Shirouzu, et al., J Health Edu Res Dev 2015, 3:2
DOI: 10.4172/2380-5439.1000130

Journal of
Health Education Research & Development

Research Article Open Access

Objective Evaluation of Workplace Stress of Kindergarten Teachers at Nazareth Kindergarten

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Rec date: Jul 20, 2015; **Acc date:** Aug 18, 2015; **Pub date:** Aug 20, 2015

Abstract

To prevent kindergarten teacher's resignation due to workplace stress, and to maintain better education, we established the stress evaluation method based on the measurement of the autonomic nervous system's activity (ANSA) by M-BIT, and we applied it to evaluate and decrease workplace stress. We proposed the method of detecting the subject with large stress and remains stress by the distribution of epoch values of sympathetic nervous system's activity (SNSA) during awake and sleep, respectively.

We also proposed the method to evaluate the degree of chronic unhealthy of ANSA, normal, incoordination of ANSA or depressed state based on epoch values of coefficients of variation of RR intervals (CVRR) during awake, and co-use of Self-Rating Scale increases the accuracy of evaluation. Furthermore, we proposed that status of ANSA, normal, incoordination of ANSA and depressed state can be evaluated by the CVRR and SNSA values measured by 120 seconds stress application measurement.

We found that the chronic continuation of large SNSA does not always lead to chronic unhealthy state of ANSA. Hence, we proposed two dimensional evaluation of SNSA with CVRR, and separation of stress to passive stress and active stress.

Keywords: Workplace stress; Self-rating scale; Depression; Autonomic nervous system's activity; Coefficients of variation of RR intervals; Sympathetic nervous system's activity

Introduction

Previously, we have developed a small wearable (size: 40×39×8mm, weight: 14g) ECG and acceleration measuring device (MBIT) and data analysis software group. Since then, we have been studying children's PA, sleep behaviors and activities of autonomic systems and their relationships with Kindergartens educational programs at Nazareth Kindergarten (Yokohama, Japan) [1,2]. In the course of our study at Kindergartens, we have noticed the fact that many female teachers resign their jobs due to stress caused by human relationships between themselves.

For good quality education, kindergartens have to keep good teachers. Furthermore, teacher's stress not only adversely influences their mental health and may cause incoordination in their autonomic nervous system's activity (ANSA) or development of depression [3,4], but also is tightly intertwined neurologically with the mechanisms responsible for cognition, decision making, problem solving, and adaptation to unpredictable environments, such as educating and caring children [5,6]. Hence, stress of kindergarten teachers must be reduced.

Stress has been measured in two conventional ways –through the use of interview format, self-rating scales and direct observation [7-10] and the use of physiological data [11,12]. However, stress evaluation method by physiological data was not established yet [13,14], and despite being criticized for their subjectivity, self-rating scales have been a primary modality for stress measurement [10,15].

Most studies have measured the frequency and quality of stressors or the degree of life changes. The Social Readjustment Rating Scale (SRRS) [16] is one of the best-known life event scales, and its total score is known to have some predictive value in terms of anticipating disease or illness. However, the scale has also been criticized for its limited clinical utility and for having a low predictability of illness. For workplace stress, Job Content Questionnaire [17] is widely used.

The majority of preexisting stress measures was originated from clinical research in psychopathology. Therefore, self-rating scales for psychopathology, including mood, have been utilized most prominently as presumptive measures of stress to date [18]. Among these measures are the Minnesota Multiphasic Personality Inventory (MMPI) and the Symptom Checklist-90-Revised (SCL-90-R) [19], which measures various psychopathologies, and the Beck Depression

Inventory [20] and the State-Trait Anxiety Inventory (STAI) [21], which measure unidimensional syndromes, such as depression and anxiety.

For depression, many rating-scales were developed since Depression-Elation-Test (1930, Jasper [22], including inventories of Lorr [23] Beck [20], Overall [24], Wechsler [25] and Zung [26]. In Japan, Japanese version of self-rating-scales of Beck [20] and Zung [26] are widely used and applied.

In order to measure psychiatric symptoms more strictly, we have to define symptoms precisely, and have to make the standard of the severity clearly. Furthermore, questionnaires of self-rating scale must be understandable for patients. Takenaka collected complaints of depression patients and depression related complaints of patients of other mental disturbances [27], and Inaba summarized them to the questionnaire composed by 53 questions expressed by easy to understandable Japanese and divided to 10 groups as Syowa University Depression-Rating-Scale 78 (D.R.S-S78) [28].

On the other hand, workplace stress which we had to measure originated not from work related matters or relationships supporting the work, but from human relationships between colleagues, "her attitude and/or wording is bad, today" or "she ignored me from yesterday" etc., and the level of stress always changes frequently. In Japan, emotional factors, such as, jealousy, quarrel, neglect and bullying between colleagues are the main sources of stress at workplace. How many times in a day one feels this kind of stress? Self-rating scales of stress, Social Readjustment Rating Scale or Job Content Questionnaire et al. cannot measure this kind of stress. We had to use physiological data.

In principle, stress activates sympathetic nervous systems activity (SNSA) and shortens RR intervals. Hence the monitoring of RR intervals variation (RRIV) through ECG measurement gives us the objective measure of stress, and most simple and direct method However, stress evaluation method by RRIV or physiological data was not established yet [13,14]. One of possible reason of this situation might be the difficulty of perfect unconstrained ECG measurement of working subjects. The development of M-BIT made this unconstrained ECG measurement of working subjects and objective measurement of stress through SNSA possible.

Besides frequently changing SNSA, ANSA sometimes falls in chronic unhealthy status such as incoordination in ANSA or depression. Decreases of coefficients of RR interval's variation (CVRR) due to depression were already reported [29-33]. In addition, we recently reported the decrease of CVRR due to the large level stress application using 10 minute's Kraepelin test [34]. These facts suggested that CVRR is a measure of chronic healthy state of ANSA.

In this study, we measured 24 hour's ANSA and sleep behavior of kindergarten teachers using M-BIT, and evaluated the largeness of daily stress using SNSA, and the degree of chronic unhealthy of ANSA by CVRR and Self Rating Scale, D.R.S-S78 [28]. We also performed automatic detection of sleep apnea.

Measurement and Analysis

Subjects

Since most teachers of kindergartens are female in Japan, all the subjects in this study were female.

On the occasion of measurement of the children in the Nazareth kindergarten (December 2008) [1,2], we also performed teachers' measurement (n=19, age=40.7 ± 15.1). We used these data (data no=30) to establish stress evaluation protocol from SNSA and RRIV (step 1).

Then, we performed 24 hour's simultaneous measurements of teachers (n=11, age=33.7 ± 11.8) at February 18, 2015 (step 2). They were persons in charge of the class who perform the care and the education of children.

For the sake of comparison we performed the measurements of patients who suffered adjustment disorder, panic disorder and clinical depression (n=6, age=42.2 ± 8.8) at Ikemi Memorial Clinic of Mind-Body Medicine (MBM), Megumi-Kai (Fukuoka, Japan) (step 3).

From this school year (2015), to prevent the resign of teacher due to workplace stress, Nazareth kindergarten started to check their stress. In this season (May-June) 26 teachers (age=41.4 ± 15.7) volunteered the 24hours stress measurements (step 4). Some of them participated to stress application measurements, too.

This study was approved by the Ethics Committee of the Japanese Research Institute of Healthcare and Education. We explained required matters for subjects in advance, and obtained their written acceptance.

M-BIT

M-BIT allows 25 hours' measurement with sampling frequency of 128 Hz (ECG) and 1 Hz (3-axes acceleration (ACC) data). Electrode placement for ECG measurements used by M-BIT involves a monitoring lead, which is similar to lead II. A body ground is unnecessary due to improvements in electronic circuit design. M-BIT is small and lightweight, allowing it to adhere to a subject's thorax using two electrodes [1,2].

Sleep/awake estimation

Our epoch duration for analysis was 1 minute.

Posture vectors (up-down, left-right, anterior-posterior) of subject's thorax, M-BIT attaching portion, were derived from 3-axes ACC data. We defined subject's posture by epoch averages of these posture vectors. We searched "in bed" area - the area where epochs whose up-down components of posture vectors were near to 0 were continued.

As the first step of sleep/awake estimation, for each sampling and for each ACC axis, we calculated difference from previously sampled data, and set "sampling difference" as the maximum value of these three differences for each sampling. Then, we searched the maximum value of these sampling differences within each epoch and defined them as "epoch differences (EPD)". We set threshold for with or without movement based on the average of EPD within whole analyzed area, and judged epoch without movement (ENMV) when EPD was less than the threshold. Then we searched "inactive areas (IAAs)", areas where ENMV were continued, and combined two successive IAAs if the duration of separation between them was one epoch or average of ENMV during separation was less than four times the threshold. Finally, we selected sleep area among these IAA, details for this selection is publicly available [35].

Sympathetic nervous systems activity (SNSA) and coefficient of variation of RR intervals (CVRR)

We detected time locations of the R waves on the ECG signal based on a robust real time QRS detection algorithm currently in broad use worldwide [36]. Details for R wave search and extraction of RR intervals are publicly available [35].

We re-sampled RR interval time series with a re-sampling frequency of 4Hz, and performed time frequency analysis with SPWV (Smoothed Pseudo Wigner-Ville) method [37], and obtained time frequency map. For the index of autonomic nervous systems activity, we calculated LF (0.04Hz-0.15Hz), HF (0.15Hz-0.40Hz) as the sum of the absolutes of mapped values of corresponding frequency bands along the frequency axis and their average along the time over the map. We set LF/HF as indexes of sympathetic nervous systems activity (SNSA) representing this epoch. Details are publicly available [35].

We calculated coefficient of variation of RR intervals (CVRR) as the ratio of epoch standard deviation to epoch mean length of RR intervals.

Sleep apnea (SA)

Usually, for automatic sleep apnea detections from ECG data, both of RRIV and ECG derived respiration which based on the variation of R wave heights, and detection of Cyclic Variation of Heart Rate (CVHR) were used and high accuracy of 83.0%-89.4% were achieved [38]. However, since R wave height is not always quantitatively reliable over the sleep duration in M-BIT measurement, we automatically detected SA only from RRIV based on CVHR. Our accuracy was 75.6%. Details are publicly available [39].

According to American Academy of Sleep Medicine's recommendation [40], we classified severity of SA occurrence of each one hour of sleep time, as NO_SA (bellow 5 epochs), Mild (5 to 15 epochs), Moderate (15 to 30 epochs) and Severe (greater than 30 epochs).

Protocols to detect a subject with large stress

Since stress is the total assessable influence impinging upon human beings from external sources [41], SNSA continues increase and decrease frequently. Hence, we may define a subject who suffers large stress (LS subject), as a subject whose SNSA values shows large peaks and tends to stay large level, and a subject who remains stress (RS subject), as a subject whose SNSA does not decrease below a certain level. For this purpose, we characterized epoch (1 minute) SNSA values' distribution by 4 quantiles.

Generally, subjects' stress level due to workplace stress, and thus, during they are working, their SNSA values are thought to be maximum. Hence, we divided awaking time zone of one day into three zones, during working (WORKING), before and after working (BEFORE and AFTER), and at the first step, for the discrimination of LS subjects, we searched threshold values in maximum values and the third quantile of subjects' SNSA values in WORKING zone. In steps 2 and 3, we searched LS subjects in WORKING, BEFORE and AFTER.

On the other hand, since subjects' stress level and SNSA values should show their minimum level during sleeping (IN-BED), we searched thresholds in minimum values and the first quantile of their SNSA values during in IN-BED for the discrimination of RS subjects.

We set each subject's IN-BED zone as from her bedtime to rise time. To divide WORKING, BEFORE and AFTER, we used each teacher's work start and finish time based on kindergartens records in step 2, and substituted them by rise time plus 3 hours and 12 hours, respectively, in other steps.

Self-Rating Scale for depression

For the measurement of the degree of chronic unhealthy of ANSA, incoordination in ANSA or development of depression, we used both the CVRR derived from ECG data and the Self-Rating Scale for depression. From the viewpoint of easy understandability of questions by kindergarten teachers, we used D.R.S-S78 [28] in this study.

An example of questions is that feeling does not look nice somehow (Easy understandable Japanese questions are hard to translate to English.), and teachers select answer from these four; very much (3 points), considerably (2 points), somewhat (1 point), no (0 point) [28]. Score for each inventory are obtained by summing up the points attached for the selected answer. Since numbers of questions are 53, score ranges from 0 to 159 [28]. Reported values of control, neurotic and depressed groups were 13.79 ± 11.51, 49.33 ± 15.99 and 61.02 ± 16.98, respectively [28].

Results and Discussion

Parameters to detect large stress subject

Maximums and the third quantiles of epoch SNSA values distribution in WORKING of step 1 subjects were shown in Figure 1. Usually, longitudinal bar plots were used in this kind of plots. However, since we had multiple data for several subjects, we used scatter plot in this study. As shown in Figure 1, large intra and inter subject difference were observed in maximums and the third quantiles of SNSA. From this figure, we set threshold values for LS subject discrimination as maximum over 25.0 and the third quantile over 5.0 as a working hypothesis. In Figure 1, subjects 4(2data/2data), 8(1/2) and 10(1/1) were discriminated as LS subjects.

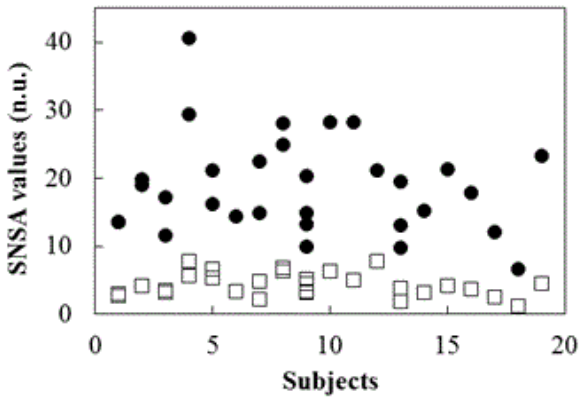

Figure 1: Maximums and third quantiles of SNSA in WORKING of step 1 subjects. (●: maximum, □: the third quantile).

Parameters to detect remaining stress subject

Minimums and the third quantiles of epoch SNSA values in IN-BED of step 1 subjects are shown in Figure 2. From this figure, as a working hypothesis, we set threshold values for RS subject discrimination as minimum over 0.1 and the first quantile over 0.8. In Figure 2, subjects 4(1/2), 5(1/2) and 14(1/1) were discriminated as RS subjects.

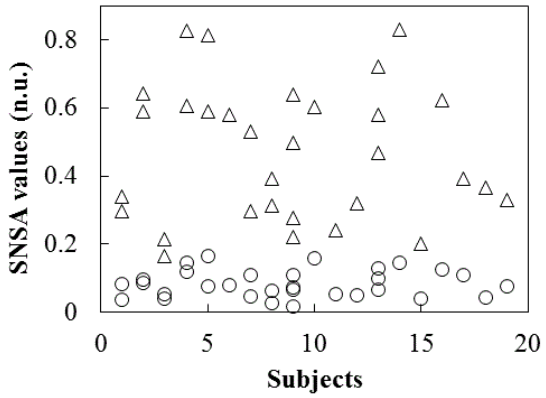

Figure 2: Minimums and the first quantiles of SNSA in IN-BED of step 1 subjects. (○: minimum, △: the first quantile).

Stress scene of kindergarten teachers at February 18, 2015

Results of detection of large stress subject in BEFORE, WORKING and AFTER, and remaining stress subject in IN-BED of teachers at February 18, 2015 were summarized together with their SA severity in Table 1 (step 2). Among them, subjects a, b and d were made up their mind to reign due to stress in this time, and subject c was the stressor in this workplace whose attitude and wordings caused stress for younger teachers. Subject f is "the boss" of this workplace.

Although some teachers who decided resign (a, d) did not show large stress anymore, five teachers within total 11 measured teachers had larges stress in Table 1. The proportion of teaches with large stress is much larger than in the case shown in Figure 1. Furthermore, two teachers show at least one hour of severe SA and other three teachers showed 4 or 5 hours moderate SA. Thus, we could understand how stressful this workplace was and teachers' sleepiness and tiredness. Although subject h had complaint she felt stress, her stress level was not so large but had severe SA. In the measurement of stress, we have to consider the sleepiness and fatigue due to SA, too. One teacher show remaining stress.

Comparisons of CVRR with mind and body medicine patients

Results of detection of large stress subject in BEFORE, WORKING, AFTER and remaining stress subject in IN-BED of mind and body medicine patients were summarized together with their SA severity in Table 2 (step 3).

		Large Stress and Remaining Stress				Sleep Apnea (hours)			
Subjects	Age	Before	Working	After	In-bed	Severe	Moderate	Mild	NO SA
a	27	N.D				0	4	4	1
b	25	N.D	Large	N.D	N.D	0	5	3	1
c	34					3	4	0	1
d	36	N.D				0	0	0	4
e	25	N.D				0	4	4	0
f	65	N.D	Large	Large		0	0	3	5
g	26	N.D	Large	Large	Remaining	0	0	0	2
h	24					1	5	1	0
i	33					0	0	4	4
j	42	Large	N.D	N.D		0	0	2	2
k	29		Large			0	0	3	2

Table 1: Stress scene of kindergarten teachers. N.D-No Data

There were no patients with large stress suggesting the possibility that SNSA do not increase if the degree of chronic unhealthy of ANSA is large such as depression state. Only one patient showed remaining stress. One patient showed severe SA one hour and another patient showed 7 hours moderate SA.

Comparisons of CVRR values in BEFORE, WORKING, AFTER and IN-BED of step 2 teachers and MBM patients are shown in Figure 3. Here, to avoid the possible effect of age dependency, data of subject f in Table 1 were removed.

				Large Stress and Remaining Stress				Sleep Apnea (hours)			
Subjects	Age	Diagnostic	Severity	Before	Working	After	In-bed	Severe	Moderate	Mild	NO SA
a	53	Panic	Medium					1	1	5	1
b	48	Adjust	Light					0	0	1	9
c	50	Adjust	Medium					0	0	1	7
d	34	Depression	Medium					0	7	4	1
e	29	Depression	Medium					0	3	5	1
f	30	Adjust	Medium				Remaining	0	0	3	2

Table 2: Stress of mind-body medicine patients. N.D-No Data

Most clear differences between step 2 teachers and MBM patients are observed in WORKING. CVRR values of MBM patients are smaller than those of step 2 teachers, except one subject, subject c in Table 1. The difference between step 2 subjects and MBM patients become unclear in BEFORE and AFTER, and vanish in IN-BED.

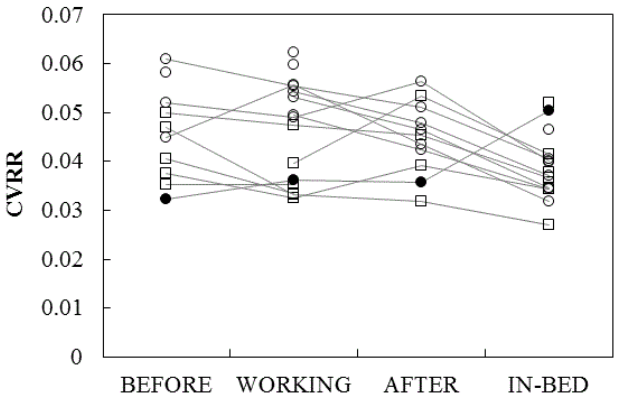

Figure 3: CVRRs of step 2 subjects and MBM patients at 4 time zones. (○: step 2 subjects, : □ MBM patients, ● : subject c in step 2).

Among step 2 teachers, CVRR values of subject c were quite different from other teachers and close to MBM patients, suggesting the degree of chronic unhealthy of ANSA of subject c was large such as incoordination in ANSA or depression. This fact and her severity of SA shown in Table 1 are the evidences that subject c has a problem related mind and body medicine, and her "bad attitudes and wordings" were caused by this problem.

Results shown in Figure 3 also demonstrate the usefulness of CVRR as the measure of chronic unhealthy of ANSA. However, our extended measurement duration to 24 hours suggested their dependences to measuring condition, WORKING, BEFORE and AFTER. In Figure 4, three days data are shown as an example of condition dependences and reproducibility. Since she has to decide everything to run kindergarten, she was very busy and always felt moderate level stress during WORKING. If we only measure her CVRR only during work, we may conclude her degree of chronic unhealthy of ANSA is large. However, with CVRR values during BEFORE and AFTER, we could understand her ANSA is healthy and decrease of CVRR was caused by stress. Hereafter, we use MAX_CVRR, the maximum value of CVRRs in WORKING, BEFORE and AFTER, as a measure of degree of chronic unhealthy of ANSA.

Stress check of kindergarten teachers at May-June, 2015 (step 4)

From this step, we introduced Self-Rating Scale, D.R.S-S78 [28] and evaluated the degree of chronic unhealthy of ANSA two dimensionally with MAX_CVRR and D.R.S-S78 score (DRS_Score).

Results of detection of large stress subject in BEFORE, WORKING and AFTER, and remaining stress subject in IN-BED were summarized together with their SA severity in Table 3.

Two dimensional plots of D.R.S-S78 score and MAX_CVRR of step 4 data are shown in Figure 5. At present, we set thresholds for normal as MAX_CVRR is over 0.04 or DRS_Score is below 25.0. On the other hand, we set thresholds for depressed state as MAX_CVRR is below 0.04 and DRS_Score is over 55.0. We judge as incoordination of ANSA if MAX_CVRR is below 0.04 and DRS_Score is over 25.0 and below 55.0.

Subject 1 in Figure 5 was in a depressed state due to chronic serious stress at home and underwent specialist's medical treatment. We performed the measurement of this teacher twice, and close MAX_CVRR values were obtained. Nazareth kindergarten is offering all the possible support including mental support.

Subject 2 in Figure 5 was thought to be in incoordination of ANSA. We performed the measurement of this teacher twice, and close MAX_CVRR values were obtained in this subject, too. Our preliminary interview investigations for teachers revealed that subject 2 was the stressor (STR) of this workplace and her "bad attitudes and wordings" were the source of workplace stress which let other teachers decided resignation. At the first survey (step 2) she showed severe sleep apnea and low MAX_CVRR close to those of incoordination of ANSA state or depressed state. Her "bad attitudes and wordings" were suggested to be originated MBM problem.

After confirming the reproducibility of severe sleep apnea and low MAX_CVR, we interviewed the subject 2 herself. She was conscious about the sleep apnea. Her father had severe SA too, however, in the case of a father, SA was surgery cured. She was also considering surgery to cure her SA too.

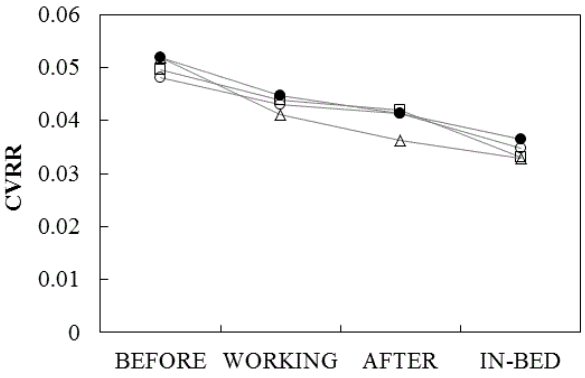

Figure 4: CVRR values in four zones. Four days measurement of a subject.

However, since she was a large BMI type, the probability that her SA is also large BMI type is rather high. We taught her sleeping postures which prevent the falling of tongue, and decided to observe the process. We will recommend her to receive specialist's treatment, if necessary.

Subject 3, 4 and 5 were thought to be belongs to normal group. The reason why MAX_CVRR value was below 0.04 in subjects 3 was thought to be the decrease due to aging. Since the numbers of data were small even in normal subjects, we could not figure exact age dependencies. We have to collect many data of normal, incoordination of ANSA and depression groups, and figure exact age dependencies and refine threshold values. Subjects 4 and 5 had very severe annoyed personal matters. Stress due to these matters thought to be lowered subject 4's MAX_CVRR and increased 5's DRS_Score, respectively.

To discriminate two chronic unhealthy status of ANSA, incoordination of ANSA and depressed state, more clearly and directly, we have to measure CVRR and SNSA in stress application measurement.

Large Stress and Remaining Stress						Sleep Apnea (hours)			
Subjects	**Age**	**Before**	**Working**	**After**	**In-bed**	**Severe**	**Moderate**	**Mild**	**NO SA**
2	20	N.D		N.D		0	2	5	4
4	43	N.D				0	1	4	1
6	56				Remaining	1	4	1	0
7	76	N.D				0	0	2	7
7	76				Remaining	0	0		6
9	34	N.D	Large			1	4	1	2
10	20			N.D	Remaining	0	3	2	3
13	44	N.D				0	6	4	0
14	75					0	0	0	6
15	52	N.D	N.D	Large		0	3	0	0
17	20					0	0	0	4
18	44		Large			0	0		3
19	25	N.D	Large			0	0	2	3
20	52		Large	Large		0	0	0	0
21	24	Large				0	2	4	1
22	38	N.D				0	0	4	1
24	43	Large	Large			0	5	4	0
24	43					0	3	1	0
26	65	Large	Large	Large		0	1	3	1
31	29	Large	Large	Large		0	3	4	4
32	35	N.D	N.D			0	0	2	0
33	33	Large				0	2	6	1

34	23			0	3	4	1
37	40			0	2	3	0
38	61	N.D	Large	0	1	3	7
39	38			0	0	2	1
40	46	N.D	Large	1	2	2	0
44	40			0	0	3	4
44	40			0	0	2	5
44	40			0	0	2	5
44	40			0	0	1	4

Table 3: Stress of kindergarten teachers (step4). N.D-No Data

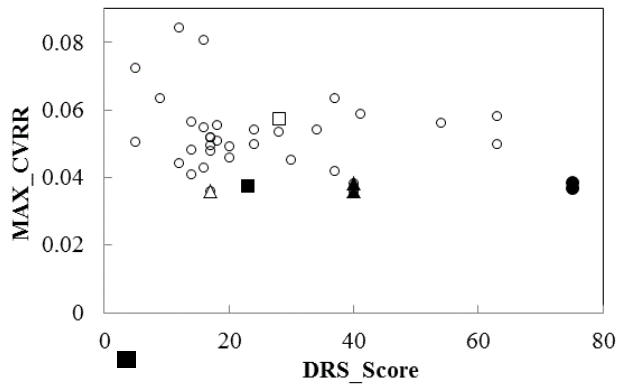

Figure 5: Two dimensional plots of DRS_Score and MAX_CVRR of kindergarten teachers. (●: Subject 1 (43 y.o.), ▲: Subject 2 (34 y.o.), ■: Subject 3 (56 y.o.), △: Subject 4 (45 y.o.), □: Subject 5 (21 y.o.),).

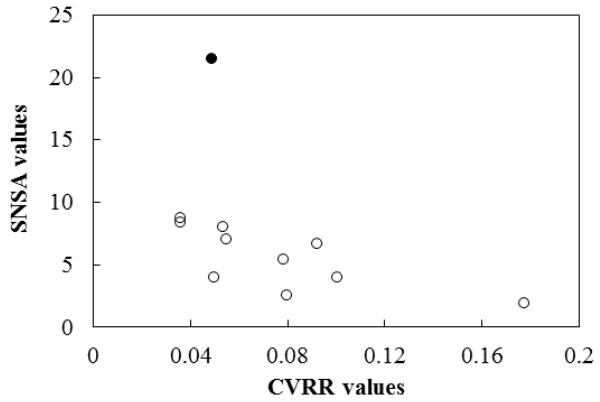

Figure 6: CVRR and SNSA values of 120 seconds measurement in stress application measurement. (○: normal group, ●: incoordination of ANSA state subject).

For stress application, we displayed seven digits numbers for 4 seconds in the display of personal computer and let subjects memorize them. In following 14 seconds, we let subjects enter them to personal computer with ten-key device in the reverse order. This protocol repeated 5 times for 90 seconds. By setting 15 seconds' margin before and after, we performed 120 seconds stress application measurement.

Plots of CVRR and SNSA measured during stress application are shown in Figure 6. From CVRR value, age and DRS_Score, we can discriminate healthy and unhealthy status of ANSA. And from the value of SNSA, we can discriminate incoordination of ANSA and depression state. SNSA value was large during stress application in incoordination of ANSA as subject 1 of Figure 6.

Comparison of the analyzed result of the data measured in 2008 and used in step 1 and recently measured data for steps 2 and 4 revealed that although stress or SNSA of chief teacher of kindergarten and other people in responsible position was considered always large, their ANSA are still healthy. Hence, chronic continuation of large SNSA does not always lead to chronic unhealthy state of ANSA. Here, we proposed two dimensional evaluation of SNSA with CVRR, and separation of stress to passive stress and active stress.

Two dimensional plots of CVRR and SNSA during WORKING of chief teacher is shown in Figure 7. Here, we divided active and passive stress, SNSA with trial threshold CVRR=0.05. Our hypothesis is that chronic continuation of only passive stress may lead to chronic unhealthy state of ANSA.

Conclusion

We proposed the method of detecting the subject with large stress and remains stress by the distribution of epoch values of sympathetic nervous system's activity (SNSA) during awake and sleep, respectively.

We also proposed the method to evaluate the degree of chronic unhealthy of ANSA, normal, incoordination of ANSA or depressed state based on epoch values of coefficients of variation of RR intervals (CVRR) during awake, and co-use of Self-Rating Scale increases the accuracy of evaluation. Furthermore, we proposed that status of ANSA, normal, incoordination of ANSA and depressed state can be evaluated by the CVRR and SNSA values measured by 120 seconds stress application measurement.

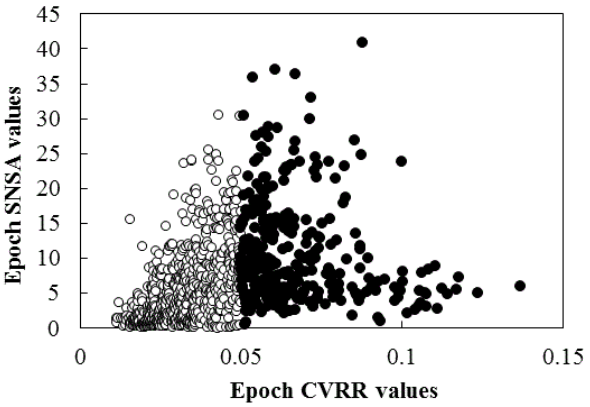

Figure 7: Two dimensional plots of epoch CVRR values and SNSA values in WORKING of the head teacher. (○: normal group, ●: incoordination of ANSA state subject).

We found that the chronic continuation of large SNSA does not always lead to chronic unhealthy state of ANSA. Hence, we proposed two dimensional evaluation of SNSA with CVRR, and separation of stress to passive stress and active stress.

References

1. Shirouzu S, Shirouzu E, Seno Y (2014) Four Years Old Children's Physical Activity: Can we confirm the difference of physical activity due to the difference of educational program? Health Innovations and Point-of-Care Technologies Conference pp. 129-132.
2. Shirouzu S, Shirouzu E, Fujitani S (2014) Four Years Old Children's Sleep: What can we obtain by using wearable measuring devices at their home? Health Innovations and Point-of-Care Technologies Conference pp. 189-192.
3. Bonde JP (2008) Psychosocial factors at work and risk of depression: a systematic review of the epidemiological evidence. Occup Environ Med 65: 438-445.
4. Kawakami N, Haratani T, Araki S (1992) Effects of perceived job stress on depressive symptoms in blue-collar workers of an electrical factory in Japan. Scand J Work Environ Health 18: 195-200.
5. Rigas G, Goletsis Y (2012) Real-Time Driver's Stress Event Detection, IEEE Trans Intell. Transp Syst 13: 221-234.
6. Lisetti CL, Nasoz F (2004) Using noninvasive wearable computers to recognize human emotions from physiological signals. EURASIP J Appl Signal Process pp. 1672–1687.
7. Kim D, Seo Y, Cho J (2008) Detection of subjects with higher self-reporting stress scores using heart rate variability patterns during the day. Conference Proceedings IEEE Engineering in Medicine and Biology Society pp. 682–685.
8. Breslau N, Kessler R, Peterson EL (1998) Post-traumatic stress disorder assessment with a structured interview: reliability and concordance with a standardized clinical interview. Ijmpr 7: 121-127.
9. Cotton DHG (1990) Stress Management: An Integrated Approach to Therapy, Brunner/Mazel, New York.
10. Koh KB, Park JK, Kim CH, Cho S (2001) Development of the stress response inventory and its application in clinical practice. Psychosom Med 63: 668-678.
11. Vrijkotte TG, van Doornen LJ, de Geus EJ (2000) Effects of work stress on ambulatory blood pressure, heart rate, and heart rate variability. Hypertension 35: 880-886.
12. Lundberg U, Kadefors R, Melin B, Palmerud G, Hassmen P, et al. (1994) Psychophysiological stress and EMG activity of the trapezius muscle. Int J Behav Med 1: 354-370.
13. Cinaz B, Arnrich B, Marca RL (2013) Monitoring of mental workload levels during an everyday lifeoffice-work scenario. Pers Ubiquit Comput 17: 229-239.
14. Sun FT, Kuo C, Cheng HT (2012) Activity-Aware Mental Stress Detection Using Physiological Sensors, Mobile Computing, Applications, and Services, Lecture Notes of the Institute for Computer Sciences. SITE 76: 211-230.
15. Derogatis LR, Coons HL (1993) Self-report measures of stress. Handbook of Stress-Theoretical and Clinical Aspects (2nd edn) The Free Press, New York pp. 200–233.
16. Holmes TH, Rahe RH (1967) The Social Readjustment Rating Scale. J Psychosom Res 11: 213-218.
17. Flynn N, James JE (2009) Relative effects of demand and control on task-related cardiovascular reactivity, task perceptions, performance accuracy, and mood. Int J Psychophysiol 72: 217-227.
18. Selye H (1950) The physiology and pathology of exposure to stress. Montreal, Acta.
19. Derogatis LR, Rickels K, Rock AF (1976) The SCL-90 and the MMPI: a step in the validation of a new self-report scale. Br J Psychiatry 128: 280-289.
20. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J (1961) An inventory for measuring depression. Arch Gen Psychiatry 4: 561-571.
21. Ezrati-Vinacour R, Levin I (2004) The relationship between anxiety and stuttering: a multidimensional approach. J Fluency Disord 29: 135-148.
22. Jasper HH, Abnorm J (1930) Optimism and pessimisim in college environment. Soc Psychol 25: 307.
23. lorr M (1954) Rating scales and check lists for the evaluation of psychopathology. Psychol Bull 51: 119-127.
24. Overall JE and Gorham DR (1962) Psychol Rep 10: 799.
25. Wechsler H, Grosser Gh, Busfield Bl Jr (1963) The Depression Rating Scale: A Quantitative Approach To The Assessment Of Depressive Symptomatology. Arch Gen Psychiatry 9: 334-343.
26. Zung Ww (1965) A Self-Rating Depression Scale. Arch Gen Psychiatry 12: 63-70.
27. Takenaka K (1965) Serum pigment epithelium-derived factor levels are independently correlated with the presence of coronary artery disease. JSMA 24: 17.
28. Inaba H (1983) The treatment of multiple sc lerosis with hyperbaric oxygen therapy Jsma 43: 189.
29. Voss A, Schulz S, Koschke M, Bär KJ (2008) Linear and nonlinear analysis of autonomic regulation in depressed patients. Conf Proc IEEE Eng Med Biol Soc 2008: 2653-2656.
30. Bär KJ, Greiner W, Jochum T, Friedrich M, Wagner G, et al. (2004) The influence of major depression and its treatment on heart rate variability and pupillary light reflex parameters. J Affect Disord 82: 245-252.
31. Carney RM, Freedland KE, Veith RC (2005) Depression, the autonomic nervous system, and coronary heart disease. Psychosom Med 67 Suppl 1: S29-33.
32. Rechlin T, Weis M, Spitzer A, Kaschka WP (1994) Are affective disorders associated with alterations of heart rate variability? J Affect Disord 32: 271-275.
33. Agelink MW, Boz C, Ullrich H, Andrich J (2002) Relationship between major depression and heart rate variability. Clinical consequences and implications for antidepressive treatment. Psychiatry Res 113: 139-149.
34. Shirouzu S and Seno Y (2012) Multiple subject simultaneous measurement of stress application and remove manuscript in preparation.
35. Shirouzu S, Narisawa H, Katayama S (2012) A case Study Comparison of Sleep Stages from Polygraph Data Based on the International Standardized Scoring System, and Sleep Analysis Results from a Small, Lightweight ECG and Acceleration Data Logger (M-BIT).Human Development for ALL 2: 8-18.

36. Hamilton PS, Tompkins WJ (1986) Quantitative investigation of QRS detection rules using the MIT/BIH arrhythmia database. IEEE Trans Biomed Eng 33: 1157-1165.

37. Cohen L (1995) Time-Frequency Analysis, Prentice-Hall Inc, New Jersey.

38. Penzel T, McNames J, Murray A, de Chazal P, Moody G, et al. (2002) Systematic comparison of different algorithms for apnoea detection based on electrocardiogram recordings. Med Biol Eng Comput 40: 402-407.

39. Shirouzu S, Kondo H, Katayama S (2013) Automatic Detection of Sleep Apnea Based on RR Interval Variation. Human Development for ALL 3: 25-30.

40. [No authors listed] (1999) Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. The Report of an American Academy of Sleep Medicine Task Force. Sleep 22: 667-689.

41. Ergonomic Principles Related to Mental Workload (1996) ISO 10075-2.