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学　位　論　文

学位論文名

Preventive measures and lifestyle habits against exertional heat illness in radiation decontamination workers（除染作業員における労作性熱中症に対する予防対策と生活習慣）

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Abstract and keywords

Objectives

The aim of this study was to reveal the current state of preventive measures and lifestyle habits against heat illness in radiation decontamination workers and to examine whether young radiation decontamination workers take less preventive measures and have worse lifestyle habits than the elder workers.

Methods

This was a cross-sectional study. Self-administered questionnaires were sent to 1,505 radiation decontamination workers in Fukushima, Japan. Five hundred fifty-eight men who replied and answered all questions were included in the statistical analysis. The questionnaire included age, duration of decontamination work, previous occupation, lifestyle habit, and preventive measures for heat illness. We classified age of the respondents into five groups: <30, 30-39, 40-49, 50-59, and ≥60 years and defined the workers under 30 years of age as young workers. Logistic regression analysis was used to reveal the factors associated with each lifestyle habit and preventive measures.

Results

In comparison with young workers, 50-59-year-old workers were significantly associated with refraining from drinking alcohol. Workers 40 years of age or older were significantly associated with cooling their bodies with refrigerant. Furthermore, 30-39-year-old workers and 40-49-year-old workers were significantly associated with adequate consumption of water compared to young workers.

Conclusion

The results of our study suggests that young decontamination workers are more likely to have worse lifestyle habits and take insufficient preventive measures for heat illness. This may be the cause of higher incidence of heat illness among young workers.

Keywords: Heat illness; Occupational health management; Radiation decontamination

論　文　内　容　要　旨（和文）

学位論文題名	除染作業員における労作性熱中症に対する予防対策と生活習慣

【目的】本研究の目的は、除染作業員における熱中症に対する予防対策と生活習慣について明らかにし、若年の作業員においてその取り組みが不十分であるかどうかを検討することである。

【方法】福島産業保健推進センターの行う除染従事者向け講習会に参加した事業所に調査参加の依頼を行った。調査協力の同意の得られた事業所から抽出した 1505 人に対して、郵送にて調査票の配布および回収を行った。回答は無記名にて実施した。2013 年 8 月に調査票を送付し、同年 10 月末までに回答をした 651 人のうち、対象項目を全て満たした男性作業員 558 人を対象とした。調査票の回答より、予防対策および生活習慣（睡眠、朝食の有無、飲酒を控えているか、保冷材などによる身体の冷却、十分な飲水、塩分の摂取）の有無を集計した。作業員の属性は、年齢、職場での毎日の予防教育の有無、前職も屋外肉体労働であったか、雇用されてからの期間（1 年以上か）とした。年齢は、30 歳未満、30 歳代、40 歳代、50 歳代、60 歳以上に分け、カテゴリー変数とした。年齢と属性、予防対策および生活習慣との関連について、二項ロジスティック回帰分析を行った。有意水準は $P<0.05$ とした。

【結果】二項ロジスティック回帰分析において、30 歳未満と比較して、飲酒を控えている者の割合は 50 歳代（オッズ比 2.276, 95%信頼区間 1.295-3.999）で有意に低く、十分な飲水を行っている者の割合は 30 歳代（オッズ比 3.015, 95%信頼区間 1.272-7.147）と 40 歳代（オッズ比 2.070, 95%信頼区間 1.019-4.206）で有意に高かった。身体の冷却を行っている者の割合は、30 歳未満に比較して、40 歳代（オッズ比 3.101, 95%信頼区間 1.358-7.083）、50 歳代（オッズ比 2.639, 95%信頼区間 1.157-6.019）、60 歳以上（オッズ比 2.321, 95%信頼区間 1.061-5.078）で有意に高く、また雇用期間が 1 年以上の群では、1 年未満の群と比較して有意に低かった（オッズ比 0.434, 95%信頼区間 0.228-0.826）。毎日の予防教育が実施されている群では、されていない群と比較して、すべての予防対策の実施割合が有意に上昇していた。

【結論】30 歳未満の労働者における熱中症予防対策は、他の年代と比較して不十分である可能性が示された。若年労働者において、予防教育が効果的に実践に移される必要がある。

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I. Introduction

The Great East Japan Earthquake and the subsequent tsunami on March 11, 2011, resulted in the Fukushima Daiichi Nuclear Power Plant accident. This led to a large fallout of radioactive materials, including cesium-137 and cesium-134. The Japanese government decided to employ a large-scale decontamination effort to reduce the risk of radioactive exposure. Due to the high requirement for decontamination workers, many workers were brought in from outside the decontamination area. Although the presumed number of workers was 15,000-20,000 in the Fukushima prefecture, the actual number is unknown. Decontamination work is a physically demanding outdoor labor job that includes removing soil, weeds and leaf fall, and washing houses and roads[1]. The workers have to wear long sleeves and pants as well as cotton gloves, dust masks, and boots in order to avoid radioactive exposure even in hot, humid conditions[1].

Previously, we reported that more than half of the decontamination workers experienced symptoms of heat illness during one summer[2]. This was despite the government demanding that employers protect their workers from risks such as heat illness[3]. Sleep deprivation[4,5] and excessive alcohol consumption[6,7] were risk factors for heat illness; however, most of the workers were temporary employees and their lifestyle, in general, was casual[8]. Sawano et al. have pointed out a high prevalence of lifestyle-related diseases, such as dyslipidemia, diabetes mellitus, and hypertension, in hospitalized decontamination workers[9]. A casual lifestyle might increase the risk of exertional heat illness. Nevertheless, little information is available on lifestyle habits and preventive measures for heat illness in radiation decontamination workers.

Previous studies, including ours[2], have shown that exertional heat illness mainly occurs in young workers. Although younger age tends to be associated with better physiological heat tolerance than older age[10,11], age has been identified as a risk factor[12]. Some young workers even developed severe symptoms of heat illness, such as headaches and nausea[2]. One reason for this is thought to be due to the heavier workloads given to the younger workers[13]. For another reason, we speculated unhealthier lifestyle habits and insufficient preventive measures for heat illness among younger decontamination workers. The aim of this study was to reveal the lifestyle habits and preventive measures for heat illness in radiation decontamination workers and to determine whether the young radiation decontamination workers take fewer preventive measures and have worse lifestyle habits than the elder workers.

II. Methods

1. Subjects

This study was conducted by the Fukushima Occupational Health Promotion Center. In August 2013, self-administered questionnaires were sent to 1,505 radiation decontamination workers who worked at companies that participated in this study and were returned anonymously by mail. By the end of October 2013, 651 workers (628 men and 23 women) replied to the questionnaire. Among them, 558 men who answered all questions were included in the statistical analysis. The response and effective response rates were 42.5% and 37.1%, respectively.

2. Questionnaire

The questionnaire included questions regarding sex, age, previous occupation, duration of decontamination work, risk education provided daily by employer, lifestyle habits, and preventive measures against heat illness. The analysis items chosen from the questionnaire were shown in Appendix 1. The questions regarding lifestyle habits and preventive measures against heat illness were multiple choice questions, and the options were taken from the "Worker's manual on occupational safety management[14]." The questions covered the following topics: enough sleep before a working day; daily breakfast consumption; refraining from consuming a lot of alcohol before a working day; cooling body with refrigerant; adequate consumption of water during breaks; intake of salt with water.

We classified previous occupation into two groups, depending on whether they were involved in outdoor manual work, which consisted of construction, agriculture, forestry and fisheries, and radiation decontamination. Age was classified into five groups: <30, 30-39, 40-49, 50-59, and ≥60 years, and we defined the workers under 30 years of age as young workers. The duration of employment was divided into two groups: one or more years and less than one year. This is because the workers who had engaged in more than one year of decontamination work were considered as having experienced the decontamination work in summer.

3. Statistical Analysis

Data were analyzed using SPSS ver. 23. Mean and standard deviation (SD) were calculated for age, and median and the 25th-75th percentiles were calculated for the duration of decontamination work. Descriptive statistics for the other items and measurements were calculated using frequencies and proportions. The relationships between the age groups and questionnaire items and the relationships between the age groups and the preventive measures were analyzed by chi-square test. We used logistic regression analysis to calculate the odds ratio (OR), along with the 95% confidence interval

(CI), to identify the variables associated with the preventive measures. The model included age, duration of employment, previous occupation, and daily education. A P value below 0.05 was regarded as statistically significant.

4. Ethics

This study was approved by the Research Ethics Committees of the Japan Labor Health and Welfare Organization (Announce No.3) and the Ethics Committees of Fukushima Medical University (Application No. 1728).

III. Results

The descriptive statistics are shown in Table 1. The mean age of participants was 47.1 years of age (SD: 13.4). The median duration of decontamination work was 6.0 (25th-75th percentile: 3.0-10.2) months. One hundred seventy-two workers (30.8%) had previous experience in outdoor manual labor, and four hundred twenty-seven workers (76.5%) were given daily education about preventing exertional heat illness. Only 103 workers (18.5%) cooled their body with refrigerant during work, and this was the least common of the preventive actions. In contrast, water was adequately consumed by 449 workers (80.5%).

The number of participants in the <30, 30-39, 40-49, 50-59, and ≥60 years age groups were 74, 100, 108, 162, and 144, respectively (Table 2). No significant differences were observed between the age groups and each item on the questionnaire. Table 3 shows the significant differences in the chi-square test between each age group and the following categories: refraining from alcohol consumption, cooling the body, and water consumption.

Table 4 shows the ORs for each preventative measure. In comparison with young workers, 40-49-year-old workers (OR 3.101, 95% CI 1.358-7.083), 50-59-year-old workers (OR 2.639, 95% CI 1.157-6.019), and ≥60-year-old workers (OR 2.321, 95% CI 1.061-5.078) were significantly associated with cooling the body. In contrast with young workers, the 30-39 years of age group (OR 3.015, 95% CI 1.272-7.147) and the 40-49 years of age group (OR 2.070, 95% CI 1.019-4.206) were significantly associated with adequate water consumption. In addition, the daily education was significantly positively associated with every measure. While workers with previous experience in outdoor manual work tended to refrain from alcohol consumption (OR 1.624, 95% CI 1.056-2.498) and cooled their body (OR 4.047, 95% CI 1.874-8.740), those with one or more years of experience as a decontamination worker tended not to cool their body (OR 0.434, 95% CI 0.228-0.826).

IV. Discussion

In this study, we revealed the preventive measures and lifestyle habits against exertional heat illness in radiation decontamination workers and analyzed the results by age group. Except for cooling of the body, every preventive measure and appropriate lifestyle habit was taken by more than half of the workers. To identify the kind of workers that did not live a healthy lifestyle and did not take measures for heat illness recommended in the worker's manual on occupational safety management[14], we investigated age, previous occupation, daily education, and duration of employment. As a result, our speculation that young workers live an unhealthier lifestyle and take less preventive measure than the elder workers was supported partially. Young workers tended not to consume an adequate amount of water, not to cool their body, and not to refrain from alcohol consumption in comparison with the elder workers. We therefore believe that such insufficient preventive measures and an unhealthier lifestyle habit of young workers may be the cause of the high number of heat illnesses.

Previous studies show that education on exertional heat illness raises awareness of the dangers of heat illness among workers and makes them receive medical check-ups before developing serious conditions[15,16]. In our study, daily education on heat illness was given to 76.5% workers, and this had a significantly positive relationship with every preventive measure. It is important that all workers receive such education, especially younger workers who are at higher risk due to personal habits and lack of awareness. Further, it requires to investigate which type of education is most effective. In addition, as satisfaction for preventive measures is associated with less perception of physical burden during working[17], young workers might think that their preventive measures were enough. Thus, not only young workers' self-regulation but also managerial support, such as flexible decisions on work-rest regimen[18] and daily check of their physical condition[19], is needed in the prevention of heat illness.

Maeda et al. reported that, in Japanese forestry workers, a short duration of employment was one of the risk factors contributing to the onset of heatstroke[13]. In our study, the workers with less than one year of experience in decontamination work tended to cool their body. The additional investigation into the relationship between the duration of employment and the prevention measures is needed.

There were some limitations to our study. No questions about heat acclimatization were included in the questionnaire. Past studies indicated that heat acclimatization not only improves exercise capacity in hot environments[20], but also prevents heat illness[21,22]. Indeed, the Japanese government requires strict heat illness preventive programs for

workers who have not been acclimated to heat stress[23]. In addition, we were unable to take workers' clothing into consideration as they have no say in what they can wear to protect themselves from radioactive exposure during work[1]. Further, we couldn't investigate the workload of the workers, which is thought to be one of the causes of the high number of heat illnesses among young workers[13]. Despite these limitations, this study was the first to focus on preventive measures and lifestyle habits against heat illness in radiation decontamination workers.

In conclusion, we revealed that younger decontamination workers tended to have unhealthier lifestyle and take insufficient preventive measures against heat illness. However, daily education on the dangers of heat illness is associated with improvement in taking every preventative measure. To decrease the high incidence of exertional heatstroke in young decontamination workers, employers should provide intensive daily education and especially encourage young workers to live a healthier lifestyle and to take appropriate preventative measures.

V. Acknowledgments

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The authors declare that there is no conflict of interest.

VI. Conflicts of interest

The authors declare that there is no conflict of interest.

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Table 1. Characteristics and preventive measures of radiation decontamination workers.

Characteristics	
Age (mean ± SD)	47.09 ± 13.39
Working duration (25th–75th percentiles)	6.0 (3.0–10.2)
Ex-outdoor manual worker (%)	172 (30.8)
Preventive action conducted by employee	
Daily education (%)	427 (76.5)
Preventive measures and lifestyle habit	
Adequate sleep (%)	418 (74.9)
Breakfast consumption (%)	387 (69.4)
Refrain from drinking (%)	298 (53.4)
Cool body (%)	103 (18.5)
Adequate drink water (%)	449 (80.5)
Salt intake (%)	349 (62.5)

Table 2. Characteristics and preventive action conducted by decontamination workers by age groups.

	n	Outdoor manual worker	Daily education	One or more years of employment
Age group (%)				
<30	74	62 (83.8)	57 (77.0)	15 (20.3)
30–39	100	85 (85)	75 (75)	25 (25)
40–49	108	82 (75.9)	85 (78.7)	19 (17.6)
50–59	162	124 (76.5)	126 (77.8)	31 (19.1)
≥60	144	87 (60.4)	84 (58.3)	27 (18.6)
$\chi 2$ test		0.302	0.898	0.630

Table 3. Preventive measures and lifestyle habits by age group.

	n	Adequate sleep	Breakfast consumption	Refrain from drinking	Cool body	Water consumption	Salt intake
Age group (%)							
<30	74	47 (63.5)	46 (62.2)	39 (52.7)	15 (20.3)	66 (89.2)	43 (58.1)
30–39	100	74 (74)	68 (68)	57 (57)	24 (24)	85 (85)	67 (67)
40–49	108	84 (77.8)	86 (79.6)	68 (63.0)	23 (21.3)	89 (82.4)	73 (67.6)
50–59	162	129 (79.6)	110 (67.9)	85 (52.5)	31 (19.1)	125 (77.2)	100 (61.7)
≧60	144	84 (58.3)	77 (53.5)	49 (34.0)	10 (6.9)	84 (58.3)	66 (45.8)
$\chi 2$ test		0.106	0.108	0.049	0.042	0.048	0.442

Table 4. Relationship between preventive measures, age groups, and characteristics.

	Adequate sleep	Breakfast consumption	Refrain from drinking	Cool body	water consumption	Salt intake
Age group						
<30	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
30–39	0.586 (0.308–1.115)	0.731 (0.388–1.377)	1.411 (0.764–2.607)	2.383 (0.976–5.819)	3.015 (1.272–7.147)	0.938 (0.509–1.727)
40–49	0.982 (0.527–1.830)	0.995 (0.549–1.805)	1.738 (0.986–3.064)	3.101 (1.358–7.083)	2.070 (1.019–4.206)	1.441 (0.810–2.563)
50–59	1.212 (0.648–2.269)	1.809 (0.965–3.391)	2.276 (1.295–3.999)	2.639 (1.157–6.019)	1.619 (0.832–3.151)	1.458 (0.829–2.563)
≧60	1.364 (0.768–2.423)	0.958 (0.565–1.626)	1.434 (0.867–2.371)	2.321 (1.061–5.078)	1.162 (0.655–2.060)	1.122 (0.679–1.856)
Daily education	2.315 (1.511–3.546)	3.144 (2.083–4.747)	3.840 (2.498–5.903)	9.795 (3.506–27.361)	3.175 (2.015–5.002)	2.826 (1.886–4.236)
Ex-outdoor manual worker	1.244 (0.776–1.994)	1.201 (0.762–1.892)	1.624 (1.056–2.498)	4.047 (1.874–8.740)	0.844 (0.492–1.447)	1.510 (0.985–2.314)
One or more years of employment	1.133 (0.692–1.855)	0.831 (0.528–1.308)	1.088 (0.706–1.676)	0.434 (0.228–0.826)	1.210 (0.696–2.105)	0.854 (0.554–1.316)

Appendix 1. Analysis items chosen from the questionnaire.

Question 1. Are you male or female?
1. male 2. Female

Question 2. Please wright your age.
( ) years

Question 3. What made you start decontamination work?
1. working for this company since before
2. job offer in advertisement or public employment security office
3. introduction by a staff agency
4. introduction by acquaintance
5. introduction by previous company
6. other
( )

Question 4. If you answer "2", "3", or "4" in the Question 3, please answer your previous occupation.
1. manufacturing
2. construction
3. agriculture, forestry and fisheries
4. seller
5. service worker (office worker)
6. unemployed or part-timer
7. other ( )

Question 5. How long have you work as decontamination worker?
( ) months

Question 6. Did you receive explanation about heat illness? (Check all that apply)
1. attending information session
2. watching operator's work video
3. receiving a daily explanation of cautionary points
4. receiving a document for work
5. receiving a support to look it up
6. nothing in particular

Question 7. What are you doing to prevent heat illness? (Check all that apply)
1. nothing in particular
2. enough sleep
3. breakfast consumption in working day
4. refraining from consuming a lot of alcohol before a working day
5. use of a cool vest during working
6. cooling body with refrigerant
7. light clothing to prevent the inside heat
8. carrying water and salt to take in easily during working
9. adequate consumption of water during breaks
10. intake water frequently during working
11. intake of salt with water