

# Employment Status and the Frequency and Causes of Burn Injuries in New England

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*We analyzed a subset of data from the New England Regional Burn Program (NERBP) to assess the effects of employment status on the rates and causes of burn injuries in New England. The subset of the NERBP data analyzed pertained to residents of the six New England states who were hospitalized for the treatment of a burn injury sustained between July 1, 1978 and June 30, 1979 and who were aged 20 years or older at the time of the injury. Analysis of the data identified that men, particularly black men and young men, experienced higher burn rates than did their female, white, and older counterparts among both employed and unemployed persons. High burn rates were observed in Maine; low rates were observed in Rhode Island. Scalds were the most common type of burn among work-related burns to women and to men aged 20 to 54 years, and flame or flash burns were the most common otherwise. The majority of work-related burn injuries were caused by activities related to food preparation or consumption, motor vehicle repair and maintenance, and use of flammable liquids. Persons employed as operatives and laborers, or persons employed in the service occupations, appeared to have the highest risk of sustaining a burn injury while at work.*

**B**urns are the fourth leading cause of injury death in the United States, accounting for approximately 6 000 deaths each year. An additional 100 000 persons are hospitalized annually for the treatment of burns. Of these patients, an estimated 50% sustain substantial, temporary or permanent disabilities resulting from the burn injury.<sup>1</sup>

Recognized risk factors for burn injury include extremes of age, alcohol use, functional or mental impairment, and low economic status. Men experience higher burn rates than do women, and, in the United States, rates for the black population are higher than the rates for the white population.<sup>2-5</sup>

The literature on burn epidemiology and control concentrates on nonoccupational burns, such as scalds to young children and flame burns involving flammable liquids and structural fires. Less well characterized, particularly in well-defined, regional populations, is the epidemiology of work-related burns and the effects of employment status on the rates and causes of burn injuries. The several published studies of occupational burns have found that work-related burn injury rates are higher for men compared with women, and higher for persons aged 15 to 24 years than for older workers.<sup>6-11</sup> The total number of work-related burn injuries treated in hospital emergency departments each year in the United States is estimated to be approximately 150 000, based on data derived from the National Institute for Occupational Safety and Health (NIOSH)-Consumer Product Safety Commission National Electronic Injury Surveillance System.<sup>8</sup>

Of particular interest with respect to the planning of preventive efforts, although lacking in the published reports, are comparisons of the relative contributions of the workplace to the total burn problem in employed populations, and comparisons of burn rates and the causes of burning in employed populations v populations that are not employed. To our knowledge, the only study that attempts to address these issues is the study by Rossignol et al,<sup>12</sup> which is based on a one-state subset of the data contained in the present study. The present analysis extends the findings from this previous one-state study and also reanalyzes the data previously reported to include more accurate estimates of the rates of work- and nonwork-related burns.

Specifically, the objectives of this study are to provide

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a definitive assessment of the effects of work status and of employment status on the rates and causes of burn injuries in New England; to evaluate risk factors for burns including age, sex, race, and place of residence; and to identify occupations associated with increased risk of burn injury.

## Methods

### New England Regional Burn Program

The New England Regional Burn Program (NERBP) was one of six projects within the National Burn Demonstration Project established under contractual agreements with the Division of Emergency Medical Services of the US Department of Health and Human Services (then the US Department of Health, Education, and Welfare) to collect data on burn injuries occurring over a 26-month interval (May 1978 to June 1980).<sup>13</sup> The primary objective of the project was to collect data pertaining to the delivery of medical treatment to burned patients nationwide. It was hoped that these data would: (1) permit evaluation of the adequacy of existing treatment facilities, (2) provide estimates of the relative effectiveness of different modes of burn care, and (3) identify the cost of acute care and rehabilitation of burned patients.

Among the NERBP's data collection efforts was the identification of persons admitted to any of 240 of New England's 256 acute-care hospitals for treatment of a new burn injury. Patients were identified primarily by review of hospital inpatient records and emergency room logbooks. A secondary method of identifying burn victims was by review of newspapers and other news reports for mention of burn injuries. Types of injuries included in the effort were scald, flame, flash, contact, electrical, chemical (International Classification of Disease codes 983.0, 983.1, 983.2, and phosphorus in code 983.9), and ultraviolet radiation burns. The present study is based on a subset of the NERBP's data. The subset consists of information for inpatients who were New England residents on the date of the burn injury, who were burned between July 1, 1978 and June 30, 1979, and who were aged 20 years or older at the time of the injury.

(Originally, adolescents between the ages of 16 and 19 years were included in the present study, but, because information pertaining to whether or not the burn was work-related was lacking for a high proportion of these patients, they were eliminated from the analysis. Fifty (25%) of the 198 burns to boys aged 16 to 19 years were known to be work-related as were 12 (19%) of the 62 such burns to 16- to 19-year-old girls. The data concerning whether or not the burn was work-related were available for 90% of the burns to 16- to 19-year-old adolescents residing in Massachusetts. For these persons, the rates of work-related burns were 142.8 burns per 100 000 person-years for boys and 15.1 burns per 100 000 person-years for girls.)

To assess the completeness of the NERBP's case finding, two case-finding quality control procedures were

implemented in a representative sample of participating hospitals. These intensive reviews indicated that the overall completeness of case finding was at least 90%.

Demographic data, including employment status, and information regarding whether the burn was work-related and the etiologic type of the burn injury were obtained by review of the medical record for each case. A burn was regarded as work-related if the method of payment was Workers' Compensation or if the description of the circumstances of the burn injury clearly indicated that the burn occurred during paid employment.

The etiologic type of burn injury was summarized using a four-digit "victim activity code" that discriminated among the various types of burns and sequences of events that result in burn injury. Use of the victim activity code was unique to the New England site of the National Burn Demonstration Project.

Categorization of persons into occupational groups was based on the 1980 US Census definitions for each occupation.<sup>14</sup>

### Analysis of Data

The study is based on data for New England residents who were burned between July 1, 1978 and June 30, 1979, who were treated as hospital inpatients in any of the 240 hospitals participating in the NERBP, and who were aged 20 years or older at the time of the burn injury. Residents of 12 Massachusetts cities and towns were not included in the analysis because three hospitals primarily serving these communities did not participate in the NERBP. In addition, the approximately 60 burn victims who died before hospitalization are not included in the present study.

Crude and age-, race-, and sex-specific incidence rates of work- and nonwork-related burns were estimated by relating the number of inpatient burns in each category of work status to the number of person-years during which the burns were observed to occur. The numbers of person-years used to calculate these rates were based on data reported in the 1980 US Census for each of the six New England states, minus the data for Massachusetts communities not included in the study.<sup>15</sup> (The number of burn injuries treated at the other 13 acute-care hospitals not participating in the NERBP was estimated to be small, and no adjustments for this under-reporting of burn cases were made.) The total population of New England aged 20 years or older, adjusted for data from the 12 nonparticipating communities in Massachusetts, was approximately 8.4 million.

The numbers of person-years used to estimate the rates of work- and nonwork-related burns among employed persons were based on the average numbers of hours worked per week by age category and sex, as tallied by the US Departments of Labor and Commerce.<sup>16-18</sup> Burn rates for persons who were not employed were based on the number of persons in the two categories of employment status, unemployed and not in the labor force, as reported in the 1980 census.

Confidence limits for the ratio of two incidence rates were calculated by the method and programs described by Rothman and Boice.<sup>19</sup>

The proportions of the work force employed in the different occupational groups were based on the 1980 census figures for each occupational group.<sup>14</sup>

## Results

### Age and Sex

One thousand six hundred fourteen new burn injuries were identified for the period July 1, 1978 through June 30, 1979. For both sexes combined, 30% of the burns (485 burns) were known to be work-related. The proportion of burns that were work-related differed considerably by sex, with 40% of the 1133 burns to men identified as work-related compared with only 7% of the 481 burns to women.

Tables 1 and 2 show the effects of employment status on the rates of burn injuries more clearly. These tables show the burn incidence rates and the number of injuries for men (Table 1) and for women (Table 2) according to age, employment status, and whether or not the burn occurred at work. The crude burn rate was substantially higher for men than for women among both employed persons (incidence rate ratio = 5.3, 90% confidence interval = 4.6 to 6.1) and for persons who were not employed (incidence rate ratio = 1.8, 90% confidence interval = 1.6 to 2.1).

Among men, the overall rate of burns was slightly higher for employed persons compared with persons who were not employed. This difference was due entirely to high rates of work-related burns, particularly among young (20- to 24-year-old) men, although higher rates at work were apparent in each age category. Overall, 55% of the burns to employed men occurred at work. For both categories of employment status combined, burn rates were highest for young men and lowest for persons aged 55 years and older.

For women (Table 2), fewer burns were observed among employed women, with a burn rate considerably lower than the rate for women who were not employed (incidence rate ratio = 0.4, 90% confidence interval = 0.3 to 0.5). Thirty percent of the burns to employed women occurred at work.

### Race

Table 3 shows the burn rates and the numbers of injuries by sex, employment status, and whether or not the burn was work-related for the white and black populations. The burn rates were considerably higher for black men and women compared with their white counterparts for both categories of employment status and, among employed persons, for both work- and non-work-related burns (crude incidence rate ratio for blacks compared with whites = 2.9, 90% confidence interval = 2.5 to 4.0 for men, and 3.0, 90% confidence interval = 2.3 to 4.0 for women).

TABLE 1  
Burn Injuries among Men by Age and Employment Status: New England Resident Inpatients, July 1, 1978 to June 30, 1979

Age, yr	Employed								Not Employed		Employment Status Unknown		Total	
	Work- and Nonwork-Related		Work-Related		Nonwork-Related		Work Status Unknown		Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns
	Burn Incidence Rate*	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns						
20-24	46.5	183	104.7	103	21.3	63	NA	17	21.4	32	NA	17	42.7	232
25-54	27.4	539	59.4	292	13.2	195	NA	52	36.3	87	NA	40	30.2	666
55-64	19.8	84	45.2	48	8.8	28	NA	8	18.5	28	NA	5	20.3	117
≥65	15.8	17	29.6	6	10.3	9	NA	2	20.6	95	NA	6	20.7	118
Total	28.5	823	62.7	449	13.6	295	NA	79	24.2	242	NA	68	28.6	1133

\* Number of burns per 100 000 person-years.

TABLE 2  
Burn Injuries among Women by Age and Employment Status: New England Resident Inpatients, July 1, 1978 to June 30, 1979

Age, yr	Employed								Not Employed		Employment Status Unknown		Total	
	Work- and Nonwork-Related		Work-Related		Nonwork-Related		Work Status Unknown		Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns
	Burn Incidence Rate*	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns						
20-24	6.3	24	10.0	8	4.3	13	NA	3	13.2	24	NA	13	10.8	61
25-64	5.2	93	7.3	27	6.3	59	NA	7	11.8	140	NA	42	9.3	275
≥65	1.4	3	9.6	1	1.8	1	NA	1	15.9	134	NA	8	15.8	145
Total	5.4	120	7.7	36	4.2	73	NA	11	13.5	298	NA	63	10.8	481

\* Number of burns per 100 000 person-years.

The rate of burn injuries among the black population exceeded the rate among the white population by more than 2.5-fold, but varied little between racial groups by employment status or work status (incidence rate ratio of employed blacks compared with whites was 2.5 for work-related burns and 2.6 for nonwork-related burns, and was 3.1 for persons who were not employed). For persons whose injuries did not involve circumstances related to work (that is, burns to persons who were not employed or nonwork-related burns to employed persons), burn injuries were consistently higher among persons who were not employed. This pattern was observed for both men and women and for both the black and white populations. The preceding comparisons changed little, if at all, when standardized for age.

### Geographic Variation

Substantial geographic variation in burn rates was observed among the New England states. For both men and women, the overall burn rate was lowest in Rhode Island (24.4 and 6.5 burns per 100 000 person-years for men and women, respectively) and highest in Maine (37.0 and 14.5 burns per 100 000 person-years for men and women, respectively). Further examination of the data revealed that, among men, Rhode Island residents experienced the lowest burn rate only for nonwork-related injuries to employed persons, whereas Maine residents experienced the highest overall burn rate primarily because their rate of work-related burns was substantially higher than the rates for residents of the other New England states (data not shown).

Employed men experienced higher burn rates and employed women had lower burn rates than their unemployed counterparts in each of the six New England states (data not shown). (The burn rate among employed men in Connecticut was only slightly higher than the corresponding rate for men who were not employed.) For men, this difference was attributable to the high

rates of work-related burns in each state. Considerable variation in work-related burn rates was observed for both men and women, with rates in Maine far exceeding the rates observed in any of the other states. The work-related burn rates in Maine were 88.0 and 20.0 burns per 100 000 person-years for men and women, respectively, compared with an average of 56.4 and 4.6 burns per 100 000 person-years for each of the other five states.

### Etiologic Type

Tables 4 and 5 show the percentage and number of burns by etiologic type, employment status, and whether or not the burn was work-related for men (Table 4) and women (Table 5). In Table 4, these percentages and numbers of burns are presented separately for men aged 20 to 54 years, and for men aged 55 years and older because these age categories display different etiologic patterns of burns. Scalds and flame or flash burns were the most common types of burn injury for men and women in each employment category and, among employed persons, for both work- and nonwork-related burns. The relative contribution of scalds and of flame or flash burns to the total numbers of burns in these different categories varied, with scalds being the most common type among work-related burns to women and men aged 20 to 54 years, and flame or flash burns being the most common type otherwise. Explosion or ignition of flammable liquids accounted for the majority of work-related flame or flash burns.

Notable among the etiologic patterns for burn injury was the contribution of burns associated with food preparation or consumption and, to a lesser extent, burns associated with motor vehicles. These two patterns of injury accounted for the majority of work-related burns and were substantial components of nonwork-related burns. Overall, burns associated with food preparation or consumption accounted for 22% and 33% of the total number of burns to men and to women, respectively.

TABLE 3

Burn Injuries among Persons Aged 20 Years or Older by Race, Sex, and Employment Status: New England Resident Inpatients, July 1, 1978 to June 30, 1979

Race/Sex	Employed						Not Employed		Employment Status Unknown		Total			
	Both Work- and Nonwork-Related		Work-Related		Nonwork-Related		Work Status Unknown		Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns
	Burn Incidence Rate*	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns	Burn Incidence Rate	No. of Burns						
White														
Male	23.7	656	51.9	356	11.4	236	NA	64	19.9	185	NA	51	24.1	892
Female	4.5	95	5.9	26	3.6	60	NA	9	12.1	255	NA	19	8.7	369
Both sexes	15.4	751	33.9	382	7.9	296	NA	73	14.4	440	NA	70	15.9	1261
Black														
Male	63.8	54	138.2	29	34.6	22	NA	3	64.2	26	NA	9	71.1	89
Female	9.7	8	23.3	4	6.2	4	NA	0	32.4	21	NA	10	26.5	39
Both sexes	37.1	62	86.6	33	20.2	26	NA	3	44.6	47	NA	19	47.0	128
Unknown														
Male	NA	113	NA	64	NA	37	NA	12	NA	31	NA	8	NA	152
Female	NA	17	NA	6	NA	9	NA	2	NA	22	NA	34	NA	73
Both sexes	NA	130	NA	70	NA	46	NA	14	NA	53	NA	42	NA	225

\* Number of burns per 100 000 person-years.

TABLE 4

Burn Injuries among Men by Employment Status, Age, and Whether the Burn Was Work-Related: New England Resident Inpatients, July 1, 1978 to June 30, 1979

Burn Type	Men, 20-54 Years						Men, ≥55 Years					
	Employed			Not Employed			Employed			Not Employed		
	Work-Related Burns		Nonwork-Related Burns	Work-Related Burns		Nonwork-Related Burns	Work-Related Burns		Nonwork-Related Burns	Work-Related Burns		Nonwork-Related Burns
	%*	No. of Burns	%	No. of Burns	%	No. of Burns	%	No. of Burns	%	No. of Burns	%	No. of Burns
Scald												
Water-based	18	71	16	40	31	36	11	6	19	7	26	31
Nonwater-based	19	72	6	16	2	2	17	9	3	1	1	1
Total	37	143	22	56	33	38	28	15	22	8	27	32
Flame/flash												
Flammable liquid	23	89	33	83	12	14	31	17	22	8	16	19
Structural fire	4	14	14	34	17	20	2	1	19	7	8	9
Other	3	12	10	25	15	17	4	2	19	7	30	35
Total	30	115	57	142	44	51	37	20	61	22	53	63
Contact	9	34	10	25	7	8	19	10	6	2	16	19
Chemical	16	64	4	11	7	8	6	3	8	3	2	2
Radiation	0	0	4	10	5	6	0	0	3	1	1	1
Electrical	8	32	3	7	3	4	11	6	0	0	1	1
Type unknown*	NA	7	NA	7	NA	4	NA	0	NA	1	NA	5
Total	100	395	100	258	100	119	100	54	100	37	100	123
Special subsets												
Food preparation/consumption	36	141	12	30	15	17	50	27	11	4	22	26
Motor vehicle-related	14	55	21	53	13	15	11	6	6	2	3	4

\* Unknowns excluded in percentage calculations.

TABLE 5

Burn Injuries among Women by Type of Burn, Employment Status, and Whether the Injury Was Work-Related: New England Resident Inpatients, July 1, 1978 to June 30, 1979

Burn Type	Employed				Not Employed	
	Work-Related Burns		Nonwork-Related Burns		%	No. of Burns
	%*	No. of Burns	%	No. of Burns		
Scald						
Water-based	61	19	22	16	30	83
Nonwater-based	13	4	11	8	9	25
Total	74	23	33	24	38	108
Flame/Flash						
Flammable liquid	6	2	15	11	19	52
Structural fire	0	1	11	8	8	22
Other	0	0	17	12	18	51
Total	10	3	43	31	44	125
Contact	10	3	13	9	13	36
Chemical	0	1	3	2	2	7
Radiation	0	0	7	5	2	5
Electrical	3	1	1	1	0	0
Type unknown*	NA	5	NA	1	NA	17
Total	100	36	100	73	100	298
Special subsets						
Food preparation/consumption	84	26	29	21	39	110
Motor vehicle-related	3	1	6	4	5	14

\* Unknowns excluded in percentage calculations.

The corresponding figures for motor vehicle-related burns were 12% and 4%. Among work-related burns, food preparation or consumption accounted for 36% of the burns to men and 84% of the burns to women.

### Occupation

Information about burn rates by occupational group is based on the 74% of employed men and 67% of

employed women for whom occupation was known. Among employed men, operatives and laborers were overrepresented among all burns, comprising 40.5% of all burns to men, compared with their corresponding percentage of the work force (18.5%), due to overrepresentation among both work- and nonwork-related burns. Sales and clerical personnel were underrepresented among both work- and nonwork-related burns, as was the group comprising professional, technical, managerial, and administrative workers (data not

shown). For this latter group, the most pronounced effect was underrepresentation among work-related burns (0.3% of the work-related burns occurred to members of this group; their proportion of the total work force was 20.2%). Among employed women, operatives and laborers were overrepresented among all burns, accounting for 30.2% of the burns and only 14.6% of the work force. This effect was observed among both work- and nonwork-related burns. In addition, service workers were overrepresented among all burns due to overrepresentation among burns that were work-related; service workers accounted for 48.3% of the work-related burns and only 14.8% of the work force. Women holding professional, technical, managerial, and administrative positions were underrepresented among work-related burns but overrepresented among nonwork-related burns (data not shown). Women who worked in sales and clerical occupations experienced low burn rates, accounting for 17.4% of all burns to women and 41.9% of the work force. No burns were observed among women who worked on farms, although the size of the work force in this occupation was small (approximately 10 000 workers). The differences in the proportion of burns occurring to male and female workers in the different occupational groups compared with their percentage of the employed work force were not attributable to differences in the average numbers of hours worked per week.

## Discussion

This study identifies the workplace as a major contributor to burn incidence among employed men aged 20 years or older, accounting for 55% of the burns to these persons. Men, and in particular black men, experienced higher burn rates than did their female and white counterparts among employed persons and among persons who were not employed. Substantial geographic variability in burn rates was observed, with high rates in Maine and low rates in Rhode Island for both men and women even though the composition of the work force with respect to occupational group, varies little among the six New England states.<sup>14</sup> Scalds were the most common type of burn among work-related burns to women and to men aged 20 to 54 years, and flame or flash burns were the most common otherwise. Activities accounting for the majority of work-related burn injuries were food preparation or consumption, motor vehicle repair and maintenance, and use of flammable liquids. Persons employed as operatives and laborers, or persons employed in the service occupations, appeared to have the highest risk of sustaining a burn injury while at work.

Three possible sources of error in this study warrant discussion. The first pertains to our use of Census and Bureau of Labor statistics in estimating the number of person-years used to calculate the burn rates for currently employed persons. The data concerning current employment status contained in these statistics refer to usual paid employment during the reference period, with

no adjustments made for atypical employment. Errors in the estimation of the appropriate number of person-years obviously would affect the magnitude of the reported work- and nonwork-related burn rates among employed persons, although not the relative magnitude of rates for employed persons compared with persons who were not employed. Errors in estimating the correct numbers of person-years might affect the various age and sex groups differentially if layoffs or other adjustments to employment occurred more frequently in some groups than in others. Although the extent of error from this source is unknown, it is unlikely that the magnitude would be large enough to affect materially the study findings because, in most instances, the differences in the sizes of the compared burn rates are large.

The second possible source of error pertains to the extent to which differential use of medical services might have affected the study findings. Persons burned at work, for example, might have been more readily admitted to a hospital than were persons burned in other settings. Such a bias would be more likely to occur among persons with small burns, among whom the probability of seeking medical attention at a hospital might be affected by factors such as insurance, liability, and responsibility for payment. The fact that we studied hospitalized burns, and not burns treated on an outpatient basis, would tend to reduce the likelihood that differential use of medical services accounted for the differences in the observed rates.

The third possible source of error pertains to the information concerning occupational group and burn injury. This information was based on data for a subset of the cases (that is, cases for whom occupation was recorded in the medical record), and, hence, may not have been representative of all burns to employed persons. Although some bias in recording occupation may exist, it seems unlikely that any such bias would be large enough to substantially alter the findings that suggest that persons who work as operatives and laborers, or who work in the service occupations, are at increased risk of sustaining a burn injury while at work.

Not examined in the present study is a comparison of burn rates among employed persons and among persons who were not employed, with the period of comparison restricted to burns that occur during usual working hours. Such a restriction would control for higher burn rates associated with nonsleeping time, and allow a clearer comparison of the burn injury risk of work activities v other activities. In addition, it would be useful, for preventive purposes, to compare risk factors for nonwork-related burns among employed v unemployed persons.

The study findings suggest the need to reassess several commonly held ideas about burn epidemiology and control. In particular, the large contribution of activities associated with food preparation or consumption to work-related burn rates counters the belief that the majority of work-related burns are associated with electrical or chemical mishaps. Another idea that may need reexamining concerns the well-known inverse relation between economic status and burn rates.<sup>4,6</sup> Specifically,

it would be useful, for the planning of preventive programs, to obtain a clearer sense of the contribution of blue collar employment to burn rates. The usual interpretations for the association between increased burn rates and lower economic status center on issues of poor housing design, overcrowding of living areas, and more limited access to inherently safer consumer products.

Work-related burns are a substantial and largely neglected component of the total burn problem in employed populations. This study identifies several high risk populations for work-related burn injury, including young persons, men, blacks, and residents of Maine. In addition, the study demonstrates that work-related burn injuries follow predictable etiologic patterns, particularly with respect to activities related to food consumption or preparation, motor vehicle repair and maintenance, and use of flammable liquids. The predictable nature of work-related burn injuries suggests that effective control programs can be designed and implemented to prevent the majority of these injuries.

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