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Cox Proportional Hazard Regression for Summer Thermal Accidents

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ABSTRACT

Cox proportional hazard regression, which focuses on the distribution of survival time, is widely used to determine the relationship between survival and multiple risk predictors. For thermal stress accidents, which are heat-dependent events, Cox proportional hazard regression focusing on the distribution of thermal conditions such as ambient temperature can be applied, and the hazard ratios of related factors indicate the strength of the accident risk. To reveal some of the personal, environmental, and behavioral characteristics associated with the risk of thermal accidents, thermal accident cases and climatic conditions published on the web were analyzed by Cox proportional hazard regression using ambient temperature as a functional parameter.

Keywords: Cox proportional hazard regression, thermal accidents, heat-dependent events, personal-environmental-behavioral characteristics

INTRODUCTION

In general, heat stress risk is assessed using the WBGT index, which is based on limited thermal indicators such as temperature, humidity, and radiant heat [1], [2], [3]. No attempt has been made to comprehensively assess heat risk by adding personal, behavioral, and environmental characteristics to the heat index. Cox proportional hazard regression [4], which focuses on the distribution of survival time, is widely used to determine the relationship between survival and multiple risk predictors [5], [6]. For thermal stress accidents, which are heat-dependent events, Cox proportional hazard regression focusing on the distribution of thermal conditions such as ambient temperature can be applied, and the hazard ratios of related factors indicate the strength of the accident risk. This study presents a proportional hazard analysis of risk factors associated with thermal accident cases in ambulance transport information published on the web.

METHODS

Thermal accident cases: Thermal accident information for July and August from 2004 to 2008 was obtained from the portal site of the Yamaguchi Prefectural Government, Japan (http://www.pref.yamaguchi.lg.jp/cms/a10900/nettyuusyo/18.html). The content of the information was the victim's gender, age, and accident site.

Climatic conditions: The climatic conditions were from the values of the meteorological station closest to the accident site. The value was downloaded from the Japan Meteorological Agency. (www.data.jma.go.jp/obd/stats/etrn/index.php?sess=6ef525a9cdef28cea634ce58ca736e68)

Statistical analysis: Proportional hazard analysis was performed with the SPSS 12.0 software package. Ambient temperature was used as a parameter of the baseline hazard function.

Ethics: Present study is based on public information.

RESULTS

Characteristics of the study cases

Table 1 shows the characteristics of the study cases. There were 1417 cases (1003 men and 414 women) in the study. Mean age was significantly higher ($p<0.001$) in women (58.2 years) than in men (47.8 years). There were no significant differences in climatic conditions between men and women, but indoor damage rates were higher in women than in men.

Proportional hazard analysis

The hazard ratios and 95% confidence interval of the predictors are listed in Table 2. Age and indoor / outdoor are not related to risk, and women are at lower risk than men. Atmospheric pressure and humidity increase the risk, and wind speed and sunshine duration act to reduce the risk.

Table 1: Descriptive statistics for personal and environmental characteristics of the study cases

	Gender	n	Mean	SD	Minimum	Maximum	*P-value*[##]
Age (years)	Men	1003	47.8	24.2	0.0	97.0	0.000
	Women	414	58.2	28.2	2.0	98.0	
	Total	**1417**	**50.8**	**25.8**	**0.0**	**98.0**	
Ambient temperature (°C)[#]	Men	1003	28.6	1.2	22.3	30.7	0.017
	Women	414	28.7	1.1	23.1	30.7	
	Total	**1417**	**28.6**	**1.2**	**22.3**	**30.7**	
Atmospheric pressure (hPa)[#]	Men	1003	1009.2	3.5	996.0	1017.1	0.251
	Women	414	1009.4	3.4	996.0	1016.4	
	Total	**1417**	**1009.3**	**3.5**	**996.0**	**1017.1**	
Relative humidity (%)[#]	Men	1003	71.1	5.0	59	92	0.947
	Women	414	71.2	4.7	62	88	
	Total	**1417**	**71.1**	**4.9**	**59**	**92**	
Wind speed (m/s)[#]	Men	992	2.1	0.8	0.9	7.0	0.751
	Women	410	2.1	0.9	0.8	7.8	
	Total	**1402**	**2.1**	**0.8**	**0.8**	**7.8**	
Sunshine duration (h)	Men	991	8.4	3.0	0.0	13.3	0.952
	Women	407	8.4	2.9	0.0	12.9	
	Total	**1398**	**8.4**	**3.0**	**0.0**	**12.9**	
Site (1, indoor; 0, outdoor)	Men	1003	0.27	0.44	0	1	0.000
	Women	414	0.39	0.49	0	1	
	Total	**1417**	**0.30**	**0.46**	**0**	**1**	

[#]Daily mean value, [##]Statistical analysis of mean values between men and women

Table 2: Hazard ratios and 95% confidence interval of the predictors

	Hazards ratio	95% confidence interval	*P*-value
Age (years)	1.000	0.998-1.002	0.849
Gender (1, women; 0, men)	0.868	0.770-0.978	0.020
Atmospheric pressure (hPa)[#]	1.093	1.075-1.111	0.000
Relative humidity (%)[#]	1.077	1.062-1.092	0.000
Wind speed (m/s)[#]	0.860	0.797-0.928	0.000
Sunshine duration (h)	0.895	0.875-0.915	0.000
Site (1, indoor; 0, outdoor)	0.961	0.852-1.085	0.524

[#]Daily mean value

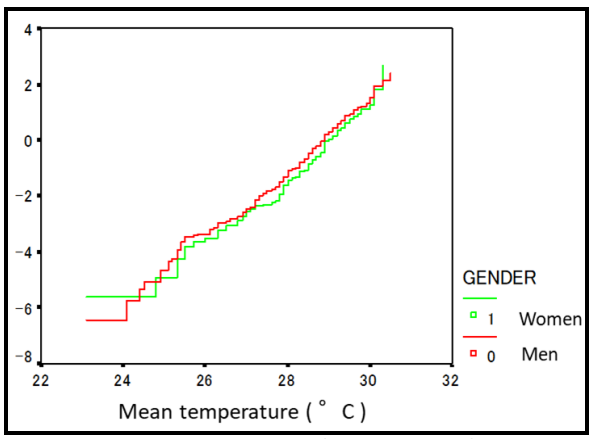

Figure 1: Log-minus-log plots of the survival function by gender

DISCUSSION

Thermal accidents such as thermal damage are heat-dependent events. For this reason, the author performed a proportional hazard analysis using ambient temperature as a parameter of the baseline hazard function. The results comprehensively revealed some of the personal, environmental, and behavioral characteristics associated with the risk of thermal accidents. Women are at lower risk than men. As shown in Figure 1, log-minus-

log plots of the survival function by gender are nearly parallel, confirming the "proportional hazard function" assumption [7]. In climatic conditions, higher atmospheric pressure and humidity increase the risk, and wind speed and sunshine duration act to reduce the risk. Regarding sunshine duration, it may reflect the behavioral characteristics of people. People may tend to refrain from outdoor activities on days with longer daylight hours.

CONCLUSION

The proportional hazard analysis method presented by the author has made it possible to numerically show the contribution of various related factors to the risk of thermal accidents.

Conflict of interest

The author reports no conflicts of interest in this work.

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