in the relationship between teachers and their environment and depends on teachers' evaluations of their environment's demands and the resources available to cope with these demands (Lazarus & Folkman, 1984). Stress in itself is indiscernible but we can capture the consequences of stress (Schlotz, 2019). Perceptions of a stressful situation are expressed in objective physiological stress measures such as cortisol level, while subjective self-reported measures refer to one's own evaluations of their coping opportunities (Weckesser et al., 2019). An ongoing need to extend methodological borders in teachers' stress studies has been widely emphasized, including adding the physiological stress as a measurement indicator (Francis et al., 2017; Weckesser et al., 2019; Wettstein et al., 2020).

Physiological stress is widely studied through hypothalamic–pituitary–adrenal (HPA) axis activity. Cortisol release in the HPA axis is a stress response that affects the brain, metabolism and the immune system (Black, 2002; Kudielka et al., 2012). In addition to the acute stress response, increased cortisol levels can indicate chronic stress and alteration in the cortisol feedback system (Herman et al., 2016). Typically, cortisol release has a normal biological diurnal rhythm, being higher in the morning and declining during the day. Both situational cortisol levels at certain time points and diurnal decline (slope) are indicators of physiological stress (Adam et al., 2017; Adam & Kumari, 2009).

A few studies have investigated teachers' physiological stress using salivary cortisol as an indicator (Katz et al., 2018; Nislin et al., 2016; Schwerdtfeger et al., 2008). Among these, research has shown that teachers' self-reported work stress may or may not be related to their physiological stress or its changes over time and has proposed that physiological stress is a different aspect of stress that should be included in teachers' stress and well-being studies (Katz et al., 2018; Wettstein et al., 2020). In view of this, we studied teachers' objective stress in authentic classroom situations, examining HPA axis activation as a physiological stress measure indicating the level of their physiological well-being and their resource loss (Dettmers et al., 2016; Holmgreen et al., 2017; Volmer & Fritsche, 2016). Thus far, it has been shown that teachers' cortisol levels are higher in the working days compared to the weekend (Wettstein et al., 2020). Teachers feeling higher job strain at school typically have higher physiological stress (Steptoe et al., 2000). However, studying teachers' physiological stress in authentic classroom situations is in its initial stages, especially using both situational cortisol levels during the school day and cortisol decline during the day simultaneously. We used both in the current study as indicators of teachers' response to their resource loss.

Teachers' positive affect

Teachers' positive affect refers to their enjoyment and positive engagement with the classroom environment (Crawford & Henry, 2004). High positive affect consists of vigour and attention directed at something agreeable while low positive affect leaves a person under gloominess and apathy (Watson et al., 1988). Positive affect is a valuable asset for resource accumulation as it helps to broaden an individual's resources, thereby ameliorating their concentration, thought processes and ability to act and interact in a purposeful manner (Fredrickson, 2001; Holmgreen et al., 2017). In order to evoke positive feelings, something favourable indicating a movement towards one's goals must occur in this relationship regarding one's well-being and goals and affect refers to one's subjective and conscious experiences of that emotional encounter (Fredrickson, 2001; Lazarus, 1991). Teachers' emotions and affect in the classroom

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are influenced by situational factors; however, they also depend on their general well-being and teaching practices (Keller et al., 2014; Sutton, 2004).

We addressed situational positive affect as an indicator of teachers' daily resource gain. Its circadian rhythm is highest around midday and lower in the late afternoon and in the evening (Murray et al., 2002; Virtanen et al., 2021). Moreover, the decline in positive affect is steeper for healthier people (Murray, 2007). Therefore, it is beneficial for teachers to have a high positive affect in the classroom during the workday, and in the evenings, to relax and let go of high levels of alertness and excitement (Murray, 2007; Steptoe et al., 2009).

Interplay between physiological stress and positive affect

Teachers' stress and emotions both have a situation-specific aspect and are reciprocally related (Montgomery & Rupp, 2005; Sutton, 2004). Lower neuroendocrine arousal and higher emotional well-being have been consistently shown to be related, although the causal direction or the mechanism between these links is not known (Joseph et al., 2021; Steptoe, 2019; Steptoe & Wardle, 2005). Studies exploring the relationships between daily physiological stress and affect in nonclinical samples have mostly revealed that positive affect is related to lower cortisol levels and concluded that emotional well-being is related to physiological health (Sin et al., 2017; Steptoe, 2019; Steptoe et al., 2009). It is worth noting that these results are mostly based on the daily average affect. Still, the recent meta-analysis of within-person relations between physiological stress and affect indicted that there is a positive but small effect between these measures in a situation—increases in positive affect were related to decreased cortisol secretion (Joseph et al., 2021). However, these results may depend on physiological stress indicators and possible covariates. For example, positive affect might be related to lower cortisol levels only if a person is in a non-stressful situation (Linz et al., 2018). To the best of our knowledge, no studies thus far have focused on the relationships between teachers' daily physiological stress and affect in classroom settings by addressing, firstly, both the normal physiological decline in daily cortisol levels and the changes in positive affect over the day and, secondly, both within- and between- person variation in teachers' cortisol levels and affect.

Role of general occupational well-being in physiological stress and positive affect

Teachers' well-being is a multidimensional concept that can be addressed through several constructs that constitute different resource gains or resource losses (Holmgreen et al., 2017). Most commonly, well-being refers to the gains and losses in professional, organizational and workload aspects, such as interpersonal self-efficacy beliefs, perceptions about the school environment and a presence or lack of energy and strength (Collie et al., 2015; Hamama et al., 2013; Malinen & Savolainen, 2016; van Horn et al., 2004). All these resource gains are supporting and resource losses restricting the teachers' living well and hence their eudaimonic well-being (see Ryan & Deci, 2001 for a review).

Self-efficacy indicates teachers' beliefs about their professional skills and abilities to organize students' learning, even if it might be challenging at times (Tschannen-Moran & Hoy, 2001). Self-efficacy, as a feeling of professional competence, is one of the key components of well-being as well as a powerful personal resource (Dicke et al., 2018; Hobfoll, 2010; van Horn et al., 2004). Hence, self-efficacy is usually considered a protective factor against stress (Schönfeld et al., 2017). Teachers who believe in their ability to manage the classroom and engage students feel less work-related stress in general (Zee & Koomen, 2016). Believing less in one's skills, in turn, is related to teachers' higher physiological stress, as well as to lower positive affect (Burić & Moè, 2020; Ringeisen et al., 2019; Schwerdtfeger et al., 2008; Taxer & Frenzel, 2015).

Teachers' perceptions about school climate, including their relationships with colleagues, emerge as one of the most prominent factors when teachers explain their understanding of the construct of well-being

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(Paterson & Grantham, 2016) and can, therefore, be considered as another, yet contextual, resource for teachers. School climate emphasizes the importance of the working environment in addition to the individual aspects of well-being (Cumming, 2017). In particular, organizational connectedness, collaboration and collegial support can reduce the effect of everyday stressors and enhance teacher well-being (Collie et al., 2015; Cumming, 2017; Olson et al., 2019). The feeling of being supported by colleagues and school leaders has been found to be related to teachers' higher self-efficacy (Aldridge & Fraser, 2016; Malinen & Savolainen, 2016). Better perceived relationships with students, as well as sufficient school resources, are related to less work-related stress in teachers (Collie et al., 2012). Higher perceived support from the school leader and colleagues is also related to teachers' positive affect (Brackett et al., 2010; Hamama et al., 2013).

Burnout symptoms refer to a serious psychological burden and are considered a core component of a lack of well-being, thus indicating a severe resource loss (Hobfoll, 2010; Jennings et al., 2013; Schussler et al., 2016). A recent meta-analysis showed that teachers' burnout symptoms are strongly related to higher stress (Park & Shin, 2020), although the stress indicators used in the referenced studies were mostly self-reported. Still, the relationship between higher cortisol levels and more burnout symptoms have been demonstrated in other samples (Traunmüller et al., 2019). Higher burnout or exhaustion is also linked to teachers' lower positive affect at the individual level (Brackett et al., 2010; Taxer & Frenzel, 2015). Burnout also predicts emotions in the classroom, such as lower situational enjoyment (Keller et al., 2014).

Aims of the present study

The aim of the study was to examine teachers' daily physiological stress as a response to the resource loss and their daily positive affect as a response to the resource gain in real-life contexts during and after the school day. In addition, we aimed to study the effect of different aspects of teachers' general occupational well-being, such as self-efficacy as an individual resource gain and perceptions of school climate as a contextual resource gain and burnout symptoms as an individual resource loss concerning teachers' stress and affect over the day (see Figure 1 for a theoretical model). Our specific research questions were as follows:

RQ 1. How are the initial level and the daily slope of teachers' physiological stress related to the initial level and the daily slope of their positive affect? Recent meta-analysis showed that higher situational cortisol levels are related to the lower situational positive affect (Joseph et al., 2021). We also know that more depressive symptoms experienced by a person are related to the smaller decline in positive affect during the day (Murray et al., 2002). Therefore, we assumed that greater physiological stress is related to feeling less positive affect in the middle of the school day, and that a steeper cortisol slope from the middle of the school day till the evening is related to the flatter slope in positive affect.

RQ 2. How are the individual (self-efficacy) and contextual (school climate) resource gains and individual resource losses (burnout symptoms) related to the initial level and the daily slope of physiological stress and positive affect of teachers? Few studies that have tackled physiological stress and occupational well-being so far indicate that higher self-efficacy is related to lower cortisol levels (Ringeisen et al., 2019; Schwerdtfeger et al., 2008) and more burnout symptoms to the higher physiological stress (Traunmüller et al., 2019). Studies addressing self-reported stress and occupational well-being have shown that better school climate is related to the lower stress (Collie et al., 2012). Higher self-efficacy (Burić & Moè, 2020), lower burnout symptoms (Taxer & Frenzel, 2015) and better school climate (Brackett et al., 2010) are shown to be related to teachers' higher positive affect. We assumed that higher self-efficacy and higher school climate would be related to lower cortisol levels and flatter cortisol slopes and that higher burnout would be related to higher cortisol levels and steeper cortisol slopes. We also expected that a higher self-efficacy and school climate are related to higher positive affect and a steeper decrease of affect towards evening and that higher burnout is related to lower positive affect and a flatter decrease of affect towards evening.

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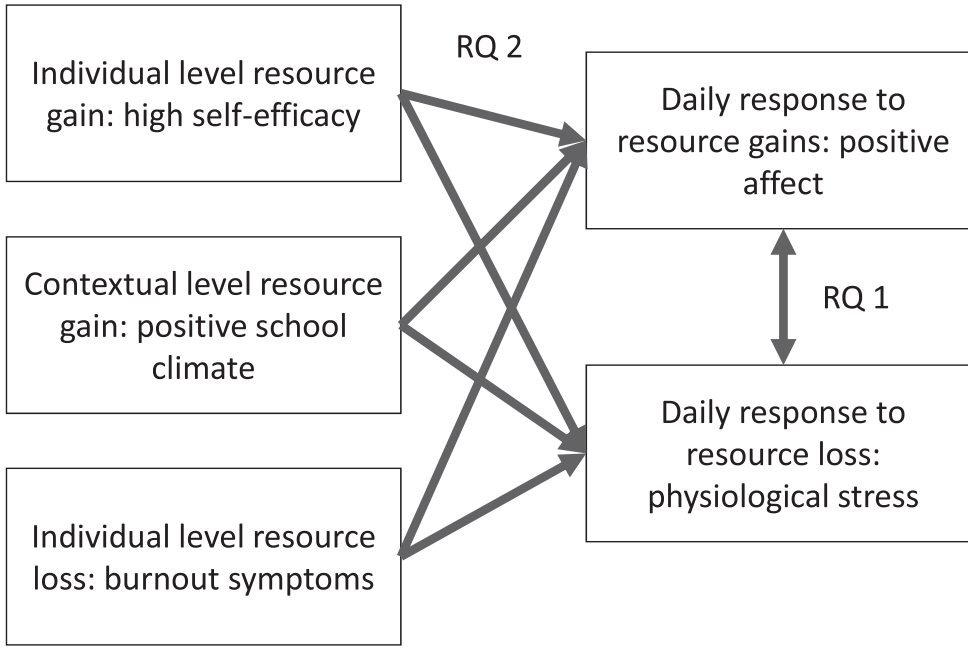

FIGURE 1 Hypothesized relations between variables. *Note*: RQ 1 = research question 1, RQ 2 = research question 2.

METHOD

Participants and procedure

This study was part of a longitudinal research project aimed at investigating teachers and students' stress and interactions in primary schools. The ethics committee of the university approved the study. Public schools were recruited on a voluntary basis from five municipalities in Central Finland. Grade 2 teachers from schools that agreed to participate in the larger project formed the sample of the current study. At the beginning of the study, the sample consisted of 50 Grade 2 classroom teachers from 37 schools (aged 24–63, three male, all with an MA degree in education). All teachers gave written consent to participate in the study. Four teachers were excluded from the further analysis because they did not provide any valid cortisol samples and/or none of their answers to the experience-sampling questionnaire complied with the timing of cortisol sampling. One teacher did not answer the well-being questionnaire. Therefore, data from 45 teachers were included in the analyses.

Data were collected in the middle of the spring semester. Physiological stress and positive affect data were collected during two consecutive school days (Day 1 and Day 2). Trained research assistants personally instructed all participating teachers to take cortisol samples and answer the experience sampling and the general occupational well-being questionnaire. The teachers also received a text message reminder about the cortisol sampling and experience-sampling questionnaire before each measurement point.

Measures

Physiological stress

Salivary cortisol was used as a physiological stress indicator. Saliva samples were collected using synthetic Salivette® Cortisol swabs (Sarstedt) and assayed in Dresden LabService GmbH using the Cortisol Lumi-

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nescence Immunoassay (CLIA RE62011; IBL International). Inter-assay variation (CV%) of cortisol samples was below 7%. In total, the teachers gave six salivary cortisol samples per day on two consecutive working days: upon awakening (T1), 30 min after awakening (T2), 45 min after awakening (T3), in the middle of the school day (approximately 10 am; T4), at the end of the school day (T5) and before bedtime (T6).

Data screening revealed that a number of teachers had negative cortisol awakening responses ($n = 5$ on Day 1 and $n = 7$ on Day 2), most probably indicating protocol noncompliance during post-awakening sampling (Smyth et al., 2013; Stalder et al., 2016). Thus, for the sake of the reliability of cortisol data, we omitted the three post-awakening cortisol samples. In further analyses, we used samples from T4, T5 and T6 from both days.

Cortisol observations violating eating restrictions ($n = 11$), taken on the wrong day ($n = 1$) or larger than 73 nmoL/L ($n = 1$) were excluded from the analyses (Miller et al., 2013). Raw cortisol values (nmol/l) were transformed because of the positive skewness of the data ($X' = X^{.25}$; Miller & Plessow, 2013). Higher cortisol levels at T4 (10 a.m.) were interpreted as indicating higher physiological stress (Adam & Kumari, 2009). Steeper daytime cortisol slopes from 10 a.m. until bedtime were interpreted as indicating higher physiological stress (Ferguson, 2008). It is important to note that we used the later decline measure and not the daily slope from awakening, which has the opposite interpretation (Adam et al., 2017).

Positive affect

Positive affect was measured using a short version of the Positive and Negative Affect Schedule (PANAS; Crawford & Henry, 2004; Hietalahti et al., 2016), capturing determination, attentiveness, activeness, alertness and excitement in the situation. Teachers were asked to rate on a 5-point Likert scale how much each of the five items applied to them at that particular moment. The mean value of the five items was used as an indicator of positive affect. Questionnaires were sent to the teachers' smartphones four times a day at the approximate time of cortisol sampling. One teacher filled out the PANAS on a personal computer. In further analysis, we used three observations per day in compliance with cortisol measurements at T4, T5 and T6.

PANAS observations closer than 15 min from the previous observation were excluded (19 out of 248 observations). Next, observations were considered in compliance with cortisol sampling if the teachers had rated their affect 60 min before or after saliva sampling. In total, we included 185 observations of positive affect from three time points per day (a total of six times) in the analyses.

We interpreted a high positive affect in the middle of the working day (T4) as beneficial for teaching quality and interaction with students, as teachers' positive affect has been shown to be positively related to their teaching efficacy and enthusiasm in the classroom and negatively to their exhaustion (Burić, 2019; Burić & Moè, 2020; Keller et al., 2014). A steeper positive affect slope over the day was interpreted as healthy and instrumental, as this indicated that teachers' alertness and activeness had been higher at the initial level, but decreased by bedtime.

General occupational well-being

Teachers' general occupational well-being was studied by means of self-efficacy, perceptions of school climate and burnout symptoms. Self-efficacy was measured using the Teachers' Sense of Efficacy Scale (Tschannen-Moran & Hoy, 2001). The subscale of efficacy for instructional strategies (8 items, $a = .92$) indicated belief in one's teaching skills and abilities to find suitable instruction for every student. Self-efficacy for classroom management (8 items, $a = .86$) referred to belief in one's abilities to control students' behaviour in the classroom and solve discipline problems. Self-efficacy for student engagement (8 items, $a = .90$) indicated belief in one's abilities to motivate students, help those who are struggling and foster their thinking skills and creativity. All three subscales were measured on a 9-point Likert scale.

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School climate was measured using the School Climate and Resources Scale (Johnson et al., 2007). Collaboration (6 items, $a = .92$) indicated perceptions of cooperation, open communication and teamwork with colleagues. Student relations (4 items, $a = .82$) referred to perceptions of students being motivated and behaving well at school in general. School resources (5 items, $a = .70$) stood for perceptions of accessibility and sufficiency of equipment and resources needed for teaching and supporting students. One item ('There is sufficient access to school health care, a school psychologist and a school counsellor') was added to the original subscale, referring to one of the most important resources Finnish schools are currently lacking (Organization for Economic Co-operation and Development [OECD], 2014). Decision-making (3 items, $a = .66$) indicated teachers' perceptions of their involvement in school management. Instructional innovation (4 items, $a = .87$) referred to the implementation of new teaching approaches and materials at school. All five subscales were measured on a 5-point Likert scale.

Burnout symptoms were measured using the Bergen Burnout Inventory (Salmela-Aro et al., 2011). Exhaustion (3 items, $a = .73$) referred to feelings of being overworked and tired. Cynicism (3 items) indicated a feeling of worthlessness and a lack of interest in one's work. Inadequacy (3 items, $a = .74$) indicated not valuing or expecting much from one's job and feeling unappreciated as a teacher. All three subscales were measured on a 6-point Likert scale.

Control variables

Teachers' cortisol and its slope were controlled for teachers' age and usage of steroid medications at the teacher level. Four teachers reported using steroid medications in the final sample. A dummy variable (1 = using, 0 = not using) was used as an indicator of medication usage. Age was used as a z-score.

Descriptive of all measures used in the study are provided in Table 1.

Analysis strategy

Statistical analyses were conducted using the Mplus 7.4 package (Muthén & Muthén, 1998–2015). Three-level models with random intercepts and slopes were used to analyse the variations and relationships between physiological stress and positive affect and the relationships between teachers' general occupational well-being and both stress and affect. A three-level model with time-dependent random slopes allowed for capturing variations of situational measures within-day, between-days and between teachers (Gilbert et al., 2017; Hruschka et al., 2005; Katz et al., 2018).

At the within-day level (level 1), the random slopes were estimated for both cortisol concentration and positive affect score, regressed on the sampling time from awakening in hours. At the day level (level 2), the variances of initial levels and slopes of cortisol and positive affect were modelled. At level 3, that is the teacher level, the means and variances of initial levels and slopes of stress and affect were estimated. The relationships between the initial levels and the slopes of cortisol and affect (RQ 1) were tested by allowing covariations among all four variables in level 3. Also, teachers' age and medication usage predicted cortisol intercept and slope at the teacher level. For RQ 2, each general occupational well-being indicator was added to a separate regression model, predicting teacher-level variances of initial levels and slopes of cortisol and affect.

The maximum likelihood procedure with non-normality robust standard errors (MLR) was used to estimate parameter values because some of the variables were not normally distributed. Unstandardized parameter estimates (B) and standard errors (*SE*) are presented in the Results section, as standardization is not available for three-level random slope models in Mplus (Muthén & Muthén, 1998–2015).

We also estimated the observed power as the precision of obtained coefficients in the three-level covariance model (Bliese & Wang, 2020; Hollenbeck & Wright, 2017). For observed (post hoc) power analysis (results are presented in the Limitations section) the Monte Carlo command in MPlus was used.

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TABLE 1 Descriptive

Measure	N	M	SD	Min	Max	Range
1. Cortisol Day 1 T4 (nmol/L)	45	13.87	10.32	5.48	62.46	–
2. Cortisol Day 1 T5 (nmol/L)	45	9.44	5.44	3.69	34.06	–
3. Cortisol Day 1 T6 (nmol/L)	44	3.75	2.01	1.16	10.70	–
4. Cortisol Day 2 T4 (nmol/L)	44	10.70	5.46	4.00	31.28	–
5. Cortisol Day 2 T5 (nmol/L)	44	8.59	4.26	2.15	23.85	–
6. Cortisol Day 2 T6 (nmol/L)	39	4.22	2.97	1.02	15.55	–
7. PA Day 1 T4	24	4.12	.50	2.80	4.80	1–5
8. PA Day 1 T5	33	3.89	.71	2.40	5.00	1–5
9. PA Day 1 T6	37	2.60	1.02	1.00	5.00	1–5
10. PA Day 2 T4	28	4.22	.65	2.80	5.00	1–5
11. PA Day 2 T5	34	3.75	.87	1.00	5.00	1–5
12. PA Day 2 T6	29	2.77	.98	1.20	4.20	1–5
13. SE instructional strategies	45	6.67	1.21	3.75	8.88	1–9
14. SE classroom management	45	7.33	.88	4.88	9.00	1–9
15. SE student engagement	45	6.74	1.10	4.38	8.75	1–9
16. Collaboration	45	3.93	.86	1.00	5.00	1–5
17. Student relations	45	4.14	.48	3.25	5.00	1–5
18. School resources	45	3.30	.74	1.80	4.80	1–5
19. Decision-making	45	2.92	.81	1.00	5.00	1–5
20. Instructional innovation	45	3.51	.73	1.25	5.00	1–5
21. Exhaustion	45	3.20	1.15	1.00	5.67	1–6
22. Cynicism	45	2.15	1.14	1.00	5.67	1–6
23. Inadequacy	45	2.40	1.20	1.00	5.33	1–6

Abbreviations: *M*, mean; *N*, number of observations; PA, positive affect; *SD*, standard deviation; SE, self-efficacy; T4, approximately at 10 am; T5, after the school day, approximately at 1 pm; T6, before bedtime.

Starting values for the population model were obtained using the SVALUES command. The number of observations was set as 180 in total and two for both the day and teacher level.

RESULTS

Physiological stress and positive affect

First, we tested whether physiological stress and positive affect in the middle of the school day and their slopes over the day are related. We assumed that higher physiological stress is related to lower positive affect in the middle of the school day and that a steeper cortisol slope is related to a smaller decline of affect over the day. The three-level random slopes model indicated no day-level variances in any of the four indicators—initial levels and slopes of physiological stress and positive affect (Table 2). Teacher-level variances at the initial level of cortisol and positive affect, as well as the daily slope of positive affect, showed significant between-teacher differences in these three indicators. We found no effect of age or the use of steroid medications on the initial level of cortisol or on cortisol slope. Therefore, we removed these control variables from further analysis for the sake of model parsimony.

The covariance model showed that teachers' initial cortisol level is slightly related to their daily cortisol slope ($r = -.002$, $SE = .001$, $p = .034$). Cortisol slope by the evening was steeper if a teacher had a

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higher cortisol level at 10 a.m. Contrary to Hypothesis 1, we found no relationships between teachers' daily physiological stress and positive affect. Cortisol levels at 10 a.m. were not related to the positive affect measured at approximately the same time and or to its slope over the course of the day. The same applied for positive affect; it was not related to its own daily slope or to the cortisol level at 10 a.m. or the cortisol slope. In addition, changes in teachers' daily physiological stress were not related to changes in their daily positive affect.

Relationships between general occupational well-being and stress and affect

Next, we studied the relationships between teachers' general occupational well-being and the initial levels and daily slopes of their physiological stress and positive affect (Hypothesis 2). We tested nine separate three-level regression models. In each model, the mean of one of the subscales of teacher self-efficacy, perceptions of school climate or burnout symptoms was set as a predictor of teacher-level cortisol and positive affect at 10 a.m., as well as for random slopes of cortisol and affect over the day. All teacher-level regression coefficients are presented in Table 3.

TABLE 2 Relationships between daily physiological stress and positive affect–three-level model

	Unstandardized estimate (*SE*)
Fixed part	
Intercept of cortisol initial level	1.970 (.041)***
Intercept of PA initial level	4.705 (.127)***
Intercept of the cortisol slope	−.038 (.003)***
Intercept of the PA slope	−.125 (.012)***
Random part: teacher level	
Cortisol initial level	.050 (.014)**
PA initial level	.438 (.153)**
Cortisol slope	.000 (.000)
PA slope	.004 (.001)**
Random part: day level	
Cortisol initial level	.010 (.005)
PA initial level	.004 (.027)
Cortisol slope	.000 (.000)
PA slope	.000 (.000)
Random part: measurement point level	
Cortisol	.017 (.004)***
PA	.161 (.035)***
Covariance: teacher level	
Cortisol initial level–cortisol slope	−.002 (.001)*
PA initial level–PA slope	−.021 (.013)
Cortisol initial level–PA initial level	−.010 (.031)
Cortisol initial level–PA slope	.005 (.004)
Cortisol slope–PA initial level	.001 (.002)
Cortisol slope–PA slope	.000 (.000)

Note: *$p < .05$, **$p < .01$, ***$p < .001$.

Abbreviations: PA, positive affect; *SE*, standard error.

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We found that teachers' self-efficacy of instruction explained cortisol levels in the middle of the school day ($B = -.061$, $SE = .029$, $p = .036$). The more confident teachers felt about their instructional skills and opportunities to choose appropriate teaching strategies, the less physiological stress they experienced at work. The same appeared true for teachers' self-efficacy in classroom management ($B = -.110$, $SE = .040$, $p = .006$). Teachers who believed in their ability to guide students' behaviour and manage disruptiveness if needed had lower cortisol levels in the middle of the school day. Higher self-efficacy of classroom management also predicted a higher positive affect at work ($B = .299$, $SE = .145$, $p = .040$), as did the self-efficacy of student engagement ($B = .259$, $SE = .121$, $p = .032$). Teachers who felt more confident about classroom management and engaging children experienced a more positive affect.

Teachers' perceptions of the overall school climate were considered in terms of five aspects: collaboration, student relations, school resources, decision-making and instructional innovation. We found that only the teachers' perceptions of the availability and accessibility of sufficient resources for teaching and supporting students had an effect on the positive affect level in the middle of the school day and on the decline of affect over the day as well as the decline of cortisol levels. Teachers who found resources more available and accessible experienced a higher positive affect at work ($B = .370$, $SE = .144$, $p = .010$). In addition, their affect decreased more towards the evening ($B = -.037$, $SE = .015$, $p = .017$), and their cortisol slope over the day was flatter ($B = .009$, $SE = .003$, $p = .006$).

Third, we used exhaustion, inadequacy and cynicism as teachers' burnout indicators. We found that none of these three burnout symptoms had an effect on teachers' physiological stress levels in the middle of the school day or its slope. However, higher exhaustion ($B = -.414$, $SE = .101$, $p < .001$), more cynicism ($B = -.243$, $SE = .113$, $p = .031$) and feelings of inadequacy as a teacher ($B = -.371$, $SE = .116$, $p = .001$) predicted lower positive affect at work. Feeling exhausted was also related to a flatter decline of positive affect over the day ($B = .038$, $SE = .010$, $p < .001$), which was related to the lower initial level of affect, but it might also indicate that feeling exhausted impedes the decrease of alertness and attentiveness towards the evening.

TABLE 3 Teacher-level regression coefficients of well-being indicators predicting individual initial levels and slopes of physiological stress and positive affect

Teacher-level predictor	Cortisol initial level, *B* (*SE*)	Cortisol slope, *B* (*SE*)	PA initial level, *B* (*SE*)	PA slope, *B* (*SE*)
Self-efficacy				
Instructional strategies	−.061 (.029)*	.003 (.002)	.199 (.107)	−.013 (.011)
Classroom management	−.110 (.040)**	.005 (.003)	.299 (.145)*	−.017 (.014)
Student engagement	−.063 (.037)	.004 (.003)	.259 (.121)*	−.017 (.011)
School climate				
Collaboration	.013 (.046)	.000 (.003)	.234 (.185)	−.013 (.013)
Student relations	−.004 (.086)	−.002 (.006)	−.150 (.272)	.013 (.024)
School resources	−.089 (.046)	.009 (.003)**	.370 (.144)*	−.037 (.015)*
Decision-making	−.034 (.042)	.002 (.003)	.091 (.201)	−.007 (.014)
Instructional innovation	−.056 (.065)	.003 (.004)	−.011 (.247)	.011 (.019)
Burnout symptoms				
Exhaustion	.011 (.030)	−.002 (.002)	−.414 (.101)***	.038 (.010)***
Cynicism	−.003 (.033)	−.001 (.003)	−.243 (.113)*	.013 (.011)
Inadequacy	.002 (.036)	−.001 (.003)	−.371 (.116)**	.021 (.011)

Note: The effects of all teacher-level predictors were tested in separate three-level regression models. *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: *B*, unstandardized regression coefficient; PA, positive affect; *SE*, standard error.

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DISCUSSION

Physiological stress and positive affect

In this study, we focused on different resource gains and resource losses and stress and affect as responses to these resource gains and losses (Hobfoll, 2010; Holmgreen et al., 2017). Although theoretical (Jennings & Greenberg, 2009; Lazarus, 1991) and empirical (Montgomery & Rupp, 2005) evidence has shown that teacher stress is related to their emotions, we are far from understanding the daily dynamics of teachers' emotional and physiological adjustments. Introducing the physiological stress measure as a stress indicator and exploring its relationships with daily affect, as well as repeatedly measuring changes over the day in stress and affect in authentic classroom settings, is a relatively novel approach in educational research. Furthermore, using objective physiological stress measure allowed us to reduce inevitable overlaps in self-perceptions while studying resource gains and losses (Hobfoll, 2010).

We first investigated the relationship between teachers' physiological stress and positive affect over the day to capture ecologically valid physiological and emotional well-being in the classroom (Francis et al., 2017). We used the stress and affect in the middle of the school day and the slopes in the evening as daily physiological and emotional well-being indicators. In short, our results did not support Hypothesis 1, that is that physiological stress and positive affect in the middle of the school day and the changes over the day would be related to each other. Previous findings concerning the relationships between physiological stress and positive affect in nonclinical samples have been contradictory, depending on the indicator of positive affect used in the study. Higher aggregated positive affect has been shown to be quite undoubtedly related to lower physiological stress (Sin et al., 2017; Steptoe et al., 2009). In the teachers' sample, our findings showed that simultaneously measured cortisol and affect, as well as their slopes during the day, do not interact. Therefore, we can suggest that affect in a particular situation is not reflected in the physiological stress levels at the same moment. In addition to the substantive explanations, there might also be measurement-related reasons for our data not supporting the covariance between cortisol and affect. It has been suggested earlier that estimating the between-person variance in the daily slopes of cortisol might require more sampling days, but the reliable differences in initial cortisol levels can be captured in fewer measurement days (Hruschka et al., 2005).

General occupational well-being in relation to daily physiological stress and positive affect

When answering the second research question (RQ 2), we relied on the ideas of COR theory assuming that daily resource gains (e.g., self-efficacy, school climate) and losses (e.g., burnout symptoms) should complement each other and accumulate (Holmgreen et al., 2017) and then be reflected on teacher stress and positive affect. We found that teachers' higher self-efficacy in instruction and classroom management was related to lower stress in the teaching situation, while self-efficacy in classroom management and student engagement correlated with a higher daily positive affect. This demonstrates that teachers' physiological stress in the classroom depends on their belief in their professional skills, such as finding appropriate teaching strategies and handling discipline problems. The same was concluded previously in regard to the relationship between psychological stress and teachers' self-efficacy (Zee & Koomen, 2016) and the effect of self-efficacy on teachers' morning stress response (Schwerdtfeger et al., 2008). At the same time, teachers' levels of positive affect in the teaching situation seem to depend on their self-efficacy beliefs in relation to engaging their students as well as handling difficult situations related to student behaviour in the classroom. Teachers' self-efficacy, as a general construct, has been shown to be related to positive affect in previous literature (Burić & Moè, 2020; Taxer & Frenzel, 2015). Our study adds to the knowledge that teacher self-efficacy is a very important resource gain for keeping teachers' stress levels lower and positive affect higher in real-life teaching situations.

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Next, we investigated school climate in relation to physiological stress and positive affect. Previous results have emphasized the importance of teachers' relations with their colleagues, students and leaders in avoiding or coping with stress and enhancing their well-being in general (Brackett et al., 2010; Cumming, 2017; Paterson & Grantham, 2016). Contrary to our hypotheses, we found no relationships between teachers' perceptions of their collaboration with colleagues, the quality of student relations at school and their involvement in decision-making processes and instructional innovation, and their cortisol levels or positive affect in the middle of the school day or changes in stress and affect over the day. However, teachers who found school resources sufficient and adequate had a higher positive affect in the classroom and their affect declined more by the evening. Also, the slope of their physiological stress was flatter over the day, indicating a smaller difference between their cortisol levels in the middle of the work day and the evening. It appears that even if relationships at school and innovation-related organizational factors of well-being are not related to teachers' daily stress or affect, feelings of having sufficient resources have an impact (Collie et al., 2012), which make it a crucial resource gain.

Burnout symptoms and their relationships with stress are probably the most studied aspect of teachers' occupational well-being. We showed that although there is compelling evidence of links between burnout and self-reported stress (Park & Shin, 2020), this does not apply to teachers' daily physiological stress. However, exhaustion, cynicism and inadequacy predicted a lower positive affect in the middle of the school day, which supports earlier findings (Brackett et al., 2010; Taxer & Frenzel, 2015). Exhaustion was also related to a smaller decline in affect by the evening.

Limitations

Some limitations should be taken into account. The relationships between teachers' physiological stress and other well-being indicators might be difficult to compare with the results of other studies that might have used different physiological stress and well-being indicators. In addition, in our study design, which combined salivary cortisol samples and experience sampling within an hour, a considerable number of positive affect data was excluded because of noncompliance with timing. Our data loss is somewhat larger than shown in previous studies (e.g., 9% in Linz et al., 2018 compared with 18% in our study) and emphasizes the need to improve the protocols of supervising and motivating participants more carefully. Next, the interpretation of a flatter cortisol slope as less physiological stress was based on the interpretation of the higher cortisol level at 10 a.m. as higher stress. Nevertheless, it has to be acknowledged that a flatter cortisol slope over the day can also mean that the cortisol level had been high at 10 a.m. and had not declined by evening. Also, in further studies with larger samples, a broader set of both individual and contextual control variables, such as the individual health characteristics that might physiologically affect cortisol levels (e.g., oral contraceptives, smoking), and the number of students in the classroom or the number of students needing help, should be included. Finally, although our sample size is comparable with those of previous studies assessing salivary cortisol and situational affect (for a review, see Joseph et al., 2021), the post hoc power analyses for cortisol and positive affect covariation model revealed that our sample size was large enough to detect effects at the measurement point level (power of .80 and .90 for random parts) but could have been too small for confirming the effects at the teacher level.

Practical implications

Understanding teachers' well-being and the relationships between its different aspects is crucial for both educators and policymakers for supporting the quality of education in terms of teaching, teacher–student interactions and students' learning outcomes as well as increasing the value of teachers' work in society (Arens & Morin, 2016; OECD, 2014; Virtanen et al., 2019). Our study also contributes to the wider theoretical frameworks for interventions aimed at increasing teachers' well-being (Schussler et al., 2016).

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Our findings suggest that belief in one's instructional and classroom management skills as an individual resource gain, and perceived sufficiency of available resources as a contextual resource gain, can decrease physiological stress. In addition, teachers' positive affect also depends on their burnout symptoms as an individual resource loss and efficacy beliefs concerning their relationships with their students as an individual resource gain. Reduced teacher stress and increased emotional well-being, in turn, can make a difference in teacher–student interactions and students' learning outcomes (Burić, 2019; Herman et al., 2018; Virtanen et al., 2019). Therefore, we concur with previous research that suggested self-efficacy beliefs as a target of interventions to increase teachers' well-being (Dicke et al., 2018). We further emphasize that school leaders should ensure that teachers have the necessary resources to thrive and stay well in their jobs.

CONCLUSIONS

We studied the associations between teachers' physiological and emotional well-being in natural classroom settings and their relationships with general occupational well-being. Contrary to our expectations, our results showed that daily physiological and emotional well-being are not related and do not directly affect each other. We can reason that changes in one might take some time before having an impact on the other, but this would require more empirical testing. However, regarding general occupational well-being, we found that teachers' self-efficacy and the sufficiency of school resources are related to both teachers' lower physiological stress and higher positive affect. Teachers' burnout symptoms were related only to their positive affect; thus, burnout may be reflected in decreased positive affect. We suggest targeting teacher self-efficacy and school resources to decrease teachers' everyday stress and increase their emotional well-being at school.

AUTHOR CONTRIBUTIONS

Anna-Liisa Jõgi: Conceptualization; data curation; formal analysis; methodology; writing – original draft; writing – review and editing. **Anna-Mari Aulén:** Conceptualization; data curation; writing – original draft; writing – review and editing. **Eija Pakarinen:** Conceptualization; funding acquisition; methodology; project administration; writing – review and editing. **Marja-Kristiina Lerkkanen:** Conceptualization; funding acquisition; project administration; writing – review and editing.

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CONFLICT OF INTEREST

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Anna-Liisa Jõgi https://orcid.org/0000-0002-4957-6516
Anna-Mari Aulén https://orcid.org/0000-0002-3626-0600
Eija Pakarinen https://orcid.org/0000-0001-7190-6705
Marja-Kristiina Lerkkanen https://orcid.org/0000-0002-5709-5800

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