Occupational Heat-Related Illness in North Carolina, 2007-2011

Introduction

Certain occupations can be at particularly high risk for heat-related illness (HRI). These occupations include outdoor workers (e.g., farmers, construction, or transportation workers), workers in hot environments (e.g. firefighters and factory workers), or indoor workers in non-climate controlled environments (e.g. warehouses)[1–3]. In work environments involving exposures to extreme external heat sources, high humidity or heavy physical labor, a range of health effects can occur from mild heat-related conditions (e.g., heat edema or heat cramps) to severe adverse effects (e.g. heat exhaustion or heat stroke), and possibly death[4].

Workers can have an increased risk for HRI as compared to the general population because their exposures and response to heat may be influenced by job requirements[5]. In North Carolina, individuals ages 19 to 45 years often visit emergency departments (ED) for occupational HRI[6]. Occupational HRI are preventable. Describing and tracking occupational HRI is essential to identify high-risk workers and inform prevention efforts.

Case Definition

An occupational heat-related illness case had the following criteria:

- A hospitalization at an acute-care clinical facility or emergency department (ED) visit in North Carolina between 2007 and 2011
- age 16 years or older
- assigned a primary or contributing International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code of 992.0 – 992.9
- an external cause of injury code (Ecode) of E900.0, E900.1, and/or E900.9
- a work-related* exposure to heat

*Work-relatedness was identified through workers' compensation as the expected payer, or the presence of a work-related Ecode[7]: civilian work (E000.0), military work (E000.1), work-related transportation (E800-E807, 4th digit = 0; E830-E838, 4th digit = 2 or 6; E840-E845, 4th digit = 2 or 8; E846), or location (E849.1-E849.3)[a].

Methods

Inpatient hospitalization data was obtained from the North Carolina Inpatient Hospital Discharge Database (NC State Center for Health Statistics) from calendar years 2007 through 2011. NC General Statute 131E-124 requires hospitals in the state to submit hospitalization data to a statewide data processor, mainly for billing purposes. Discharge data includes demographic, diagnostic, payer and cost information.

Emergency Department (ED) visit data was obtained through the North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) for calendar years 2008 to 2011. NC DETECT was created by the North Carolina Division of Public Health, in collaboration with the Carolina Center for Health Informatics in the UNC Department of Emergency Medicine, and collects state-mandated data from all 122 EDs in North Carolina. ED data includes patient demographic, diagnostic and insurance provider data.

[a] Technical note: North Carolina tracks occupational heat-related illness as a state-added occupational health indicator (OHI). Although the workers' compensation payer source is a good proxy for identifying work-related cases in hospitalization data[8], data collection methods for this OHI includes information for using a work-related "Ecode algorithm" to identify more work-related cases in hospitalization and ED visit databases than through just using the workers' compensation payer source method alone[7,9].

Population denominators were defined as all employed people in North Carolina during 2007 through 2011, age 16 years or older. Counts for the employed population (denominators) were obtained from the Bureau of Labor Statistics (BLS) Current Population Survey (CPS) and the BLS Geographic Profile of Employment and Unemployment (GP)[b].

Non-North Carolina residents were included to present a more accurate estimate of occupational HRI since the North Carolina workforce is increasingly including workers from other states and countries[9]. However, occupational HRI rates were calculated for NC state residents only.

Data were categorized by sex, age groups, expected payer source and patient status.

The following comorbid conditions co-diagnosed with occupational HRI ED visits and IHs were examined: cardiovascular disease (ICD-9-CM codes 390-398, 404-429, 440-448 and 402), cerebrovascular disease (ICD-9-CM codes 430-438), respiratory disease (ICD-9-CM codes 460-519), renal disease (ICD-9-CM codes 580-589), diabetes (ICD-9-CM code 250), and all injuries (ICD-9-CM codes 800-904). For each of these conditions (except injury) the diagnosis codes include complications of a current or past event. Summary statistics for length of hospital stay were also provided.

Results

Demographics

For the five-year study period (2007 through 2011), there was a total of 850 ED visits (797 residents and 53 non-residents) and 63 hospitalizations (61 residents and two non-residents) for occupational HRI in North Carolina.

Occupational status was determined through payer source or the work-related "Ecode algorithm". The workers' compensation payer source alone identified 76 percent of work-related cases for hospitalization data and 52 percent of ED visit data (Table 1). However, the "Ecode algorithm" identified an additional 24% of work-related cases of hospitalizations and 48 percent of ED visits for occupational HRI.

Emergency Department Visits

An average of 213 occupational HRI ED visits occurred each year; an average rate of 4.8 ED visits per 100,000 resident workers (Table 2). Males accounted for 730 (86%) of these visits and females accounted for 120 (14%). Workers ages 25 to 34 years had the highest proportion of occupational HRI visits (Table 3). Only four percent of ED visits were admitted to the hospital, and two cases (0.2%) died. As expected, the largest proportion of occupational HRI ED visits occurred during the hottest summer months (June-August), however, 11 percent of all visits occurred in May and September. One hundred and forty-seven (17%) had a diagnosis code for at least one comorbid condition, the most common was a respiratory outcome/history (5%) (Figure 3).

Hospitalizations

Occupational HRI infrequently required hospitalization. An average of 13 occupational HRI hospitalizations among workers in NC occurred each year, at an average rate of 0.3 hospitalizations per 100,000 resident workers (Table 2). Males accounted for 60 (95%) of 63 HRI hospitalizations. Workers ages 35 to 44 years had the highest proportion of occupational HRI hospitalizations (Table 3). The average length of stay for an occupational HRI hospitalization was 4.8 days (Range=1.0 – 42 days). Predictably, the largest proportion of occupational HRI hospitalizations occurred during the hottest summer months (June-August), however, 10 percent of all hospitalizations occurred in September, and hospitalizations occurred for all months throughout the year except December. Fifty-two (83%) of cases had a

[b] The CPS is a monthly survey of households conducted by the Bureau of Census for the BLS, and provides comprehensive employment data on the labor force.[10] The GP provides employment and unemployment annual averages from the CPS by geographic regions and selected demographic and economic characteristics.[11] Rates were calculated annually per number of employed persons.

diagnosis code for at least one comorbid condition, the most frequent were renal outcome/history (60%), followed by cardiovascular outcomes/history (24%) and respiratory outcome/history (22%) (Figure 3).

Public Health Significance

About 78 percent of all occupational HRI hospitalizations and 84 percent of ED visits occurred during the summer months. However, an additional 10 percent of hospitalizations and 11 percent of ED visits occurred in May and September, months adjacent to the summer period (June through August). This accounts for 107 additional workers who were hospitalized and/or visited an ED for heat-related illness. Additionally, there has been a steady increase in the rate of hospitalizations and ED visits for occupational HRI over time, with almost double the rate of ED visits in 2011 from 2007, and a six-fold increase in hospitalizations in 2011 from 2007. This problem may continue to increase as environmental temperatures continue to rise[12,13].

Males comprised the vast majority of occupational HRI cases (95% of hospitalizations, 86% of ED visits). This reflects that the industries with highest risk of HRI (agriculture, forestry and fishing; construction; and transportation and warehousing) are male-dominated industries[9]. HRI affects all ages, but older workers may be more likely to experience severe health effects that may result in hospitalization.

Workers who have an underlying condition are especially at risk for more severe outcomes resulting in hospitalization. Acute renal failure is a common complication resulting from exertional heat stroke[14,15]. The high proportion of renal diagnoses among those hospitalized (60%) indicates a strong association between renal conditions and occupational HRI. However, it is unclear if the renal conditions, or any of the other comorbid diagnoses, were outcomes of occupational HRI or pre-existing conditions made worse by heat exposure.

Occupational HRI are preventable. Timely surveillance and effective prevention strategies by employers that include a heat illness prevention program are important to reduce incidents of occupational HRI[9,16].

Limitations

The number of occupational HRI in this analysis may be underestimated due to hospitalization data not capturing cases treated in outpatient setting or federal acute-care facilities. North Carolina residents hospitalized in other state are also not captured in hospitalization data. ED visit data was also not available for all years of the study period. Additionally, selecting cases using workers' compensation as the primary payer source does not capture workers using other sources of payment, or workers who chose not to report their injuries as work-related. However, the Ecode algorithm developed captured many more potential missing cases. Workers and employers may also be exempt from workers' compensation coverage or not provide it, or workers may be unaware of benefits. Variables that help describe patterns of occupational HRI such as race, ethnicity, type of industry and occupation were not systematically available in hospitalization or ED visit data. Finally, occupational HRI rates may be underestimated due to inclusion of non-exposed workers (e.g. office workers) in the denominator.

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Appendix

Table 1. Work-Related Selection Criteria for Occupational Heat-Related Illness in North Carolina, 2007*-2011

Work-Related Selection Criteria	Hospitalizations for Occupational Heat-Related Illness (n=63)		ED Visits for Occupational Heat-Related Illness (n=850)	
	Number	*%*	*Number*	*%*
Primary Payer Source: Workers' Compensation	48	76	443	52
Ecode Algorithm	15	24	407	48

Source: North Carolina Inpatient Hospital Discharge Database and North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT).
*ED visit data was only available from 2008 onward.
Notes: Counts reflect state and non-state residents ages ≥16 years and employed in North Carolina. Hospital discharge records are limited to records from non-federal, acute-care hospitals. This data excludes North Carolina residents hospitalized out of state. NC DETECT is an advanced, statewide public health surveillance system. NC DETECT is funded with federal funds by North Carolina Division of Public Health (NC DPH), Public Health Emergency Preparedness Grant (PHEP), and managed through a collaboration between NC DPH and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics (UNC CCHI). The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented. The NC DETECT Data Oversight Committee (DOC) includes representatives from the NC DPH, UNC NC DETECT Team and NC Hospital Association.

Table 2. Number and Crude Rate of Occupational Heat-Related Illness Hospitalizations and Emergency Department (ED) Visits in North Carolina, 2007*-2011

Year	Hospitalizations for Occupational Heat-Related Illness		Emergency Department Visits for Occupational Heat-Related Illness	
	Number[1]	*Crude Rate*[2]	*Number*[1]	*Crude Rate*[2]
2007	6	0.1	--[3]	--[3]
2008	9	0.2	139	3.1
2009	4	0.1	131	3.1
2010	19	0.4	306	7.0
2011	25	0.6	274	6.1
Average	**13**	**0.3**	**213**	**4.8**

Source: North Carolina Inpatient Hospital Discharge Database and North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT). Workforce estimates from the BLS Current Population Survey and Geographic Profile of Employment and Unemployment.
*ED visit data was only available from 2008 onward.
[1] Counts reflect state and non-state residents.
[2] Rates reflect state residents only, and were calculated per 100,000 annual estimate of employed people ages ≥16 years in North Carolina.
[3] ED visit counts not available for 2007.
Notes: Counts are of employed people ages ≥16 years in North Carolina. Hospital discharge records are limited to records from non-federal, acute-care hospitals. This data excludes North Carolina residents hospitalized out of state. NC DETECT is an advanced, statewide public health surveillance system. NC DETECT is funded with federal funds by North Carolina Division of Public Health (NC DPH), Public Health Emergency Preparedness Grant (PHEP), and managed through a collaboration between NC DPH and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics (UNC CCHI). The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented. The NC DETECT Data Oversight Committee (DOC) includes representatives from the NC DPH, UNC NC DETECT Team and NC Hospital Association.

Table 3. Demographics of Occupational Heat-Related Illness Hospitalizations and Emergency Department (ED) Visits in North Carolina, 2007*-2011

Worker Characteristics	Hospitalizations for Occupational Heat-Related Illness (n=63)		ED Visits for Occupational Heat-Related Illness (n=850)	
	Number	*%*	*Number*	*%*
Age (Years)				
16-19	--[a]	--	55	6
20-24	--[a]	--	124	15
25-34	16	25	227	27
35-44	20	32	208	24
45-54	12	19	166	20
55-64	8	13	61	7
65+	--[a]	--	--[b]	--
Sex				
Female	--[a]	5	120	14
Male	60	95	730	86
Patient Status[1]				
Discharged	55	87	812	96
Transferred	6	9	6	1
Observation[2]			10	1
Hospice[3]	1	2		
Left against/ w/o medical advise	1	2	9	1
Died	0	0	2	0
Unknown/missing	0	0	11	1
Expected Payer				
Workers' Compensation	45	71	443	52
Private Insurance Company	6	10	140	16
Governmental Insurance	4	6	48	6
Self-Pay	8	13	185	22
Other	0	0	25	3
Unknown/missing	0	0	9	1

Source: North Carolina Inpatient Hospital Discharge Database and North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT).

*ED visit data was only available from 2008 onward.

[a] Hospitalization counts under 5 for personally identifiable demographic data (e.g. age, sex) were censored for confidentiality purposes.

[b] ED visit counts under 10 for personally identifiable demographic data (e.g. age, sex) were censored for confidentiality purposes.

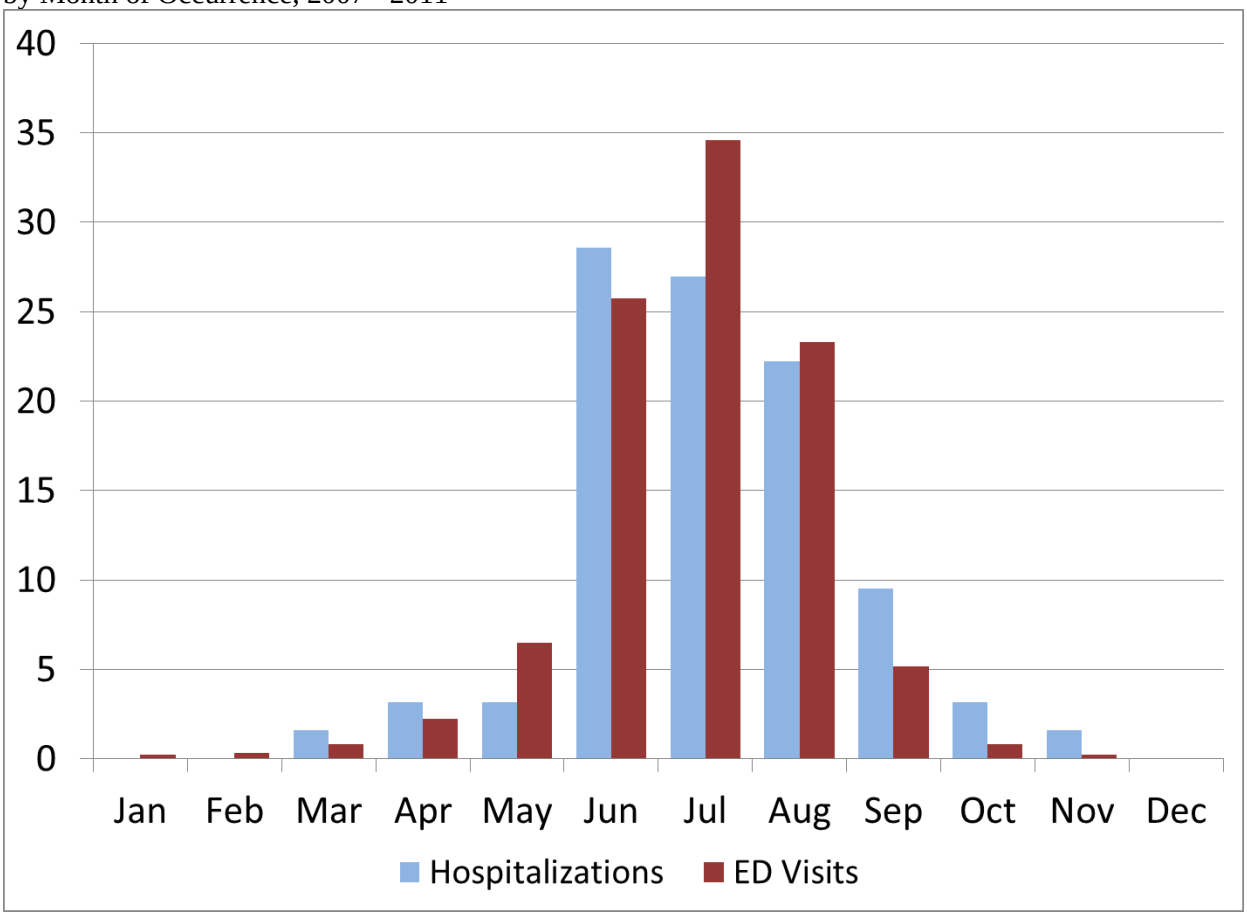
[1] Patient's status after receiving treatment at acute care facility.

[2] Category only available in ED data.

[3] Category only available in hospitalization data.

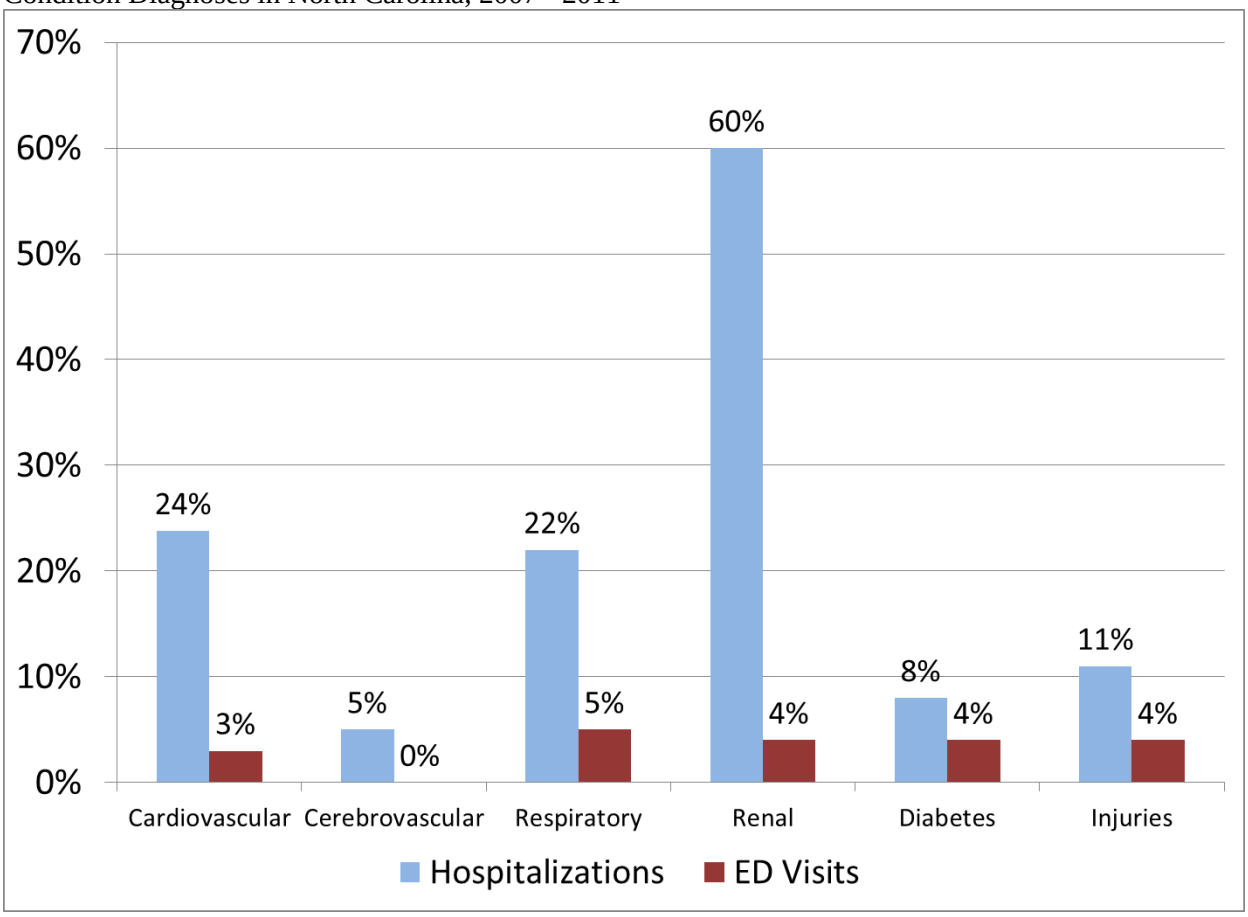
Notes: Counts reflect state and non-state residents ages ≥16 years and employed in North Carolina. Hospital discharge records are limited to records from non-federal, acute-care hospitals. This data excludes North Carolina residents hospitalized out of state. NC DETECT is an advanced, statewide public health surveillance system. NC DETECT is funded with federal funds by North Carolina Division of Public Health (NC DPH), Public Health Emergency Preparedness Grant (PHEP), and managed through a collaboration between NC DPH and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics (UNC CCHI). The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented. The NC DETECT Data Oversight Committee (DOC) includes representatives from the NC DPH, UNC NC DETECT Team and NC Hospital Association.

Figure 1. Proportions of Occupational HRI Hospitalizations & Emergency Department (ED) Visits in North Carolina by Month of Occurrence, 2007*-2011



Source: North Carolina Inpatient Hospital Discharge Database and North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT).
*ED visit data was only available from 2008 onward.
Notes: Proportions of counts reflect state and non-state residents ages ≥16 years and employed in North Carolina. Hospital discharge records are limited to records from non-federal, acute-care hospitals. This data excludes North Carolina residents hospitalized out of state. NC DETECT is an advanced, statewide public health surveillance system. NC DETECT is funded with federal funds by North Carolina Division of Public Health (NC DPH), Public Health Emergency Preparedness Grant (PHEP), and managed through a collaboration between NC DPH and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics (UNC CCHI). The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented. The NC DETECT Data Oversight Committee (DOC) includes representatives from the NC DPH, UNC NC DETECT Team and NC Hospital Association.

Figure 2. Percentage of Occupational HRI Hospitalizations and Emergency Department (ED) Visits with Comorbid Condition Diagnoses in North Carolina, 2007*-2011



Source: North Carolina Inpatient Hospital Discharge Database and North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT).
*ED visit data was only available from 2008 onward.
Notes: Comorbid conditions are not mutually exclusive. Proportions of counts reflect state and non-state residents ages ≥16 years and employed in North Carolina. Hospital discharge records are limited to records from non-federal, acute-care hospitals. This data excludes North Carolina residents hospitalized out of state. NC DETECT is an advanced, statewide public health surveillance system. NC DETECT is funded with federal funds by North Carolina Division of Public Health (NC DPH), Public Health Emergency Preparedness Grant (PHEP), and managed through a collaboration between NC DPH and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics (UNC CCHI). The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented. The NC DETECT Data Oversight Committee (DOC) includes representatives from the NC DPH, UNC NC DETECT Team and NC Hospital Association.

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