[Research Note]

Effect of Work Conditions and Work Environments on the Formation of 8-OH-dG in Nurses and Non-Nurse Female Workers

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Abstract : The purpose of our study was to examine the effects of job stress factors on oxidative DNA injuries among female workers. The levels of urinary 8-hydroxydeoxyguanosine (8-OH-dG) were measured along with a survey on work conditions and environments. The result showed that female workers in shift work excreted increased levels of 8-OH-dG in comparison with the result of those who were engaged in part time work ($P<0.01$). Moreover, the nurses who marked higher depressive scores excreted significantly increased levels of urinary 8-OH-dG than the nurses who scored lower depressive states. The result revealed a positive correlation between 8-OH-dG levels of nurses in the 35 – 45 age group and the individual scores of their depressive states ($r=0.32$, $P<0.05$). Together, it was suggested that a heavy burden of work in addition to daily domestic roles increases urinary excretion levels of 8-OH-dG.

Key words : 8-hydroxydeoxyguanosine, female workers, shift work, nurses.

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Introduction

According to a research survey by the Ministry of Health, Labor and Welfare, more than one third of people in Japan feel chronic fatigue. Also, more than 70% of workers expressed tiredness. In particular, female workers perceived work related fatigue at higher rates than male workers [1]. The elimination of regulations pertaining to overtime, holidays and night shift labor for female workers has compelled them to work outside of their home as a result of the implementation of the Equal Employment Opportunity Law for Men and Women in Japan. Moreover, the women's labor force is expected to increase as a result of the declining birth rate.

Reactive oxygen species (ROS) are produced in cellular metabolisms, and excess uses of oxygen in physiological and disease processes that induce an imbalance between oxidation and reduction results in ROS accumulation [2]. Accumulated ROS plays a significant role in the pathogenesis of cancers, chronic neurodegenerations, cardiovascular diseases, immune system declines and cataracta through injuries of DNA and cytoskeletons [3]. In DNA injuries, due to the oxidation of deoxyguanosine, 8-hydroxydeoxyguanosine (8-OH-dG) is produced and excreted in the urine. Exposures to various carcinogens and hazardous materials are also closely associated with the formation of 8-OH-dG. Therefore, urinary 8-OH-dG is considered as the most sensitive and useful marker of oxidative DNA damages in the body as a whole [4 – 7].

In spite of the increasing women's work force, there is scarce evidence of the formation of 8-OH-dG in relation to actual health conditions in the work environment of female workers. In a previous study of occupational and lifestyle factors and urinary 8-OH-dG, long work hours and cigarette smoking were identified as a link to the formation of 8-OH-dG for men [4]. A study reported that a younger age, a college education and work in a specialty area were attributing factors of longer overtime work for both men and women [8]. Since the percentage of female graduates finding employment exceeded that of male graduates [9], it is useful to elucidate any effect of long work hours including nightshift work on the formation of 8-OH-dG in female workers.

The purpose of our study was to investigate the effects of work conditions and work environment on the formation of 8-OH-dG in female workers in relation to fatigue. After investigating job stress factors and job related physical and psychological stress responses by using Brief Job Stress Questionnaires [10], their urinary 8-OH-dG was measured. The result indicated that shift work significantly affected the formation of 8-OH-dG in the group of nurses as their physical and psychological stress response increased.

Materials and Methods

Research participants and urine sample collections

The data collection instrument of our study and the method to collect urine samples were approved by the ethics committee of our university. Nine hundred ninety-two questionnaires were delivered to representatives of 25 workplaces located in the Fukuoka, Yamaguchi, Osaka, and Kobe areas, and the responses to the survey were collected during the period of October 1, 2004 through January 31, 2005. In order to measure 8-OH-dG, urine samples were collected

from participants who agreed with verbal and written consent to this study when they responded to the questionnaires. The responses to the survey and urine samples from males were also collected and used as positive controls in order to compare differences in gender. Collected urine samples were stored at -80°C in a freezer until they were used for analysis.

The data collection instrument

The data collection instrument in our study consisted of three parts. The first part included basic demographic items such as age, sex, marital status, employment status, types of work, sleeping hours, duration of overtime work, any role in domestic work as a family member and lifestyle habits. The second part was called the Brief Job Stress Questionnaire, which was constructed to measure job stress factors and job related physical and psychological stress responses associated with signs and symptoms of physical and mental fatigue [10]. The Internal Consistency Analyses made by its inventors has been described as Chronbach α ranging from 0.66 to 0.92 [11]. In their inventory, there were four components which consisted of 17 items concerning work conditions and environments, such as the quality and quantity of one's workload, controllability of one's own jobs, and interpersonal relationships in the workplaces, 29 items concerning signs and symptoms related to fatigue in the past month, 9 items concerning social supports, and 2 items concerning comfort in the job and daily life. In the last part of this instrument, there were items pertaining to work conditions and subjective symptoms in relation to the handling of VDT (Visual Display Terminal) devices.

Analysis of urine

Urinary 8-OH-dG was analyzed by a high performance liquid chromatography coupled to an electrochemical detector (HPLC-ECD) [12]. Briefly, human urine samples were mixed with an equal volume of a solution (4% acetonitrile, 130 mM NaOAc (pH4.5), 0.6 mM H_2SO_4) containing the ribonucleoside marker 8-hydroxyguanosine. Eppendorf tubes containing this solution were then centrifuged at 13,000 rpm for 5 min. The prepared samples (20 μl) were then fractionated by an anion exchange column (65°C , 2% acetonitrile in 0.3 mM sulfuric acid). The 8-OH-dG fraction was automatically collected based on the marker 8-hydroxyguanosine peak position as detected at 245 nm, and was injected into the second reversed phase column (40°C , 5% methanol in 10 mM phosphate buffer, pH 6.7). 8-OH-dG was detected by a Coulochem II EC detector (ESA) with a guard cell (5020) and an analytical cell (5011), applied potentials: guard cell=350 mV, E1=170 mV and E2=300 mV. A guard column before the anion exchange column was back washed with 0.5 M ammonium sulphate: acetonitrile (7:3 v/v). Creatinine values in the urine were determined by a commercial laboratory using the colorimetric method (BML Co., Kitakyushu).

Statistical analysis

A basic statistical analysis was applied to items of basic demographics, and proportions, means and standard deviations were calculated in relation to urinary 8-OH-dG levels. Student-*t*-tests were completed to find any difference in these variables between male and female workers,

and Mann-Whitney *u*-test was employed to calculate differences of 8-OH-dG levels among different employment status. After respondents were divided into three groups of male workers, female nurse workers and non-nurse female workers, a one way analysis of variance (one way ANOVA) was made on variables of basic demographics, life style characteristics and Brief Job Questionnaires. Tukey's multiple comparison tests were implemented to find significant differences of 8-OH-dG levels in these variables among the three groups. The correlation coefficient among the levels of 8-OH-dG of each group and these variables were also calculated.

The responses in 17 items related to work conditions as well as 29 items of signs and symptoms of fatigue, were refined by a factor analysis, and the delineated factor scores were used for computing correlation coefficients with the levels of urinary 8-OH-dG of the three groups. Under the categories of the 6 factors from 29 items as well as the 5 factors from 17 items, respondents were separated into two sub-groups corresponding to higher or lower degrees of signs and symptoms of fatigue within each group, and then statistical differences of urinary 8-OH-dG levels between the higher and lower sub-groups were calculated by *t*-tests. The statistical analysis was conducted using statistical packages of the Amos 5.0 for Windows Japanese ed. (SPSS Japan Inc., Tokyo) and JMP 6.0 Japanese ed. (SAS Campus Drive, Cary).

Results

8-OH-dG levels in relation to demographics, occupational and life style characteristics

A total of 752 of the 992 surveys were returned. Urine samples were collected from 26 male and 165 female participants out of the 752 respondents. The mean age of the female respondents was younger (37.4 years) than that of the male respondents (39.9 years). With regard to marital status, 72.2% of the male workers were married, while 48.3% of the female respondents were married. Almost all male respondents were full time workers (98.6%), whereas 69.2% female respondents were engaged in a full-time work, and the rest were either temporary or contracted workers. The majority of male participants were either office workers or research and developmental professionals, whereas more than 60% of female workers were either office workers or nurses (Table 1).

Levels of urinary 8-OH-dG were measured to find any change depending on the differences in sex, age, life style factors and work types. The results of the urinary measurement revealed that the mean of 8-OH-dG of female participants showed slightly higher levels (3.12 µg/g creatinine, n=165) than that of male participants (3.07 µg/g creatinine, n=26) even though the result did not prove any statistical difference. Furthermore, female participants who were engaged in shift work excreted increased levels of 8-OH-dG in comparison to the result of female participants who were engaged in part-time work ($P<0.01$ in Table 2). On the other hand, the urinary 8-OH-dG levels of male and female workers did not indicate any significant increase in proportion to the duration of overtime work (Table 3). Also, we could not find a significant result between the handling of VDT devices and levels of urinary 8-OH-dG.

With regard to domestic roles, the urinary 8-OH-dG levels of female workers who had to deal with housework besides their primary work of employment were significantly increased

Table 1. Characteristics of respondents

		Male N=151		Female N=601	
		n	(%)	n	(%)
Age	18~19	0	(0.0)	1	(0.2)
	20~29	16	(10.6)	178	(29.6)
	30~39	55	(36.4)	176	(29.3)
	40~49	57	(37.7)	143	(23.8)
	50~59	23	(15.2)	93	(15.5)
	60~69	0	(0.0)	8	(1.3)
	No-answer	0	(0.0)	2	(0.3)
Employment status	Employed work	149	(98.6)	416	(69.2)
	Temporary work	0	(0.0)	118	(19.6)
	Contract work	2	(1.3)	28	(4.7)
	Other	0	(0.0)	17	(2.8)
	No-answer	0	(0.0)	22	(3.7)
Work types	Office work	57	(37.7)	193	(32.1)
	Research & development professional	70	(46.4)	72	(12.0)
	Industrial technology work	0	(0.0)	44	(7.3)
	Sales work	17	(11.3)	55	(9.2)
	Nurse	0	(0.0)	190	(31.6)
	Other	1	(0.7)	28	(4.7)
	No-answer	6	(4.0)	19	(3.2)
Work schedule	Daytime work	144	(95.4)	342	(56.9)
	Shift work	7	(4.6)	137	(22.8)
	Part time work	0	(0.0)	106	(17.6)
	Other	0	(0.0)	14	(2.3)
	No-answer	0	(0.0)	2	(0.3)
Years of work (Y)	$Y < 3$	12	(7.9)	144	(24.0)
	$3 \leq Y < 10$	28	(18.5)	207	(34.4)
	$10 \leq Y < 20$	73	(48.3)	166	(27.6)
	$20 \leq Y$	37	(24.5)	84	(14.0)
	No-answer	1	(0.7)	0	(0.0)

Table 2. Effect of working patterns on urinary 8-OH-dG levels of female workers

Working patterns		Mean $\pm$ SD	<i>t</i> -value	<i>P</i>
Shift work	(n=65)	3.20 $\pm$ 2.01	3.08	*
Part-time work	(n=12)	2.06 $\pm$ 0.96		

The results of 8-OH-dG were described as the mean levels of $\mu\text{g/g}$ creatinine and $\pm$ standard deviations(SD). (n) represents the numbers of urine samples *: $P < 0.01$

in comparison with the levels of female workers who were not involved in such domestic work (Table 3, $P < 0.01$). Contrary to the results of those with housework, the 8-OH-dG levels of those who had undertaken child-rearing and home care-giving did not show any difference from the result of the groups of male and female workers who did not take part in these roles. Moreover, there was no statistically significant change among the male and female participants in the mean level of the urinary 8-OH-dG associated with lifestyle factors, which included alcohol intake, smoking and exercise habits. (Table 3).

8-OH-dG levels in relation to job stress factors, signs and symptoms of fatigue

A factor analysis was employed for 17 items of job stress factors as well as for 29 items of signs and symptoms of fatigue in the brief job stress questionnaires. Items which scored higher than 0.4 were selected after completing factor analyses. In the first place, 5 factors were depicted from 17 items associated with job conditions and environments, but we could not find any statistical difference in levels of 8-OH-dG between the two sub-groups of higher and lower scores of the refined factors. In the analyses of 29 items, there were six refined factors, which were 5 items of loading scores of depressive states, 6 items of psychosomatic symptoms, 5 items of mental fatigue, 5 items of physical fatigue, 3 items of lack of vigor and 3 items of irritation. The Cronbach's α of measuring internal consistency in these refined factors of our study was from 0.74 to 0.89, and the cumulative contribution rate of the 6 factors was 64.83% (Table 4). Based upon the result of the factor analysis, groups of nurses, especially in their age 20s to 30s, presented a positive linear relationship between the first and the second factors. The first factor was considered to be depressive states and the second factor was considered to be psychosomatic symptoms (Table 4). This result also indicates that the nurse groups exhibited not only higher degrees of depressive states but also increased numbers of complaints of psychosomatic symptoms than any other group. In contrast, the result of nurses in their 20s to 30s and nurses in their 40s presented the highest psychosomatic symptoms, such as dizziness, palpitations, insomnia, diarrhea and loss of appetite. Following the above result, all nurses were divided into two sub-groups by higher or lower scores for signs and symptoms of fatigue in the 6 factors and then a comparison of urinary 8-OH-dG levels was made between the two sub-groups. The result indicates that the urinary 8-OH-dG levels of nurses who marked items of the first factor as higher depressive states showed significantly increased amounts than those who complained

Table 3. Urinary 8-OH-dG levels in relation to domestic roles, over-time work and lifestyle characteristics of male and female workers

	Male (N=151)			Female (N=601)		
	n	(%)	8-OH-dG (n)	n	(%)	8-OH-dG (n)
House keeping	Yes	50 (33.11)	2.9 ± 1.07 (8)	455 (75.71)	3.3 ± 2.34 (128)	*]
	No	93 (61.59)	3.2 ± 1.18 (18)	111 (18.50)	2.5 ± 0.99 (28)	
	NA	8 (5.30)		35 (5.82)		
Child-rearing	Yes	33 (21.85)	2.5 ± 1.49 (6)	50 (8.32)	3.6 ± 3.49 (13)	
	No	114 (75.50)	3.3 ± 0.98 (19)	541 (90.02)	3.2 ± 2.04 (149)	
	NA	4 (2.65)		10 (1.66)		
Home care-giving	Yes	2 (1.32)	2.9 (1)	14 (2.33)	4.5 ± 2.98 (4)	
	No	145 (96.03)	3.1 ± 1.15 (25)	577 (96.01)	3.2 ± 2.16 (158)	
	NA	4 (2.65)		10 (1.66)		
Overtime work	More than 30 hours/week	45 (29.80)	3.1 ± 0.81 (5)	64 (10.65)	3.0 ± 1.75 (18)	
	10~29 hours/week	58 (38.41)	3.0 ± 1.45 (9)	188 (31.28)	3.5 ± 2.48 (67)	
	Less than 10 hours/week	28 (18.54)	3.0 ± 0.98 (9)	194 (32.28)	3.1 ± 2.23 (57)	
	None	18 (11.92)	4.0 ± 0.76 (2)	144 (23.96)	2.8 ± 1.48 (18)	
	NA	2 (1.32)		11 (1.83)		
Lifestyle	Exercise	Yes	3.0 ± 0.83 (10)	133 (22.13)	3.0 ± 2.39 (12)	
		No	3.2 ± 1.30 (16)	465 (77.37)	3.2 ± 2.13 (131)	
	Alcohol intake	Yes	3.0 ± 1.21 (16)	239 (39.77)	3.0 ± 1.84 (67)	
		No	3.4 ± 0.95 (9)	358 (59.57)	3.3 ± 2.41 (92)	
	Smoking	Yes	3.1 ± 1.04 (12)	73 (12.15)	3.1 ± 2.57 (28)	
		No	3.1 ± 1.24 (14)	525 (87.35)	3.2 ± 2.09 (132)	

The results of 8-OH-dG were described as the mean levels of $\mu\text{g/g}$ creatinine $\pm$ standard deviations(SD), NA means not applicable, (n) represents the number of urine samples * : $P < 0.01$

Table 4. The result of factor analysis and loading scores in the 29 refined items of signs and symptoms of fatigue

Refined name and item		Matrix of factors pattern					
		1	2	3	4	5	6
Depressive states	Unable to concentrate	0.887	-0.087	-0.099	0.126	0.045	-0.015
	Tired (troublesome)	0.887	-0.169	0.007	0.186	0.001	0.005
	Unable to bring oneself to work	0.632	0.251	-0.133	-0.008	0.045	0.001
	Depressed	0.534	0.101	0.172	-0.053	-0.087	0.120
	Miserable	0.526	0.084	0.298	-0.049	-0.062	0.036
Psychosomatic symptoms	Decreased appetite	0.087	0.604	-0.051	0.080	-0.021	-0.063
	Dysfunction of stomach & bowels	-0.064	0.570	0.117	0.091	-0.071	-0.024
	Dizziness	0.031	0.533	-0.083	0.183	-0.006	0.004
	Palpitation	-0.010	0.492	-0.047	0.224	0.050	0.026
	Diarrhea	-0.066	0.452	0.152	0.130	-0.012	0.013
	Insomnia	-0.007	0.437	0.051	0.086	0.003	0.079
Mental fatigue	Awfully tired	-0.034	-0.080	0.787	0.209	0.007	0.049
	Exhausted	-0.003	-0.072	0.770	0.185	0.006	0.033
	Extremely tense	-0.061	0.117	0.645	0.007	0.136	0.037
	Weariness	0.123	-0.060	0.615	0.284	-0.134	-0.049
	Anxious	0.296	0.251	0.473	-0.235	0.034	-0.022
Physical fatigue	Stiff shoulder	0.001	0.063	0.140	0.622	-0.015	-0.022
	Backache	0.059	0.164	0.005	0.617	0.009	-0.017
	Eye strain	-0.025	0.030	0.174	0.527	0.080	0.036
	Body ache	0.044	0.355	-0.093	0.490	0.031	0.026
	Headache	0.082	0.314	0.034	0.453	-0.059	0.015
Vigor	Energetic	0.014	-0.021	0.053	0.007	0.945	-0.020
	Healthiness	0.026	-0.030	-0.011	0.011	0.874	0.030
	Be active	-0.008	0.025	0.036	0.029	0.844	-0.013
Hostility	Anger	-0.011	-0.008	0.010	0.021	0.036	0.876
	Outrage	0.024	0.025	-0.027	0.010	-0.013	0.874
	Irritation	0.104	-0.002	0.184	-0.023	-0.043	0.641
Cumulated contribution ratio (%), factors 1-6		35.232	44.023	51.159	57.007	61.077	64.829
Cronbach's α		0.886	0.740	0.864	0.788	0.844	0.845

less depressive states (Table 5). Similar to this result of nurses in their 20s to 30s, we had a significant result in the levels of 8-OH-dG in relation to the scores of their depressive states when we expanded the scope of the target to include up to 48 years ($P<0.01$, result not shown). However, the result of 8-OH-dG in other factors did not prove any significant difference among these younger nurses (Table 3) as well as other age groups. Similar to this result, levels of 8-OH-dG in the male and non-nurse female groups did not demonstrate any difference in their higher and lower degrees of signs and symptoms in the scores of the other 5 factors.

Table 5. The levels of urinary 8-OH-dG in relation to the degree of symptoms in the refined 6 factors among nurses in their 20s to 30s

Groups of factors	Degrees of conditions	N	Mean 8-OH-dG ± SD	P - value
Depressive states	High	50	3.61 ± 2.79	0.01 *
	Low	22	2.46 ± 0.95	
Psychosomatic symptoms	High	53	3.53 ± 2.70	0.11
	Low	19	2.50 ± 1.24	
Mental fatigue	High	42	3.37 ± 2.30	0.82
	Low	30	3.23 ± 2.71	
Physical fatigue	High	43	3.44 ± 2.46	0.58
	Low	29	3.11 ± 2.44	
Vigor	High	52	3.16 ± 2.11	0.39
	Low	20	3.71 ± 3.60	
Hostility	High	41	3.60 ± 2.48	0.20
	Low	31	2.10 ± 2.36	

The results of 8-OH-dG were described as the mean levels of µg/g creatinine ± SD: standard deviations, N: represents the number of urine samples *: $P < 0.05$

The result of 8-OH-dG levels in correlation with job stress factors and signs and symptoms of fatigue

Analysis of the scattering patterns and correlation coefficient was calculated to find any relation between urinary 8-OH-dG levels and the individual scores of the 5 refined factors from 17 items for job stress, and the 6 factors from 29 items for signs and symptoms of fatigue. As far as the job stress factors are concerned, we could not prove any parallel relation in the elevation of 8-OH-dG among the male, female nurse and non-nurse female groups. Different from these results, there was a positive correlation between 8-OH-dG levels of nurses in the ages ranging from 35 to 45 years and the individual factor scores which represented higher depressive state in the first factor (Fig. 1). The result of these scattering patterns showed that the urinary 8-OH-dG levels of these nurses increased as their depressive scores shifted from the negative to the positive. As a result, the regression coefficient was 0.32, which is statistically significant. In addition to this result, we examined whether or not a positive relation would exist when we expanded the range of ages to include 25 years. Figure 2 shows that there is a significant positive correlation between their urinary excretion and their depressive states, as shown as a regression line (Fig. 2 $r = 0.23$, $P < 0.05$). However, the scattering patterns of individual factor scores in the remaining 5 factors did not indicate any relation to the urinary 8-OH-dG levels of nurses in the same age group. Moreover, the urinary 8-OH-dG levels of the male and non-nurse female participants did not indicate any correlation with individual scores of these extracted factors.

Fig. 1. The result of the scattering pattern between individual factor scores of depressive states and urinary 8-OH-dG levels in nurses in the 35 – 45 age group.

The X axis displays the scores of depressive states and the Y axis displays the level of 8-OH-dG / Creatinine ($\mu\text{g/g}$). Each point represents one participant. R represents the regression coefficient of 41 participants.

■ Y: levels of 8-OH-dG, — : regression line: Y, $R=0.32$ ($P=0.040$), $N=41$, N: represents numbers of nurses along with their urine samples.

Fig. 2. The result of the scattering pattern between individual factor scores of depressive states and urinary 8-OH-dG levels in nurses in the 25 – 45 age group.

The X axis displays the scores of depressive states and the Y axis displays the level of 8-OH-dG / Creatinine ($\mu\text{g/g}$). Each point represents one participant. R represents the regression coefficient of 80 participants.

■ Y: levels of 8-OH-dG, — : regression line: Y, $R=0.23$ ($P=0.037$), $N=80$, N: represents numbers of nurses along with their urine samples.

Discussion

Level of 8-OH-dG in relation to demographics, occupational and lifestyle characteristics

In this result of our study, the mean urinary 8-OH-dG of female workers was measured in a slightly higher amount than that of male workers, although it was statistically insignificant. Previous studies reported that oxidatively damaged mitochondrial DNA would be higher, approximately four fold in males than in females, and estrogen induces the expression of antioxidant enzymes through NF- κ B to the nucleus [13]. Consequently, females have an increased capacity to detoxify ROS due to their higher superoxide dismutases and glutathione peroxidases activities. Therefore, males usually tend to excrete a higher amount of 8-OH-dG than females [14]. In contrast to these reports, our study result suggested that a higher percentage of shift work among females (22.8%) than males (4.6%) caused to increase the mean 8-OH-dG level of female workers since almost all male participants (95.4%) in our study worked during the daytime (Table 1). Moreover, our result also showed that the mean 8-OH-dG of the urine excreted by female workers engaged in the shift work was more significant than that by female workers who worked part time (Table 2). For this reason, we could state that shift work would be one of the provoking factors to induce the formation of 8-OH-dG.

Different from child-rearing and home care-giving, housework influenced 8-OH-dG levels to increase significantly in our result (Table 3). Since there were not so many participants who undertook child-rearing and home care-giving, we did not conclude that these types of domestic works failed to induce any oxidative damages to DNA. However, the result of our study indicated that housework besides primary work of employment led to an increase of the mean 8-OH-dG level of participants. Cleaning dishes, doing laundry and preparing each meal are common domestic work, and many participants responded that they had to deal with this housework. Especially, females often take major roles in housework in addition to their regular work schedule compared with men, and therefore, such extra work made them physically exhausted.

There were studies reporting significantly positive correlations of the 8-OH-dG level with the average number of cigarettes smoked and the average volume of alcohol consumed. Especially, cigarette smoking was a link to the formation of 8-OH-dG, whereas there was a significantly negative correlation of the 8-OH-dG level with average hours of exercise practice [4,15]. In this result of our study, however, the 8-OH-dG level of the participants did not reveal any consistent relation with increased alcohol intake, smoking or exercise habits to ascertain the previous studies. A further study would be needed to collect more urine samples from female as well as male participants in order to draw a conclusion of any relation between 8-OH-dG formation and lifestyles.

Increased 8-OH-dG levels associated with the factor analysis of signs and symptoms of fatigue

From the result of factor analysis, the groups of female nurses in their 20s to 30s rated the highest scores in the first factor as well as the second factor. Based upon this result, the mean urinary 8-OH-dG of these nurses in relation to the severity of symptoms in the first factor

resulted in a significant difference in contrast with the mean amount of 8-OH-dG of nurses who complained of these depressive states ($P<0.01$) to a lesser degree. Psychological stress was suggested to increase production of ROSs [2]. In studies of peripheral leukocytes, there was a positive correlation between the formation of 8-OH-dG in female workers and negative emotions, including depression and an inadequate stress-coping behavior [16]. In another study, the severe depression scores of the General Health Questionnaires (GHQ) in females were strongly and positively associated with the 8-OH-dG levels through neutrophil activation [17]. Also, another study described a significant positive correlation between scores of the Center for Epidemiologic Studies Depression scale (CES-D) and the 8-OH-dG levels in depressive, particularly female patients [18]. Nevertheless, it is not completely clear if psychological stress modifies urinary excretion of 8-OH-dG. In the result of this study, younger nurses who scored a higher depressive state in the items of the first factor showed higher 8-OH-dG levels than nurses who scored a lower depressive state. A study result in relation to work conditions reported that workers in physical labor showed significantly higher levels of 8-OH-dG in contrast to the result of sedentary workers ($P<0.01$) [4,18]. In the analysis of job stress factors, we found that nurses, especially younger nurses, significantly carried a burden of quality and quantity of workload ($P<0.001$) [19]. Moreover, nurses felt strongly that there were some physically demanding duties to deal with under the least controllable situation, even though they were required to implement specialized knowledge in providing care ($P<0.05$ and 0.001) [19]. Consequently, these physically and mentally demanding conditions could induce them to burn out, leading to a depressive state. Our result confirmed a previous study which found that younger nurses in their 20s tended to become depressive because of long working hours associated with shift work and their immature stress coping abilities [20,21]. Hence, the result of our study can suggest that depressive states derived from mental and physical exhaustions may trigger a DNA oxidation in the nucleus and mitochondria, thus resulting in an excretion of urinary 8-OH-dG among nurses in the 20-30 age group. However, further studies will be needed to elucidate the precise relationship between depressive states and increased urinary excretion of 8-OH-dG in younger nurses.

A positive correlation between the levels of 8-OH-dG and the score of depressive state

Our study result also revealed that there was a positive correlation between the levels of 8-OH-dG in nurses and the score of their depressive state. With regard to age factors, the depressive scores of nurses in the 35 – 45 age group (Table 1) showed a much higher regression coefficient than that of nurses in the 25 – 45 age group (Table 2). Since nurses in the 35 – 45 age group are in the prime of their working life, they must take dependable roles as core figures. Simultaneously, they have to manage their own chores at home, such as housework, child-rearing and other family matters. We previously reported that nurses in their 40s, who marked higher psychosomatic symptoms, needed to take care of household matters [19]. Therefore, nurses, particularly in this age group, showed increased 8-OH-dG-levels in proportion to depression scores due to physical exhaustion. As far as working patterns are concerned, the result of the data showed that there were increased numbers of subjective symptoms among

female workers in the shift work in comparison with the result of those who were engaged in regular daily work ($P<0.001$) [19]. We also found that work in the night shift caused female workers, particularly nurses, to become exhausted when compared to overtime work ($P<0.001$) [19]. During the daytime following a night shift, female workers must handle household chores which deprive them of time to get enough sleep. Additionally, nightshift work causes a circadian rhythm irregularity. Since working the night shift shortens sleeping hours and lowers the quality of sleep, it is difficult for nurses to fully recover from fatigue after a night shift [22]. Taking all these into consideration, these accumulated exhaustive states could lead nurses to chronic fatigue which precedes mental depression. Thus, these results implied that a heavy burden of work, such as working on the night shift in addition to undertaking housework, accelerates oxidative damages of DNA to induce increased urinary 8-OH-dG levels, regardless of the higher antioxidant activities of enzymes to detoxify ROS among females.

Limitations of this study

The method of collecting data including data on urine samples could have been conducted more strategically. There were differences in the sample sizes of various sub-populations and therefore further studies will be needed to elucidate an exact relation between the formation of 8-OH-dG and depressive states caused by workloads.

Conclusion

In order to investigate the effects of job stress factors on oxidative DNA injuries among female workers, the levels of urinary 8-OH-dG were measured along with a survey on work conditions and environments.

The findings are as follows:

1. Female workers in shift work schedules excreted increased levels of 8-OH-dG in comparison with part-time workers ($P<0.01$). The duration of overtime work did not affect the formation of 8-OH-dG in both male and female workers.
2. The levels of urinary 8-OH-dG of female workers who worked on household chores besides their primary work of their employment were significantly at a higher level than those of female workers who did not work on household chores ($P<0.01$).
3. We found the result that nurses who marked higher depressive scores excreted significantly higher levels of urinary 8-OH-dG than those who scored lower depressive states ($P<0.01$).
4. The result revealed a positive correlation between the 8-OH-dG levels of nurses in the age range of 35 to 45 years and the individual factor scores of their depressive states ($r=0.32$, $P<0.05$).

In conclusion, the result of our study suggests that a heavy burden of work in addition to undertaking housework increases the urinary excretion of 8-OH-dG in nurses.

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看護師を含む就労女性の労働態様と尿中8-ヒドロキシデオキシグアノシン(8-OH-dG)排泄量への影響

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要 旨： 女性労働者の職業性ストレスと細胞内の酸化ストレスに伴うDNA損傷との関連を明らかにする目的で、労働態様に関する質問紙調査と尿中に排泄される酸化ストレスマーカー8-OH-dG量の測定を行った。仕事とともに家事労働を行わなければならない就労女性は、そうでない場合と比較して尿中8-OH-dG排泄量が高い値となった($P<0.01$)。パートタイム女性労働者と比較して、交代勤務に従事する女性の尿中8-OH-dG測定値は有意に高かった($P<0.01$)。交代勤務に従事する職種として、看護職の割合が高くさらに、看護師で抑うつ傾向が高い場合は、抑うつ傾向の低い看護師に比較して8-OH-dG量の尿中排泄量は多かった($P<0.05$)。また、35歳-45歳看護師の尿中の8-OH-dG排泄量と抑うつ得点とに相関($r=0.32$, $P<0.05$)を認めた。以上の結果より、家事労働に加え交代勤務を含む過重労働に従事する就労女性の場合、尿中への8-OH-dGの排泄量が高いことが示唆された。

キーワード： 8-ヒドロキシデオキシグアノシン, 就労女性, 交代勤務, 看護職.

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