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Original Research

Occupational Stress in Helicopter Emergency Service Pilots From 4 European Countries

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A B S T R A C T

Objective: Working conditions are known to affect motivation, well-being, and ultimately work performance. Helicopter emergency medical services (HEMS) pilots' work is highly demanding and safety critical, but virtually no published data on occupational stress and strain symptoms in HEMS pilots are available. We investigated work stressors and resources and their association with work engagement, subjective well-being, and energy levels in European HEMS pilots.

Methods: Cross-sectional questionnaire data were collected consecutively from 72 European HEMS pilots (24 Western European and 48 Eastern European, mean age = 51.9 years). We examined the stressor, resource, and strain symptom levels by age group and region of origin and the association of stressors and resources with work engagement, well-being, and energy.

Results: Although the responses differed notably between the Eastern and Western European pilots, their overall profile was quite favorable. At the same time, those stressor/resource variables, which on average had the most favorable ratings, were the most strongly associated with (reduced) well-being and energy.

Conclusion: On the whole, the HEMS pilots' perception of their work situation appears to be positive, and they are highly engaged in their work. The pilots' strong identification with their work should be taken into account in pilot mental health support systems.

Although helicopter emergency medical services (HEMS) have been successfully established in many countries across the globe,[1,2] there is an ongoing debate about their cost, benefit, and incremental value relative to conventional ground-based emergency services.[3-5] The overall usefulness of HEMS is affected by many factors such as integration into a properly triaged trauma system,[6] crew configuration,[7] and geographic distribution of HEMS stations.[8] A further aspect that has been a focus of attention in recent years is mission risk. Compared with other types of commercial air transports, HEMS flights have a relatively high accident rate. On average, 5.6 accidents per 100,000 flight hours occurred between 1998 and 2007 in the United States, with an average yearly fatality rate of 113 per 100,000 crewmembers. In Germany, the accident rate in the same time span was found to be 4.6 per 100,000 missions.[9-11] Unlike most other types of aviation, HEMS operations may have to be conducted in congested, uneven, or otherwise hostile terrain with an increased risk of terrain collision.[12] Because of their inherent urgency, HEMS missions may also carry a higher risk of unplanned adverse weather encounters,[12-14] one of the most prominent causes of fatal HEMS accidents.[12,15] In a survey of US HEMS pilots, 36% reported "sometimes" or "often" pressuring themselves to accept or complete a flight. Between 21% and 24% reported the same with respect to pressure from medical staff or management or because of competition between HEMS programs.[16]

In line with this finding, current human factors models of accident causation acknowledge the role of more distal contextual factors such as inadequate oversight of aircraft operators, competitive pressures, and stressful working conditions[17,18] even though the immediate cause of aircraft accidents is most often related to pilots' decision making or aircraft handling mistakes[19] (eg, in the case of HEMS, accepting a mission despite borderline weather conditions or flying

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too close to a power line). Meta-analytic evidence from the wider context of occupational safety and health research attests to adverse effects of job stressors (such as a high pace of work or job insecurity) and corresponding beneficial effects of job resources (such as social support) on safety outcomes, job performance, work motivation, subjective well-being, and health[20-24] and to adverse effects of reduced work motivation, job satisfaction, and well-being on performance and safety outcomes.[20,25] Stressful working conditions, including shift work and long work hours, may also affect work safety through increased levels of worker fatigue, sleep impairment, disruption of circadian rhythm, and reduced recovery.[26-30] Although an appropriate level of job demands combined with the availability of sufficient personal and workplace resources leads to stimulation, increased motivation, skill development, and good work performance, a combination of high demands, low resources, and the presence of work stressors results in reduced motivation; emotional irritability; and, in the long-term, mental and somatic illness.[31,32] Adverse and beneficial effects of job characteristics have been shown across a broad range of occupations; however, an individual worker's stressor-resource profile may depend on several factors such as economic and cultural context[33]; the worker's age and hierarchical position[34]; and, naturally, the type of occupation itself. Besides physical factors such as vibration, noise, thermal, or postural stress, HEMS pilots are exposed to a considerable number of psychosocial stressors during their work including emotionally demanding patient encounters; the necessity to conduct a complex, high-stakes task under time pressure; or the need for quick decision making in situations in which relevant information may be lacking.[35,36] Shift work and long work hours are also common in HEMS.

On the other hand, being professional pilots, HEMS pilots constitute a highly selected group because they are required to successfully complete both initial training as well as recurrent aeromedical certification and check flight routines.[37] Mortality and morbidity from common somatic conditions such as cardiovascular diseases and cancer are markedly reduced in airline pilots in comparison with the general population[38,39]; their suicide mortality is also lower, suggesting better mental health as well.[38,40] However, the prevalence of burnout symptoms (emotional exhaustion and cynical attitudes toward work) were found to be remarkably high in studies of European[41] and US[42] airline pilots. Of the participants in a recent anonymous survey of airline pilots, 13.5% scored above the threshold of a validated depression screening inventory.[43] Another survey study of airline pilots found that those with long work hours were more likely to report feeling anxious or depressed; this association vanished after adjustment for work-related sleep disturbances and in-cockpit fatigue, which were strongly predictive of feelings of depression or anxiety.[44]

Fatigue has also been recognized as a potential hazard in HEMS, with 84% of respondents to a survey of US HEMS pilots reporting that fatigue had affected their flight performance in some way (eg, because of reduced alertness).[45] However, in a different sample of US HEMS pilots, self-reported fatigue was not associated with the number of day or night shifts before the current shift although fatigue levels were higher in respondents on night shifts compared with those on day shifts.[46] Almost no published research appears to exist that investigates the effect of working conditions and job stress on fatigue, work motivation, and well-being in HEMS. In a sample of Dutch HEMS pilots, higher workload during a shift was associated with a reduction in perceived sleep quality. Distressing shifts were associated with rumination and delayed sleep onset and led to reduced subjective well-being, particularly during night shifts. It also took longer for the HEMS pilots' well-being levels to return to baseline levels after night shifts compared with day shifts.[30,47] The results of an informal survey of crewmembers of a US air ambulance (which may to some degree be transferable to HEMS pilots) suggested irregular work schedules and work-family conflict as potential sources of stress and social interaction with colleagues as an important coping mechanism.[36]

Given the potential impact of adverse working conditions on work performance and safety as well as the paucity of published data on occupational sources of stress and strain in HEMS pilots, our aim was to investigate the prevalence of various work-related psychosocial stressors and resources (overall and within demographic subgroups) as well as their association with work motivation, psychological well-being, and energy levels in a sample of European HEMS pilots. The findings may help identify targets for interventions to improve the psychosocial work environment of HEMS pilots and, ultimately, flight safety in HEMS.

Methods

Study Design, Setting, and Participant Selection

The presented findings are based on a cross-sectional analysis of questionnaire data from active HEMS pilots employed in 2015/2016 with 1 of 5 air rescue organizations (2 based in Germany and 1 each in Austria, Poland, and the Czech Republic) operating about two thirds of all HEMS bases in these countries. The questionnaires were collected in the context of a study of potential hazards to flight safety in HEMS, which also investigated pilot simulator performance and aeromedical examination findings, with a special focus on the impact of pilot age on flight safety.[9] The study had been approved by the Ethics Committee at the Medical Faculty of Ludwig Maximilian University (project no. 466-15), and written informed consent had been obtained from all study participants before data collection.

Recruitment into the study was consecutive, with an additional effort to oversample pilots near or above 60 years of age because of the focus on age as mentioned previously. During the data collection period from September 2015 to October 2016, HEMS pilots completing a check or training flight session at training sites in Hangelar, Germany, or Warsaw, Poland, were personally approached for participation by a research team member or a flight training instructor of the respective organization who handed them the questionnaire from which the present analysis draws. A small number of pilots not attending training at either of the 2 sites also received the questionnaire via their employer. The questionnaire items covered different aspects of work-related demands, stressors, resources, and symptoms of strain and took about 15 to 20 minutes to complete. Scales and items used in the present analysis are summarized in Table 1. The questionnaire was available in English, Polish, and German. Validated translations of the scales into the respective languages were used whenever possible.

Analysis Variables

Predictor Variables

The predictor variables used in the analyses comprise demographics and occupational stressors and resources. Demographics include pilot age and region (Eastern European: pilots employed with the Polish or the Czech operator vs. Western European: pilots employed with the Austrian or German operators).

Because psychosocial stress at work is a complex process involving many different aspects of the work situation,[31,32] our questionnaire assessed a broad range of psychosocial work characteristics known to affect physical and/or mental health, well-being, and work motivation. Brief descriptions, inventories, number of items, and ranges of the scales used to assess these characteristics are listed in Table 1. Of these variables, emotional demands, work pace, demands for hiding emotions, role conflict, effort-reward ratio, job insecurity, work hours, night shift duty, and work-family conflict represent potential work stressors, whereas social support, work predictability, role clarity, autonomy, supervisor feedback, and procedural justice represent potential resources or protective factors.

Table 1
An Overview of Questionnaire Scales/Items Used in Analysis (Stressors, Demands, and Resources in the Upper Table Section and Outcome Variables in the Lower Section)

Variable (Name of Parent Inventory/Scale)	# of Items	Untransformed Item Scaling	Brief Description	Sample Items (Scale Facet, If Applicable)	Source[a]
Work hours per month	1	# of hours	Average number of actual work hours per month	"On average, how many hours are you on duty per month?"	—
Night shift duty	1	Yes/no	Working night shifts?	"Which type of shifts are you working? Night shift"	—
Demands for hiding emotions (COPSOQ II)	1	1 = to very small extent 5 = to very large extent[b]	Necessity to suppress expression of emotions during work	"Does your work require that you hide your feelings?"	84
Emotional demands (COPSOQ II)	2	1 = never 5 = (almost) all the time[b]	Requirement to deal with emotionally complex/difficult situations/interactions during work	"Does your work put you in emotionally disturbing situations?" "Do you have to relate to other people's personal problems as part of your work?	84
Social support (COPSOQ I)	4	1 = never 5 = (almost) all the time[b]	Work-related support received by colleagues and superiors	"How often do you get help and support from your immediate superior?" (support by superior) "How often are your colleagues willing to listen to your work related problems?" (support by colleagues)	85
Work pace (COPSOQ II)	2	1 = to very small extent 5 = to very large extent[b]	Tempo at which work tasks need to be conducted	"Do you work at a high pace throughout the day?"	84
Work predictability	3	1 = to very small extent 5 = to very large extent[b]	Degree to which day-to-day work tasks and events are perceived as expectable	"To what extent do unexpected events occur on your job?"	86
Role clarity (COPSOQ II)	3	1 = to very small extent 5 = to very large extent[b]	Degree to which one's responsibilities at the job are known and understood	"Do you know exactly what is expected of you at work?"	84
Role conflict (COPSOQ II)	4	1 = to very small extent 5 = to very large extent[b]	Inconsistency of different demands or responsibilities at the job	"Do you do things at work, which are accepted by some people but not by others?"	84
Autonomy (TAA-KH-S)	3	1 = not at all 5 = to very great extent[b]	Latitude at the job with regards to task execution, decision-making, and using own ideas in carrying out one's work	"My work offers discretion on how to do my work." (activity latitude) "My work allows for making decisions on which tasks I have to perform." (decision latitude) "My work permits using my own ideas." (design latitude)	31
Supervisor feedback (TAA-KH-S)	3	1 = not at all 5 = to very great extent[b]	Explicit information received by supervisor about one's work behavior, performance, and results	"My supervisor provides explicit feedback about my work performance."	31
Procedural justice	4	1 = do not agree at all 5 = fully agree[b]	Degree to which one is given the chance to appropriately participate in organizational decision-making	"With regard to working group and management decisions at my job, procedures are designed to hear the concerns of all those affected by the decision."	87
Effort-reward ratio (ERI)	7	Ratio can take values ≥0.25 Scaling of individual items: 1 = strongly disagree 4 = strongly agree	Balance of perceived personal effort invested into work relative to perceived gratifying aspects of work, e.g. recognition or monetary rewards	"Over the past few years, my job has become more and more demanding." (effort) "I receive the respect I deserve from my superiors." (reward)	88
Job insecurity (ERI)	1	1 = strongly disagree 4 = strongly agree[b]	Perceived employment insecurity (item is also included as a reverse coded aspect of reward in the effort-reward ratio)	"My employment security is poor."	88
Work-family conflict (COPSOQ II)	2	1 = no, not at all 4 = yes, certainly[b]	Degree to which work interferes with private life	"Do you feel that your work drains so much of your energy that it has a negative effect on your private life?"	84
Work engagement (UWES-9)	9	0 = never 6 = always (every day)[b]	Degree of enthusiasm about/involvement in one's job. Defined as the opposite of burnout.	"At my job, I feel strong and vigorous." (vigor) "I am proud of the work that I do." (dedication) "I am immersed in my work." (absorption)	48

Table 1 (*Continued*)

Variable (Name of Parent Inventory/Scale)	# of Items	Untransformed Item Scaling	Brief Description	Sample Items (Scale Facet, If Applicable)	Source[a]
Subjective well-being (WHO-5)	5	0 = at no time 5 = all of the time[b]	General sense of positive mood and vitality (not specifically with respect to work situations)	"Over the past two weeks, I have felt cheerful and in good spirits."	51
Energy/Fatigue (WHOQOL-100)	4	Anchor labels differ between items; overall scale ranges from 4 (lowest energy) to 20 (highest energy)[b]	Everyday level of energy (not specifically with respect to work situations)	"Considering the past two weeks, how much were you bothered by fatigue?"	53

COPSOQ I/II = Copenhagen Psychosocial Questionnaire Version 1/2; ERI = Effort-Reward-Imbalance scale (version Effort B–Reward A from cited reference); TAA-KH-S = Tätigkeits- und Arbeitsanalyseverfahren für das Krankenhaus, Selbstbeobachtungsversion (activity and work analysis procedure for hospitals, self-report version); UWES-9 = Utrecht Work Engagement Scale, 9-item version; WHO-5 = World Health Organization 5-item well-being index; WHOQOL-100 = World Health Organization Quality of Life inventory, 100-item version.

[a] Items in which no source is provided were self-developed by the authors for the purposes of the reported study.

[b] Variable has been rescaled to 0-100 range for all analyses to facilitate comparisons.

Outcome Variables

Work motivation was operationalized by the 9-item version Utrecht Work Engagement Scale (UWES-9), which comprises the facets of absorption, dedication, and vigor at work. Work engagement has been conceptualized by its authors as the opposite of burnout on a spectrum of occupational motivation.[48] It is considered to be more stable than work-related emotions but less so than personality traits[48] and was found to be associated with increased self-efficacy at work, better work performance, and better health and to depend on the availability of job resources.[49]

Psychological well-being was quantified by the World Health Organization 5-item measure (WHO-5).[50] This unidimensional scale indirectly assesses affective and motivational symptoms of depression by inquiring about experiences of positive mood and vitality during the preceding 2 weeks (regardless of whether or not related to work). It has found wide application in clinical and quality of life research and has been successfully used as a screening instrument for depression, with a score below the scale midpoint warranting follow-up.[51] Using this cutoff, the scale had a positive predictive value of 34% with respect to diagnosed clinical depression in a sample of primary care patients.[52]

Finally, to quantify energy levels (ie, lack of fatigue), the 4-item "Energy/Fatigue" subscale of the WHO quality of life instrument (WHOQOL-100) was included in our questionnaire. It is designed to assess feelings of energy and endurance with respect to tasks of daily living during the preceding 2 weeks[53] and was found to be applicable with good reliability and validity in working populations.[54]

Statistical Analysis

We present descriptive statistics of all variables of interest for the overall sample and stratified by region (Eastern vs. Western Europe) and age group (< 55 vs. ≥ 55 years). The age cutoff of 55 years was chosen as the 5-year multiple, which was closest to the sample median of age to optimize between estimation certainty and comparability of results. Scale reliabilities were estimated by Cronbach alpha. In case of low reliabilities, we present estimates for individual items or modified scales resulting from the elimination of items that reduce internal consistency, in addition to estimates for the full scale. We further present bivariate correlations between all study variables for the overall sample. Finally, for each of the 3 outcome variables, a series of multiple linear regressions was performed. First, a model containing only region and age in years as predictors was fitted. Then, for each work stressor/resource, a separate model was fitted predicting the outcome by region, age in years, and the respective predictor. Ninety-five percent confidence intervals and *P* values for the regression coefficients of region, age, and work stressors/resources are presented. As a sensitivity analysis, the same procedure was repeated substituting flight experience (total flight hours) for age.

With the exception of work hours, night shift duty, and effort-reward imbalance, all work stressors, resources, and outcome variables have been rescaled to a "percent of maximum possible" score for analysis purposes, such that they take values between 0 and 100; these 2 values indicate complete disagreement and agreement with all scale item statements, respectively. This scale facilitates both interpretation of effect sizes and comparisons between scales and with other published results.[55] The original scale ranges are provided in Table 1. Analyses were performed using SPSS Version 24 (IBM Corp, Armonk, NY) and R version 3.4. Missing data were handled by case-wise deletion.

Results

Overall, 148 pilots of the 5 air rescue organizations with a scheduled training session were targeted for participation in the simulator study described. No response to the participation request was received from 47 (31.8%) of these, and 21 (14.2%) refused to participate. Agreement to participate was given by 80 pilots (54.1%); for 7 of them, the training session did not take place before the end of data collection, and we did not receive a completed questionnaire from another 5. Thus, we obtained completed questionnaires from 68 pilots (45.9% of the 148 pilots targeted for participation in the simulator study and 90.7% of the 75 pilots who did actually take part in the simulator study and to whom a questionnaire was handed). Additionally, 4 pilots had received the questionnaire outside of the training session context via their employer; all of them completed and returned it, yielding a total sample size of 72 pilots aged between 29 and 64 years at the time of questionnaire completion. Although we did not explicitly inquire about the HEMS bases where participants were stationed, information about HEMS base assignment could be recovered for 61 of the pilots through an informal review of administrative study records. The bases identified in this way were concentrated in eastern Austria, the northeast and southwest of Germany, and southern and eastern Czech Republic; Polish bases were evenly distributed across the country. None of these bases were located in strongly mountainous terrain although some of the Austrian bases bordered the Eastern Alps. However, because of the informal nature of this base assignment information, which was in many cases available only for time points well before the questionnaire collection period (and with some pilots switching bases rather frequently), it should be regarded with caution and is not considered any further in the analyses reported subsequently.

Scale reliabilities and descriptive statistics by region and age group are shown in Table 2. Reliabilities were acceptable except for emotional demands, autonomy, and role clarity. In the former 2 constructs, this may be explained by the fact that they summarize rather distinct facets (encountering disturbing situations and having to relate to others' problems in the case of emotional demands and

Table 2
Scale Reliabilities (Cronbach's Alpha) and Sample Descriptives for Work Stressors/Resources (Upper Table Section) and Outcome Variables (Lower Table Section)

			By Region			By Age Group			
	# Missing	Cronbach's Alpha	Eastern Europe (n = 48)	Western Europe (n = 24)	*P* Value[a]	< 55 Years (n = 40)	≥ 55 Years (n = 32)	*P* Value[a]	Overall (N = 72)
Age (y)	0		49.9 (8.2)	55.8 (7.3)	.004[d]	46.1 (6.8)	59.1 (2.4)	<.001[e]	51.9 (8.4)
Flight experience (1,000 h)	4	—	3.8 (2.0)	7.7 (3.6)	< .001[e]	3.4 (1.6)	7.3 (3.4)	<.001[e]	5.2 (3.2)
Average work hours/month	7	—	166 (25)	175 (30)	.183	169 (26)	168 (27)	.836	169 (27)
Working night shifts	*2*	—	*34 (73.9)*	*10 (41.7)*	*.008*[d]	*25 (65.8)*	*19 (59.4)*	*.580*	*44 (62.9)*
Hide emotions (% MP)	0	—	37.0 (29.6)	49.0 (25.0)	.093	34.4 (29.2)	49.2 (25.8)	.027[e]	41.0 (28.6)
Emotional demands (% MP)	0	0.32	28.9 (15.3)	44.8 (13.2)	< .001[e]	31.6 (17.0)	37.5 (15.2)	.127	34.2 (16.4)
Disturbing situations (% MP)	0	—	36.5 (17.8)	40.6 (14.4)	.324	37.5 (18.8)	38.3 (14.2)	.846	37.8 (16.8)
Relate to others' problems (% MP)	0	—	21.4 (20.6)	49.0 (22.7)	< .001[e]	25.6 (24.3)	36.7 (24.6)	.060	30.6 (24.9)
Social support (% MP)	0	0.78	53.0 (23.1)	65.4 (20.6)	.030[c]	56.3 (23.6)	58.2 (22.2)	.722	57.1 (22.9)
Work pace (% MP)	0	0.73	58.3 (18.3)	50.5 (15.0)	.075	59.1 (20.0)	51.6 (13.0)	.059	55.7 (17.5)
Predictability (% MP)	0	0.64	53.1 (18.2)	32.3 (18.6)	< .001[e]	49.0 (17.9)	42.7 (23.6)	.206	46.2 (20.7)
Role clarity (% MP)	0	0.49	92.2 (10.8)	88.5 (12.5)	.204	91.9 (9.1)	89.8 (13.8)	.478	91.0 (11.4)
Role conflict (% MP)	0	0.78	19.1 (16.5)	28.9 (16.6)	.021[c]	22.0 (15.2)	22.9 (19.4)	.819	22.4 (17.1)
Autonomy (% MP)	0	0.35	53.0 (18.5)	51.4 (17.3)	.731	51.7 (18.0)	53.4 (18.2)	.690	52.4 (18.0)
In task execution (% MP)	0	—	44.3 (28.4)	54.2 (24.1)	.148	45.6 (26.5)	50.0 (28.4)	.502	47.6 (27.2)
In decision making (% MP)	0	—	69.3 (25.9)	37.5 (24.5)	< .001[e]	61.3 (29.9)	55.5 (28.9)	.411	58.7 (29.4)
In using own ideas (% MP)	0	—	45.3 (24.5)	62.5 (22.1)	.005[d]	48.1 (26.2)	54.7 (23.3)	.271	51.0 (25.0)
Supervisor feedback (% MP)	0	0.96	46.0 (26.9)	60.8 (29.8)	.038[c]	48.8 (29.5)	53.6 (27.6)	.474	50.9 (28.6)
Procedural justice (% MP)	0	0.86	75.1 (15.1)	63.0 (22.6)	.024[c]	70.8 (19.4)	71.5 (18.1)	.875	71.1 (18.7)
Effort-reward imbalance ratio	0	0.75/0.63[b]	0.81 (0.34)	1.10 (0.41)	.002[d]	0.81 (0.31)	1.03 (0.44)	.021[c]	0.91 (0.39)
Employment insecure (% MP)	1	—	34.0 (22.3)	27.5 (25.9)	.280	28.3 (22.1)	36.6 (24.9)	.145	31.9 (23.5)
Work-family conflict (% MP)	0	0.86	20.1 (24.8)	31.9 (26.4)	.067	24.6 (27.5)	23.4 (23.9)	.853	24.1 (25.8)
Work engagement (% MP)	0	0.85	75.0 (12.1)	85.0 (11.5)	.001[d]	74.6 (12.3)	82.9 (11.9)	.005[d]	78.3 (12.8)
Well-being (% MP)	0	0.90	72.7 (15.0)	76.3 (16.2)	.345	71.3 (16.8)	77.1 (13.1)	.112	73.9 (15.4)
Well-being (% MP) ≤ 50	*0*	—	*4 (8.3)*	*3 (12.5)*	*.574*	*5 (12.5)*	*2 (6.3)*	*.374*	*7 (9.7)*
Energy (% MP)	0	0.74	81.8 (12.4)	77.6 (15.7)	.223	79.2 (14.9)	81.8 (11.8)	.421	80.4 (13.6)

% MP = percent of maximum possible scale/item score.
Mean (standard deviation) for quantitative variables; number (percentage) for binary variables (in italics). Component items of scores are indented beneath the corresponding overall score.
[a] Quantitative variables: *t* test. Categorical variables: chi-square test.
[b] Reliability coefficient for effort/reward subscale, respectively.
[c] $P < .05$.
[d] $P < .01$.
[e] $P < .001$.

latitude with regard to execution of work tasks, decision making, and realizing own ideas in the case of autonomy). Hence, we report results both for the overall scales and the individual items. The reliability coefficient of role clarity could be increased to 0.61 by removing 1 of the 3 items; however, this had only very minor effects on the analysis results (Supplementary Tables S1-S3). Therefore, we confined reporting results to those for the original 3-item scale.

Contrary to what might be expected, in the overall sample, the profile of subjectively perceived occupational stressors is characterized by medium to low levels. For example, despite the usually long shift durations and the prevalence of night shifts, work-family conflict was on average rated at one quarter of the maximum possible score. The average work pace rating is near the scale midpoint despite the unquestionably high urgency in many HEMS missions, which may also involve witnessing human suffering; still, emotional demands were on average rated low. Moreover, very low levels of role stress were reported, as evidenced by low average role conflict and very high average role clarity. Overall, procedural justice in the HEMS organizations was also rated favorably. On the other hand, autonomy, supervisor feedback, and social support ratings were on average near the scale midpoint, suggesting room for improvement. The pilots displayed on average high to very high levels of work engagement, energy, and subjective well-being although approximately 10% of them scored below the WHO-5 cutoff value used to screen for depression.

Two thirds of the participating pilots were employed with the Eastern European operators. These pilots were on average younger than their Western European counterparts, which likely also explains the rather large difference in accumulated flight hours between Eastern and Western European pilots. With regard to potential sources of occupational stress, Eastern European pilots were more likely than Western European pilots to be working night shifts and reported less social support, lower autonomy to use own ideas in their work, and lower levels of explicit supervisor feedback. On the other hand, Western European pilots reported greater emotional demands (in particular, having to relate to others' personal problems), lower predictability of daily work demands, higher levels of role conflict, lower decision-making autonomy, less procedural justice, and a higher effort-to-reward ratio. They also reported higher levels of work engagement than their Eastern European colleagues although in absolute terms reported work engagement levels were still high in the latter. Between the 2 age groups, differences in work stressors, resources, and outcome variables were less pronounced. Older pilots were more likely to report having to conceal emotions at work, and their effort-reward ratio was more unfavorable compared with younger pilots. In contrast, they reported higher degrees of work engagement.

Supplementary Table S1 additionally provides descriptions on the individual facets of the social support, effort-reward imbalance, and work engagement scales, revealing that the social support differential between Eastern and Western European pilots is stronger with regard to support by colleagues, that the observed effort-reward imbalance differences between the subgroups are caused by differences in perceived effort (not reward), and that the dedication component of work engagement received especially high ratings by the HEMS pilots.

Bivariate correlations between work stressors, resources, and outcome variables are shown in Table 3. Association patterns between stressors and resources are in general plausible; for example, predictability is significantly negatively correlated with role conflict, and work hours are positively correlated with effort-reward imbalance. The 3 outcome variables are significantly correlated, particularly subjective well-being and energy. Work engagement is in general only weakly correlated to the stressors and resources; the only coefficient significant at the 5% level is a positive correlation with the need to hide emotions. In contrast, energy and subjective well-being are both strongly negatively correlated with reporting disturbing situations, low levels of role clarity, and high levels of work-family conflict. Energy levels are also significantly lower in pilots reporting longer work hours (however, no appreciable difference with respect to night shift duty appears to exist).

Multiple regression models revealed that the difference in work engagement between Eastern and Western European pilots does not seem to be caused by a confounding with age (Table 4). Findings of the region-age stressor/resource models are broadly consistent with the bivariate correlation results. In particular, work stressors and resources are poor at predicting work engagement. On the other hand, reporting disturbing situations, low procedural justice, high levels of role stress, or work-family conflict is strongly predictive of reduced subjective well-being and energy. Longer work hours are associated with lower levels of energy. An unfavorable effort-reward ratio and perceived employment insecurity (which is a component item of the effort-reward imbalance scale) also appear to adversely affect well-being and energy in the pilots. Substituting flight experience for pilot age did not appreciably affect these results although flight experience was positively predictive of work engagement (Supplementary Table S4).

To illustrate the association of work characteristics with well-being, WHO-5 scores are plotted against the most significantly associated work stressors/resources (exposure to disturbing situations at work, role clarity, work-family conflict, and procedural justice) in Figure 1. The plots show approximately linear relationships; in particular, the relationships do not seem to be exclusively caused by outliers. Individuals with the least favorable ratings of these stressors and resources appear to be at a higher risk of a disturbed mood, as judged by a WHO-5 score of 50 or less. However, this finding is based on a very small number of cases because the distributions of these work characteristics are rather strongly skewed toward favorable ratings.

Discussion

In this cross-sectional questionnaire-based study, we aimed to investigate the prevalence of work-related stressors and resources and their association with work motivation, psychological well-being, and energy levels in Eastern and Western European HEMS pilots. On the whole, the pilots' response profile was characterized by low to medium levels of perceived work stressors as well as high levels of motivation, well-being, and energy. The profiles of younger and older pilots were rather similar although the latter reported a less favorable effort-reward ratio but at the same time higher work engagement. Eastern and Western European pilots differed significantly with respect to multiple work characteristics, such as night shift duty, social support, predictability of work demands, and effort-reward imbalance and also with respect to reported work engagement. An interesting pattern emerged in bivariate and multiple regression analyses of work characteristics and the outcome variables; the adverse characteristics that on average had the lowest levels in the sample (being exposed to disturbing situations at work, lack of role clarity, low levels of procedural justice, and work-family conflict) were most strongly associated with reduced subjective well-being and energy. On the other hand, work engagement was only weakly correlated with the work stressors and resources considered in this analysis.

To provide some context, Table 5 contrasts some of the work stressors, resources, and outcome variables included in our study as reported by the HEMS pilots with ratings of work characteristics as reported by a representative sample of male German workers from various occupational backgrounds[56] as well as with those reported by European airline pilots.[41] Although interpretation must remain cautious because most of the contrasted scales differ to varying degrees in the number of items, wording, or construct measured, some striking differences emerge that merit interpretation. First, when considering the ratings of the Western European (ie, German and Austrian) HEMS pilots' and the German workers, the former are more favorable

Table 3
Pearson Correlations Between Stressors/Resources and Outcome Variables

	(1)	*(2)*	(3)	(4)	(4a)	(4b)	(5)	(6)	(7)	(8)	(9)	(10)	(10a)	(10b)	(10c)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) Average work hours/month	—	.01	.07	.27[a]	.29[a]	.15	.26[a]	.01	−.17	−.18	.26[a]	−.15	.19	−.39[b]	−.07	.29[a]	−.29[a]	.25[a]	.04	.36[b]	−.06	−.20	−.40[c]
(2) Working night shifts		—	−.12	−.19	−.13	−.16	−.29[a]	.01	.26[a]	.08	−.22	.02	−.03	.23	−.21	−.23	.06	−.09	.05	−.16	−.08	.01	.14
(3) Hide emotions			—	.17	.15	.12	−.12	.13	−.16	−.17	.10	−.12	−.04	−.14	−.06	−.01	−.12	.35[b]	.10	.19	.32[b]	−.02	−.12
(4) Emotional demands				—	.67[c]	0.87[c]	.06	−.06	−.38[b]	−.23	.44[c]	−.07	.06	−.26[a]	.08	.12	−.41[c]	.36[b]	.25[a]	.40[c]	−.05	−.23	−.36[b]
(4a) Disturbing situations					—	.21	.13	−.07	−.14	−.38[c]	0.33[b]	−.13	−.01	−.23	−.01	.05	−.38[f]	.27[a]	.20	.36[b]	−.15	−.43[c]	−.51[c]
(4b) Relate to others' problems						—	−.01	−.03	−.40[c]	−.05	.36[b]	.00	.09	−.19	.12	.12	−.28[a]	.30[a]	.20	.28[a]	.04	−.01	−.13
(5) Social support							—	−.04	−.11	−.20	−.01	−.07	−.02	−.20	.11	.60[c]	.12	−.06	−.23	.12	−.02	.03	−.19
(6) Work pace								—	−.01	.06	.03	−.08	−.15	.12	−.16	−.14	.07	.12	−.02	.20	.00	.06	.17
(7) Predictability									—	.19	−.45[c]	.02	−.17	.35[b]	−.17	−.16	.20	−.46[c]	−.13	−.19	−.16	−.14	.15
(8) Role clarity										—	−.44[c]	−.03	−.16	.11	−.04	−.19	.27[a]	−.39[c]	−.28[a]	.24[a]	.12	.34[b]	.51[c]
(9) Role conflict											—	−.19	−.06	−.31[b]	.01	.08	−.51[c]	.43[c]	.31[b]	.34[b]	−.04	−.23	−.45[c]
(10) Autonomy												—	.71[c]	.57[c]	.72[c]	.15	.16	−.04	−.02	−.07	.06	.18	.05
(10a) In task execution													—	−.01	.44[c]	.24[a]	.02	.13	.07	.18	.21	.09	−.12
(10b) In decision making														—	.06	−.16	.32[b]	−.32[b]	−.07	−.27[a]	−.23	.08	.25[a]
(10c) In using own ideas															—	.23[a]	−.04	.14	−.04	−.04	.17	.20	−.05
(11) Supervisor feedback																—	.13	.16	−.06	.20	.07	−.01	−.23
(12) Procedural justice																	—	−.37[b]	−.24[a]	−.17	.03	.28[a]	.37[b]
(13) Effort-reward imbalance																		—	.57[c]	.51[c]	.14	−.20	−.28[a]
(14) Employment insecure																			—	.17	.06	−.22	−.20
(15) Work-family conflict																				—	−.08	−.49[c]	−.53[c]
(16) Work engagement																					—	.44[c]	.35[b]
(17) Well-being																						—	.64[c]
(18) Energy																							—

n = 65–72. Binary variables are in italics. Component items of scores are indented beneath the corresponding overall score.
[a] $P < .05$.
[b] $P < .01$.
[c] $P < .001$.

Table 4
Linear Regression Model Coefficients and Explained Variation for Models of Outcome Variable Including Only Region and Age (Upper Table Section, N = 72) and Models Including Region, Age, and the Respective Work Stressor/Resource (Lower Table Section, n = 65-72)

	Work engagement (% MP)			Well-being (% MP)			Energy (% MP)		
	Coefficient (95% CI)	*P* Value	Model R^2	Coefficient (95% CI)	*P* Value	Model R^2	Coefficient (95% CI)	*P* Value	Model R^2
Eastern Europe (ref: Western Europe)	*−8.86 (−15.16 to −2.56)*	*.007*[b]		*−1.77 (−9.87 to 6.33)*	*.664*		*5.20 (−1.99 to 12.38)*	*.154*	
Age (y)	0.19 (−0.16 to 0.55)	.281	0.15	0.32 (−0.14 to 0.78)	.164	0.04	0.18 (−0.23 to 0.58)	.393	0.03
Average work hours/month	−0.06 (−0.17 to 0.05)	.304	0.21	−0.12 (−0.26 to 0.03)	.106	0.08	−0.20 (−0.32 to −0.08)	.002[b]	0.18
Working night shifts (ref: no night shifts)	*1.37 (−4.89 to 7.63)*	*.663*	0.16	*2.35 (−5.57 to 10.27)*	*.556*	0.06	*3.41 (−3.69 to 10.51)*	*.341*	0.05
Hide emotions (% MP)	0.11 (0.01 to 0.21)	.036[a]	0.21	−0.05 (−0.18 to 0.09)	.472	0.05	−0.06 (−0.18 to 0.06)	.306	0.05
Emotional demands (% MP)	−0.22 (−0.41 to −0.03)	.022[a]	0.22	−0.34 (−0.58 to −0.10)	.005[b]	0.14	−0.32 (−0.53 to −0.11)	.003[b]	0.15
Disturbing situations (% MP)	−0.15 (−0.32 to 0.01)	.071	0.19	−0.42 (−0.62 to −0.23)	< .001[c]	0.25	−0.41 (−0.58 to −0.24)	<.001[c]	0.28
Relate to others' problems (% MP)	−0.11 (−0.24 to 0.02)	.090	0.19	−0.06 (−0.23 to 0.11)	.493	0.05	−0.05 (−0.20 to 0.11)	.548	0.04
Social support (% MP)	−0.06 (−0.19 to 0.07)	.331	0.16	0.01 (−0.16 to 0.17)	.914	0.04	−0.10 (−0.24 to 0.05)	.188	0.06
Work pace (% MP)	0.09 (−0.08 to 0.26)	.321	0.17	0.12 (−0.10 to 0.34)	.286	0.06	0.14 (−0.05 to 0.33)	.148	0.06
Predictability (% MP)	0.03 (−0.13 to 0.18)	.743	0.15	−0.07 (−0.27 to 0.13)	.494	0.05	0.08 (−0.10 to 0.26)	.374	0.04
Role clarity (% MP)	0.21 (−0.04 to 0.45)	.101	0.19	0.50 (0.20 to 0.80)	.001[b]	0.18	0.60 (0.36 to 0.85)	<.001[c]	0.28
Role conflict (% MP)	−0.12 (−0.29 to 0.05)	.158	0.20	−0.26 (−0.48 to −0.05)	.017[a]	0.19	−0.36 (−0.54 to −0.18)	<.001[c]	0.29
Autonomy (% MP)	0.04 (−0.12 to 0.20)	.604	0.18	0.14 (−0.07 to 0.34)	.189	0.12	0.02 (−0.16 to 0.21)	.802	0.22
In task execution (% MP)	0.07 (−0.04 to 0.17)	.212	0.16	0.03 (−0.10 to 0.17)	.617	0.06	−0.05 (−0.17 to 0.07)	.385	0.03
In decision making (% MP)	−0.02 (−0.14 to 0.09)	.672	0.17	0.09 (−0.05 to 0.23)	.213	0.04	0.11 (−0.02 to 0.23)	.092	0.04
In using own ideas (% MP)	0.01 (−0.11 to 0.14)	.826	0.16	0.09 (−0.07 to 0.25)	.278	0.06	−0.02 (−0.16 to 0.12)	.803	0.07
Supervisor feedback (% MP)	−0.01 (−0.11 to 0.09)	.848	0.15	−0.02 (−0.15 to 0.11)	.764	0.06	−0.09 (−0.21 to 0.02)	.105	0.03
Procedural justice (% MP)	0.11 (−0.05 to 0.27)	.180	0.15	0.28 (0.08 to 0.47)	.006[b]	0.04	0.26 (0.09 to 0.43)	.003[b]	0.07
Effort-reward imbalance ratio	−0.87 (−8.94 to 7.20)	.831	0.18	−12.94 (−22.83 to −3.05)	.011[a]	0.14	−10.71 (−19.54 to −1.88)	.018[a]	0.15
Employment insecure (% MP)	0.05 (−0.08 to 0.17)	.482	0.15	−0.19 (−0.35 to −0.03)	.022[a]	0.13	−0.16 (−0.30 to −0.02)	.029[a]	0.11
Work-family conflict (% MP)	−0.08 (−0.19 to 0.03)	.155	0.18	−0.31 (−0.44 to −0.19)	< .001[c]	0.11	−0.27 (−0.38 to −0.16)	<.001[c]	0.10

CI = confidence interval; % MP = percent of maximum possible scale/item score.
Binary variables are in italics, with reference category in parentheses. Component items of scores are indented beneath the corresponding overall score.
[a] $P < .05$.
[b] $P < .01$.
[c] $P < .001$.

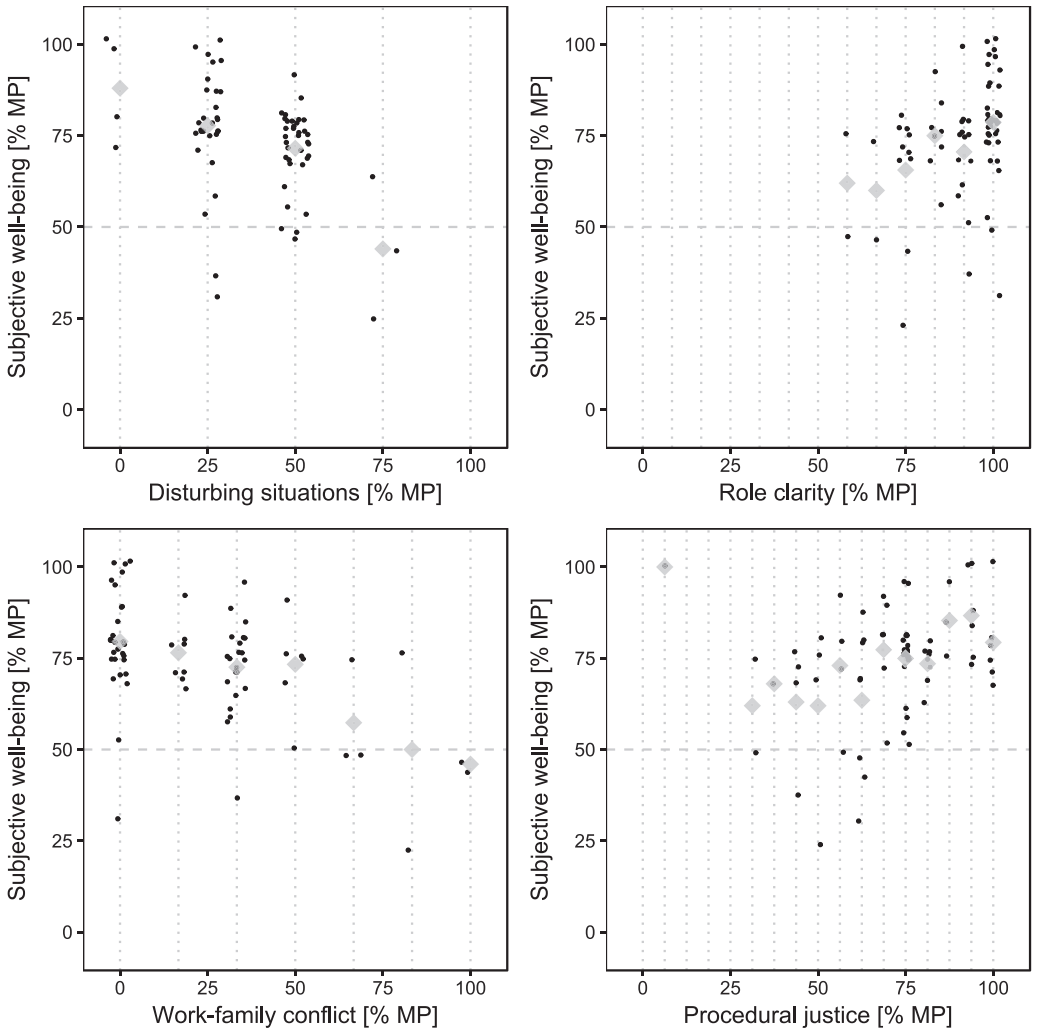

Figure 1. Scatterplots of WHO-5 subjective well-being score against selected work stressors. Vertical dotted lines = possible values of respective work stressor on percent of maximum possible scale. Black dots = individual data points (jittered horizontally to avoid overplotting). Gray diamonds = mean WHO-5 score within subgroup defined by value of work stressor. Horizontal line = WHO-5 depression screening cutoff value (=50). % MP = percent of maximum possible.

in all work stressor/resource comparisons except the need to hide emotions. The particularly large differences with respect to role stress and feedback at work might be explained by the crucial role of recurrent training, standardized procedures, and communications in aviation.[57,58] More surprisingly, the Western European pilots also reported notably less interference of their work with their private life compared with the general working population in Germany, perhaps because of longer regular off-duty periods, although this is admittedly a speculative explanation.

Also, psychological strain symptoms appear to be less pronounced in the Western European HEMS pilots compared with the German general working population based on the scores of the 3 outcome variables in the former and life satisfaction and burnout ratings in the latter. Although the constructs are conceptually distinct, burnout symptoms include reduced well-being, energy, and work motivation, and, in fact, the work engagement construct has been described as the "opposite" of burnout[48]; life satisfaction is conceptually and empirically[59] related to subjective well-being. The finding of relatively low strain symptoms in the HEMS pilots is also supported by comparison with results from a sample of 12,631 workers (male and female) of various occupational groups from 9 countries who reported an average UWES-9 score of 67.5% of the maximum possible score[60] with an average WHOQOL-100 energy subscale rating of 66.2% in German and Austrian general population samples (overall N = 738, male and female).[61] Both averages are notably lower than those of the HEMS pilots. Moreover, the result is consistent with the expectation that professional pilots in general exhibit better health because of healthy worker (survivor) effects induced by selection through entrance examinations as well as recurrent proficiency checks and medical certification.[37]

Assuming a positive predictive value to detect clinical depression of 0.34[52] for a WHO-5 score < 50%, the estimated point prevalence of depression in the pilots is 3.3% (2.8% for Eastern European and 4.3% for Western European pilots). Ferrari et al[62] reviewed prevalence rates of depressive disorder as found in general population cohorts across the globe. When considering only diagnoses ascertained by structured or clinical interview based on *Diagnostic and Statistical Manual of Mental Disorders* or *International Classification of Diseases* in adult males, the average point prevalence is 3.4% (range, 0.9%-8.8%; authors' own calculation), suggesting that depression levels in the pilots are not higher but also not lower than in the general population (note that this figure differs from the frequently cited 12-month prevalence estimate of 6.9% in European general populations[63] because it only considers point prevalence estimates in men, which are better comparable with our data). Upon further limiting the samples considered to only Western European or only Central/Eastern European

Table 5
A Comparison of Selected Psychosocial Work Characteristics and Strain Symptoms in Helicopter Emergency Medical Services (HEMS) Pilots, the General Working Population, and Airline Pilots

Eastern and Western European Male HEMS pilots (N = 72)[a]		Western European Male HEMS Pilots (n = 24)[a]		German Male Workers (n = 4,546)[b]		European Airline Pilots (n = 1,147)[c]	
Scale	M (SD)	Scale	M (SD)	Scale	M (SD)	Scale	M (SD)
Work pace	55.7 (17.5)	Work pace	50.5 (15.0)	Quantitative demands	55.1 (18.7)		
Emotional demands	34.2 (16.4)	Emotional demands	44.8 (13.2)	Emotional demands	51.5 (21.2)		
Need to hide emotions?	41.0 (28.6)	Need to hide emotions?	49.0 (25.0)	Need to hide emotions	45.8 (25.9)		
Work-family conflict	24.1 (25.8)	Work-family conflict	31.9 (26.4)	Work-privacy conflict	44.5 (28.6)	Work-private life conflict	55.3 (16.8)
Role clarity	91.0 (11.4)	Role clarity	88.5 (12.5)	Role clarity	72.8 (18.4)		
Role conflict	22.4 (17.1)	Role conflict	28.9 (16.6)	Role conflict	47.3 (20.8)		
Social support (colleagues and supervisor)	57.1 (22.9)	Social support (colleagues and supervisor)	65.4 (20.6)	Social support	62.0 (21.2)		
Social support (colleagues)	52.9 (21.8)	Social support (colleagues)	67.7 (20.2)			Social support (colleagues)	60.0 (19.0)
Supervisor feedback	50.9 (28.6)	Supervisor feedback	60.8 (29.8)	Feedback (supervisor and colleagues)	42.4 (22.1)		
Employment insecure?	31.9 (23.5)	Employment insecure?	27.5 (25.9)	Job insecurity	32.6 (23.5)	Future insecurity	56.3 (16.3)
Work engagement	78.3 (12.8)	Work engagement	85.0 (11.5)	Burnout	39.5 (19.0)	Burnout: disengagement	53.7 (15.7)
Well-being	73.9 (15.4)	Well-being	76.3 (16.2)	Satisfaction with life	64.2 (19.4)	Happiness	62.3 (21.9)
Energy	80.4 (13.6)	Energy	77.6 (15.7)			Burnout: exhaustion	62.0 (15.3)

M = mean; SD = standard deviation.
All figures on % of maximum possible scale. Horizontal rules indicate groups of related although not necessarily identical constructs.
[a] From the sample analyzed in the present study.
[b] Various occupational groups. Based on a representative sample of German male workers drawn from larger database of German Copenhagen Psychosocial Questionnaires collected between 2003 and 2010.[56]
[c] Members of a European airline pilots' association who participated in an invitation-based online survey in 2016 (91.4% male)[41] based on scales of varying origins (Disengagement & Exhaustion: Oldenburg Burnout Inventory[89]).

samples, the average point prevalences are respectively 4.6% and 2.1%, replicating the difference between Western and Eastern European HEMS pilots in our sample. However, it is difficult to draw firm conclusions for such small percentages based on the moderate size of our sample.

HEMS pilots' stressor/resource and strain symptom ratings also appear to be more favorable than those of the airline pilots although again the measures are not fully comparable. Airline pilots report higher levels of work-private life conflict and (to the extent represented by future insecurity) job insecurity as well as lower levels of engagement and energy. The high burnout ratings in the airline pilot sample reproduced in Table 5 replicate the significantly elevated levels of exhaustion, cynicism, and overall burnout found in a study of US regional airline pilots.[42] These findings are surprising and seem somewhat at odds with the notion of a generally better mental health in professional pilots. Ongoing deterioration of the labor market situation of airline pilots (particularly those newly entering the profession)[64,65] because of increasing cost cutting in the industry may be one driving factor behind the difference between the airline and the HEMS pilots, who are less likely to be affected in the same way by low-cost competition although depending on air rescue system architecture, competitive pressures might also affect HEMS safety.[16,66] Overall fatigue burden may also differ because HEMS pilots may have more opportunity to rest between missions and jet lag is not an issue in HEMS. This is also suggested by a study of US regional airline pilots, of whom 80% reported having nodded off in the cockpit compared with 32% of US HEMS pilots.[45] Nonetheless, and especially given that HEMS flights are often operated by a single pilot, the latter figure shows that fatigue remains an important safety issue in HEMS, which involves specific issues such as frequently interrupted sleep (with corresponding interruption of circadian rhythms) and sleep inertia.[67] The WHOQOL subscale we used may in fact be more reflective of general fatigue, mental well-being, and vitality than of specific incidents of physical fatigue. It may be helpful to differentiate among different facets of fatigue (eg, general fatigue, mental fatigue, and physical fatigue[68]) as well as between overall and situation-specific fatigue in future studies. Finally, given that distress symptoms seem to be more pronounced in the younger airline pilots,[42,43] the differences may also partly be caused by the fact that the average age in the HEMS pilot sample is rather high (an interpretation supported by the higher levels of work engagement and to some degree also of well-being in HEMS pilots aged 55 and over compared with pilots aged 54 or less).

When further comparing Eastern and Western European pilots, it seems that the latter reported higher levels of stressors/resources related to social interactions (having to relate more to others' problems, higher social support, and more supervisor feedback) than Eastern European pilots, who in turn reported higher levels of predictability of work demands and procedural justice and lower levels of role conflict, which is suggestive of a more structured work environment. Multiple factors may contribute to the observed differences between Eastern and Western European pilots. HEMS systems in Europe differ considerably in terms of density of bases, recency of

introduction of HEMS, financing models/type of service provider, or kinds of services provided,[1] which is likely to affect the work situation of the pilots (as seen for example in the large differences in night shift duty between Eastern and Western European pilots). Cultural differences probably also play a role; power distance (the acceptance of uneven distribution of power in society) was found to be higher on average in Eastern compared with Western European countries.[69,70] According to European Values Study data, Eastern European workers rated a good pay, job security, and being respected as more important and working with pleasant people, meeting people, and using initiative as less important compared with Western European workers.[71] However, it is important to emphasize that job stress (as measured by questionnaires) is associated with poor health in both Western and Eastern European respondents.[33,72,73]

Turning to the relation between work stressors and outcome variables, the strongest associations of work characteristics with well-being and energy were found for those adverse work characteristics that appeared to be the least prevalent in the sample (ie, encountering disturbing situations, lower role clarity, low levels of procedural justice, and interference of work with private life). Because the results are cross-sectional, the direction of causality cannot be firmly established, and several possible explanations of these results are possible. On the one hand, there is strong existing evidence for causal effects of occupational stress on mental health.[23] For example, work-privacy conflict may impact partnership quality; the importance of a functioning partnership to professional pilots' well-being and performance has been noted repeatedly in the literature.[41,74,75] Also, given the crucial role of operational standards in aviation in general as well as the high stakes involved in HEMS, perceived role unclarities may be especially burdensome to HEMS pilots. The same may apply with regard to the role of procedural justice in the organization; perceived injustices may be compounded by the pride that HEMS pilots take in their role (as evidenced by high levels of work engagement, especially of the "dedication" subscale), and this is consistent with the finding that effort-reward imbalance was also significantly negatively associated with well-being.

On the other hand, another possible explanation that does not clearly assign causal priority to the work stressors may be as follows: doubtlessly, HEMS pilots are exposed to a considerable amount of psychosocial stress in the course of their work, such as confrontation with human suffering, uncontrollable adverse outcomes of rescue missions, long periods of separation from family and friends, or critical flight situations. Professional pilots are selected and trained to deal with these situations, and, accordingly, generally display high levels of emotional stability, conscientiousness, orientation toward action, and assertiveness[76] as well as a problem-focused, emotion-avoidant coping style.[77,78] Therefore, at least as long as these coping resources are still intact, HEMS pilots may tend to portray the work situation in optimistic terms, which would be consistent with the comparison to the general population showing generally lower stressor levels in HEMS pilots. However, this behavioral pattern may break down in those pilots in whom coping resources are overtaxed by chronic stress (be it through the examined work stressors or other sources), leading the affected pilots to acknowledge, for example, emotionally disturbing situations or interpersonal conflict.

The associations of work stressors with pilots' energy levels are for the most part quite similar to those with well-being. Although, as noted previously, the energy subscale we used may be more reflective of general as opposed to situation-specific fatigue, it is the only outcome to be significantly (negatively) associated with the number of work hours, which does suggest some validity and points to the importance of adequate recovery periods[47,30] as well as flight and duty time limitations in HEMS. The absence of associations between job stress and work engagement found in our sample is consistent with the theoretical model posited by work engagement theory, which does not assume a relation between work stressors and engagement.[79] However, it does assume a positive relation between resources and engagement, which we could not find. Possibly, associations are masked by the very high levels (and thus low variation) of engagement reported by the pilots.

One of the foremost limitations of the present study is the small sample size, which may have led to some associations not being detected and also precluded more sophisticated multivariate analyses, such as mutual adjustment of stressors/resources, moderation and mediation analyses, and structural equation modeling. The overall population of HEMS pilots in Europe is quite small, which makes recruitment of large samples difficult. Because the focus of the overarching study was on age effects, we oversampled older pilots, such that the age distribution in our sample is unlikely to be representative of that of European HEMS pilots in general. Some differences in the stressor/resource profile and the outcome variables existed between younger and older pilots although they were not dramatic. The differences between Eastern and Western European HEMS pilots were more salient; given the heterogeneity of cultures as well as of HEMS systems within Europe,[1] it is somewhat problematic to speak of "the" European HEMS pilot although judging, for example, from the uniformly low ratings of role stress and high ratings of work engagement, there does seem to be some commonality in HEMS' pilots attitudes and mind-sets. Furthermore, the overall participation rate was moderate. Even though nonparticipation was likely to be because of the more sensitive aspects of the study (aeromedical examination results and simulator performance) and not because of the questionnaire analyzed here, some nonresponse bias may be present. The direction of the bias is unclear; nonresponse in survey studies is often more pronounced in those with worse mental or physical health,[80] which would lead to a bias toward positive ratings. On the other hand, in the present context, participation might also have been higher in those who perceived an opportunity to highlight problems at work, leading to a negative bias. Also, because our data are cross-sectional, we cannot make confident statements about the direction of causality of the reported associations. Therefore, we offered different possible explanations for the stressor/resource outcome associations. Finally, no data were collected about operational conditions, such as predominant terrain or available technological equipment, which may affect mission complexity and therefore the potential for the occurrence of stressful situations. Although we did not explicitly gather information about the bases the pilots were assigned to, an informal review of administrative study records suggested that very few, if any, of the participating pilots were working on mountain bases (where missions are often particularly challenging). A considerable proportion of pilots in our sample were working night shifts, and although doing so did not appear to have an effect on strain symptoms, it is not known under which conditions they operated flights during such shifts and how this might affect work stress. However, overall, although our sample suffers from several limitations as outlined previously, the patterns we found are plausible and provide a first starting point for further investigations of job stressors, resources, work motivation, and well-being in HEMS pilots, who, according to our analysis results, appear to differ in some respects from the more frequently studied group of airline pilots.

To conclude, the work stressors/resources profile reported by the HEMS pilots in our sample was on the whole more positive than that of both the general workforce and airline pilots. Despite this encouraging result, which implies that the person-environment fit in the work situation of the HEMS pilots is adequate and thus conducive to flight safety, a number of work characteristics, in particular the presence of work-family conflict, perceived procedural injustice, the encounter of emotionally disturbing situations, and a lack of role clarity, were associated with reduced well-being and energy. Recently, a number of suggestions have

been made to promote pilot mental health, including the establishment of a "just culture" and peer support groups, which allow confidential discussion of this sensitive topic.[81] Our results provide background information that may be helpful in the implementation of such measures in the context of HEMS, such as the great pride and dedication that the HEMS pilots invest into their occupation (as a resource but also as a precondition for perceived organizational injustices) or the need to discuss emotionally burdensome events such as failed rescue missions. Future, ideally prospective longitudinal, studies could investigate the effect on pilot well-being and motivation of such events and their interplay with pilot personality, with contextual factors like unclear responsibilities in the organization, high workload, and fatigue, and with opportunities for distancing oneself from work.[82] A vital further step would also be to link working conditions and strain symptoms of HEMS pilots to the occurrence of safety critical events such as in-cockpit microsleep episodes[45] and aeronautical decision making (eg, with respect to acceptance of missions under borderline weather conditions).[16] Finally, the role of both the wider and the specific operational context might be considered by explicitly contrasting pilots working under different regulatory and organizational (eg, public vs. private sponsorship of the HEMS program[1]), geographic (eg, mountainous vs. flat and rural vs. urban), or technological (eg, night flying with vs. without the use of night vision goggles[83]) conditions. The results of such future studies may provide valuable information for the implementation or modification of work design measures to improve the well-being of pilots and the overall safety of HEMS.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.amj.2018.11.011.

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