Risk Factors for Frequent Work-related Burn and Cut Injuries and Low Back Pain among Commercial Kitchen Workers in Japan

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Abstract: This study investigated risk factors for frequent work-related burn and cut injuries and low back pain (LBP) among kitchen workers including personal, work-related and environmental factors. Subjects were 991 kitchen workers in 103 schools, 17 hospitals and nursing homes, and 6 restaurants in central Japan. A cross-sectional survey was carried out using a structured self-administered questionnaire. Logistic regression models were used to examine associations between frequent injuries/LBP and risk factors. The effective response rate was 75.1% (n=744), the mean age was 40.7 (SD 11.7) and 77.2% were female. Burn injury was associated with a smaller kitchen (OR 1.94; 95%CI, 1.13–3.33), and gas kitchens rather than electric kitchens (OR 2.30; 95%CI, 1.17–4.52). LBP was associated with female gender (OR 2.46; 95%CI, 1.37–4.43), high body height (>160 cm) (OR 2.03; 95%CI, 1.22–3.36), and large number of meals produced per person (≥150 meals) (OR 1.83; 95%CI, 1.12–3.00). The results of this study suggest that securing adequate work space and introducing electric kitchen systems may reduce the risk to kitchen workers, as well as the importance of adequate height of cooking equipment and selecting an appropriate volume of meals to produce per person to prevent LBP in kitchen workers.

Key words: Injuries, Low back pain, Burns, Work environment, Kitchen work

Introduction

Work-related burn and cut injuries are a major safety problem in commercial kitchens in many industrial settings, such as restaurants, school, hospital and nursing homes. Burn and cut injuries were reported to be the

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second and third leading causes of injuries in workers in hospital emergency departments in the United States (US)[1], catering workers in Ireland[2] and kitchen workers in Canada[3]. Work-related burn injuries accounted for 42.5% of all burn injuries in the US[4]. In addition to burn and cut injuries, low back pain (LBP) is prevalent in these working populations found in previous studies[5–8]. LBP is the most frequent cause of disability compensation, accounting for a very large portion of workers' compensation cost in industrialized countries[9–12].

Risk factors for work-related injuries focused on individual characteristics have been reported based on workers' compensation databases or company medical records in various types of workplaces. As for personal factors, female gender[13, 14] and younger age (<25 yr[15, 16], <30 yr[17–19]) or older age (≥40[17]) have been reported as risk factors. Health-related risk factors such as obesity[20], sleep disorders[18, 21, 22] and smoking habit[8, 18, 21] are also indicated. Work related factors are known to be risk factors as well. Shorter length of employment (<1 yr[23], ≤5 yr[18, 19, 21]) and overtime work schedules, which include working at least 12 h per day or 60 h per wk[24, 25], have been reported to be risk factors as well as night and evening shifts[16, 25]. In addition to these studies, a cross-country questionnaire survey on risk factors for LBP among Japanese school lunch cooks showed that the height of cooking equipment, inadequate for the body height of a worker, and the number of cooked lunches per cook (≥150 meals) was associated with LBP[8].

Kitchen work requires cooking in a short time, in large quantities, and in a sanitary manner. It has been reported to involve a heavy workload and carry risks of musculoskeletal disorders[5–8]. Kitchen workers are also reported to be one of the highest risk occupational groups for work-related injuries because of the nature of their work and the types of materials handled[14, 15, 26, 27]. School lunches are provided for all pupils five days a week at primary schools in Japan. The principal task of kitchen workers in schools is to provide meals for lunch, so their working hours are limited to the daytime. The number of meals produced daily is relatively high and the kitchen area also tends to be large, although this varies according to the number of children in each school. As for kitchen workers in hospitals and nursing homes, they provide breakfast, lunch and supper to inpatients. The number of meals and the kitchen areas vary according to the number of beds. There are early and late shifts at hospitals. As for kitchen workers in restaurants, they provide various kinds of meals at various times. The number of meals produced daily and the kitch-

en areas are relatively small and there are comparatively high ratios of part-timers and shift workers at restaurants.

In recent years, there have been some changes in the working environments of kitchen workers. Semi-dry or dry floor processing systems to reduce the workloads of kitchen workers have been introduced[28]. Electric kitchens are also considered to improve the work environment and to reduce the physical workload of kitchen workers in Japan[29–31]. It is also considered that electric kitchens have safety benefits for workers because the surface of cooking devices is not heated itself by induction heating systems.

However, risk factors for work-related burn/cut injuries, as well as musculoskeletal disorders such as LBP among kitchen workers, are still unclear. Especially, the associations between injuries and the kitchen work environment, which are changing, have not been evaluated. Previous studies based on databases or company records were objective to investigate risk factors for work-related injury. On the other hand, the information about workplace environments was incomplete. In addition, those records focused on severe injuries and probably underestimated the frequency of work-related injuries[32]. We performed a questionnaire survey in this study to obtain more detailed information on kitchen workers and kitchen environments. The objective of this study was to evaluate risk factors for work-related injuries and LBP among kitchen workers including personal, work-related, and environmental factors.

Subjects and Methods

The design of this study was a cross-sectional survey using a self-administered questionnaire to investigate associations between work-related burn/cut injuries, as well as LBP, and risk factors among Japanese commercial kitchen workers. The subjects were 991 kitchen workers recruited from 126 kitchen facilities. Of all workers, 578 worked at 103 primary schools and secondary schools, 343 worked at 17 hospitals and nursing homes, and 70 worked at 6 restaurants in central Japan. All the schools were public schools, and 81 of them were located in a medium-sized city in the Chūbu region, while 22 were located in the Tokyo metropolitan area. The number of kitchen workers varied from 2 to 20 in each school. The principal task of these workers was to provide meals for lunch for all pupils 5 d a week. The 11 hospitals were regional hub hospitals, university hospitals and affiliated hospitals. The six nursing homes were their related institutes. Nine out of the 11 hospitals were located in the Tokyo metropolitan area and the others were in Shikoku and Tohoku region re-

spectively. The number of workers varied from 10 to 60 in each hospital. The five nursing homes were located in the Chūbu region and the other was in the Tokyo metropolitan area. Five to nine workers worked in each nursing home. Kitchen workers in these institutions provided meals for breakfast, lunch, and dinner for all inpatients. The six restaurants were located in the Tokyo Metropolitan area. The number of workers in the restaurants varied from 7 to 20. All restaurants were open until midnight and two of them were open 24 h. Kitchen workers in these restaurants provided meals at irregular times. All workers were invited to participate in the questionnaire survey. We included these different institutional workers in this study to investigate associations between work-related burn/cut injuries, as well as LBP, and various work-related factors and environmental factors.

Questionnaire

We devised a structured self-administered questionnaire including questions on burn injuries, cut injuries, LBP, personal factors, work-related factors, and work environmental factors. In this study, all minor injuries were included whatever their severity, regardless of resulting in a working day lost or medical consultation. The frequencies of burn and cut injuries were measured including all self-treated cases within the latest one year by a 4-point Likert scaled item with response categories as follows: 1 "5 times or less", 2 "6 to 10 times", 3 "11 to 20 times", and 4 "21 times or more". We defined those who were injured six times or more a year as the frequent group and used them to analyze the association between each factor and the injuries. LBP was defined as an experience of an episode of pain, stiffness, or discomfort in the low back anytime during the previous month. It was measured by a 4-point Likert scaled item with response categories as follows: 1 "none or little", 2 "sometimes", 3 "frequently", and 4 "almost always". Those who answered 3 or 4 were defined as the frequent group. Information on personal factors consisted of gender, age, obesity and body height. Age was categorized as middle-aged and older (≥40 yr) group and younger (<40 yr) group referring to previous research[5, 8, 33]. Obesity was defined as body mass index ≥25 kg/m² according to the international classification for Asian populations recommended by WHO[34]. Forward bending due to inadequate height of cooking equipment has been shown to be a risk factor of LBP for kitchen workers, and kitchen counters of 80 cm to 85 cm high are commonly used in Japanese commercial kitchens for workers 160 cm tall as a standard[8, 35]. Therefore, we dichotomized workers' height into

"less than 160 cm" and "160 cm or more". Work-related factors included years of employment, working hours per day, working contract, presence or absence of shift work, and number of meals produced daily per person. Length of employment was dichotomized to "5 yr or less" and "more than 5 yr" with reference to previous studies[18, 19]. Production of meals was dichotomized to "less than 150 meals/person/day" and "150 meals/person/day" according to a previous study which indicated the association with LBP among Japanese school lunch cooks[8]. The questionnaire survey for facilities was also applied to investigate kitchen environmental factors for administrators of the 126 kitchen facilities. This questionnaire assessed the area of the kitchen, floor state such as dry or wet, and whether a gas or electric system kitchen was used. The area of the kitchen was categorized into two groups of smaller and larger by using the median as the cut-off point.

Data collection

The questionnaire was mailed to potential participants during the period from August to November 2006. All potential participants were informed of the purpose, risks and benefits of the study. Personal identification information was not collected by the questionnaire. The participants were considered to have consented to participate in the study upon returning the questionnaire. This study was approved by the Human Ethics Committee, Dokkyo Medical University.

Data analysis

We calculated the prevalence of burn injuries, cut injuries, and LBP. The crude odds ratios and 95% CI for burn injuries, cut injuries, and LBP were respectively calculated according to the following independent variables: personal factors, work-related factors, and environmental factors. The adjusted odds ratios for burn injuries, cut injuries, and LBP were calculated by using multiple logistic regression models. The significance level was set at $p<0.05$. We used the SPSS (Ver. 12.0 J) computer package for statistical analysis.

Results

Of the 991 kitchen workers, 744 (170 males and 574 females) responded, giving a response rate of 75.1%. Table 1 shows the characteristics of personal factors, work-related factors and environmental factors among the respondents. As for personal factors, more than three-quarters of respondents were female, and the mean age was

Table 1. Characteristics of study participants

		Total		School		Hospital		Restaurant		*p* value*
		n	(%)	n	(%)	n	(%)	n	(%)	
Total		744	100.0	394	53.0	294	39.5	56	7.5	
Personal factors										
Gender										<0.001
	Male	170	22.8	38	9.6	90	30.6	42	75.0	
	Female	574	77.2	356	90.4	204	69.4	14	25.0	
Age (years)										<0.001
	40≤	425	57.1	256	67.3	153	52.0	49	87.5	
	<40	319	42.9	129	32.7	141	48.0	7	12.5	
BMI										0.251
	<25	600	84.9	319	86.4	238	84.1	43	78.2	
	25≤	107	15.1	50	13.6	45	15.9	12	21.8	
Height (cm)										<0.001
	≤160	441	60.2	267	69.0	162	55.9	12	21.8	
	160<	291	39.8	120	31.0	128	44.1	43	78.2	
Work-related factors										
Years of employment										<0.001
	5<	441	66.6	270	74.8	157	62.5	14	28.0	
	≤5	221	33.4	91	25.2	94	37.5	36	72.0	
Working hours/day										<0.001
	≤8	643	88.4	365	95.3	233	80.6	45	81.8	
	8<	84	11.6	18	4.7	56	19.4	10	18.2	
Work contract										<0.001
	Full-time	466	62.6	274	70.3	178	63.3	14	25.0	
	Part-time	261	35.1	116	29.7	103	36.7	42	75.0	
Shift										<0.001
	Day shift	538	76.4	380	99.0	129	46.9	29	64.4	
	Split shift	166	23.6	4	1.0	146	53.1	16	35.6	
Production (meals/person/day)										<0.001
	<150	548	80.6	217	39.6	275	50.2	56	10.2	
	150≤	132	19.4	113	85.6	19	14.4	0	0.0	
Environmental factors										
Area of kitchen (m²)										<0.001
	>282	338	50.1	142	41.6	189	68.0	7	12.5	
	≤282	337	49.9	199	58.4	89	32.0	49	87.5	
Floor state										<0.001
	Dry	431	60.6	206	57.1	202	68.7	23	41.1	
	Semi-dry	105	14.8	45	12.5	46	15.6	14	25.0	
	Wet	175	24.6	110	30.5	46	15.6	19	33.9	
Type of kitchen										0.620
	IH	382	51.3	198	50.3	152	51.7	32	57.1	
	Gas	362	48.7	196	49.7	142	48.3	24	42.9	

*χ^2 test for the difference between three sectors.

40.7 (SD 11.7) overall: 36.9 (SD 11.8) for males and 41.9 (SD 11.4) for females. Fifteen percent of the respondents were obese (BMI≥25 kg/m²) and 19% of the respondents were over 160 cm tall. Regarding work-related factors, two-thirds of the respondents had worked for more than five years and most of them worked eight hours or less per day routinely. More than 60% were full-time workers, and shift workers accounted for less than 25%. The majority of the respondents cooked less than 150 meals a day, while 19.4% cooked more than 150 meals a day. As for

Table 2. Work-related burn/cut injuries and LBP according to each factor

		Frequent burn injuries		Frequent cut injuries		Frequent LBP	
		n	(%)	n	(%)	n	(%)
Total		118	15.9	177	23.8	276	37.1
Personal factors							
Gender	Male	38	22.4	32	18.8	52	30.6
	Female	80	13.9	145	25.3	224	39.0
Age (yr)	40≤	60	14.1	91	21.4	156	36.7
	<40	58	18.2	86	27.0	120	37.6
BMI	<25	95	15.8	142	23.7	224	37.3
	25≤	21	19.6	28	26.2	36	33.6
Height (cm)	≤160	61	13.8	107	24.3	161	36.5
	160<	56	19.2	68	23.4	108	37.1
Work-related factors							
Years of employment	5<	76	17.2	99	22.4	172	39.0
	≤5	35	15.8	57	25.8	77	34.8
Working hours/day	≤8	95	14.8	153	23.8	231	35.9
	8<	19	22.6	19	22.6	39	46.4
Work contract	Full-time	80	17.2	113	24.2	188	40.3
	Part-time	37	14.2	60	23.0	83	31.8
Shift	Day shift	86	16.0	130	24.2	205	38.1
	Split shift	26	15.7	38	22.9	59	35.5
Production	<150	86	15.7	119	21.7	187	34.1
(meals/person/d)	150≤	22	16.7	43	32.6	63	47.7
Environmental factors							
Area of kitchen (m^2)	>282	40	11.8	75	22.2	130	38.5
	≤282	68	20.2	90	26.7	122	36.2
Floor state	Dry	59	13.7	99	23.0	153	35.5
	Semi-dry	21	20.0	29	27.6	35	33.3
	Wet	32	18.3	43	24.6	72	41.1
Type of kitchen	IH	49	12.8	90	23.6	135	35.3
	Gas	69	19.1	87	24.0	141	39.0

environmental factors, half of the respondents worked in a kitchen area of 282 square meters or less, 60% worked in a dry floor kitchen, and half worked in an electric system (IH) kitchen. Regarding category of kitchen, 394 (response rate: 68.2%) worked at schools, 294 (85.7%) worked at hospitals and nursing homes, and 56 (80.0%) worked at restaurants. Most of the factors investigated except BMI and type of kitchen were significantly different between three categories of kitchen.

Table 2 shows the number and percentages of the respondents who experienced burn injuries, cut injuries and low back pain frequently. The prevalence of frequent burn injuries, cut injuries and LBP were 15.9%, 23.8% and 37.1%, respectively. The association of frequent work-related burn/cut injuries and LBP with personal, work-related, and environmental factors is shown in Table 3.

Among personal factors, gender, age and height were significantly associated with frequent injuries and LBP respectively. Female gender had a lower OR of frequent burn injuries, while females had a higher OR of LBP. Younger workers (<40 yr) had a relatively higher OR of burn and cut injuries, but the association was not statistically significant. Two out of five work-related factors were significantly associated with injuries and LBP, and these were regular work and daily production of meals per person. Working >8 h/day had a relatively higher OR of burn injuries and LBP, but the association was not significant. As for environmental factors, a smaller kitchen (≤282m^2) had a higher OR of burn injuries. A gas kitchen system showed a higher OR of burn injuries.

The results of multiple logistic regression analysis (Table 4) showed that gender, body height, daily working hours,

Table 3.   Association of frequent work-related burn/cut injuries and LBP with each factor by univariate analysis

		Frequent burn injuries		Frequent cut injures		Frequent LBP	
		OR	95%CI	OR	95%CI	OR	95%CI
Personal factors							
Gender	Male	1.00		1.00		1.00	
	Female	0.56	0.37–0.87	1.46	0.95–2.24	1.45	1.01–2.10
Age (yr)	40≤	1.00		1.00		1.00	
	<40	1.35	0.91–2.01	1.35	0.97–1.90	1.04	0.77–1.40
BMI	<25	1.00		1.00		1.00	
	25≤	1.30	0.77–2.19	1.14	0.71–1.83	0.85	0.55–1.31
Height (cm)	≤160	1.00		1.00		1.00	
	160<	1.48	1.00–2.21	0.95	0.67–1.35	1.03	0.76–1.39
Work-related factors							
Years of employment	5<	1.00		1.00		1.00	
	≤5	0.90	0.58–1.40	1.20	0.82–1.75	0.84	0.60–1.17
Working hours/day	≤8	1.00		1.00		1.00	
	8<	1.69	0.97–2.94	0.94	0.54–1.61	1.55	0.98–2.44
Work contract	Full-time	1.00		1.00		1.00	
	Part-time	0.80	0.52–1.22	0.93	0.65–1.33	0.69	0.50–0.95
Shift	Day shift	1.00		1.00		1.00	
	Split shift	2.85	0.37–21.89	0.93	0.62–1.41	0.90	0.62–1.29
Production	<150	1.00		1.00		1.00	
(meals/person/d)	150≤	1.07	0.64–1.79	1.74	1.15–2.64	1.76	1.20–2.59
Environmental factors							
Area of kitchen (m²)	>282	1.00		1.00		1.00	
	≤282	1.88	1.23–2.88	1.28	0.90–1.82	0.91	0.66–1.24
Floor state	Dry	1.00		1.00		1.00	
	Semi-dry	1.58	0.91–2.74	1.28	0.79–2.07	0.91	0.58–1.43
	Wet	1.41	0.88–2.26	1.09	0.72–1.65	1.27	0.89–1.82
Type of kitchen	IH	1.00		1.00		1.00	
	Gas	1.60	1.07–2.38	1.03	0.73–1.44	1.17	0.87–1.57

daily production of meals per person, area of kitchen and type of kitchen remained significantly associated with frequent work-related burn injuries and LBP. Female gender was significantly associated with LBP (OR 2.46, 95%CI 1.37–4.43), although the significance of the association between gender and burn injuries disappeared. Height over 160 cm was significantly associated with LBP (OR 2.03, 95%CI 1.22–3.36). As for work-related factors, those who cooked more than 150 meals a day experienced LBP (OR 1.83, 95%CI 1.12–3.00) significantly. The environmental factors found to be significantly associated with frequent work-related burn injuries in the univariate analysis retained the same relationship in the multivariate regression analysis. The respondents who worked in a smaller kitchen had a 1.9 times higher risk of burn injuries. Moreover, those who worked in a gas kitchen were 2.3 times more likely to experience frequent burn injuries.

Discussion

This cross-sectional study on risk factors for frequent work-related burn/cut injuries among kitchen workers showed a high rate of frequent burns, cut injuries and LBP. The results indicated that work-related burn injuries were independently associated with environmental factors such as a smaller kitchen and a gas system kitchen, and that LBP was associated with female gender, being tall, and daily production of meals. These findings suggest that adequate working space and utilization of an electric kitchen system may reduce the risk of frequent burn injuries and that the ergonomics of cooking equipment/stations and an appropriate volume of meals prepared by each worker may be used as interventions for reducing LBP in commercial kitchen workers.

Regarding personal factors, associations between fe-

Table 4. Association of frequent work-related burn/cut injuries and LBP with each factor using multiple logistic regression models

		Frequent burn injuries		Frequent cut injures		Frequent LBP	
		adj. OR	95%CI	adj. OR	95%CI	adj. OR	95%CI
Personal factors							
Gender	Male	1.00		1.00		1.00	
	Female	0.74	0.36–1.50	1.82	0.95–3.50	2.46	1.37–4.43
Age (yr)	40≤	1.00		1.00		1.00	
	<40	1.13	0.65–1.95	1.20	0.75–1.94	1.10	0.72–1.68
BMI	<25	1.00		1.00		1.00	
	25≤	1.36	0.72–2.60	1.21	0.66–2.20	0.82	0.47–1.42
Height (cm)	≤160	1.00		1.00		1.00	
	160<	1.36	0.71–2.63	1.41	0.81–2.43	2.03	1.22–3.36
Work-related factors							
Years of employment	5<	1.00		1.00		1.00	
	≤5	1.09	0.58–2.06	1.41	0.81–2.46	0.91	0.55–1.50
Working hours/d	≤8	1.00		1.00		1.00	
	8<	1.64	0.81–3.33	0.97	0.48–1.94	1.63	0.90–2.94
Work contract	Full-time	1.00		1.00		1.00	
	Part-time	0.99	0.52–1.88	0.95	0.54–1.66	0.73	0.44–1.20
Shift	Day shift	1.00		1.00		1.00	
	Split shift	0.89	0.48–1.65	1.10	0.64–1.90	1.20	0.74–1.95
Production	<150	1.00		1.00		1.00	
(meals/person/d)	150≤	1.08	0.58–2.02	1.65	0.96–2.82	1.83	1.12–3.00
Environmental factors							
Area of kitchen (m^2)	>282	1.00		1.00		1.00	
	≤282	1.94	1.13–3.33	1.25	0.78–2.02	0.72	0.47–1.09
Floor state	Dry	1.00		1.00		1.00	
	Semi-dry	0.54	0.24–1.22	1.20	0.58–2.51	0.99	0.50–1.98
	Wet	0.66	0.32–1.37	1.10	0.55–2.22	1.41	0.74–2.68
Type of kitchen	IH	1.00		1.00		1.00	
	Gas	2.30	1.17–4.52	1.04	0.54–1.97	1.02	0.56–1.86

Adjusted for all variables.

male gender and body height and LBP were found in this study. The majority of kitchen workers in this study were female, as in previous studies about injuries in this occupation[3, 8, 15]. Islam *et al.* showed that female workers had a greater risk of injuries such as musculoskeletal injury, sprains and burns compared to males in various jobs like educational services, janitors and cashiers in the US[13]. Another report in the US hotel industry also showed an association between female gender and injury risk[14]. As for kitchen workers, female school lunch cooks were reported to have a higher risk of LBP in Japan[8]. Our results were consistent with these previous studies.

The higher risk of LBP among female workers has been linked to various reasons such as pregnancy[36], postmenopausal osteoporosis[37, 38], and more domestic work[39]. Because more than half of female workers were middle aged or older in this study, it was thought that there were many workers who might be affected by postmenopausal osteoporosis. In addition, many of them were considered to be affected by household work as a housewife. For this reason, female workers might be more vulnerable if working conditions do not take into account this background. In addition, future studies including factors outside of work will be important. The higher risk of work-related injuries in younger workers has been reported in Western countries[1, 17, 26, 40, 41]. Some previous studies on workers in some industries reported that age was a risk factor for LBP[8, 33, 42, 43], while other studies reported no association between age and LBP[8, 39]. The results of this study did not show an association between age and injury or LBP among kitchen workers. We need to consider the possibility that this result was influenced by a healthy worker

effect, which leads to an underestimation of risk for LBP. Obesity is a well known risk factor for work-related injury and musculoskeletal disorders, especially for LBP. However, there only 15% of workers were obese (BMI≥25 kg/m^2) in this study and obesity was not associated with injuries or LBP. Miranda *et al.* showed that workers with a BMI≥30 kg/m^2 had a higher incidence of LBP among forest industry workers in Finland[43] and Poston *et al.* reported a relationship between injury-related absenteeism and obesity (BMI≥35 kg/m^2) among firefighters in the US[20]. Compared with these reports from western countries, only 10 workers had a BMI≥30 kg/m^2 in this study. Uncomfortable standing postures such as forward bending were considered to be a risk factor of LBP in relation to the height of workers and cooking equipment[8]. In this study, body height over 160 cm was shown as a risk factor for LBP. A possible explanation of this result is that the height of cooking equipment was not suitable for taller workers in many of the kitchens in this study. This suggests that an adequate height of cooking equipment can be effective in terms of LBP prevention.

Regarding work-related factors, only a large number of meals cooked per person was associated with LBP. Schedules involving overtime and long working hours more than 12 h per day were reported to have a great impact on workplace injuries[24, 25]. There were only 14 workers who had worked more than 12 h per day in our study subjects, and no association was found. As for other work-related factors, unskilled employees with a short duration of employment[17–19, 21, 23, 44], not being a full time worker[25] and shift schedule workers[25, 45] have been shown to have a higher rate of work-related injuries in previous studies. While our results did not show an association between these factors and work-related burn/cut injuries, the number of cooked lunches per person was shown to be a risk factor for LBP, consistent with a previous study on Japanese school lunch cooks[8]. From these results, it appears necessary to have an appropriate number of workers to control the workload to prevent LBP in the workplace.

It was a notable result that an association between environmental factors and frequent burn injuries was found in our study. Those who worked in smaller kitchens had a higher risk of burn injuries. International labour organization (ILO) gave a warning that a bad site layout and lack of space disturb safe movement of workers and cause accidents on construction site[46]. The results of this study suggest that this warning is also applicable to kitchen workers. A further study about providing an adequate area will be necessary. Although a previous study showed that a wet floor increased the risk of LBP among seafood processing factory workers[33], floor state was not associated with injuries in this study. The reason may be because slippy places were managed adequately even in wet floor system kitchens. In addition to this, an administrator of each kitchen, not workers, answered the question about the floor state in this study; dry or wet. It is possible that a kitchen was incorrectly in the field sites, getting the floor wet in semi-dry or dry kitchen systems. In that case, the risk of a wet floor may be underestimated. Gas kitchens showed a higher risk of burn injuries than electric kitchens in this study. Lyngdorf showed that scalds and contact burns were dominant causes of burn injury among kitchen workers[47]. The surface of cooking devices does not become hot in an electric kitchen system. Therefore, it was shown that electric kitchens were safer in terms of risk of burn injury. From these results, safety measures should be considered according to the characteristics of each kitchen. It is necessary to secure adequate work space to prevent burns in small kitchens. Furthermore, safety measures focusing on burn injuries are important for kitchen workers who work in gas kitchens.

Due to our method of data collection, there are several limitations to this study. The 126 kitchen facilities were not selected by a random sampling method and the number of restaurant workers was comparatively small. In addition, there were sectors which were not included in this study, such as kitchen workers in the hotel industry. In addition, although there are various factors involved in working conditions in kitchen work such as the number of meals on menus and job intensity, which may vary in each type of industry, they could not be fully analyzed. For this reason, we should be careful in generalizing the results of this study. We developed a self-administered questionnaire because we were not able to identify a previously validated, standardized questionnaire suitable for the purpose of this study in similar settings, so there may be an issue regarding the validity and reliability of the questionnaire. We defined those who were injured six times or more a year as a frequent group even if the injuries were minor ones, but this arbitrary dichotomization of frequent injury rates is subject to definitional biases. In addition to this, we did not investigate workers with no injury separately and this needs future investigations based on large populations. Furthermore, the injuries were not diagnosed by physicians, but were self-reported. The occurring of burn/cut injuries is observed objectively by the injured themselves and LBP is usually recognized as a subjective symptom. For this reason, the influence of misdiagnosis due to self-reporting was considered to be limited. However, the

information about severity of injuries or working days lost could not be included in the study.

However, this study showed evidence of an association between working conditions and environmental factors and frequent work-related burn/cut injuries, as well as LBP, among kitchen workers and highlighted the need to develop injury prevention programs considering workloads and workplace design.

Conclusions

The study suggests that kitchen workers in Japan experienced frequent burn and cut injuries and LBP. The study subjects exhibited 15.9%, 23.8% and 37.1% prevalence of frequent burn, cut injuries and LBP in the previous year, respectively. Frequent burn injuries were associated with smaller kitchen size and gas kitchen, suggesting that adequate working space and utilization of an electric kitchen system may reduce the risk of frequent burn injuries. LBP was found to be associated with female gender, taller persons, and a large number of meals cooked per kitchen worker. This finding suggests that the ergonomics of cooking equipment/stations and an appropriate volume of meals prepared by each worker may be interventions for reducing LBP in commercial kitchen workers.

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