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## A Study on the Safety Measures for Thermal Diseases, Focusing on the Cases of Disaster by Construction Industry

Hye-Ryeong O<sup>1</sup>, Won-Mo GAL<sup>2</sup>, Ok-Nam Park<sup>3</sup>, Mi-Hwa JANG<sup>4</sup>, Seok-Soon KWON<sup>5</sup>, Seung-Hyuck PARK<sup>6</sup>

1. First Author Researcher, Dept. of Environmental Health & Safety, Eulji University, Korea.

Email: [yongsim1970@daum.net](mailto:yongsim1970@daum.net)

2. Corresponding Author Professor, Dept. of Environmental Health & Safety, Eulji University, Korea.

Email: [wongal@eulji.ac.kr](mailto:wongal@eulji.ac.kr)

3. Second Author Professor, Dept. of Industrial Safety Management Engineering, Sunmoon University, Korea.

Email: [p8988571@hanmail.net](mailto:p8988571@hanmail.net)

4. Third Author Researcher, Dept. of Environmental Health & Safety, Eulji University, Korea.

Email: [jang0220@daum.net](mailto:jang0220@daum.net)

5. Co-Author Researcher, Dept. of Environmental Health & Safety, Eulji University, Korea.

Email: [dadadibo@naver.com](mailto:dadadibo@naver.com)

6. Co-Author Researcher, Dept. of Environmental Health & Safety, Eulji University, Korea.

Email: [janghoon0301@naver.com](mailto:janghoon0301@naver.com)

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### Abstract

**Purpose:** Construction sites are currently facing a socialization problem as the incidence of thermal disease-related disasters increases due to summer heat waves, exacerbated by factors like the concentration of middle-aged and older workers and global warming. The reason why construction sites are particularly vulnerable to heat waves is that there are many outdoor work, which is the peculiarity of the construction industry, and most of the construction workers are elderly. This study analyzes disaster statistics of workers at construction sites for five years to investigate the occurrence of thermal diseases and analyze factors through disaster cases to provide basic data for future disasters to be reduced. **Research design, data, and methodology:** According to the Construction Workers' Mutual Aid Association, as of June, more than 60% of the construction workers working in the field were in their 50s and 60s. More than 24% are in their 60s and older. Thermal diseases caused by heat waves occur when exposed to high heat or strong sunlight for a long time, accompanied by headaches and dizziness. The problem is that many elderly people have underlying diseases, so if they lose consciousness, they cannot easily recover and are likely to die. **Results:** According to industrial accident statistics, 182 people were injured by heat-related diseases in the summer from 2016 to 2021, of which 29 died. In particular, in the construction industry, which has a lot of outdoor work, 87 people were injured and 20 people died. **Conclusions:** In order to prevent heat diseases caused by outdoor work, it is emphasized that exposure time is controlled, and sufficient rest and hydration are essential. Rest, water, and shade are in line with the three principles.

**Keywords :** A Thermal disease, A Worker's lounge, A Heat-related disease disaster

**JEL Classification Code :** I31, I38 N60

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## 1. Introduction

Currently, construction sites have emerged as a social problem due to the increasing number of thermal disease disasters relate with heat waves in summer due to environmental changes such as the concentration of middle-aged and old-aged workers and global warming. The reason why construction sites are particularly vulnerable to heat waves is that the construction industry has a lot of outdoor work, and according to statistics from the Construction Workers' Mutual Aid Association, more than 60% of workers working at construction sites were in their 50s and 60s and more than 24% were reported as of June 2021. Thermal diseases caused by heat waves occur when exposed to high heat and strong sunlight for a long time, and symptoms such as headache, dizziness, and high fever appear. Many elderly workers have underlying diseases, and if they lose consciousness and fail to recover due to heat diseases when exposed to high temperatures and direct sunlight, they are likely to be linked to disasters such as death. Therefore, in order to prevent heat diseases in outdoor work, it is essential to minimize the body's exposure time and to provide sufficient rest and hydration (rest, water, and shade). According to industrial accident statistics (Ministry of Employment and Labor, 2022), a total of 182 people were injured from heat-related diseases in summer from 2016 to 2021, of which 29 died. In particular, in the case of the construction industry with a lot of outdoor work, a total of 87 people were injured and 20 people died.

This study analyzes disaster statistics of workers at construction sites for the past five years (2016-2021), investigates major occupations that can cause thermal diseases, and analyzes disaster occurrence factors to use them as basic data to promote disaster reduction in the future. The statistics on thermal diseases caused by heat waves are as follows from 2016 to 2021 announced by the Ministry of Employment and Labor.

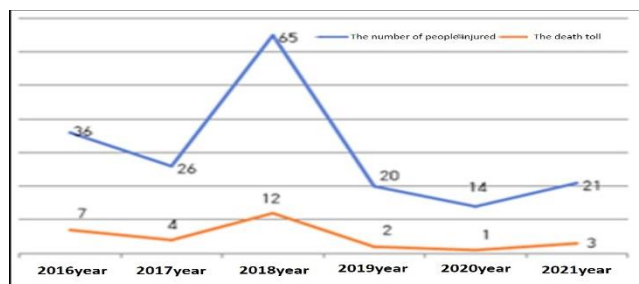


Figure 1: Current Status of Thermal Diseases caused by Heat Wave

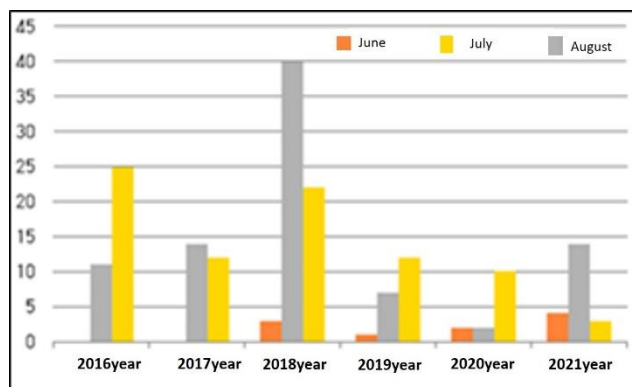


Figure 2: Monthly status of thermal disease industrial accidents in summer

## 2. Literature Review

### 2.1. Health Effects of Heat Wave

Health damage caused by heat waves varies internally depending on age, underlying disease, education level, income, and region, and externally (environmentally) depending on various factors such as aging, urban development, and government or local government policies. Symptoms such as heat stroke, heat exhaustion, swelling, febrile rash (sweat band), headache, convulsions, vomiting, and lethargy appear when continuously exposed to high temperatures such as heat waves or high temperature working environments. Heat illness, an acute disease caused by heat, occurs, causes problems in the central nervous system that controls body temperature, and heat stroke and heat exhaustion may be linked to life-threatening diseases if left unattended continuously without improvement measures. In addition, vulnerable groups such as chronically ill patients, the elderly, children, and workers at construction sites can also die due to the heat wave.

### 2.2. Types of Thermal Diseases

Thermal disease is an acute disease caused by heat, and refers to a disease in which symptoms such as headache, dizziness, fatigue, muscle cramps, and loss of consciousness appear when a worker works for a long time under hot environmental conditions. Types of thermal diseases include heat stroke, heat exhaustion, heat cramps, heat swelling, heat fainting, heat rash, sweat bands, and sunburn.

**Table 1:** Types of Thermal Diseases

Types	Causes
Heat stroke	A disease caused by the loss of function of the nervous system that regulates body temperature because it cannot withstand the stimulation of heat
Heat exhaustion	A disease caused by excessive sweating and inadequate supply of water and salt due to heat
Heat cramps	A disease that causes muscle cramps due to excessive loss of water and salt contained in sweat when sweating a lot
Heat fainting	A disease that temporarily loses consciousness due to a lack of blood flow to the brain
Heat swelling	When the body temperature increases, the amount of blood on the body surface increases and the amount of blood in the core decreases in order to dissipate heat to the outside. A disease caused by edema as moisture in the blood moves out of the blood vessels when standing or sitting for a long time in this state
Heat rash, Sweat bands	A disease that causes small rashes and blisters as sweat cannot be discharged to the epidermis smoothly due to clogging of sweat tubes and holes in the sweat tube
Sunburn	Symptoms of redness and inflammatory reactions due to prolonged exposure to sunlight (ultraviolet)

### 3. Research Methods and Materials

#### 3.1. General Matters

Construction sites are high-risk workplaces where thermal diseases can occur. Due to the large number of outdoor work, workers are directly exposed to sunlight and heat, and it is practically impossible to completely prevent the occurrence of thermal diseases at all construction sites across the country. Unlike government-ordered government-funded construction projects, private construction projects are difficult to adjust the construction budget or construction period, and it is difficult to provide workers with sufficient rest facilities and rest time due to various problems such as the extended process period and addition of input budget when the rainy season and rainy or snowy periods continue to increase due to abnormal temperatures such as rainy seasons.

According to related laws such as the Occupational Safety and Health Regulations and guidelines of the Ministry of Employment and Labor, companies should provide resting

places for workers to rest, give 10 to 15 minutes per hour when a heat wave warning is issued, and when a heat wave warning is issued, work between 14 and 17 o'clock should be stopped and rest and cool water should be provided to workers.

**Table 2:** Tips for responding to heat wave risk levels (guide for implementing the three major rules)

Sortation	wind chill temperature	Tips for responding to heat wave risk levels (guide for implementing the three major rules)	
Attention	31°C or higher	Provide water, shade, and rest Pre-confirmation of heat-related disease sensitive groups (※ Common in each step)	
Caution	33°C or higher	Shade break for 10 minutes every hour Shortening outdoor work and adjusting working hours during hot weather hours (14:00 to 17:00)	
Warning	35°C or higher	Shade rest for 15 minutes every hour	Suspension of outdoor work during hot weather hours (excluding inevitable cases)
Danger	38°C or higher		Suspension of outdoor work during hot weather hours (excluding emergencies such as disasters)

#### 3.2. Laws and Regulations related to Thermal Diseases at Construction Sites

Heatstroke is included in the Serious Disaster Punishment Act for heat-related diseases caused by heat waves at construction sites, and if more than three heatstroke patients occur or even one person dies a year, efforts are being made to prevent safety, such as establishing heat wave measures at construction sites in accordance with legal liability. The relevant laws and main contents are shown in the table below.

**Table 3:** Laws on Thermal Diseases at Construction Site

Laws	Clause
Occupational Safety and Health Act	Article 70 (Extension of Construction Period)
	Article 128-2 (Installation of Resting Facilities)

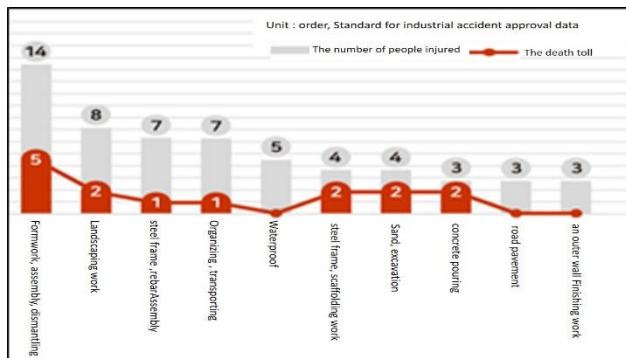
Rules on Occupational Safety and Health Standards	Article 571 (Keeping Salt and Beverages, etc.), Article 566 (Rest, etc.)
Serious Disaster Punishment Act	Occupational diseases, attached Table 1 No. 24
Ministry of Strategy and Finance (contract rules)	Article 23 (Adjustment of the contract amount due to changes in other contract details) Article 25 (deferred prize money) and Article 26 (extension of contract period) Article 47 of General Conditions of Construction Contract (Pause of Construction)
Ministry of Land, Transport and Maritime Affairs (Standard Contract for Private Construction Works)	Article 17 (Extension of Construction Period)
Ministry of Public Administration and Security (Standards for Bidding and Contract Execution of Local Governments) (Formula)	Chapter 13, Section 5 and 6 (Holidays and Night Work) Chapter 13, Section 7 (4) (Other adjustments to the contract amount due to changes in the contract details) Chapter 13, Section 8 (Deferral of contract performance and cancellation and termination of contract)

## 4. Results and Discussion

### 4.1. Thermal Disease Disaster at Construction Site

#### 4.1.1. Thermal diseases of construction site

The risk period of heat illness at construction sites occurs intensively from July to August, and is likely to occur to workers working outdoors who are vulnerable to heat waves, and the recent industrial accidents of heat illness between 2016 and 2021 were 87 out of 182 people (29 deaths) who were injured in the construction industry for six years from 2016 to 2021, and 20 people (68.96%) died, which was a very high proportion of the construction industry. In particular, 58 people (66.7%) occurred in the 10 major work types, including formwork assembly and dismantling, landscaping, reinforcement assembly, material arrangement and transportation, painting and waterproofing, steel frame and scaffolding, soil excavation, concrete pouring, road pavement, and outer wall finishing. Among them, the work types in which two or more deaths occurred are five work types, including formwork assembly, concrete pouring, steel scaffolding, soil excavation, and landscaping. According to the statistics of the Ministry of Employment and Labor, the top 10 tasks of thermal diseases in the construction industry are as follows.



**Figure 3:** Top 10 tasks for the occurrence of thermal diseases in the construction industry from 2016 to 2021

#### 4.1.2. Analysis of Thermal Disease Disaster Cases at Construction Site

The analysis of disaster cases at construction sites used presentation data from the Ministry of Employment and Labor and the Korea Safety and Health Agency, and disaster statistics and disaster occurrence factors between 2016 and 2021 were investigated and analyzed. Most of the heat-related patients, such as death and injury, occur during outdoor work among heat waves, and the main cases of disasters are shown in the table below.

**Table 4:** Case of Thermal Disease at Construction Site

Type of construction	Type of disaster	Disaster matters
Construction work	Death	A mold assembly worker (22) at a construction site in Siheung, Gyeonggi Province
	Death	Two Concrete Placing Workers at Daejeon Construction Site (22)
	Death	Roller Worker (22) at Country House Construction Site
	Death	Reinforcement workers at the construction site of a new apartment building in a new city
	Death	Workers after morning concrete installation in new construction works
	Death	Concrete pouring worker at Cheongju site
	Injury	Thermal diseases during welding work in Pyeongtaek, Gyeonggi-do
	Injury	Construction of a new urban development project in Daegok District, Gyeonggi Province, is under construction of concrete
	Injury	Thermal diseases during construction of multi-family housing in Paju-si, Gyeonggi-do
	Injury	Thermal diseases during the construction of new apartment houses in Munsan-dong



	Injury	Construction of Childcare Complex in South Gyeongsang Province Smart Farm Innovation Valley
Civil engineering work	Death	Death after exhaustion at the road extension pavement site
	Death	Death due to heat stroke at the industrial complex construction site
landscaping work	Death	Landscape worker at the construction site of Ganghwa Island, Incheon
Construction of solar power facilities	Death	Death from heat stroke at the solar facility construction site

## 4.2. Management and Prevention of Thermal Diseases for Workers in the Construction Industry

### 4.2.1. General Common Matters

In accordance with the Heat Death Prevention Guide distributed by the government to major workplaces, it is stipulated that construction site workers must supervise the 10 major work types at risk of heat stroke during hot weather hours. If there is no choice but to work, it is necessary to work under the direction and supervision of the management supervisor, and work is required after wearing cool equipment such as ice vests and cool toshis while giving workers enough time to rest. After working, attention should also be paid to thermal diseases that may occur after returning home, such as checking the presence of symptoms such as thermal diseases and educating the worker that sufficient fatigue recovery is necessary.

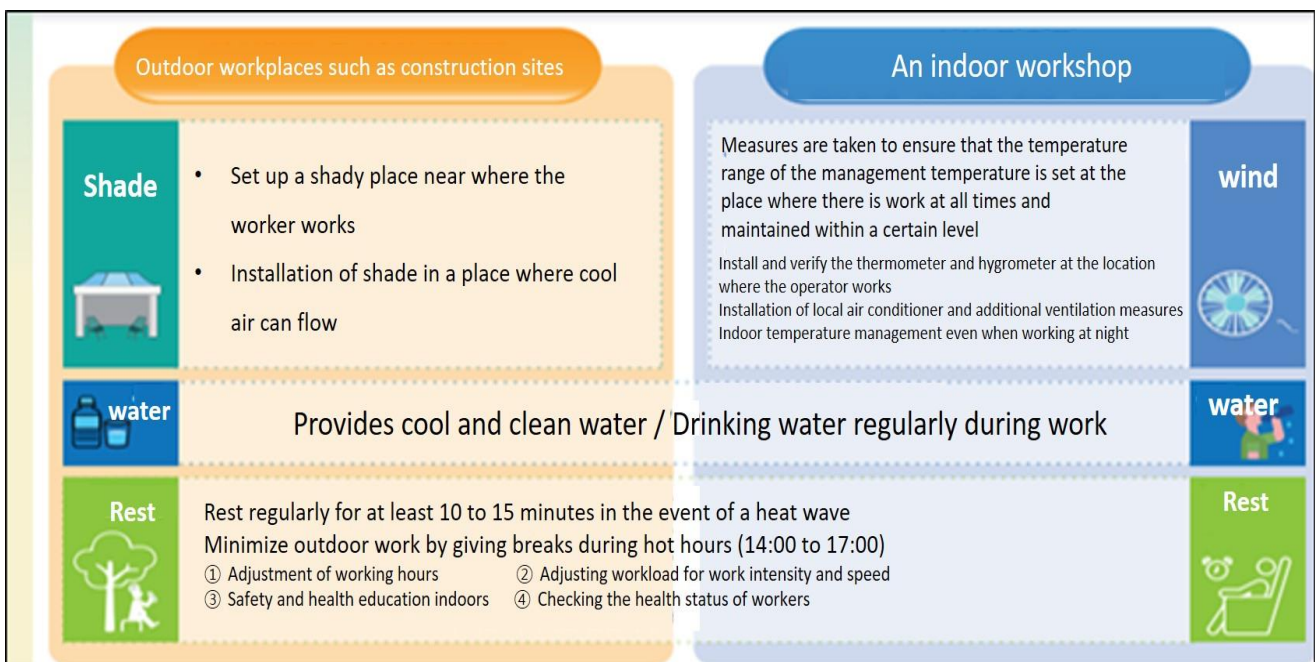


Figure 4: Guide to the Prevention of Thermal Diseases caused by Summer Heat Wave-1

### 4.2.2. Safety management by engineering type

The main safety measures for formwork assembly and dismantling, landscaping, rebar assembly, material arrangement and transportation, painting and waterproofing, steel and scaffolding, soil excavation, concrete pouring, road pavement, and outer wall finishing are as follows.

1) Through risk assessment and TBM, it is necessary to identify harmful risk factors that can lead to health hazards such as heat stroke, heat cramps, and heat exhaustion during outdoor work, establish measures to reduce them, and

conduct risk assessments.

2) By conducting a preliminary confirmation survey on thermal disease-sensitive groups and work occupations with high work intensity, it is necessary to check the health of workers before starting work and to properly arrange and manage workers in the working environment.

Table 5: Safety management of thermal diseases at work

Working time	Safety management matters
Before	1) Review whether to change the work schedule

work	2) Work arrangement after considering work intensity after investigation of heat disease sensitive group
	3) Recognize the top 3 rules for preventing heat stroke
Working on it	1) Work under the supervision of a supervisor
	2) Allowing enough time to rest
	3) Wear cool equipment such as ice vests
	4) If there is a thermometer, measure the body temperature
	5) Refrain from outdoor work during hot weather (14:00-17:00)
	6) Follow the precautions for the prevention of heat-related diseases thoroughly
After work	1) Check for symptoms such as thermal diseases
	2) Nutrition and fatigue recovery

### 4.2.3. Measures in the event of the thermal diseases

For safety, it is necessary to manage not only workers but also business owners' appropriate thermal diseases. If a worker shows suspected symptoms of heat-related diseases such as high fever of 38°C or higher, rapid breathing and pulse, headache, twitch, and collapse, the employer should immediately stop working and take emergency measures. If the patient is conscious and the symptoms do not improve after taking emergency measures, report to 119, and if the patient is unconscious from the beginning, there is a risk of death, so he/she should report it quickly and transfer it to the hospital. The figure below is a schematic diagram of the situation of measures taken according to the occurrence of heat-related diseases.

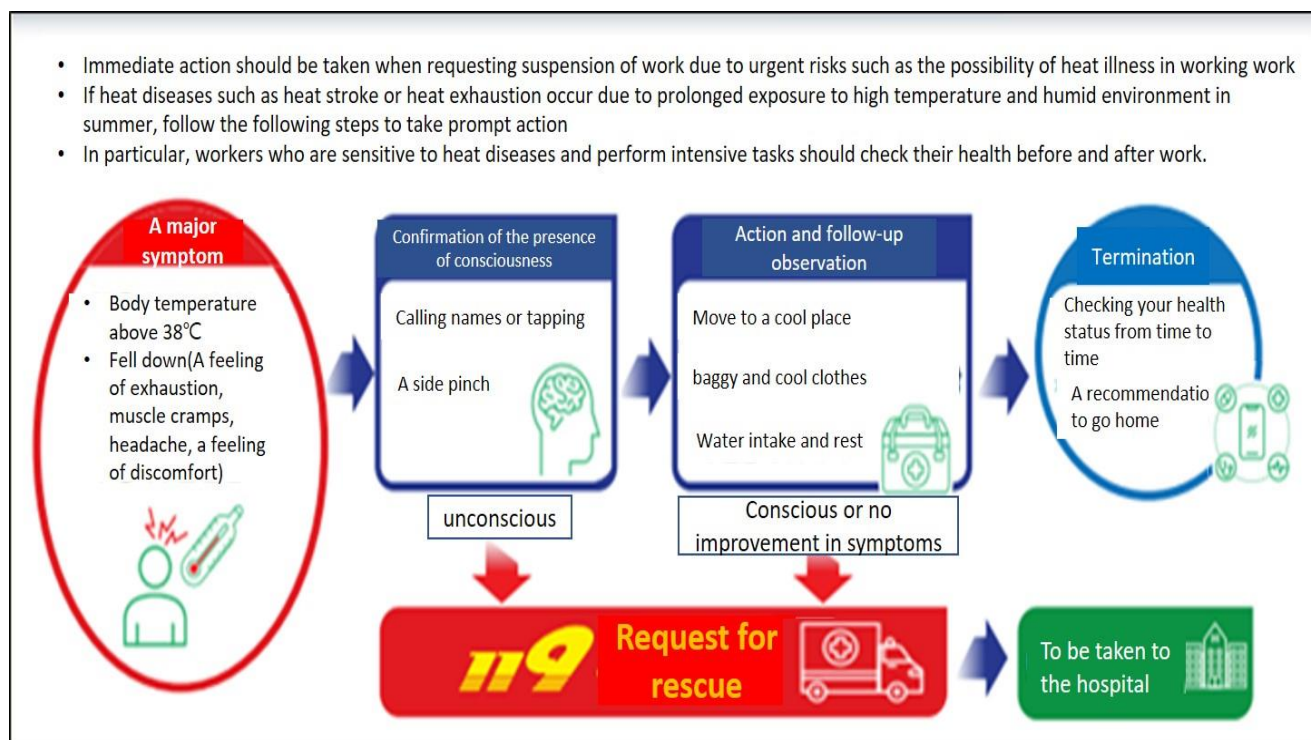


Figure 5: Guide to the Prevention of Thermal Diseases caused by Summer Heat Wave-2

In addition, the wind chill temperature varies depending on each region and topography, and it is necessary to respond according to the situation. Unlike the actual Korea Meteorological Administration's forecast, the wind chill temperature is different for each person. Therefore, it is very important to prevent heat diseases such as rest time, shade, and water, which should be provided basically, and to be familiar with the countermeasures of heat-related patients in case of emergency. It is necessary to check the step-by-step response to the heat wave according to the wind chill temperature announced by the Korea

Centers for Disease Control and Prevention, and to make education or training in advance a daily life.

In addition, each workplace shall manage workers through a checklist for preventing heat diseases, check their sensitivity, and identify latent risk factors due to heat waves in advance. In addition to establishing a plan to address the risk at this time, if there is a risk of heat diseases due to exposure to heat waves, the checklist for heat diseases shall be used to improve the working environment, comply with

the three basic rules, and respond urgently in the event of an accident.

Korea Meteorological Administration (KMA) Sensory Temperature Table																
	Interest			Watchdog			Watch			Warning			Alert		Danger	
°C	28	29	30	31	32	33	34	35	36	37	38	39	40			
40	26.6	27.6	28.5	29.5	30.4	31.4	32.4	33.3	34.3	35.3	36.2	37.2	38.2			
45	27.1	28.1	29.0	30.0	31.0	32.0	32.9	33.9	34.9	35.9	36.9	37.8	38.8			
50	27.6	28.6	29.5	30.5	31.5	32.5	33.5	34.5	35.4	36.4	37.4	38.4	39.4			
55	28.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0			
60	28.4	29.4	30.4	31.4	32.4	33.5	34.5	35.5	36.5	37.5	38.5	39.5	40.5			
65	28.9	29.9	30.9	31.9	32.9	33.9	34.9	35.9	36.9	38.0	39.0	40.0	41.0			
70	29.3	30.3	31.3	32.3	33.3	34.3	35.4	36.4	37.4	38.4	39.5	40.5	41.5			
75	29.7	30.7	31.7	32.7	33.7	34.8	35.8	36.8	37.8	38.9	39.9	40.9	42.0			
80	30.0	31.1	32.1	33.1	34.1	35.2	36.2	37.2	38.3	39.3	40.4	41.4	42.4			
85	30.4	31.4	32.5	33.5	34.5	35.6	36.6	37.7	38.7	39.7	40.8	41.8	42.9			
90	30.8	31.8	32.9	33.9	34.9	36.0	37.0	38.1	39.1	40.2	41.2	42.3	43.3			

Figure 6: Korea Meteorological Administration's Sensory Temperature Table

#### 4.2.4. Measures for Prevention of Thermal Diseases

In the new guidelines related to the construction industry's top 10 work processes, managers and ordering companies must prepare safety manuals for each type of thermal disease suitable for the company with a sense of safety culture, regularly distribute them to the site, and regularly supervise construction sites. Therefore, the budget for the field of thermal diseases should be allocated and the budget should be executed if necessary. In addition, the construction site must comply with the guidelines for the top 10 work processes and require the client to change the construction period in relation to the construction period and compliance with the work process suitable for the characteristics of the site. In particular, in conducting the risk assessment specified in the Occupational Safety and Health Act, the contents of thermal diseases should be inserted into the 10 major work types, workers should actively participate in spreading rules and contents, and education related to thermal diseases should be focused on safety and health education in summer to prevent worker accidents.

Nevertheless, safety and health education and emergency medicine first-aid kit should be installed in preparation for heat waves so that emergency measures can be taken in case of thermal diseases, and emergency contact networks and organizational charts for thermal diseases should be temporarily established to prepare for emergencies. In addition, in relation to the law, budget execution items for thermal diseases should be added to the industrial safety management cost to strengthen the supervision of the relevant construction sites on the provision and utilization of rest facilities and items required at the site. Therefore, it is now necessary to open industrial accident statistics and support related research funds to contribute to the prevention of thermal diseases in Korea by expanding and revitalizing research jointly in the public, government, and academia in connection with the revision of the construction site work guidelines.

## 5. Conclusions

Construction sites are high-risk workplaces that cause Thermal diseases and occur intensively from July to August, and there is a high risk of occurrence for outdoor workers who are vulnerable to heat waves such as construction sites. The reason why construction sites are particularly vulnerable to heat waves is that there are many outdoor workers, which are unique to the construction industry, and the proportion of foreign workers who have difficulty communicating is also high. According to the National Statistical Office survey (2023, National Statistical Portal of the National Statistical Office), 1,574 out of 2,117,000 workers in the construction industry are middle-aged and old aged between 55 and 79, which are vulnerable to Thermal diseases, especially for the elderly. According to the Korea Centers for Disease Control and Prevention (2021, Korea Centers for Disease Control and Prevention), the elderly and the elderly living alone, the chronically ill, outdoor workers, and children are classified as high-risk groups based on statistics on visiting emergency rooms due to Thermal diseases. In the reality that the proportion of outdoor work is high, and workers are directly exposed to sunlight and heat, it is practically impossible to completely prevent the occurrence of Thermal diseases at construction sites across the country. However, it is possible to minimize the risk if the working environment is improved as follows and efforts are made through continuous education.

- 1) As a management measure, to prevent Thermal diseases caused by outdoor work, exposure time is minimized, rest and hydration are essential, and compliance must be observed. In addition, employers should immediately stop working and take emergency measures if workers show suspicious symptoms of Thermal diseases, and immediately report to 119 and transfer them to hospitals after taking emergency measures.
- 2) Legal measures require special workplace management and close management supervision for 10 major work types such as formwork, landscaping, rebar, material arrangement and transportation, painting and waterproofing, steel and scaffolding, soil excavation, concrete pouring, road pavement, and exterior wall finishing, which are vulnerable to thermal diseases at construction sites.
- 3) As educational measures, safety education and training at construction sites, such as risk assessment and TBM, should be strengthened. Therefore, risk assessment and safety education and training should be conducted thoroughly to identify harmful factors to workers' health hazards such as heat stroke, heat cramps, and heat exhaustion during outdoor work, and to establish and implement reduction measures accordingly.

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