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ORIGINAL RESEARCH

Shifted Firefighter Health Investigation by Personal Health Insurance Record in Taiwan

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Introduction: Taiwan's firefighters use a shift rotation system with 2 days of work and 1 day of rest. Numerous papers have already explored the risks of shift work to the body. However, little data concern the impact of shift work on health as reflected in medical visits. This study used individuals' medical visit record in Taiwan's health insurance system. The locally called "health bank" contains individuals' medical visit record, health insurance payment points and the medicine used.

Methods: Consent was obtained from 150 firefighters who were serving under the shift rotation system to obtain their 2015 individual "My Health Bank" medical data. Comparisons were made between national health insurance data norm.

Results: Firefighters make significantly more visits for Western medicine than the annual average (firefighters 6.27 vs norm 5.24, P = 0.04142), more total number of medical visits (9.57 vs 7.75, P = 0.0102), more annual average payment points for Western medicine (4079 vs 2741, P = 0.003151), and a greater average number of total annual medical visit points (7003 vs 4940, p = 0.0003157). Firefighters had significantly higher incidents of respiratory diseases, urogenital diseases, skin and subcutaneous tissue diseases, musculoskeletal system and connective tissue diseases, injuries, and illness from poisoning than did the norm (P<0.05).

Conclusion: A persuasive health-survey-based method for workers in high occupational hazard industries was proposed in this study, and the result was highly correlated with risk factors of fireworkers. The proposed study method is potential to investigate risk factors of other working.

Keywords: firefighters, shift worker, health insurance record

Introduction

The shift rotation system is a work pattern that is necessary in many fields, particularly for workers who often work at night for long periods of time. However, long-term shift rotations have a negative impact on workers' health.[1,2] Firefighters work under the shift rotation system, and the long-term shift rotations have a significant impact on their sleep[3] and psychological stress.[4] Because frontline firefighters must protect the life and assets of the public and arrive at incident sites immediately, they must be on call during the shift rotation system. In addition, uncertainty in different types of disaster sites significantly affects the physical and mental health of disaster rescue personnel, and this can cause many types of occupational hazards and diseases. Taiwan's firefighters shift rotation system is based on a work pattern of 2 days of work and 1 day of rest (working for 48 h and resting for 24 h). In Taiwan, 40% of firefighters have gastrointestinal diseases,

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followed in percentage by respiratory system diseases, high blood pressure, and liver diseases. Injuries to the hands (arms) and feet (legs) account for most work-related injuries (approximately 50%), followed by waist (hip) injuries (20%).[5] Thus, the health problems of shift rotation firefighters remain a focus for academia.[6] Table 1 lists recent studies on occupational injuries that are related to firefighters and shift rotations. These mainly involve sleeping,[14,15] depression and stress,[16,17] cognitive functions,[18] cancer,[19,20] hypertension,[21] physical activity and obesity,[22–24] metabolic syndromes,[25] and injuries and musculoskeletal disorders.[26,27] According to the 2154 work

Table 1 Recent Studies on Occupational Injuries That are Related to Firefighters and Shift Rotations

Ref no.	Year	Country	Subjects	Stuy Method	Major Finding
16	2008	japan	1301 shift-work firefighters.	CES-D; job dissatisfaction survey	Workload, intergroup conflict, social support from a supervisor related to depressive symptoms and/or job dissatisfaction
14	2018	Iranian	60 shift work firefighters	melatonin, sleepness	Melatonin level change at 3:00 and 7:00
15	2017	Korea	110 shift work firefighters	Pittsburgh Sleep Quality Index, the Insomnia Severity Index, the Epworth Sleepiness Score, the Stanford Sleepiness Score, the Fatigue Severity Scale, and the Berlin Questionnaire	60% of the participating firefighters had a certain degree of insomnia
17	2017	Finland	firefighters	Heart rate variability during shifts.	Physiological load and psychological stress were temporarily high
18	2020	Poland	18 paramedics, 16 firefighters and 17 day worker	EEG	Higher amplitude of the P200 and P300 potential
19	2018	Danish	11,775 firefighters	mortality ratios	Death from stomach cancer increased
21	2016	USA	330 firefighters	Blood pressure	Sixteen 24-h shifts had 5.0 mmHg higher DBP
22	2016	Australia	Thirty-four salaried firefighters	wore an Actical accelerometer for 28 consecutive days	70% light-intensity physical activity
25	2016	Germany	97 firefighters and 46 office workers	metabolic syndrome	Sedentary occupation as an office worker is associated with a high risk of MetS
23	2017	Canada	N.A	Veterans' Affairs Wellness kit	Suitability of Veterans' Affairs Wellness kit
24	2016	USA	308 male firefighters	obesity	Increased the risk for obesity
20	2017	Canada	Review article	Prostate cancer	Small excess risks of prostate cancer were observed from firefighter studies with moderate to substantial heterogeneity
26	2019	Ghana	320 firefighters	musculoskeletal disorders	Positive effect on musculoskeletal disorders
27	2017	USA	10,000	injury	Strains, sprains, and muscular pain.

injuries that were recorded from 2010 to 2015 in South Korea in reference,[28] the majority of injuries concerned the upper and lower back (25.3%). Such study results were similar to the results of this study. Although the data were from a different country, firefighters do the same work worldwide, and the distribution of common occupational injuries and diseases is similar. However, most studies on the health problems of firefighters have been based on questionnaire surveys. Some studies have focused on specific diseases or physical/mental situations such as by using the Pittsburgh Sleep Quality Index questionnaire to study sleeping problems[7] or surveys that focus on respiratory tract diseases.[2] These methods are excellent but can be influenced by the subjective views of the researcher. The interviewees may not accurately reflect topics that the researcher is not focused on, and this can result in omissions. Thus, direct research of interviewees' medical records can offer opportunities to find different answers.

Taiwan has a public health insurance system that includes nearly all residents. Currently, the National Health Insurance Administration (NHIA), Ministry of Health and Welfare, is responsible for its management. To allow the public to sufficiently understand their use of medical resources, convenient channels have been established for the public to access their individual health-care data to conduct individual health management and for them to cherish these medical resources. In 2014, the NHIA introduced the "My Health Bank" information service. Mobile devices such as smart phones or tablet computers can be used to search or download the My Health Bank and check individual health information. This can help achieve self-health management, integrate information from different hospitals/clinics, and allow users to understand their own medical use (to prevent the repeated use of drugs).[8] My Health Bank can be used to download medical treatment data such as outpatient data, inpatient data, dental health bank data, allergy information, checkup data, images or pathology examination reports, hospital discharge medical records, organ donation or hospice treatment wishes, vaccination bank data, and insurance billing and premium payment information. Similar systems include Australia's Medicare[9] and the US Department of Veterans Affairs' "Blue Button" individual medical record download plan.[10] The public can download their own individual medical records and share these with doctors when necessary.[11] Thus, My Health Bank can be used to collect all patients' medical visit information and prevent researchers' subjectivity from limiting the scope of occupational hazard research.

My Health Bank's disease categorization system is based on the International Statistical Classification of Diseases and Related Health Problems (ICD-9) coding principle.[12] The ICD-9 categorizes diseases and signs, symptoms, abnormalities, discomfort, social environments, and trauma into 19 categories. By using these 19 categories, the information obtained through My Health Bank, and with firefighters from the Taichung City Fire Department as interview participants, this study compared and analyzed the number of annual medical visits by firefighters (including for Western medicine, Chinese medicine, and dental services, and the total number of such visits), use of Medicare payment points, ICD-9CM distribution, and the total number of annual medical visits by the general public for diseases that are published by the Ministry of Health and Welfare[11] to better understand the health situation of firefighters who work on shift rotations.

Materials and Methods

Subject Information

The participants of this study were field-service firefighters from the Taichung City Fire Department who were working under the 2 day on/1 day off work rotation system (ie, working for 48 h and resting for 24 h). There are 11 firefighting departments in Taichung City, and two departments are chosen to recruit subjects. The A department has 6 units, and B department has 5 units. Total members of these two departments are 223, and 150 subjects agree to participate in this project. This sampling procedure is a kind of cluster sampling. The sampling numbers and proportion of each unit are listed in Table 2. Most subjects are recruited by one of the authors, he is also the member of Fire Bureau of Taichung City Government.

Basic Questionnaire, Health Database Collection, and Data Processing

This study was divided into two parts. The first part involved the "Individual Basic Information Survey Form." The second part involved collecting individual My Health Bank data by using individual health insurance card logins to the website. The description is as follows:

(1) The Individual Basic Information Survey Form explored firefighters' demographic variables. Each variable contained several choices, as presented in Table 3.

(2) The participants downloaded their individual My Health Bank, and personal information was removed. Frontline researchers coded the information, compiled the medical records, and input the number of

Table 2 Sample Collection Compilation Table of Participants

Unit	Number of People in the Unit	Number of Samples Collected	Sample Collection Rate	Unit	Number of People in the Unit	Number of Samples Collected	Sample Collection Rate
A1	28	24	85%	B1	24	13	54%
A2	25	22	88%	B2	19	11	58%
A3	19	12	63%	B3	17	6	35%
A4	17	15	88%	B4	26	16	62%
A5	16	14	88%	B5	17	7	41%
A6	15	10	67%	Total	223	150	67%

Western medicine medical visits, Chinese medicine medical visits, dental visits, total number of medical visits, payment points for Western medicine medical visits, payment points for Chinese medicine medical visits, and payment points for dental visits. The total number of medical visits for each disease code (based on the ICD-9CM) for 2015 were inputted. The data were then compiled and analyzed. The payment point information referred to the amount that the NHIA paid to medical agencies according to the ICD disease category and the medical services used other than the fixed registration fees that were paid by the patient. The payment points were approximately equivalent to NTD; however, the ratio of payment points to NTD amount was adjusted slightly annually. This data collection and research process were reviewed and approved by the Asia University Human Experiment Institutional Review Board (number: 10505001). The participants were informed about the purpose of the study, and that it was conducted in accordance with the Declaration of Helsinki.

Statistics

Descriptive Statistical Analysis

Analysis of individual basic information. The individual background variables (sex, age, education level, marital status, number of children, service seniority, current position, shift rotation status, smoking habits, drinking habits) are shown in percentages, means, and standard deviation.

Independent Samples *t*-Test and One-Way Analysis of Variance

The number of medical visits, and their number of medical visit points (means) difference among participants' personal background variables listed in Table 3 were examined. The significant alpha value is 0.05.

One Sample *t*-Test

This involved comparing the participants' and general public's average number of medical visits and medical visit points to determine whether a significant difference resulted.

Results

This study collected the information from 150 participants. The complete demographic variables and their distribution are presented in Table 4. Men accounted for 92% of participants. The age distribution was 20–50 years old, and most had college education (84.67%). Half of the participants were married, and the other half were not married. Most participants served for less than 10 years (73.3%). Table 5 shows the participants' average number of Western medicine, Chinese medicine, and dental visits, and the average number of total annual medical visits. The participants' health insurance payment point distribution is presented in Table 6. The participants had a significantly higher number of Western medicine visitations, Western medicine health-care payment points, total number of medical visits, and total number of health-care payment points than did the same age groups in the general public. The within-group variables in the total number of medical visits included age, seniority, and job positions. The within-group variable for the total payment points only included age. The participants had a significantly higher number of medical visits for disease codes 460–519, 580–629, 680–709, 710–739, and 800–999 than did the same age groups in the Taiwanese general public, as shown in Table 7.

Discussion

This study used individual National Health Insurance records to compare the number of medical visits, health-care payment amounts, and the medical visit disease categories of firefighters

Table 3 Variables and Candidate Items in the Demographic Data

Question Number	Individual Variables	Choices
1	Sex	Men, women
2	Age	21–30 years old; 31–40 years old; 41–50 years old; 51–60 years old
3	Education level	Junior high school or below; high school (vocational); college (vocational); graduate school (graduated or still attending)
4	Marital status	Not married; Married; divorced
5	Number of children	None; One; Two; three or more
6	Service seniority	5 years or less; 6–10 years; 11–15 years; 16–20 years; 21 years or more
7	Current position	Supervisor (team leader or higher); nonsupervisory positions
8	Shift status	Normal hours; work 1 day and off 1 day; work 2 days and off 1 day
9	Smoking habits	Nonsmoker; quit smoking; still smoking
10	Drinking habits	Nondrinker; quit drinking; still drinking

Table 4 Participants' Demographic Variables

Items		Numbers	Percentage %
Gender	Male	138	92
	Female	12	8
Age	21–30	63	42
	31–40	66	44
	41–50	15	10
	51–60	6	4
Education	High school (vocational)	2	1.33
	College (vocational)	127	84.67
	Graduate institute	21	14
Marriage	Not married	74	49.33
	Married	74	49.33
	Divorced	2	1.34
Children number	None	85	56.67
	One	28	18.66
	Two	34	22.67
	Three or more	3	2
Service seniority	5 or less	61	40.67
	6–10 years	49	32.67
	11–15 years	20	13.33
	16–20 years	8	5.33
	21 years or more	12	8
Current position	Supervisor	21	14
	Nonsupervisory position	129	86
Smoking habits	Nonsmoker	124	82.67
	Quit smoking	5	3.33
	Still smoking	21	14
Drinking habits	Nondrinker	99	66
	Quit drinking	5	3.33
	Still drinking	46	30.67

who worked in shift rotations. The annual average number of outpatient medical visits by firefighters who worked in shift rotations was 9.57 times, whereas that of the general public was on average 7.75. On average, firefighters who worked in shift rotations used 7003 health insurance payment points in a year (approximately US$230), and the general public used on average 4940 points for the same year (approximately US $165). Medical visit for diseases such as respiratory diseases, urogenital diseases, skin and subcutaneous tissue diseases, musculoskeletal system and connective tissue diseases, and injuries and poisonings all indicated significance ($P < 0.05$) compared with the norm. These diseases are related to firefighters' work. Firefighters' main job is to provide disaster relief and rescue. During disasters, smoke and toxic substances that are created by a fire can significantly damage firefighters'

Table 5 Distribution of Medical Visits. Data is Represented as the Mean (SD). *Denote P<0.05; ***p<0.001

Individual Demographic VariableS		Western Medicine	P1	Chinese Medicine	P2	Dentist	Total Medical Visit Count	P3
Norm mean Subject mean		5.24 6.27	0.041*	1.26 1.75	0.180	1.25 1.55	7.75 9.57	0.010*
Sex	Man Woman	5.95 (5.56) 10 (10.55)	0.028 *	1.8 (4.6) 1.08 (1.51)	0.590	1.54 (2.04) 1.67 (1.56)	9.3 (8.39) 12.75 (10.48)	0.182
Age	21–30 years 31–40 years 41–50 years 51–60 years	5.52 (5.25) 6.14 (6.45) 7.27 (6.39) 13.17 (7.91)	0.029*	1.37 (2.72) 1.52 (3.06) 1.4 (2.77) 9.17 (16.76)	0.000369 ***	1.67 (1.91) 1.55 (2.14) 1.2 (1.9) 1.33 (1.97)	8.56 (7) 9.2 (8.1) 9.87 (9.04) 23.67 (15.9)	0.000444 ***
Education level	High school (vocational) College (vocational) Graduate institute	10 (8.49) 6.13 (5.95) 6.81 (7.34)	0.620	0.5 (0.71) 1.83 (4.65) 1.33 (3.09)	0.824	0 (0) 1.61 (1.96) 1.38 (2.31)	10.5 (9.19) 9.57 (8.68) 9.52 (8.32)	0.988
Marital status	Not married Married Divorced	5.62 (5.46) 6.91 (6.82) 7 (1.41)	0.443	1.45 (2.86) 2.04 (5.56)	0.414	1.57 (1.72) 1.54 (2.28) 1.5 (0.71)	8.64 (7.28) 10.49 (9.64)	0.187
Number of children	None One Two Three or more	5.87 (5.70) 5.82 (5.18) 7.97 (7.82) 2.67 (2.08)	0.249	1.51 (2.99) 1.46 (3.27) 2.59 (7.47) 1.67 (2.89)	0.665	1.53 (1.75) 1.71 (2.31) 1.53 (2.42) 1 (1)	8.91 (7.68) 9 (6.94) 12.09 (11.46) 5.33 (5.86)	0.233
Service seniority	0–5 years 6–10 years 11–15 years 16–20 years 21 years or more	4.92 (4.51) 6.53 (5.8) 5.8 (6.9) 10.88 (10.15) 9.83 (8.21)	0.018*	1.51 (2.81) 1.51 (2.87) 1.35 (3.37) 1.63 (4.21) 4.67 (12.09)	0.224	1.64 (1.84) 1.65 (2.13) 1.05 (1.67) 1.5 (3.12) 1.58 (2.15)	8.07 (6.53) 9.69 (7.39) 8.2 (8.79) 14 (11.122) 16.08 (15.42)	0.020 *
Current position	Supervisor Nonsupervisory position	8.33 (7.28) 5.94 (5.91)	0.098	3.38 (9.43) 1.48 (2.91)	0.068	1.62 (2.46) 1.54 (1.93)	13.33 (13.1) 8.96 (7.5)	0.029 *
Smoking habits	Nonsmoker Quit smoking Still smoking	6.27 (6.15) 12 (9.33) 4.90 (4.70)	0.067	1.44 (2.94) 3.2 (4.6) 3.19 (9.26)	0.188	1.42 (1.82) 2.8 (3.56) 2.05 (2.47)	9.14 (7.72) 18 (12.47) 10.14 (11.47)	0.072
Drinking habits	Nondrinker Quit drinking Still drinking	6.72 (6.41) 5.6 (7.83) 5.39 (5.4)	0.471	1.88 (5.04) 0.2 (0.45) 1.63 (3.06)	0.697	1.41 (1.7) 1.6 (1.82) 1.85 (2.56)	10.01 (8.9) 7.4 (8.08) 8.87 (8.02)	0.900

respiratory system.[13] Musculoskeletal system and connective tissue diseases, injuries, and poisonings are also related to disaster relief. This indicates that a survey of firefighters' health insurance medical history can reveal diseases that are related to their job. Furthermore, the participants worked in 2 days on/1 day off shift rotations, which suggested that they were affected by the abnormal resting time of shift rotations.

Compared with other research methods, surveys and medical record statistics are sampling survey methods that do not reveal participants' disease orientation. However, other studies have first targeted the specific research topic before appropriate research tools were used to survey it. For example, the research topic in reference[16] was depression, and the questionnaire used is the Center for Epidemiologic Studies Depression Scale. The participants knew that the study was about depression. However, this type of focused research can exaggerate the importance of the phenomenon because the participant focuses on it. However, other diseases or symptoms that are related to firefighters may not be understood because the participants and researchers overlook them. By contrast, this study used medical visit data as a basis to accurately understand the entire disease distribution of firefighters. The comprehensive health-care database in Taiwan can be used to compare

Table 6 Distribution of Payment Points Data is Represented as Mean (Std). *Denote P<0.05; **P<0.01; ***p<0.001

Individual Demographic VariableS		Western Medicine	P1	Chinese Medicine	P2	Dentist	Total Payment Points	P3
Norm mean Subject mean		2741 4079	0.0031**	639 900	0.128	1558 2026	4940 7003	0.0003***
Sex	Man Woman	3858.02 (5237.14) 6616.67 (7371.57)	0.093	915.03 (2140.81) 715.5 (1274.96)	0.751	2015.39 (3211.24) 2142.33 (2004.79)	6788.44 (6778.98) 9474.5 (7501.85)	0.194
Age	21–30a 31–40a 41–50a 51–60b	3163.41 (3866.18) 4443.94 (6413.42) 3763.73 (3818) 10,459.33 (8094.47)	0.014 *	775.67 (1346.64) 768.79 (1605.59) 723.93 (1318.27) 4065.67 (7472.23)	0.0018 **	2503.27 (3647.08) 1799.26 (2843.56) 1305 (2114.93) 1300 (1764.27)	6442.35 (5377.93) 7011.99 (7378.56) 5792.67 (5388.74) 15,825 (12,224.8)	0.011*
Education level	High school (vocational) College (vocational) Graduate institute	3885.06 (5394.14) 5268.29 (5832.68)	0.283	45 (63.64) 959.59 2189.86) 614.38 (1384.59)	0.661	0 2180.84 (3258.11) 1279.29 (2198.36)	13,941 (15,074.1) 6867.84 (6887.03) 7161.95 (5881.35)	0.350
Marital status	Not married Married Divorced	3685.91 (4672.23) 4324.3 (6114.07) 9526 (6454.47)	0.285	849.03 (1574.88) 947.79 (2489.39)	0.501	2274.73 (3317.95) 1781.04 (2966.36) 1852.5 (1438.96)	6809.66 (6218.92) 7191.9 (7452.73)	0.734
Number of children	None One Two Three or more	3625.97 (4486.38) 4046.64 (6878.67) 5525.44 (6396.07) 809.67 (439.44)	0.257	820.6 (1561.8) 634.61 (1358.64) 1258.27 (3346.6) 1519.67 (2632.14)	0.608	2177.27 (3243.49) 2024.39 (3106.37) 1774 (3025.54) 588.33 (511.721)	6623.84 (6163.78) 6705.64 (6941.81) 8557.71 (8406.78) 2917.67 (3381.31)	0.375
Service seniority	0–5 years 6–10 years 11–15 years 16–20 years 21 years or more	2868.07 (3780.42) 3818.18 (4306.75) 5751.1 (9077.93) 6936.25 (6093.89) 6604.33 (7231.74)	0.042 *	849.77 (1382.62) 849.73 (1673.66) 549.7 (1399.79) 776.63 (2001.14) 2015 (5342.94)	0.396	2605.07 (3749.62) 1861.41 (2822.7) 1184.5 (1875.95) 1526.13 (3345.54) 1484.58 (2010.05)	6322.90 (5684.5) 6529.33 (5710.17) 7485.3 (9208.59) 9239 (6523.19) 10,103.92 (11,210.05)	0.377
Current position	Supervisor Nonsupervisory position	6228.24 (7070.87) 3728.79 (5097.92)	0.051	1486.81 (4182.64) 803.39 (1499.68)	0.164	1527.57 (2480.85) 2106.61 (3221.02)	9242.62 (9771.82) 6226.38	0.107
Smoking habits	Nonsmoker Quit smoking Still smoking	3971.61 (5280.41) 8863.4 (8431.50) 3571.91 (5496.01)	0.067	744.93 (1380.6) 1350.6 (1906.76) 1701.71 (4357.29)	0.133	1945.8 (3111.41) 2577 (2751.10) 2365.14 (3401.37)	6662.34 (6117.92) 12,791 (9389.7) 7638.76 (9611.67)	0.132
Drinking habits	Nondrinker Quit drinking Still drinking	4137.23 (5396.43) 5023.6 (9396.96) 3850.07 (5217.51)	0.887	934.81 (2266.6) 71.8 (160.55) 912.07 (1757.97)	0.667	1755.94 (2319.43) 2687.8 (3102.93) 2533.80 (4397.33)	6827.98 (6566.43) 7783.2 (9446.64) 7295.94 (7305.94)	0.900

the averages in similar age groups among the general public and to highlight disease types in which firefighters have a higher number of medical visits and medical care costs than does the general population. This is an interesting research method, and its advantages are shown in this study.

One advantage of this study is that it is built on Taiwan's comprehensive National Health Insurance system. The normal medical visit characteristics of the general public in the same area can be compared with publicly downloaded data. The convenient information system allows for easy access to individual medical visit information. Therefore, this study only required consent from the participants to connect to the Internet with the health insurance IC card and download their information. This easy access to information and the study method cannot be replicated in every area. However, this type of study method can be extended to health studies of participants in other special groups, such as with other work fields or work with special routines that are combined with other special topics (insomnia, anxiety, and patients with

Table 7 Total Number of Medical Visits of Participants and the General Public by International Statistical Classification of Diseases and Related Health Problems (ICD-9) Disease Categorization

ICD-9 Number	Diseases of ICD-9 Code	Firefighters Aged 20–60 Years	General Public (Aged 20–60 Years Old)	P
001–139	Infectious and Parasitic Diseases	0.37	0.19	0.251 [a,b,c]
140–239	Neoplasms	0.09	0.1	0.905
240–279	Endocrine, Nutritional and Metabolic Diseases, and Immunity Disorders	0.21	0.16	0.490 [a]
280–289	Diseases of the Blood and Blood-forming Organs	0	0.03	n.a
290–319	Mental Disorders	0.09	0.1	0.828 [a,b,c,d]
320–359	Diseases of the Nervous System	0.03	0.05	0.216
360–389	Diseases of Sense Organs	0.43	0.28	0.072
390–459	Diseases of the Circulatory System	0.31	0.16	0.134 [a,b]
460–519	Diseases of the Respiratory System	2.03	0.64	1.16e-07
520–579	Diseases of the Digestive System	0.67	0.65	0.834
580–629	Diseases of the Genitourinary System	0.68	0.26	0.0002 [a,b,c]
630–676	Complications of Pregnancy, Childbirth, and The Puerperium	0.03	0.06	0.115
680–709	Diseases of the Skin and Subcutaneous Tissue	0.82	0.34	0.0010 [d]
710–739	Diseases of the Musculoskeletal System and Connective Tissue	0.79	0.33	0.0012
740–759	Congenital Anomalies	0.01	0.01	0.7233
780–799	Symptoms, Signs, and Ill-defined Conditions	0.67	0.44	0.079
800–999	Injury and Poisoning	0.79	0.32	0.0036

Notes: Individual demographic variables that achieved significance ($P < 0.05$): [a]Age, [b]Service seniority, [c]Current position, [d]Smoking habits.

chronic diseases). This interesting research method can be used to discover new phenomena that were not observed previously.

Conclusion

By reviewing individual medical visit records in Taiwan's National Health Insurance database, this study discovered that firefighters who worked on shift rotations had a higher number of outpatient visits and higher outpatient medical cost expenditures than did people in the same age group in Taiwan. This was particularly true for respiratory diseases, urogenital diseases, skin and subcutaneous tissue diseases, musculoskeletal system and connective tissue diseases, and injuries or poisonings that were related to firefighters working on shift rotations. This type of research method may be able to uncover new phenomena that were not observed previously, which renders this method worth investigation.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. Moreno CR, Marqueze EC, Sargent C, Wright KP Jr, Ferguson SA, Tucker P. Working time society consensus statements: evidence-based effects of shift work on physical and mental health. *Ind Health*. 2019;57:139–157. doi:10.2486/indhealth.SW-1
2. Loef B, Van Baarle D, Van Der Beek AJ, Sanders EA, Bruijning-Verhagen P, Proper KI. Shift work and respiratory infections in health-care workers. *Am J Epidemiol*. 2019;188:509–517. doi:10.1093/aje/kwy258

3. Jeong KS, Ahn Y-S, Jang T-W, et al. Sleep assessment during shift work in Korean firefighters: a cross-sectional study. *Saf Health Work*. 2019;10:254–259. doi:10.1016/j.shaw.2019.05.003
4. Kazronian S, Zakerian SA, Mortezapour A, Saraji GN, Hosseini M. Influence of 24-hours shift work system on occupational stress among iranian firefighters. *Archives Adv Biosci*. 2019;10.
5. Wen-Feng Chiu Y-H-H, Tang W-L. The study of investigation on firefighter line-of-duty injuries and the post-incident illness. *National Taiwan Police College Bulletin*. 2009;4:61–86.
6. Johnson CC, Vega L, Kohalmi AL, Roth JC, Howell BR, Van Hasselt VB. Enhancing mental health treatment for the firefighter population: understanding fire culture, treatment barriers, practice implications, and research directions. *Prof Psychol Res Pr*. 2019;51:304–311. doi:10.1037/pro0000266
7. Khan WAA, Conduit R, Kennedy GA, Abdullah Alslamah A, Ahmad Alsuwayeh M, Jackson ML. Sleep and mental health among paramedics from Australia and Saudi Arabia: a comparison study. *Clocks Sleep*. 2020;2:246–257. doi:10.3390/clockssleep2020019
8. Administration, N.H.I. My health bank. Availabe from: https://www.youtube.com/watch?v=km-BATMxMjA&feature=youtu.be. Accessed January 19, 2021.
9. Lee M-C, Bariol SV. Evolution of stone management in Australia. *BJU Int*. 2011;108:29–33. doi:10.1111/j.1464-410X.2011.10695.x
10. Turvey C, Klein D, Fix G, et al. Blue Button use by patients to access and share health record information using the Department of Veterans Affairs' online patient portal. *J Am Med Informatics Association*. 2014;21:657–663. doi:10.1136/amiajnl-2014-002723
11. NHIA. My Health Bank. Availabe from: https://www.nhi.gov.tw/English/Content_List.aspx?n=21D194F3C675DB0E&topn=BCB2B0D2433F6491. Accessed January 27.
12. McCarthy EP, Iezzoni LI, Davis RB, et al. Does clinical evidence support ICD-9-CM diagnosis coding of complications? *Med Care*. 2000;38:868–876. doi:10.1097/00005650-200008000-00010
13. Games KE, Winkelmann ZK, Eberman LE. Physical exertion diminishes static and dynamic balance in firefighters. *Int J Athletic Therapy Training*. 2020;1:1–5.
14. Kazemi R, Zare S, Hemmatjo R. Comparison of melatonin profile and alertness of firefighters with different work schedules. *J Circadian Rhythms*. 2018;16:16. doi:10.5334/jcr.155
15. Kim HW, Jung S-M, Choi YS, et al. Sleep patterns of firefighters with shift working schedules in Seoul Metropolitan area. *Sleep Med Res*. 2017;8:68–75. doi:10.17241/smr.2017.00059
16. Saijo Y, Ueno T, Hashimoto Y. Twenty-four-hour shift work, depressive symptoms, and job dissatisfaction among Japanese firefighters. *Am J Ind Med*. 2008;51:380–391. doi:10.1002/ajim.20571
17. Kaikkonen P, Lindholm H, Lusa S. Physiological load and psychological stress during a 24-hour work shift among Finnish firefighters. *J Occupational Environmental Med*. 2017;59:41–46. doi:10.1097/JOM.0000000000000912
18. Sumińska S, Nowak K, Łukomska B, Cygan H. Cognitive functions of shift workers: paramedics and firefighters. An EEG study. *Int j Occupational Safety Ergonomics*. 2020;1–21.
19. Petersen KU, Pedersen JE, Bonde JP, Ebbehøj NE, Hansen J. Mortality in a cohort of Danish firefighters; 1970–2014. *Int Arch Occup Environ Health*. 2018;91:759–766. doi:10.1007/s00420-018-1323-6
20. Sritharan J, Pahwa M, Demers PA, Harris SA, Cole DC, Parent M-E. Prostate cancer in firefighting and police work: a systematic review and meta-analysis of epidemiologic studies. *Environmental Health*. 2017;16:124. doi:10.1186/s12940-017-0336-z
21. Choi B, Schnall P, Dobson M. Twenty-four-hour work shifts, increased job demands, and elevated blood pressure in professional firefighters. *Int Arch Occup Environ Health*. 2016;89:1111–1125. doi:10.1007/s00420-016-1151-5
22. Chappel SE, Aisbett B, Vincent GE, Ridgers ND. Firefighters' physical activity across multiple shifts of planned burn work. *Int J Environ Res Public Health*. 2016;13:973. doi:10.3390/ijerph13100973
23. Sommerfeld A, Wagner SL, Harder HG, Schmidt G. Habital health and firefighters: an intervention and interviews with Canadian firefighters. *J Loss Trauma*. 2017;22:307–324. doi:10.1080/15325024.2017.1284515
24. Choi B, Dobson M, Schnall P, Garcia-Rivas J. 24-hour work shifts, sedentary work, and obesity in male firefighters. *Am J Ind Med*. 2016;59:486–500. doi:10.1002/ajim.22572
25. Strauß M, Foshag P, Przybylek B, et al. Occupation and metabolic syndrome: is there correlation? A cross sectional study in different work activity occupations of German firefighters and office workers. *Diabetol Metab Syndr*. 2016;8:57. doi:10.1186/s13098-016-0174-0
26. Kodom-Wiredu JK. The relationship between firefighters' work demand and work-related musculoskeletal disorders: the moderating role of task characteristics. *Saf Health Work*. 2019;10:61–66. doi:10.1016/j.shaw.2018.05.004
27. McGinnis K, Games K. Contributing factors to structural firefighter injury. *J Sci Med Sport*. 2017;20:S91–S92. doi:10.1016/j.jsams.2017.07.012
28. Kim HD, An YS, Kim DH, Jeong KS, Ahn YS. An overview of compensated work-related injuries among Korean firefighters from 2010 to 2015. *Ann Occupational Environmental Med*. 2018;30:57. doi:10.1186/s40557-018-0268-2