

Title: Factors affecting heat-related illness symptoms among school food service workers: A cross-sectional study in Korea

Running title: Heat-related symptoms among school food service workers

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Ethics statement

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Title Factors affecting heat-related illness symptoms among school food service workers: A cross-sectional study in Korea

Abstract

Background: School food service workers are highly likely to develop heat-related illnesses because of their work environment. However, studies that have examined the risk of heat-related illnesses among them are limited. The purpose of this study was to investigate the status of heat exposure, implementation of heat wave countermeasures, and prevalence of heat-related illness symptoms among school food service workers in Korea, and to explore the relationship between them.

Methods: A cross-sectional study was conducted through an online survey of school food service workers from May 25 to June 12, 2023, via three labor unions. We analyzed 6,244 valid responses. We assessed general characteristics, heat-related illness symptoms (heat rash, heat cramps, heat edema, heat exhaustion, heat syncope), duration of heat exposure during heat waves, and heat wave preventive measures. Multiple logistic regression analyses were performed, with adjustments for age, occupation, hypertension, diabetes, and school type.

Results: More than one-third of school food service workers reported heat exposure between May and September exceeding 4 hours daily, and 94.6% experienced at least one heat-related illness symptom during the last year. A dose-response relationship was observed between heat exposure duration and heat-related illness symptoms (P for trend < 0.001). School food service workers who did not have increased rest periods or did not reduce high-heat prepared foods showed significantly higher odds ratios for heat-related illness symptoms.

Conclusions: School food service workers experience substantial heat exposure and a high prevalence of heat-related illness symptoms. The risk of heat-related illness symptoms was associated with extended duration of heat exposure. Increasing rest periods and reducing high-heat food preparation were effective preventive measures. These findings underscore the need for improved heat exposure management and implementation of effective preventive measures to protect the health of school food service workers, with particular attention to appropriate rest periods.

28 Keywords: Heat exhaustion; Occupational health; Workplace; Heat Stress Disorders; Food Services

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Background

Heat-related illnesses have become an important social concern as the climate crisis has increased extreme weather phenomena such as heat waves. Heat-related illness is an acute condition characterized by symptoms such as headaches, dizziness, muscle cramps, fatigue, and loss of consciousness due to prolonged exposure to hot environments. Symptoms can range from mild conditions, such as heat cramps and heat rash, to potentially life-threatening heat stroke.¹

Heatwaves affect workers' health. Because the human core body temperature increases in proportion to workload and metabolic rate, workers who work in hot and humid conditions are at an increased risk of developing heat-related illnesses.² According to the 2022 Heat-Related Illness Surveillance Report, 45.3% of heat-related illness cases in Korea occurred in the workplace.³ Furthermore, from 2018 to 2023, there were 147 recorded industrial accidents due to heat-related illnesses, 22 of which were fatal.⁴ Consequently, there is a growing concern about safety and health in work environments owing to heat waves.

Article 558 of the Occupational Safety and Health Standards Regulations defines "high heat" as temperatures that may cause health impairments such as heat cramps, heat exhaustion, or heat stroke in workers, and Article 559 designates work that requires temperature management as "high heat work."

This classification focuses primarily on manufacturing work involving heat sources such as furnaces, excluding other heat-exposed work environments, such as school food services. To address this, amendments to the Occupational Safety and Health Standards Regulations were enacted in July 2025, defining "heat wave work" as prolonged work in workplaces with an apparent temperature of 31°C or higher and mandating employers to implement preventative measures.⁵

Food service workers are at risk of heat-related illnesses because of kitchen equipment that generates high temperatures, inadequate ventilation, confined spaces, and high population densities in the workplace. In addition, impermeable work attire, including waterproof aprons, boots, rubber gloves, and inadequate rest schedules, further contribute to the potential heat exposure of food service workers. In South Korea, research has been conducted to measure indoor Wet-Bulb Globe Temperature (WBGT) in the food and accommodation industry.⁶ Several studies have assessed the degree of heat exposure in

메모 포함[NK1]: Reviewer #2 (Response 5)

kitchens,⁷⁻⁹ the relationship between heat-related symptoms and working conditions among bakery workers,¹⁰ the relationship between heat exposure levels, physiological changes, and heat-related symptoms among cooks,¹¹ and heat stress among bakery workers.¹² However, studies on the prevalence of heat-related illnesses and preventive measures against heat-related illnesses among food service workers are limited.

The Occupational Safety and Health Manual for School Food Services, published in South Korea in 2021, recommends installing ventilation facilities, adjusting the interval between tasks that generate hot steam, distributing breaks, and installing portable air conditioners to prevent heat-related illnesses among food service workers.¹³ Article 566 of the Occupational Safety and Health Standards Regulations also requires employers to take measures to prevent heat-related illnesses in workers. However, the extent to which preventive measures have been implemented remains unknown.

The purpose of this study was to examine the status of heat exposure, implementation of heat protection measures, and prevalence of heat-related symptoms among school food service workers and to explore the relationship between heat protection measures and heat-related symptoms. This study aimed to identify effective methods to prevent and manage heat-related symptoms among school foodservice workers and to contribute to policy proposals for protecting school foodservice workers from heat-related symptoms.

Methods

Participants

An online survey was conducted from May 25 to June 12, 2023, through three labor unions involved in school food services, yielding 6,703 responses. After excluding participants with missing or incorrect birth year information (n=46) and those with less than one year of service (n=413), 6,244 valid responses were analyzed.

Gender was not separately analyzed; however, previous studies have shown that most school food service workers in Korea are female.^{14,15}

84 Variables

85 General characteristics

86 Data on age, duration of employment in school food services, presence of hypertension, presence of
87 diabetes mellitus, occupation (food service assistant, nutritionist, cook), and type of school (elementary
88 school, middle/high school, or other) were collected. Other schools included kindergartens, daycare
89 centers, and universities.

91 Heat-related illness symptoms

92 Based on the major symptoms of heat-related illnesses classified by the Korea Disease Control and
93 Prevention Agency (KDCA),¹⁶ the survey investigated whether the participants had experienced the
94 following five heat-related illness symptoms related to heat waves during the last 12 months: heat rash,
95 heat cramps (muscle cramps in calves, thighs, shoulders, or others), heat edema (swelling of hands, feet,
96 or ankles), heat exhaustion (extreme weakness, fatigue, or dizziness), and heat syncope (fainting,
97 temporary loss of consciousness, or dizziness). Multiple selections were allowed as heat-related illnesses
98 can occur simultaneously. Participants were considered to have experienced heat-related illness symptoms
99 if they experienced at least one symptom. Heat stroke was not assessed because it is a potentially fatal
100 condition that occurs infrequently and was therefore considered impractical to assess.

102 Duration of heat exposure

103 From May to September, the average duration of exposure to temperatures high enough to cause
104 sweating while working was recorded at the following intervals: less than 30 min, 30 min to 2 h, 2 h to 4
105 h, and > 4 h. This period was determined with reference to the heat wave countermeasure period (May 20
106 to September 30) administered by the Korean government to prevent damage caused by heat waves.
107 Although heat stress assessment tools such as the Heat Strain Score Index exist, their extensive item
108 structure was impractical for large-scale surveys and inappropriate for school food service contexts. A
109 novel assessment tool was therefore developed after establishing content validity through an expert
110 review and face validity through evaluation by school food service worker union representatives.

메모 포함[NK2]: Reviewer #2 (Response 2)

메모 포함[NK3]: Reviewer #1 (Response 2-2)

메모 포함[NK4]: Reviewer #1 (Response 1)

111

112 Heat wave preventive measures

113 Each participant was asked whether the following heatwave preventive measures had been implemented
114 at the schools currently working: installing thermometers in the kitchen to measure temperatures,
115 operating air conditioners in the kitchen, limiting the preparation of high-heat prepared foods to no more
116 than twice per week, reducing hot water disinfection methods, and increasing break times. Identifiable
117 information about the participants' workplaces was not collected.

메모 포함[NK5]: Reviewer #1 (Response 4)

118 Heatwave preventive measures were selected based on the measures for preventing heat-related illness
119 disasters presented in the Occupational Safety and Health Manual for School Food Service ¹³ and the
120 Heat-Related Illness Prevention Guide for Summer Heatwaves issued by the Ministry of Employment
121 and Labor.¹⁷

122

123 Statistical methods

124 All statistical analyses were performed using SPSS version 22.0. Chi-squared tests were used to compare
125 characteristics according to school type for the analyzed variables, with a probability of significance of
126 $P < 0.05$. Multiple logistic regression analysis was performed to assess the association between heat
127 exposure durations and heatwave preventive measures for heat-related illness symptoms. Odds ratios
128 (ORs) and 95% confidence intervals (CIs) were calculated for heat-related illness symptoms. All analyses
129 were adjusted for age, occupation, hypertension, diabetes mellitus, and school type.

130

131 Additional analyses

132 Other heat-related illness symptoms may result from both heat exposure and work processes, making
133 causation unclear. Heat rash, a skin-specific symptom caused by hot and humid environments, shows
134 more direct association with heat exposure. Therefore, we conducted additional analyses using individual
135 heat-related illness symptoms, including heat rash, as primary outcomes.

메모 포함[NK6]: Reviewer #2 (Response 3)

136

137 Results

138 The characteristics of the study population are summarized in Table 1. Among all school food service
139 workers, 72.3% were in their 50s, and 46.0% had worked for 10-19 years, representing the largest
140 proportion. This was similar when analyzed according to school type. Cooking was the most common
141 occupation (98.4%). Exposure to heat for more than 4 h was the most common among all food service
142 workers (32.9%), with 34.5% of middle/high school workers having longer exposure times than the other
143 school types. Of all school food service workers, 7.7% reported experiencing no heat wave preventive
144 measures, and 94.6% reported experiencing heat-related illness symptoms.

145 Heat-related illness symptoms by school type are shown in Table 2. Among all food service workers, the
146 reported heat-related illness symptoms were heat exhaustion (67.9%), heat edema (64.1%), heat cramps
147 (61.1%), heat rash (59.1%), and heat syncope (6.8%). Statistically significant differences were observed in
148 the experience of heat-related illness symptoms according to school type, except for heat syncope, with
149 workers at middle/high schools showing a higher proportion of heat-related illness symptoms. [The
150 distribution of the number of heat-related illness symptoms experienced by participants is presented in
151 Supplementary Table 1.]

152 Table 3 presents the prevalence of heat wave preventive measures according to school type. Among all
153 school food service workers, 90.6% reported having air-conditioning operating in the kitchen, 25.4%
154 reported having thermometers installed in the kitchen, 7.4% reported using reduced hot water
155 disinfection methods, 6.1% reported limiting the preparation of high-heat prepared foods to no more
156 than twice per week, 3.0% reported increased break times, and 7.7% reported no heat wave preventive
157 measures. The experience of heatwave preventive measures varied by school type, with middle/high
158 schools being less likely than other school types to install thermometers in the kitchen (24.3%), limit the
159 preparation of high-heat prepared foods (4.9%), and reduce hot water disinfection methods (6.3%).

160 Table 4 illustrates the associations between heat-related illness symptoms, heat exposure duration, and
161 heat wave preventive measures. The OR for experiencing heat-related illness symptoms increased with
162 longer heat exposure durations (P for trend < 0.001). Compared to cases where preventive measures were
163 implemented, the ORs for cases without preventive measures were 1.59 times higher (95% CI = 1.10–
164 2.29) for limiting high-heat prepared side dishes to no more than twice per week, and 1.86 times higher

메모 포함[NK7]: Reviewer #1 (Response 2-2)

165 (95% CI = 1.16–2.99) for increasing break times. Although not statistically significant, the ORs for heat-
166 related illness symptoms were higher in cases without preventive measures than in cases with preventive
167 measures such as installing thermometers in the kitchen, operating air conditioners in the kitchen, and
168 reducing hot water disinfection methods.

169 The additional analyses revealed that the significant factors identified for any heat-related illness
170 symptoms remained consistent when using heat rash as the dependent variable. Similar results were
171 observed with other individual heat-related illness symptoms (Supplementary Table 2).

메모 포함[NK8]: Reviewer #2 (Response 3)

173 Discussion

174 This study examined the status of exposure to high temperatures, implementation of heat wave
175 protective measures, and experiences of heat-related illness symptoms among school food service
176 workers and analyzed the relationships between these factors. This study found that 32.9% of school
177 food service workers were exposed to high temperatures for more than 4 h a day, with 94.6%
178 experiencing at least one heat-related illness symptom. Preventive measures were less commonly
179 implemented, and 7.7% of the respondents reported that no preventive measures were taken. The risk of
180 heat-related illness symptoms increased with longer heat exposure durations, and was higher in
181 workplaces without certain preventive measures, particularly without increased rest periods and without
182 limitations on high-heat food preparation.

183 The study found that more than one-third of school food service workers reported being exposed to high
184 temperatures for more than 4 hours per day, indicating a substantial duration of heat exposure among
185 them. While previous studies investigating the duration of heat exposure in cooking facilities are limited,
186 there has been research on the level of temperature exposure. The food and accommodation industry
187 (cooking) was classified as moderate work with continuous operation in Korea, with WBGT ranging from
188 26.0 to 29.9°C.⁶ This was higher than that measured in elementary schools in Japan (24.5–27.4°C)⁹ or
189 public schools in the United States (25°C).⁷ A study evaluating the work intensity of school food service
190 workers in Korea found that the average Metabolic Equivalent Task (MET) during work was 3.78 ± 1.06 ,¹⁸
191 which is equivalent to moderate work intensity and brisk walking.¹⁹ The WBGT measured in Korean

192 cooking facilities exceeded the exposure standard of 26.7°C for moderate work, as suggested by the
193 Korea Occupational Safety and Health Agency guidelines for managing high-heat work environments.
194 The high-temperature exposure standards were based on acclimatized workers wearing summer work
195 clothes. The adjusted WBGT for school food service workers wearing protective equipment such as
196 waterproof aprons, shoes, and gloves is estimated to be 32.0-35.9°C, which exceeds the moderate work
197 standard of 25% work, 75% rest every hour. The duration of heat exposure for school food service
198 workers in this study (more than one-third experienced 4 h or more) was significantly longer than the
199 standard of 25% working and 75% resting.

200 It is important to note that when assessing hot environments, the workplace temperature is a
201 representative measure of a single space, which limits the ability to identify associations with health
202 problems at the individual level. This study overcame some of these limitations by identifying exposure
203 durations at the individual level, which allows for a more accurate understanding of its association with
204 health problems. However, it has the limitation of being based on subjective responses, although
205 subjective heat stress measurements have been employed in previous studies²⁰ and enable individual-level
206 exposure assessment.

207 Objective measurements in school food service workplaces in Korea are limited. Therefore, further
208 research and monitoring of heat stress among school food service workers through objective
209 measurements of their work environments are needed. In addition, measures such as ensuring adequate
210 breaks, improving cooking methods, and strengthening ventilation systems are required to reduce the time
211 spent at high temperatures.

212 In this study, the prevalence of experiencing at least one heat-related illness symptom between May and
213 September among school foodservice workers was 94.6%. The prevalence of experiencing at least one
214 heat-related illness symptom during work among bakery workers in Lebanon was reported to be 47.2%,¹⁰
215 35% of bakery workers in Egypt experienced heat-related symptoms from August to December,¹² and
216 67.1% of hotel kitchen workers in Ethiopia experienced at least one heat-related illness symptom within 6
217 months.²¹ Although differences in survey methodologies limit direct comparisons of the prevalence of
218 these symptoms, it is probable that the prevalence of heat-related illness symptoms among school food

메모 포함[NK9]: Reviewer #1 (Response 1)

219 service workers in Korea exceeds that observed among similar workers in other countries. This
220 discrepancy may be attributed to several factors. First, school food service facilities in Korea prepare
221 meals in large quantities, which can generate relatively more heat during the cooking process. Second,
222 Korean food service facilities are under pressure to provide large quantities of meals within limited
223 timeframes. This can increase work intensities and reduce rest periods, thereby increasing the risk of heat-
224 related illness symptoms. Third, the intensity of heat exposure in school food services can be increased
225 by the use of waterproof clothing, the operation of multiple cooking equipment, and crowded working
226 environments. The high prevalence of heat-related illness symptoms among school food service workers
227 suggests that they are vulnerable to occupational heat exposure and should be monitored for their
228 experiences of heat-related illness symptoms.

229 [The higher prevalence of heat-related illness symptoms among middle/high school workers may be
230 attributed to lower implementation of preventive measures. Additionally, middle/high schools serve more
231 frequently grilled and stir-fried dishes, necessitating high-heat cooking methods.²²

232 In this study, a dose-response relationship was observed between the duration of heat exposure and the
233 OR of heat-related illness symptoms (P for trend < 0.001). In comparison with heat exposure durations
234 of less than 30 minutes, the likelihood of heat-related illness symptoms increased 5.04-fold (95% CI =
235 3.58–7.12) for exposures of 2–4 hours and 10.20-fold (95% CI = 6.74–15.43) for exposures exceeding 4
236 hours. Several studies examined the relationship between high temperature exposure and heat-related
237 illnesses.^{23–28} However, few epidemiological studies have quantitatively analyzed the risk of heat-related
238 illness symptoms based on heat exposure durations at the individual worker level. This study evaluated
239 the duration of heat exposure experienced by individual workers and examined its association with
240 symptoms of heat-related illnesses. The observed dose-response relationship between heat exposure
241 durations and heat-related illness symptoms indicates that the management of heat exposure durations
242 can serve as a preventive measure against heat-related illnesses and as evidence for establishing future
243 policies to prevent heat-related illnesses among workers.

244 This study found that a considerable proportion of the participants did not experience heatwave
245 preventive measures, with 7.7% reporting that no preventive measures were taken at all. Among the heat

메모 포함[NK10]: Reviewer #1 (Response 3)

246 wave preventive measures, the OR of heat-related illness symptoms was significantly higher for those
247 who did not reduce high-heat prepared dishes to no more than twice per week and those without
248 increasing rest compared to those with these measures. Fundamental principles for preventing heat-
249 related illnesses include water (sufficient fluid intake), shade (or ventilation in indoor settings), and rest.
250 This study also confirmed that increased rest periods were significantly associated with a reduction in
251 heat-related illness symptoms, thereby reaffirming the critical role of rest in preventing heat-related
252 illnesses. Workloads and breaks should be adjusted according to the intensity and pace of work to prevent
253 heat-related illnesses among school food service workers.

254 Certain preventive measures, such as operating air conditioners and installing thermometers, were not
255 associated with a statistically significant reduction in the risk of experiencing heat-related illness
256 symptoms despite their implementation. This finding suggests that a more effective approach should go
257 beyond the mere implementation of preventive actions and instead focus on their practical effectiveness.
258 For instance, air-conditioning systems should not only be turned on but also supplemented with local
259 ventilation systems around heat sources to prevent the accumulation of hot air. In addition, a sufficient
260 cooling capacity should be secured to offset the amount of heat generated. Thermometers should not be
261 installed, but should also be utilized for monitoring temperatures, with measurement results promptly
262 reflected in adjustments to the workplace environment. In the future, there is a need for research on the
263 development and effectiveness of heat-related illness prevention measures that consider the specific
264 characteristics of food-service environments.

265 This study has several limitations. First, this was a cross-sectional study, which limited the identification
266 of causal relationships. Although the temporal sequence of high-temperature exposure and heat-related
267 illness symptoms could not be identified, it is feasible to estimate a causal relationship. This is because it is
268 difficult to attribute heat-related illness symptoms to causes other than high-temperature environments.

269 Second, a selection bias may have existed during the sampling process. However, it is noteworthy that this
270 study was conducted nationwide with a large sample representing approximately 10% of the total school
271 food service worker population. Third, this study relied on self-reported heat-related illness symptoms,
272 which may be subject to measurement bias and misclassification. To address this, the questionnaire

273 provided clear symptom descriptions based on the KDCA definitions to improve recall accuracy.
274 Nevertheless, as most heat-related illnesses, except heatstroke, are diagnosed based on symptoms, the
275 investigating symptoms experienced remains a meaningful approach for assessing their prevalence. While
276 the development of objective assessment tools for heat-related illnesses is required in the future,
277 investigating experiences of heat-related illness symptoms remains a valuable method in the absence of
278 such tools. Fourth, this study had limitations in measuring occupational heat exposure through subjective
279 responses. Although it is not an objective measure, it is important to note that it captures the perceived
280 subjective heat exposure experiences by workers at the individual level. In the future, objective
281 measurements of temperature and humidity in school food service kitchens will be necessary to assess
282 the occupational heat exposure of food service workers.

283 Fifth, the evaluation of heatwave preventive measures was based on individual worker reports rather than
284 institutional records, and school-identifying information was not collected, preventing the linkage of
285 responses to specific schools. This may introduce reporting bias, as workers' perceptions may not fully
286 reflect actual institutional policies. Future research should incorporate both worker perspectives and
287 institutional-level data for a more accurate assessment.

288 To the best of our knowledge, this is the first Korean epidemiological study to examine the prevalence of
289 high-temperature environments and heat-related illness symptoms, and their association with school food
290 service workers. Previous studies on heat-related illnesses in Korean workers have primarily focused on
291 construction²⁹ and outdoor workers,³⁰ with comparatively less attention paid to workers exposed to high
292 indoor temperatures. This study is significant because it examined heat-related illnesses among school
293 food service workers, a relatively neglected group. Furthermore, this study investigated the previously
294 unknown compliance status of school food service workers with heat-related illness prevention measures.
295 This study also provides insight into the effectiveness of preventive measures that can help establish
296 future heat-related illness prevention policies.

297

298 Conclusions

메모 포함[NK11]: Reviewer #1 (Response 2-1)

메모 포함[NK12]: Reviewer #1 (Response 4)

This study found that school food service workers are exposed to substantial heat in their workplaces, with more than one-third reporting heat exposure exceeding 4 h per day. The prevalence of heat-related illness symptoms was remarkably high (94.6 %), and a dose-response relationship was observed between the duration of heat exposure and the risk of heat-related illness symptoms, with longer exposures associated with significantly higher odds of experiencing symptoms. Our findings confirm the significant role of preventive measures, particularly increasing rest periods and reducing high-heat food preparations, in mitigating heat-related illness symptoms. However, the mere implementation of measures such as installing thermometers or operating air conditioners without considering their practical effectiveness may be insufficient. These results underscore the need for improved management of heat exposure durations and the implementation of effective preventive measures tailored to the unique characteristics of school food service environments. Future policies should focus on ensuring adequate rest periods, optimizing cooking methods to reduce heat generation, and providing effective cooling systems to protect the health of school food service workers.

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393	Supplementary materials
394	Supplement 1. Supplementary Tables.
395	Supplement 2. Korean manuscript.
396	

Epub ahead of print

1 Table1. Characteristics of study population by school type

	Elementary school (n= 3,229)		Middle/High school (n= 2,719)		Other schools ^a (n= 296)		Total (n= 6,244)		
	N	%	N	%	N	%	N	%	P-value
Age									0.776
<50	681	21.1	580	21.3	70	23.6	1331	21.3	
50-59	2334	72.3	1970	72.5	210	70.9	4514	72.3	
>59	214	6.6	169	6.2	16	5.4	399	6.4	
Duration of employment (year)									<0.001
1-4	772	23.9	750	27.6	74	25	1596	25.6	
5-9	540	16.7	479	17.6	56	18.9	1075	17.2	
10-19	1492	46.2	1244	45.8	134	45.3	2870	46	
> 19	425	13.2	246	9	32	10.8	703	11.3	
Hypertension									0.02
No	2673	82.8	2175	80	244	82.4	5092	81.6	
Yes	556	17.2	544	20	52	17.6	1152	18.4	
Diabetes									0.818
No	3030	93.8	2562	94.2	278	93.9	5870	94	
Yes	199	6.2	157	5.8	18	6.1	374	6	
Occupation									<0.001
Food service assistant	19	0.6	8	0.3	4	1.4	31	0.5	
Nutritionist	33	1.0	50	1.8	18	6.1	101	1.6	
Cook	3177	98.4	2661	97.9	274	92.6	6112	97.9	
Duration of Heat Exposure									0.005
Less than 30 minutes	251	7.8	207	7.6	37	12.5	495	7.9	
30 minutes to 2 hours	933	28.9	738	27.1	95	32.1	1766	28.3	
2 hours to 4 hours	1006	31.2	837	30.8	87	29.4	1930	30.9	
more than 4 hours	1039	32.2	937	34.5	77	26.0	2053	32.9	

2 ^aOther schools included kindergartens, day care centers, universities, and others.

3 Table 2. Prevalence of heat-related illness symptoms by school type

	Elementary school (n= 3,229)		Middle/High school (n= 2,719)		Other schools ^a (n= 296)		Total (n= 6,244)		P-value
	N	%	N	%	N	%	N	%	
Heat-related illness symptoms									
No	171	5.3	141	5.2	26	8.8	338	5.4	0.031
Yes	3058	94.7	2578	94.8	270	91.2	5906	94.6	
Heat rash	1865	57.8	1661	61.1	167	56.4	3693	59.1	0.021
Heat cramps	1969	61	1689	62.1	156	52.7	3814	61.1	0.007
Heat edema	2054	63.6	1782	65.5	165	55.7	4001	64.1	0.003
Heat exhaustion	2187	67.7	1873	68.9	180	60.8	4240	67.9	0.018
Heat syncope	224	6.9	193	7.1	10	3.4	427	6.8	0.052

4 ^aOther schools included kindergartens, day care centers, universities, and others.

5

6 Table 3. Heat Wave Preventive Measures by school type

Elementary school				Middle/High school		Other schools ^a		Total		P-value
(n= 3,229)				(n= 2,719)		(n= 296)		(n= 6,244)		
		N	%	N	%	N	%	N	%	
Heat Wave Preventive Measures										
No		235	7.3	229	8.4	19	6.4	483	7.7	0.177
Yes			2994	92.7	2490	91.6	277	93.6	5761	92.3
installing thermometers		823	25.5	662	24.3	102	34.5	1587	25.4	0.001
operating air conditioners		2945	91.2	2439	89.7	272	91.9	5656	90.6	0.104
high-heat prepared foods		226	7.0	134	4.9	23	7.8	383	6.1	0.002
no more than twice a week										
reducing hot water disinfection		273	8.5	172	6.3	19	6.4	464	7.4	0.006
increasing break times		102	3.2	81	3.0	6	2.0	189	3.0	0.543

7 ^aOther schools included kindergartens, day care centers, universities, and others.

8

9 Table 4. The associations between heat-related illness symptoms, duration of heat exposure and heat
10 wave preventive measures

			N	Case (%)	Adjusted ^a OR (95% CI)
Duration of Heat exposure	Less than 30 minutes		495	395 (79.8)	Ref.
	30 minutes to 2 hours		1766	1635 (92.6)	2.55 (1.89-3.45)
	2 hours to 4 hours		1930	1860 (96.4)	5.04 (3.58-7.12)
	More than 4 hours		2053	2016 (98.2)	10.20 (6.74-15.43)
Heat Wave Preventive Measures	Installing thermometers	Y	1587	120 (7.6)	Ref.
		N	4657	4439 (95.3)	1.05 (0.81-1.36)
	Operating air conditioners	Y	5656	5338 (94.4)	Ref.
		N	588	568 (96.6)	1.29 (0.80-2.07)
	High-heat prepared foods no more than twice a week	Y	383	324 (84.6)	Ref.
		N	5861	5582 (95.2)	1.59 (1.10-2.29)
	Reducing hot water disinfection	Y	464	414 (89.2)	Ref.
		N	5780	5492 (95.0)	1.31 (0.91-1.89)
	Increasing break times	Y	189	157 (83.1)	Ref.
		N	6055	5749 (94.9)	1.86 (1.16-2.99)

11 CI: confidence interval, OR: odds ratio

12 ^aAdjusted for age, occupation, hypertension, diabetes, and school type.

메모 포함[NK1]: Reviewer #2 (Response 4)