Human Factors in Exhaustion and Stress of Japanese Nursery Teachers: Evidence from Regression Model on a Novel Dataset

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***Abstract*—Japan is well known for one of the highest suicide rates in the world, and suicide is the third cause of death after cancer and accidents. The most common reason for suicide comes from overwork and stress-related issues. Researchers have found that education is listed in the top 6 job categories that are highly affected by overwork and stress. In this paper, we investigate the human factors that influence the exhaustion and stress levels of nursery teachers, which is one of the top social issues in the education system of Japan. We are the first to own a novel dataset that contains the data of nursery teachers in Tokyo including demographics, working schedule, and stress and exhaustion information. The data was collected using survey-based and real-time approaches with professional devices. We built a regression model in machine learning with t-test in statistics and divided the effect levels of the factors into three levels: normal, nearly-significant, and significant. We found the following results. First, we found the evidence that working on Thursday and Friday affects both exhaustion and stress. Interestingly, although working on Friday is more exhaustive than on Thursday, working on Thursday is more stressful than on Friday. Surprisingly, we found that while working on Saturday does not affect either exhaustion or stress, working on Sunday is a factor affecting the stress (but not exhaustion) of the participants. Furthermore, gender, weight, and height do not appear as affecting factors. Also, people who are less than 30 years old get more easily stressed than the other ages.**

Keywords–Machine Learning; Multiple (Linear) Regression; Student's T-test (t-test); Human Factors.

I. INTRODUCTION

Japan is well known for having one of the highest suicide rates in the developed world. Japanese culture has a long history of considering certain types of suicides honorable, especially during military service. According to the National Police Agency (Government of Japan), 24,025 people died by suicide in Japan in 2015; and among those, 2,159 (12.0%) were suicides due to overwork and stress-related issues [1]. Y. Takashi et al. [2] studied 18 most common job categories and found that education/learning support is listed in the top 6 job categories that are highly affected by overwork and stress.

A. Motivation

Based on the data mentioned above, we ask the question: why does education/learning support have such a very high rank of overwork and stress rates? It is even higher than some other job categories that were believed to have high overwork and stress rates, such as scientific research, professional, and technical services, or information and communications. Furthermore, while a national initiative towards the prevention of overwork and stress-related issues becomes a challenge, Japan is encountering another big social issue in education that is the massive demand for nursery teachers [3][4]. According to the Ministry of Health, Labor and Welfare in Japan, the number of children on the waiting lists of nursery schools was over 20,000 between 2009 and 2016 [5]. Especially, this problem is serious in large cities like Tokyo. In 2016, more than 35% of the children on waiting lists lived in Tokyo [6]. So, we ask another question: Is there a relation between these two social issues in Japan, especially in Tokyo? More concretely, what are the factors influencing the exhaustion and stress of nursery teachers?

B. Contribution

In this work, we investigate human factors that affect the stress and exhaustion of Japanese nursery teachers:

- To the best of our knowledge, we are the first to collect a novel dataset related to the exhaustion and stress measurements of the nursery teachers in Tokyo. Our dataset was collected using a survey-based approach (i.e., questionnaire) and a real-time approach with the help of professional devices.
- Many people thought (but did not have evidence) that working on the days of the week that are before and close to weekends is more exhaustive and stressful than on the other days, and we are the first to find the evidence about it. We built a regression model in machine learning, applied the t-test, and found that the teachers working on Thursday and Friday tend to get exhausted and stressed. Moreover, while working on Friday is more exhaustive than on Thursday, working on Thursday is more stressful than on Friday.
- We also found that, while working on Saturday does not affect either the exhaustion or the stress, working on Sunday is a factor affecting the stress but not the exhaustion, although both Saturday and Sunday are weekend. Furthermore, gender, weight, and height do not appear as effecting factors; but people under 30 years old get stressed easier than the others.

C. Roadmap

The rest of this paper is organized as follows. The related work is described in Section II. The procedure is presented in Section III. The model is given in Section IV. The experiment and discussion are analyzed in Sections V. Finally, the conclusion is drawn in Section VI.

II. Related Work

In this section, we introduce related work about factor analysis in exhaustion and stress.

A. Exhaustion and Stress in Education

A. Rudman et al. [7] studied the influences of burnout during nursing education in health and professional development, and quality of care. They monitored the burnout of a national sample of nursing students during their years in higher education and at follow-up one year post-graduation, and found that the burnout during education is an important concern to the future clinical performance. A. Antoniou et al. [8] investigated the occupational stress and professional burnout of teachers in primary and secondary education. They showed that the teachers in primary education and the female teachers experience higher levels of stress compared to those in secondary education and male teachers, respectively. Furthermore, female teachers experience lower personal accomplishment than male teachers. N. Barkhuizen et al. [9] analyzed the relationship between burnout and work engagement in higher education. They found that job demands contributed to burnout while job resources contributed to work engagement. Dispositional optimism strongly affects perceptions of job resources, burnout, work engagement, ill-health, and organizational commitment. L. Flook et al. [10] analyzed the Mindfulness-Based Stress Reduction course (mMBSR) for teachers. They showed that the course has a good effect on the participants with significant reductions in psychological symptoms and burnout, improvements in classroom and performance on a computer task of affective attentional bias, and an increase in self-compassion. In contrast, control group participants showed declines in cortisol functioning and significant increases in burnout. Contrary to our work, none of the related work analyzed the stress and exhaustion for nursery teachers.

B. Exhaustion and Stress in Other Fields

N. Khamisa et al. [11] analyzed the nature of relationships between work-related burnout, job satisfaction, and general health of nurses. They showed that lack of support was associated with burnout, patient care was associated with job satisfaction, and staff issues were associated with general health of nurses. Furthermore, burnout is more strongly related to job satisfaction than general health. M. Mikolajczak et al. [12] analyzed whether parental burnout is affected by overwhelming exhaustion related to parental roles, emotional distance with children, and sense of ineffectiveness in parental roles. They showed that parental burnout is a multi-determined syndrome mainly predicted by three sets of factors: parent's stable traits, parenting, and family-functioning. P. Gkorezis et al. [13] studied Machiavellian leadership (a person's tendency to be unemotional, lacking in concern for conventional morality and more inclined to engage in interpersonal manipulation) in employees' emotional exhaustion. They showed that Machiavellian leadership has both direct and indirect effect on employees' emotional exhaustion through organizational cynicism. W. Liang et al. [14] analyzed whether the stress itself affects other issues (i.e., the problematic smartphone used among college students). Stress measurement is used as a factor not a target function like our goal. G. Mark et al. [15] analyzed three email use patterns, such as duration, interruption habit, and batching in affecting workplace productivity and stress. They tracked email usage of 40 information workers for 12 workdays and found that the longer daily time spent on email, the lower productivity and the higher stress. Furthermore, people who primarily check email through self-interruptions report higher productivity with longer email duration compared to those who rely on notifications. A. Barbarin et al. [16] investigated whether health information technology can support overweight or obese women in addressing emotion and stress-related eating. They showed that the factors (participants' needs) are holistic health goal development, building motivation to achieve goals, and assistance with handling stress. J. Adriaenssens et al. [17] analyzed the influence of changes over time in work and organizational characteristics on job satisfaction, work engagement, emotional exhaustion, turnover intention and psychosomatic distress in emergency room nurses. They found that changes in job demand, control, and social support predicted job satisfaction, work engagement, and emotional exhaustion. In addition, changes in reward, social harassment, and work agreements predicted work engagement, emotional exhaustion, and intention to leave, respectively.

III. Procedure

We collaborated with the Center of Early Childhood Development, Education, and Policy Research (CEDEP) at the University of Tokyo, Japan. CEPDEP helped contact 36 nursery teachers, who are working in seven nursery schools located in different wards in Tokyo. All the teachers agreed to participate in our measurement and signed the Privacy Policy agreement about their personal data.

A. Demographics

A paper-based questionnaire is prepared and distributed to the participants. The questions related to the demographics include:

- Gender: It is a single-choice question with two answer options (male and female).
- Age: The inputs are integers. The valid values are from 15 to 65 (years old), which are the allowed working ages by the Japanese government.
- Weight and height: The inputs are integers. The units are kilogram (kg) and centimeter (cm), respectively.

The distribution of gender, age, weight, and height are given in Tables I, II, III, and IV, respectively.

B. Working Days

All the measurements were conducted in 2019. Since there were not enough devices for all the participants to use at the same time, the data of each participant was collected in different periods. Each day in the measurement period is transformed to the corresponding day of the week (Monday to Sunday). The distribution is given in Table V. The first column represents the participant ID (36 participants in total). The second column represents the measurement periods. Some

Figure 1. Garmin (Left) and Omron (Right) Devices

participants have discontinuous measurement periods which are presented in different rows. The third to ninth columns represent the number of weekdays extracted from the measurement periods.

C. Stress and Exhaustion Measurement

Professional devices were used to measure the stress and exhaustion. The devices were given to the participants only in the corresponding measurement periods that were designed for each participant, as mentioned in Section III-B. The teachers were required to wear the devices during the working time in the nursery schools only, and had to return them before leaving the schools.

To measure the stress, we used Garmin smartwatches (Vivoactive 3), as depicted in Figure 1 (left). Garmin is a technology company specializing in wearable technology products, such as activity trackers and smartwatches [18]. The devices measured the stress from 1 to 100. 1 to 25 represents the resting states, 26 to 50 represents the low stress, 51 to 75 represents the medium stress, and 76 to 100 represents the high stress. The devices determine the stress based on the heart-rate variability. From the heart rate data, the device extracts the interval between each heartbeat. If the variable length of time in between each heartbeat is fast, it reflects the autonomic nervous system of the user's body. The lower the variability between beats, the higher the stress levels, whereas an increase in variability indicates less stress. We can read the stress directly from the devices or logging in the accounts from the Application Programming Interface (API) webpage of Garmin.

To measure the exhaustion, we used Omron devices (Active Style Pro HJA-750C), as depicted in Figure 1 (right). Omron is an electronics company that is well-known for medical equipment devices [19]. The devices measure the total calories burned and the Basal Metabolic Rate (BMR). These values are then used to calculate the exhaustion. More details are explained in Section IV.

TABLE I. DISTRIBUTION OF GENDER

Value	#Participants	Percentage
1 (Male)	6	16.67%
0 (Female)	30	83.33%
Total	36	100%

TABLE II. DISTRIBUTION OF AGE

Value	#Participants	Percentage
≤ 29	16	44.44%
30 to 39	10	27.78%
≥ 40	10	27.78%
Total	36	100%

TABLE III. DISTRIBUTION OF WEIGHT

Weight	#Participants	Percentage	Weight	#Participants	Percentage
44	1	2.78%	56	1	2.78%
45	2	5.56%	57	1	2.78%
46	3	8.33%	58	1	2.78%
47	2	5.56%	60	1	2.78%
48	3	8.33%	63	3	8.33%
49	2	5.56%	65	1	2.78%
50	2	5.56%	66	1	2.78%
51	4	11.11%	68	1	2.78%
53	3	8.33%	70	1	2.78%
55	2	5.56%	73	1	2.78%
Total	#Participants = 36 (100%)				

TABLE IV. DISTRIBUTION OF HEIGHT

Height	#Participants	Percentage	Height	#Participants	Percentage
150	1	2.78%	160	5	13.89%
152	1	2.78%	161	2	5.56%
153	1	2.78%	162	1	2.78%
154	1	2.78%	163	1	2.78%
155	1	2.78%	165	2	5.56%
156	1	2.78 %	167	1	2.78%
157	6	16.67%	168	3	8.33%
158	4	11.11 %	177	2	5.56%
159	2	5.56%	179	1	2.78%
Total	#Participants = 36 (100%)				

IV. MODEL

Let f denote the model for both the exhaustion and stress:

$$f = demog + wdays \tag{1}$$

where $demog$ and $wdays$ denote the features extracted from demographics and working weekdays, respectively.

A. Variables

The explanatory variables related to $demog$ consist of gender, age, weight, and height. For the gender, the input values are normalized to binary numbers, such as male: 1 and female: 0. For the age, the input values are grouped into three features (i.e., ≤ 29, 30 to 39, and ≥ 40 (years old)), and are normalized to binary numbers for each feature. For the weight and height, the variables use the original input values.

The explanatory variables related to $wdays$ are the seven days in a week (Monday to Sunday) which are extracted from the measurement period. For each weekday, the variable is a binary number, such as working on that day: 1 and not working on that day: 0. In summary, there are 13 variables (11 binary variables and 2 continuous variables).

B. Target functions

For the exhaustion, the target function is defined as follows:

$$f_1 = \frac{wkcal}{bmr} \tag{2}$$

where $wkcal$ denotes the calories burned during the working time for each weekday (Monday to Sunday); and bmr

TABLE V. DISTRIBUTION OF MEASUREMENT PERIOD (IN 2019)

#Part.	Measurement Period	Mon	Tue	Wed	Thu	Fri	Sat	Sun
01	5/29-5/31	0	1	1	1	0	0	0
02	5/29-5/31	0	1	1	1	0	0	0
03	5/29-5/31	0	1	1	1	0	0	0
04	5/29-5/31	0	1	1	1	0	0	0
05	5/29-5/31	0	1	1	1	0	0	0
06	5/29-5/31	0	1	1	1	0	0	0
07	6/06-6/08	0	0	0	1	1	1	0
08	6/03-6/12	2	2	2	1	1	1	1
09	6/07-6/09	0	0	0	0	1	1	1
10	6/06-6/07	0	0	0	1	1	0	0
11	6/06-6/07	0	0	0	1	1	0	0
12	5/27-6/12	3	3	3	2	2	2	2
13	6/06-6/07	0	0	0	1	1	0	0
14	6/06-6/07	0	0	0	1	1	0	0
15	6/06-6/07	0	0	0	1	1	0	0
16	6/06-6/07	0	0	0	1	1		0
17	6/12	0	0	1	0	0	0	0
18	6/13-6/14	0	0	0	1	1	0	0
	6/17-6/18	1	1	0	0	0	0	0
19	6/12-6/14	0	0	1	1	1	0	0
20	5/27-6/18	4	4	3	3	3	3	3
21	5/27-6/18	4	4	3	3	3	3	3
22	6/12-6/15	0	0	1	1	1	1	0
23	5/27-7/08	7	6	6	6	6	6	6
24	6/12-6/14	0	0	1	1	1	0	0
25	6/19-6/21	0	0	1	1	1	0	0
	6/23-6/24	1	0	0	0	0	0	1
26	6/19-6/20	0	0	1	1	0	0	0
	6/24	1	0	0	0	0	0	0
27	6/19	0	0	1	0	0	0	0
	6/21	0	0	0	0	1	0	0
28	6/19-6/21	0	0	1	1	1	0	0
29	6/19-6/21	0	0	1	1	1	0	0
30	6/19-6/21	0	0	1	1	1	0	0
31	6/19-6/21	0	0	1	1	1	0	0
32	6/19-6/21	0	0	1	1	1	0	0
33	6/19-6/21	0	0	1	1	1	0	0
34	6/20-6/21	0	0	0	1	1	0	0
35	6/20-6/22	0	0	0	1	1	1	0
36	6/19-6/21	0	0	1	1	1	0	0

denotes the BMR, which is the body's metabolism. BMR represents the required calories to keep one's body functioning at rest (a constant for each person). Thus, we calculate the exhaustion by the rate of total calories burned everyday and the BMR. For each weekday, $wkcal$ is calculated as the average of calories burned in all the working days that can be transformed to this weekday. More concretely, suppose that the measurement period is n days $\{d_1, \cdots, d_n\}$. For each weekday $w \in$ {Monday, $\cdots$, Sunday}, $wkcal$ is calculated as $wkcal = \mathsf{average}(\mathsf{CaloriesBurned}(d_i))$ for all $\forall i$ such that $\mathsf{WeekDay}(d_i) = w$.

For the stress, the target function is defined as follows:

$$f_2 = wsl \tag{3}$$

where wsl dennotes the stress for each weekday. wsl is calculated as the average of stress levels in all the working days that can be transformed to the weekday: $wsl = \mathsf{average}(\mathsf{StressLevel}(d_i))$ for all $\forall i$ such that $\mathsf{WeekDay}(d_i) = w$.

C. Factor Determination

After constructing the model, the (multiple) linear regression is applied for each target function. The linear regression is used instead of the logistic regression because the exhaustion and stress have continuous values. Formally, suppose y_p is the predicted value. y_p is determined as:

$$y_p(w, x) = w_0 + w_1 x_1 + \cdots + w_n x_n \tag{4}$$

where $(x_1, \cdots, x_n)$ are the variables and n is the number of variables. The algorithm designates the vector $w = (w_1, \cdots, w_n)$ as the coefficients and w_0 as the intercept (i.e., the constant which is the expected mean value of y_p when all x's are 0). To estimate w and w_0, we use the Ordinary Least Squares (OLS) method which fits the model with coefficients to minimize the residual sum of squares between the observed targets in the dataset and the targets predicted by the linear approximation:

$$\mathsf{min}_x \mid\mid xw - y \mid\mid_2^2 \tag{5}$$

The t-test is then applied to find the factors whose p-values are less than or equal to 0.05. The factors are categorized as follows:

- $0.01 < p \leq 0.05$: normal affecting factors
- $0.001 < p \leq 0.01$: nearly-significant affecting factors
- $p \leq 0.001$: significant affecting factors

In the experiment result, besides the p-value, we also show the t-value which measures the size of the difference relative to the variation in the sample data, the coefficients w_i of the linear equation, and 95% of Confidence Interval (CI) which is an estimated range of values that may contain the true mean of the population.

V. Experiment

The program is written in Python 3.7.4 on a computer MacBook Pro 2.8 GHz Intel Core i7, RAM 16 GB. The regression model is executed using *scikit-learn* library 0.21. The t-test is applied using *statsmodels* library 0.10.

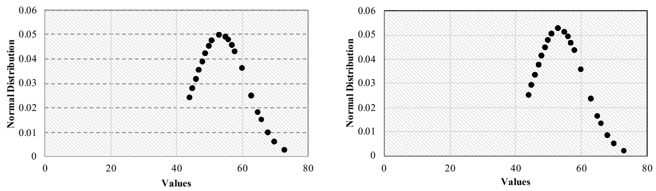
A. Data Pre-processing and Statistics

1) Cronbach's Alpha (α): Cronbach's α is used to measure the Internal Consistency (IC) or the reliability of the questions that have multiple Likert-scale sub-questions. Suppose a quantity which is a sum of K components is measured as: $X = Y_1 + Y_2 + \cdots + Y_K$. The value α is defined as follows:

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2}\right) \tag{6}$$

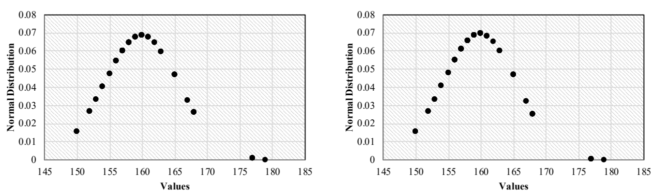
where σ_X^2 denotes the variance of the observed total test scores and $\sigma_{Y_i}^2$ denotes the variance of the component i for the current sample of persons. The values of α can be interpreted as follows: $\alpha \geq 0.9$ (excellent IC), $0.9 > \alpha \geq 0.8$ (good IC), $0.8 > \alpha \geq 0.7$ (acceptable IC), $0.7 > \alpha \geq 0.6$ (questionable IC), $0.6 > \alpha \geq 0.5$ (poor IC), and $0.5 > \alpha$ (unacceptable IC). For our dataset containing the working weekdays (Table V), we can ask the same type of question. We run the Cronbach α test on the set of 36 rows (36 participants) and 7 columns (Monday to Sunday) in the table. For the participants that have more than one row, the values are summed for each working weekday. The number of sub-questions is $K = 7$. The sum of the item variances is $\sum_{i=1}^{K} \sigma_{Y_i}^2 = 10.49$. The variance of total scores is $\sigma_X^2 = 67.01$. Therefore, $\alpha = \frac{7}{7-1}(1 - \frac{10.49}{67.01}) = 0.98$ (excellent IC). This indicates that the data for working days is reliable.

2) Noise Removal: Each participant has different working weekdays. In Table V, 122 samples are extracted as the number of working weekdays of the 36 participants. For the exhaustion measurement, we used all the 122 samples for the learning dataset and applied the regression to the dataset. For the stress measurement, there are nine samples that have zero or untraceable stress levels. We thus considered them as data outliers, and removed them from the dataset. We applied the regression on the remaining $122 - 9 = 113$ samples.



(a) Exhaustion (b) Stress

Figure 2. Normal Distribution Curves (Weight)



(a) Exhaustion (b) Stress

Figure 3. Normal Distribution Curves (Height)

3) Distribution: As mentioned in Section IV-A, the model consists of 13 variables (11 binary variables and 2 continuous variables). The distributions are separately calculated on 122 samples for the exhaustion and 113 samples for the stress. The distribution of binary variables is given in Table VI. In some variables, the values may have a low distribution. For instance, the variables Monday, Tuesday, Saturday, and Sunday have less than 10% of the distribution for the binary value '1' (or 'yes'). This may raise the question whether this kind of variables will affect the result and should be removed from the dataset. However, for the linear regression model, it is not necessary to remove such variables because the influences of any variable, which is even strong or weak, will be reflected in the t-test's result. For the continuous variables, the distribution scores are described in Table VII and the distribution curves are given in Figures 2 (weight) and 3 (height). The curve shapes for the exhaustion and the stress look the same but in fact, are different. All the variables have bell curves and the skewness in $[-2, +2]$; this indicates that the variables are valid for normal (Gaussian) distribution.

B. Main Experimental Results

1) Exhaustion: The regression is applied to 122 samples. The result is shown in Table VIII. Two factors were found:

- Friday: *significant affecting factor* ($p = 0.001$). The positive coefficient (0.2541) indicates that the teachers who work on Friday tend to get exhausted. If the coefficient is negative, the variable and the target function will have an inverse effect (e.g., the teachers who do NOT work on Friday tend to get exhausted).
- Thursday: *nearly-significant affecting factor* ($p = 0.004$). The positive coefficient (0.2126) indicates that the teachers who work on Thursday tend to get exhausted, but the effect is less than working on Friday.

TABLE VI. DISTRIBUTION OF BINARY VARIABLES

Variable	Exhaustion (122 samples)		Stress (113 samples)	
	Yes/1	No/0	Yes/1	No/0
Male	15 (12.30%)	107 (87.70%)	12 (10.62%)	101 (89.38%)
Age: ≤ 29	47 (38.52%)	75 (61.48%)	43 (38.05%)	70 (61.95%)
Age: 30-39	35 (28.69%)	87 (71.31%)	31 (27.43%)	82 (72.57%)
Age: ≥ 40	40 (32.79%)	82 (67.21%)	39 (34.51%)	74 (65.49%)
Monday	8 (06.56%)	114 (93.44%)	7 (6.19%)	106 (93.81%)
Tuesday	6 (04.92%)	116 (95.08%)	5 (4.42%)	108 (95.58%)
Wednesday	25 (20.49%)	97 (79.51%)	25 (22.12%)	88 (77.88%)
Thursday	33 (27.05%)	89 (72.95%)	31 (27.43%)	82 (72.57%)
Friday	34 (27.87%)	88 (72.13%)	33 (29.20%)	80 (70.80%)
Saturday	9 (07.38%)	113 (92.62%)	8 (7.08%)	105 (92.92%)
Sunday	7 (05.74%)	115 (94.26%)	4 (3.54%)	109 (96.46%)

TABLE VII. DISTRIBUTION OF CONTINUOUS VARIABLES

Score	Exhaustion (122 samples)		Stress (113 samples)	
	Weight	Height	Weight	Height
Mean	53.61	159.96	53.61	159.90
Standard Error	0.72	0.53	0.72	0.53
Median	51	159	51	159
Mode	46	160	46	157
Standard Deviation	7.99	5.80	7.99	5.73
Sample Variance	63.79	33.64	63.79	32.79
Kurtosis	-0.32	2.59	-0.32	2.66
Skewness	0.87	1.44	0.87	1.44
Range	29	29	29	29
Minimum	44	150	44	150
Maximum	73	179	73	179

TABLE VIII. RESULT FOR EXHAUSTION

No	Factor	Coef.	p-Value	t-Value	95% CI
	Intercept	0.328	0.467	0.729	[-0.563, 1.218]
1	Male	-0.029	0.708	-0.375	[-0.179, 0.122]
2	Weight	-0.002	0.380	-0.882	[-0.007, 0.003]
3	Height	0.007	0.111	1.608	[-0.002, 0.015]
4	Age: ≤ 29	0.145	0.360	0.919	[-0.167, 0.457]
5	Age: 30 to 39	0.080	0.584	0.549	[-0.207, 0.366]
6	Age: ≥ 40	0.103	0.500	0.677	[-0.199, 0.406]
7	Monday	-0.078	0.365	-0.909	[-0.249, 0.092]
8	Tuesday	-0.097	0.304	-1.034	[-0.282, 0.089]
9	Wednesday	0.104	0.148	1.455	[-0.038, 0.245]
10	Thursday	0.213	(**) **0.004**	2.941	[0.069, 0.356]
11	Friday	0.254	(***) **0.001**	3.543	[0.112, 0.396]
12	Saturday	0.070	0.398	0.848	[-0.093, 0.233]
13	Sunday	-0.138	0.114	-1.594	[-0.309, 0.034]

(*): $0.01 < p \leq 0.05$, (**): $0.001 < p \leq 0.01$, and (***): $p \leq 0.001$

2) Stress: The regression model is applied to 113 samples. The result is shown in Table IX. Five factors were found:

- Age $\leq$ 29: *normal affecting factor* ($p = 0.030$). The positive coefficient (44.9775) indicates that the teachers who are less than or equal to 29 years old tend to get stressed.
- Wednesday: *normal affecting factor* ($p = 0.030$). The positive coefficient (20.1024) indicates that the teachers who work on Wednesday tend to get stressed.
- Sunday: *normal affecting factor* ($p = 0.029$). The positive coefficient (27.0998) indicates that the teachers

who work on Sunday tend to get stressed.

- Thursday: *nearly-significant affecting factor* ($p = 0.005$). The positive coefficient (27.6259) indicate that the teachers who work on Thursday tend to get stressed.
- Friday: *nearly-significant affecting factor* ($p = 0.007$). The positive coefficient (25.9464) indicate that the teachers who work on Friday tend to get stressed.

TABLE IX. RESULT FOR STRESS

No	Factor	Coef.	p-Value	t-Value	95% CI
	(Intercept)	116.777	0.047	2.012	[1.653, 231.901]
1	Male	-0.088	0.993	-0.009	[-19.792, 19.616]
2	Weight	0.150	0.617	0.502	[-0.442, 0.741]
3	Height	-0.920	0.093	-1.698	[-1.994, 0.155]
4	Age: ≤ 29	44.978	(*) **0.030**	2.203	[4.469, 85.486]
5	Age: 30 to 39	33.416	0.074	1.806	[-3.294, 70.125]
6	Age: ≥ 40	38.384	0.055	1.943	[-0.797, 77.565]
7	Monday	2.692	0.804	0.249	[-18.778, 24.163]
8	Tuesday	-2.020	0.864	-0.172	[-25.334, 21.294]
9	Wednesday	20.102	(*) **0.030**	2.201	[1.984, 38.220]
10	Thursday	27.626	(**) **0.005**	2.873	[8.553, 46.699]
11	Friday	25.946	(**) **0.007**	2.762	[7.314, 44.579]
12	Saturday	15.330	0.143	1.477	[-5.254, 35.914]
13	Sunday	27.100	(*) **0.029**	2.214	[2.823, 51.377]

(*): $0.01 < p \leq 0.05$, (**): $0.001 < p \leq 0.01$, and (***): $p \leq 0.001$

C. Discussion

Both the results of exhaustion and stress show that the nursery teachers who work on Thursday and Friday tend to get exhausted and stressed. It is probably caused by the fact that Thursday and Friday are the latest two days before the teachers can take the weekend holidays. Furthermore, although working on Friday is more exhaustive than on Thursday, working on Thursday is more stressful than on Friday. The results also show that the people under 30 years old get stressed easier than the others. In our survey, the people under 30 years old are the youngest participants (compared with 30 to 39 and over 30) and it is quite obvious that the young people often do not have good control on their anxiety, emotion, and stress. The deeper reasons that explain these results will be formally examined in future work. Furthermore, a new questionnaire can be re-designed to collect other promising factors including the information related to schools (e.g., the number of male/female teachers and children, public or private schools, etc.) and teachers (e.g., experience (acquired skills), self-confidence, salary, full/part-time, etc.).

VI. Conclusion

In this paper, we used professional devices to collect exhaustion and stress information from 36 nursery teachers working in Tokyo. We built a regression model and found the evidence that working on Thursday and Friday affects both the exhaustion and stress. While working on Friday is more exhaustive than on Thursday, working on Thursday is more stressful than on Friday. While working on Saturday does not affect either the exhaustion or stress, working on Sunday is a factor affecting the stress, but not the exhaustion. Gender, weight, and height do not appear as affecting factors. People under 30 years old get stressed easier than the others.

References

[1] National Police Agency, Government of Japan. Toukei (in Japanese). https://www.npa.go.jp/toukei/index.htm. Retrieved: August 15, 2019.

[2] Y. Takashi et al., "Overwork-related disorders in Japan: recent trends and development of a national policy to promote preventive measures". *Industrial Health*, vol. 55, no. 3, 2017, pp. 293-302.

[3] W. Rupert, "Japan: The worst developed country for working mothers?". *BBC News*, 2013. Available: https://www.bbc.com/news/magazine-21880124. Retrieved: February 02, 2020.

[4] Y. Nohara, "Low pay haunts Tokyo's nurseries despite massive demand for places". *Bloomberg*, 2016. Available: https://www.japantimes.co.jp/news/2016/08/16/national/social-issues/japans-nursery-school-teachers-opt-better-paying-jobs/#.XUaYlpMzbBJ. Retrieved: February 02, 2020.

[5] Ministry of Health, Labour and Welfare, "Nursery school related situation report", 2016. Available: https://www.mhlw.go.jp/stf/houdou/000013 5392.html. Retrieved: February 02, 2020.

[6] Y. Okumura, "School Choice with General Constraints: A Market Design Approach for the Nursery School Waiting List Problem in Japan". *The Journal of the Japanese Economic Association*, 2018. Online Access. Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3176853. Retrieved: February 02, 2020.

[7] A. Rudman and J. P. Gustavsson, "Burnout during nursing education predicts lower occupational preparedness and future clinical performance: A longitudinal study". *International Journal of Nursing Studies*, vol. 49, no. 8, 2012, pp. 988-1001.

[8] A. S. Antoniou, A. Ploumpi, and M. Ntalla, "Occupational Stress and Professional Burnout in Teachers of Primary and Secondary Education: The Role of Coping Strategies". *Psychology*, vol. 4, no. 3A, 2013, pp. 349-355.

[9] N. Barkhuizen, S. Rothmann, and F. Vijver, "Burnout and Work Engagement of Academics in Higher Education Institutions: Effects of Dispositional Optimism". *Stress and Health*, vol. 30, no. 4, 2014, pp. 322-332.

[10] L. Flook, S. B. Goldberg, L. Pinger, K. Bonus, and R. J. Davidson, "Mindfulness for Teachers: A Pilot Study to Assess Effects on Stress, Burnout, and Teaching Efficacy". *Mind, Brain, and Education*, vol. 7, no. 4, 2013, pp. 256-256.

[11] N. Khamisa, K. Peltzer, I. Dragan, and B. Oldenburg, "Work related stress, burnout, job satisfaction and general health of nurses: A follow-up study". *Journal of Nursing Practice*, vol. 22, no. 6, 2016, pp. 538-545.

[12] M. Mikolajczak, M. Raes, H. Avalosse, and I. Roskam, "Exhausted Parents: Sociodemographic, Child-Related, Parent-Related, Parenting and Family-Functioning Correlates of Parental Burnout". *Journal of Child and Family Studies*, vol. 27, no 2, 2018, pp. 602-614.

[13] P. Gkorezis, E. Petridou, and T. Krouklidou, "The Detrimental Effect of Machiavellian Leadership on Employees' Emotional Exhaustion: Organizational Cynicism as a Mediator". *Europe's Journal of Psychology*, vol. 11, no. 4, 2015, pp. 619-631.

[14] W. Liang, W. Zhen, J. Gaskin, and L. Wang, "The role of stress and motivation in problematic smartphone use among college students". *Computers in Human Behavior*, vol. 53, 2015, pp. 181-188.

[15] G. Mark et al., "Email Duration, Batching and Self-interruption: Patterns of Email Use on Productivity and Stress". *Conference on Human Factors in Computing Systems (CHI'16)*, 2016, pp. 1717-1728.

[16] A. M. Barbarin, L. R. Saslow, M. S. Ackerman, and T. C. Veinot, "Toward Health Information Technology that Supports Overweight/ Obese Women in Addressing Emotion- and Stress-Related Eating". *Conference on Human Factors in Computing Systems*, 2018, No. 321.

[17] J. Adriaenssens, V. Gucht, and S. Maes, "Causes and consequences of occupational stress in emergency nurses, a longitudinal study". *Journal of Nursing Management*, vol. 23, no. 3, 2015, pp. 346-358.

[18] Garmin Ltd, www.garmin.com. Retrieved: February 02, 2020.

[19] Omron Corporation, https://www.omron.com. Retrieved: February 02, 2020.