Estimating Workers' Mental Health Using Personality Traits and Life Logs

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ABSTRACT

Workers' mental health is important for their well-being; although a stress check system has been introduced in Japan, some issues remain, such as subjective evaluations and infrequent measurements. In this study, personality traits, wearable device data such as sleep duration, and attendance data such as personal computer usage time were collected from research workers, and an integrative study was performed objectively predict daily stress. The results showed a positive correlation between neuroticism and stress buffering factor ($r = 0.72$, $p < 0.01$), implying a reduced stress buffering capacity in individuals with higher neuroticism. Furthermore, a positive association was found between conscientiousness and hours worked ($r = 0.50$, $p = 0.04$). A multiple regression analysis model that included personality traits and life logs significantly improved the predictive accuracy of the stress response (Adjusted $R^2 = 0.71$). These results suggest that the integration of personality traits and life logs can be instrumental in predicting workers' stress reactions and providing personalized mental health care within ubiquitous computing environments beyond traditional, infrequent assessments to enhance well-being in the workplace.

CCS CONCEPTS

- Human-centered computing → Ubiquitous and mobile computing → Ubiquitous and mobile computing systems and tools
- Applied computing → Life and medical sciences → Health informatics

KEYWORDS

Mental Health, Personality Traits, Life Logs, Wearable Device, Attendance Data

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1 Introduction

Mental health is important for workers' well-being [1, 2]; however, the number of people with mental health problems has increased. Here, mental health problems refer to mental disorders as well as stress, severe concerns, anxiety, and other mental and behavioral problems that may affect workers' physical and mental health and the quality of their social lives. According to a survey conducted by the Ministry of Health, Labour and Welfare (MHLW) of Japan in 2023 [3], among all industries, 0.6% of workers took consecutive leave for one month or more and 0.2% resigned due to mental health problems. Furthermore, the number of compensation claims for mental disorders among workers increased by more than twofold over the past decade, from 1,257 cases in 2012 to 2,683 cases in 2022 [4].

In Japan, a stress check system using questionnaires has been introduced to assess worker's mental health. These stress checks are currently required in workplaces with 50 or more employees [5]; moreover, the MHLW is considering making them mandatory for companies with fewer than 50 employees as well [6]. However, there are several issues associated with the current stress check system. First, subjective assessments can introduce bias and may not reflect stress levels accurately in cases of unrecognized stress. Second, stress check tests only measure stress levels once a year, making it difficult to assess stress levels that fluctuate daily. Therefore, to enable effective real-time interventions for workers' mental health, this study aims to objectively predict daily stress levels.

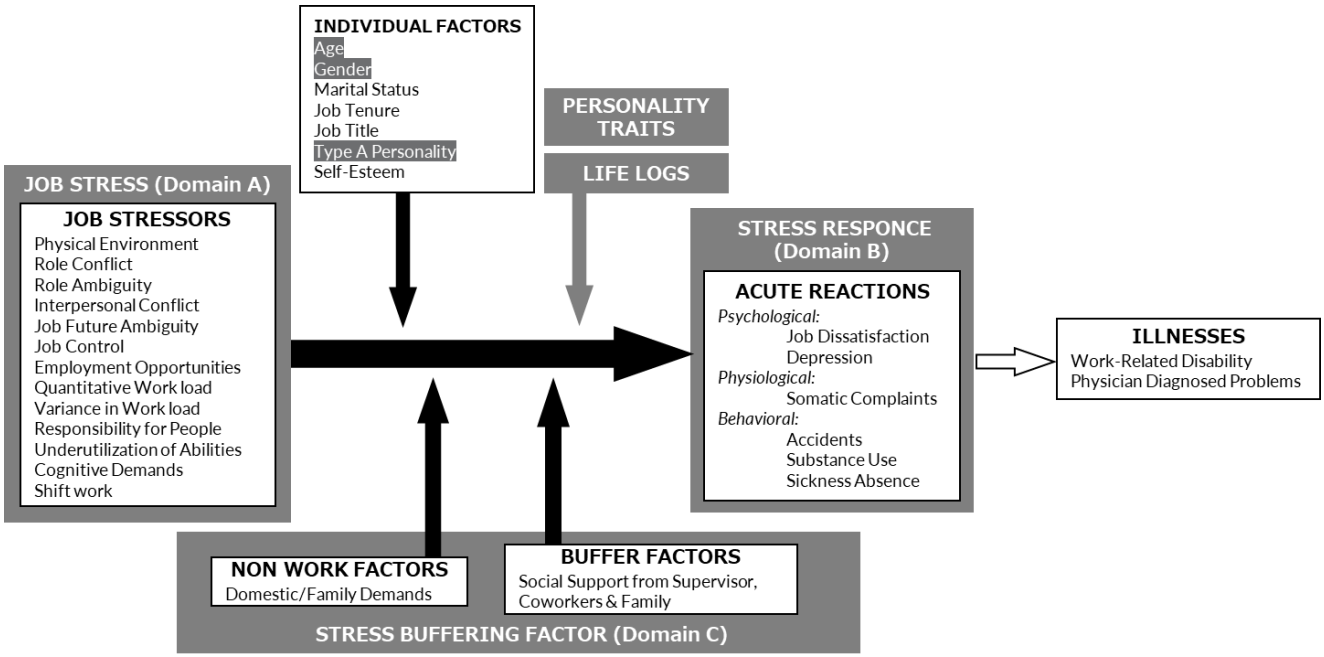

Figure 1: NIOSH Model of Job Stress and This Study's Extended Model.
The uncolored boxes the NIOSH Model of Job Stress, while gray-shaded boxes indicate the models of this study.

2 Related Research

The National Institute for Occupational Safety and Health (NIOSH) [7] proposed an occupational stress model (Figure 1) that suggested the interaction of various factors affects workers' mental health, leading to diagnoses such as depression. Previous studies have identified the influence of factors such as sleep duration and irregular mealtimes on workers' mental health [8]. Furthermore, recently, information technology (IT) adoption has advanced across various industries, thereby increasing the amount of work involving computers. Studies have reported that prolonged time working on computers [9] and low physical activity [10] are associated with mental health problems such as depression and anxiety. Furthermore, a previous study reported that certain personality traits are associated with depression and anxiety disorders [11]. This suggests that personality traits may influence workers' mental health problems. Iwamoto et al. [12] conducted a study to predict workers' stress using attendance data, wearable devices, and self-administered questionnaires. However, this study did not include psychological factors such as personality traits. Hence, there has been no comprehensive examination of the relationship between mental health including factors such as high stress and lifestyle habits and personality traits among Japanese workers.

This study aims to accurately estimate workers' mental status by conducting an integrated analysis encompassing objective information such as wearable device and attendance data in addition to personality traits.

3 Materials and Methods

3.1 Study Participants

This study surveyed 17 researchers aged 25–59 years who belonged to an IT company. The examination period was 14 days, from January 25 to February 7, 2025 (Figure 2). Informed consent was obtained from employees using a web-based consent form. This study was conducted with approval from the Fujitsu Limited Ethics Committee (No. 24-002).

Figure 2: Data Collection Schedule

3.2 Measurement Methods for Each Variable

3.2.1 Demographic Data We collected sex and age data using a questionnaire on entry to the examination.

3.2.2 Physical Activity and Sleep Duration Data on physical activity and sleep duration were collected using the Fitbit Charge 5 smartwatch, a wearable device, throughout the study period. Participants were instructed to charge the device while bathing and to wear it at all other times. The device's step count was used as an indicator of physical activity.

3.2.3 Attendance Data Attendance data were extracted from TIME CREATOR, a system by Fsas Technologies, which the study participants used for their work. The time of login to the personal computer to that of logout was defined as the "working time," and the time from logging out onward was the "non-working time."

3.2.4 Personality Traits Personality traits were assessed using the Japanese version of the Ten-Item Personality Inventory (TIPI-J) [13], which is based on the Big Five theory [14], the most commonly used framework for estimating personality traits in the field of psychology. The participants responded to the questionnaire using a 7-point scale, and scores were calculated for five factors extraversion, agreeableness, conscientiousness, neuroticism, and openness [15].

3.2.5 Mental Health Indicators Mental health indicators were obtained using the Brief Job Stress Questionnaire [16] developed by the MHLW through a web-based survey at the end of the experiment. As shown in Table 1, the questionnaire comprised 57 questions across three domains: Domain A: job stressors, Domain B: stress response, and Domain C: stress-buffering factors. In all domains, higher scores indicate worse condition. The total score of each domain was calculated. High stress was defined as a Domain B score ≥ 77, or a combined score of Domain A and C ≥ 76 and a Domain B score ≥ 63 [17].

Table 1: Structure of Stress Check

Domain A	Domain B	Domain C
Job Stress	**Stress Response**	**Stress Buffering Factor**
・Quantitative workload ・Variance workload ・Physical strain ・Interpersonal relationships ・Work environment ・Job control ・Skill utilization ・Suitability ・Job satisfaction	・Energy ・Irritability ・Fatigue ・Anxiety ・Depression ・Somatic complaints	・Supervisor support ・Coworker support ・Support from family and friends ・Job and life satisfaction

3.3 Statistical Analysis

3.3.1 Pre-analysis Processing The average values for sleep duration, step count, and attendance were used for the measurement period. The working ratio was calculated as working time/(working + non-working time). The distribution of personality traits and each mental health indicator was shown using interquartile ranges and histograms.

3.3.2 Correlation Analysis Spearman's rank correlation coefficient was used to analyze correlations between the measurement parameters.

3.3.3 Multiple Regression Analysis with Stress Response (Domain B) as the Objective Variable We assumed that each domain of the stress check corresponds to each element of the NIOSH Model of Job Stress, as shown in Figure 1, and considered job stressors (Domain A) as "workplace stressors," stress response (Domain B) as "acute stress responses," and stress-buffering factors (Domain C) as "non-work factors" and "buffering factors." Using the score for Domain B as the dependent variable, we created four models and performed multiple regression analysis. Model 1 used the job stressor (Domain A) and stress-buffering factors (Domain C) as independent variables, Model 2 included personality traits in Model 1, and Model 3 added age, sex, and lifelog data to Model 2. Finally, Model 4 was based on Model 3 and was adjusted to mitigate the effects of multicollinearity. Using these models, we constructed a model to predict the stress responses due to labor.

Statistical significance was defined as $p < 0.05$.

4 Results

4.1 Participant Characteristics

After excluding one participant who dropped out, the final number of participants was 16. Table 2 shows the basic attributes of the participants. The median age was 28 years, and 75% were male. The median values for each lifelog item were as follows: a sleep duration of 6 hours 49 minutes, steps 7490, working time 9 hours 20 minutes, and working ratio 83%. The median personality trait scores (range: 2–14) were as follows: extraversion 8.0, agreeableness 8.5, conscientiousness 8.5, neuroticism 8.0, and openness 10.0 (Figure 3). The median stress check scores for each domain were 37 for job stressors (Domain A), 52 for stress response (Domain B), and 22 for stress-buffering factors (Domain C).

Table 2: Characteristics of the Participants. Continuous variables are shown as median (25%, 75%) and categorical variables as n (%).

Category	Parameter	Data (n = 16)
Demographic data	Age	28.0 (27.5, 30.3)
	Sex: Male	12 (75%)
Personality traits	Extraversion	8.00 (7.50, 9.00)
	Agreeableness	8.50 (8.00, 11.25)
	Conscientiousness	8.00 (6.00, 8.25)
	Neuroticism	8.00 (7.50, 10.25)
	Openness	10.00 (7.75, 11.00)
Lifelog	Sleep duration	6:49 (6:22, 7:19)
	Steps	7490 (5151, 10262)
	Working time	9:20 (8:38, 10:29)
	Working ratio	83.0 (79.7, 88.4)
Stress check	Job stress (Domain A)	37 (33, 40)
	Stress response (Domain B)	52 (47, 60)
	Stress-buffering factors (Domain C)	22 (19, 24)

Furthermore, one participant was identified as having high stress levels based on the stress check criteria (Figure 4).

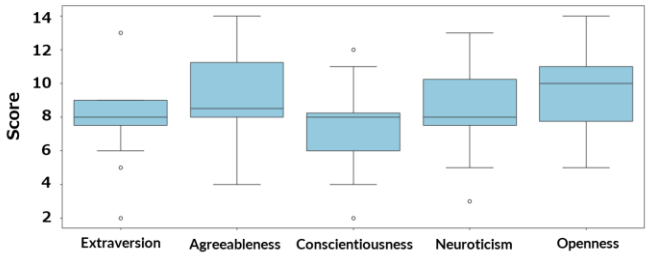

Figure 3: Quartile Range for Personality Trait

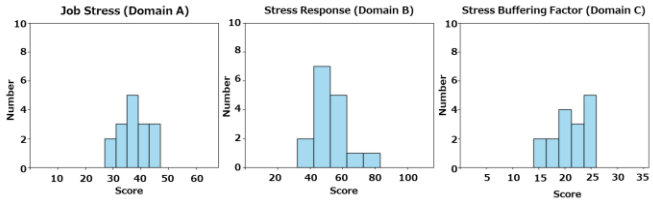

Figure 4: Histogram of the Stress Check Score for Each Domain

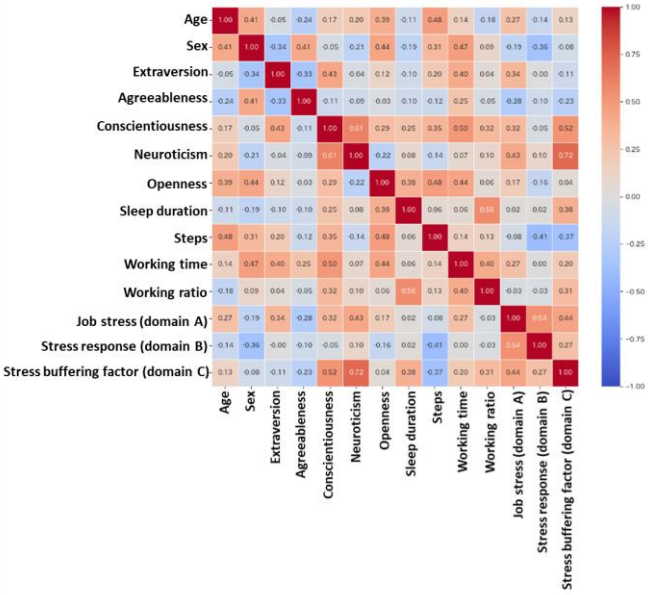

Figure 5: Correlations Between Personality Traits, Life Logs, and Stress Check. Dark red indicates a strong positive correlation, and dark blue indicates a strong negative correlation.

4.2 Correlations Between Personality Traits, Lifelog Data, and Stress Check Items

Figure 5 shows the correlations between personality traits, lifelog data, and the domains of the stress check. A significant positive correlation was found between conscientiousness and working time in personality traits and lifelog data ($r = 0.50$, $p = 0.04$). Regarding the relationship between personality traits and the stress check, strong positive correlations were observed between neuroticism and conscientiousness with stress-buffering factors (Domain C) (neuroticism vs. Domain C: $r = 0.72$, $p < 0.01$; conscientiousness vs. Domain C: $r = 0.52$, $p = 0.04$). Furthermore, positive correlations were observed between sleep duration and working ratio ($r = 0.56$, $p = 0.03$), and between Domain A and Domain B of the stress check ($r = 0.54$, $p = 0.03$).

4.3 Multiple Regression Analysis with Stress Response (Domain B) as the Dependent Variable

Table 3 shows the results of multiple regression analysis with stress response (Domain B) as the dependent variable. The adjusted R^2 for Model 1, consisting of job stress (Domain A) and stress-buffering factors (Domain C), was 0.29. For Model 2, which added personality traits to Model 1, the adjusted R^2 was 0.30. Furthermore, for Model 3, which included lifelog data and other variables in Model 2, the adjusted R^2 increased to 0.50, but strong influence of multicollinearity was suspected. Therefore, in Model 4, stress-buffering factors (Domain C), sex, and steps, which had high variance inflation factors in Model 3, were excluded. As a result, the adjusted R^2 was 0.71, showing a significant increase compared to the other models. To examine the effect of personality traits on the prediction model for stress response (Domain B), Model 5 was created by removing the five personality trait variables from Model. The Adjusted R^2 for Model 5 was 0.17, indicating a considerable decrease in predictive accuracy.

5. Discussion

In this study, we attempted to estimate the mental health, especially stress responses, of workers in research positions in the information and communication industry, which has the highest rate of workers taking leave or resigning due to mental health problems among all industries. The results suggest that integrating personality traits and lifelog data into stress check tools improves their predictive accuracy of stress responses. In this study, only one participant was identified as having high stress. Therefore, the mental health status of the current study population was relatively good. However, it is important not only to identify individuals with high stress levels but also to detect individuals with potential stress risks at early stages and provide appropriate support.

The analysis revealed that higher levels of conscientiousness were associated with longer working hours. This finding highlights the need to consider the increased potential for poor mental health due to prolonged work hours among highly conscientious individuals. Furthermore, strong positive correlations were observed between neuroticism and conscientiousness and stress buffering factors. These personality traits influence relationship building with people around the individuals, such as supervisors, colleagues, family, and friends, which can potentially impact mental health negatively. A previous study reported that people with high neuroticism tend to have greater vulnerability to stress and may require more social support [18]. Actually, in this study, it was found that people with higher neuroticism were less satisfied with the support they received from those around them, suggesting that further consideration is needed for them. Furthermore, high levels of neuroticism and conscientiousness have been suggested as factors that can reduce marital satisfaction [19]. Consequently, it cannot be ruled out that individuals with these traits may receive less support

from their families. Also, the positive correlation between sleep duration and working ratio suggests that individuals with longer sleep durations tend to have a higher rate of working due to fewer interruptions. Therefore, sufficient sleep may contribute to improved work efficiency. The positive correlation between job stress and stress responses demonstrates that increased job stress was associated with heightened stress responses. This finding supports the NIOSH Model of Job stress and suggests that mitigating work-related stressors is crucial for improving workers' mental health.

The substantial increase in adjusted R^2 observed in the multiple regression models incorporating job stress, personality traits, and lifelog data suggests the potential for improved accuracy in predicting stress responses through combined use, potentially addressing the limitations of traditional stress check systems. Previously, workers have raised concerns about the difficulty in responding to stress checks due to issues of psychological safety and privacy [20]. The results indicate that a more personalized approach to mental healthcare is feasible by integrating objective data, such as wearable device data and attendance records, with personality traits, rather than relying solely on subjective assessments. For instance, interventions such as alerts or prompts for rest could be implemented for highly conscientious workers who are prone to working long hours. Furthermore, tailored stress management training could be offered to workers with high levels of neuroticism who are more susceptible to the influence of non-work-related stressors.

This study has several limitations. First, the small sample size limited statistical power, necessitating careful consideration of the generalizability of the findings. Second, the focus on research positions within the IT industry restricted the applicability of the results to other industries and occupations. Different industries and occupations, particularly those with varying work environments and job duties, may exhibit distinct patterns of stressors and stress responses. Third, the short investigation period of two weeks made it difficult to capture long-term changes in mental health. The influence of long-term factors, such as seasonal variations and life events, on mental health needs to be considered in future studies. Fourth, careful ethical considerations must be made to ensure that the disclosure of personality traits and stress levels does not disadvantage workers. Future research should prioritize privacy protection even more, increase the sample size, extend the investigation period, and include workers from diverse industries and occupations to enhance the reliability and generalizability of the results.

Table 3: Multiple regression analysis with the stress response (domain B) as the objective variable

	Model 1			**Model 2**			**Model 3**			**Model 4**			**Model 5**		
	β	SE	*p*-value	β	SE	*p*-value	β	SE	*p*-value	β	SE	*p*-value	β	SE	*p*-value
Stress Check															
Job Stress (Domain A)	1.40	0.52	0.02	2.18	0.63	0.01	1.92	0.81	0.14	1.69	0.44	0.01	1.59	0.62	0.03
Stress buffering factor (Domain C)	−0.12	0.76	0.88	0.49	1.18	0.69	0.09	2.90	0.98						
Individual data															
Age							−0.18	0.60	0.79	0.06	0.36	0.86	−0.35	0.43	0.43
Sex							15.07	25.83	0.62						
Personality traits															
Extraversion				−2.57	2.21	0.28	−8.03	3.27	0.13	−6.93	1.82	0.01			
Agreeableness				0.10	1.16	0.93	−5.17	3.17	0.25	−3.39	1.40	0.06			
Conscientiousness				2.73	2.80	0.36	6.04	7.51	0.51	4.93	1.91	0.05			
Neuroticism				−3.91	2.47	0.15	−7.98	3.18	0.13	−6.58	1.72	0.01			
Openness				−3.09	1.76	0.12	−11.43	5.01	0.15	−7.75	1.73	0.01			
Lifelog															
Sleep duration							11.69	5.33	0.16	7.70	2.28	0.02	−0.31	2.36	0.90
Steps							0.06	0.29	0.86						
Working time							6.09	3.31	0.21	4.90	1.52	0.02	−0.34	1.10	0.77
Working ratio							−2.55	1.18	0.16	−1.66	0.53	0.03	−0.15	0.61	0.81
Adjusted R^2	0.29			0.30			0.50			0.71			0.17		

6. Conclusion

This study suggested that integrating personality traits and lifelog data can improve the accuracy of predicting stress responses in workers. These findings indicate that personality traits and life logs can be useful for predicting workers' stress reactions and may contribute to realizing personalized mental health care.

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