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DATABASE ANALYSIS

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Effects of Occupational Radiation Exposure on Job Stress and Job Burnout of Medical Staff in Xinjiang, China: A Cross-Sectional Study

Authors' Contribution:
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Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Background: Although the potential effects of long-term and low-dose radiation exposure on physical health have attracted considerable attention, few systematic evaluations have been reported regarding the mental health of occupational groups. This study sought to investigate the effects of occupational radiation exposure on job stress and job burnout of medical radiation staff.

Material/Methods: Using cluster random sampling, a total of 1573 medical radiation workers were initially selected from 10 hospitals in Xinjiang, China, and 1396 valid questionnaires were finally collected. Job stress and job burnout were assessed using the Effort-Reward Imbalance (ERI) questionnaire and the Chinese Maslach Burnout Inventory (CMBI), respectively.

Results: The percentages of medical radiation staff experiencing job stress and job burnout were 53.08% and 63.32%, respectively. A statistically significant difference in job stress was observed in association with age, ethnicity, professional title, marital status, radiation work type, radiation working years, family history, hypertension, obesity, smoking, and drinking (P<0.05). A statistically significant difference in job burnout was observed in association with age, sex, ethnicity, professional title, educational level, marital status, job post, radiation work type, radiation working years, family history, hypertension, diabetes, and obesity (P<0.05). Female (odds ratio [OR]=0.75, 95% confidence interval [CI]: 0.58–0.98), senior professional title (OR=0.64, 95% CI: 0.43–0.96), and radiation work types of nuclear medicine (OR=0.15, 95% CI: 0.07–0.33) and radiotherapy (OR=0.54, 95% CI: 0.36–0.79) were protective factors, and job stress (OR=4.57, 95% CI: 3.55–5.91) was the risk factor for job burnout of medical radiation staff.

Conclusions: Medical radiation staff experience high levels of job stress and job burnout. The interventions of occupational physical examination, personal dose monitoring, occupational health education, and management optimization are recommended to relieve job stress and job burnout and enhance occupational health of medical radiation staff.

MeSH Keywords: **Burnout, Professional • Medical Staff • Occupational Exposure • Radiation, Ionizing • Stress, Physiological**

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Background

Job stress refers to a pressure state in physiology and psychology when job demands extend beyond individual resources, needs, abilities, and knowledge [1]. Job burnout refers to physical or mental exhaustion caused by overwork or stress [2]. With a sustained rise in anxiety and mood disorders within professional populations, the effects of negative occupational factors on job stress and job burnout have drawn growing interest in the field of public health [3,4], and a large number of studies have confirmed that job stress occurs in many professions [5–7]. Job stress and job burnout have become problems that cannot be ignored in the field of occupational health.

Medical radiation workers belong to a special occupational group that has dual roles as health care workers and radiation workers. Health care workers are among the most stressed professionals owing to their risk of infections, high job demands, dissatisfied patients, and intensely competitive promotions [8,9]. More than half of US physicians were found to have at least one symptom of burnout, which was significantly higher than in the general population [10]. Furthermore, exposure to several physical, chemical, and biological risk factors exacerbate the psychological burden in certain occupational groups. Radiation is widely regarded as a physical risk factor with both deterministic and stochastic effects on physical health that increase the prevalence of cancer, cardiovascular diseases, and cataract [11,12]. With the improvement of health services and an aging population, the use of radioisotopes and ionizing radiation in diagnosis and treatment have steadily increased [13]. Global estimates show that approximately 3.6 billion radiation examinations on average were conducted annually from 2000 to 2007, and the use of diagnostic procedures involving radiation has more than doubled during the past 25 years in many countries [14–16]. Thus, medical radiation workers have gradually become the largest occupational group exposed to artificial radiation sources [17].

With the technical improvements of radiological equipment, radiation shielding, and radiation protection tools, high-dose occupational radiation exposure and occupational radiation accidents are uncommon [18,19]. The average annual effective dose of medical radiation workers in various countries is much lower than the annual effective dose limit of the international standards (20 mSv/y) [13,20]. However, radiation still has negative effects on people even under safety limits. The World Health Organization (WHO) and the International Labour Organization (ILO) have expressed concern about the potential effects of long-term and low-dose radiation exposure on physiological and psychological risks [21–23]. Psychosocial changes usually happen before physiological disorders are apparent, and there is often a lack of attention and intervention to address them [24]. Thus, the focus of occupational health management is not only on physical health, but also on mental health [25]. It is hence important to provide data on risk of stress and burnout for specific professional categories.

For medical radiation workers, some studies have found that job stress and the risk of anxiety or depression among radiographers and oncologists in hospitals were much higher than in the general population [26,27]. However, few studies have systematically evaluated job stress and job burnout of medical radiation staff in different work roles using validated questionnaires. In this study, a cross-sectional study was conducted to investigate job stress and job burnout of medical radiation staff in diagnostic radiology, nuclear medicine, radiotherapy, interventional radiology, and other types of work involving radiation in Xinjiang, China, to provide a theoretical basis for alleviating job stress and job burnout and thereby promoting occupational health of medical radiation staff.

Material and Methods

Participants

This cross-sectional study was carried out from May to October 2019. With the assistance of radiation protection managers in the hospitals, a total of 1573 medical radiation workers from 10 hospitals in Urumqi City, Changji Prefecture, Yili Prefecture, Aksu Region, Bayingolin Prefecture, Kashgar Area, and Hotan Region were initially selected using a cluster sampling method. An informed consent form explaining the questionnaire, survey purpose, and the principle of voluntary participation was distributed to the workers, and 1536 participants volunteered to complete the questionnaire survey. The study included 1506 participants who were licensed as radiation workers and had more than 1 year of occupational radiation exposure. By on-the-spot inquiry during distribution of questionnaires, workers with psychiatric disease or a family history of such diseases and those taking psychoactive drugs were excluded. Based on the inclusion and exclusion criteria, 1489 medical radiation workers were enrolled in this survey. A total of 1396 valid questionnaires were collected (93.75% response rate). Figure 1 presents a flowchart of participant selection.

Research methods

General investigation

The general investigation included participants' age, sex, ethnicity, professional title, educational level, marital status, job post, radiation work type, radiation working years, family history, smoking, drinking, hypertension, diabetes, and obesity.

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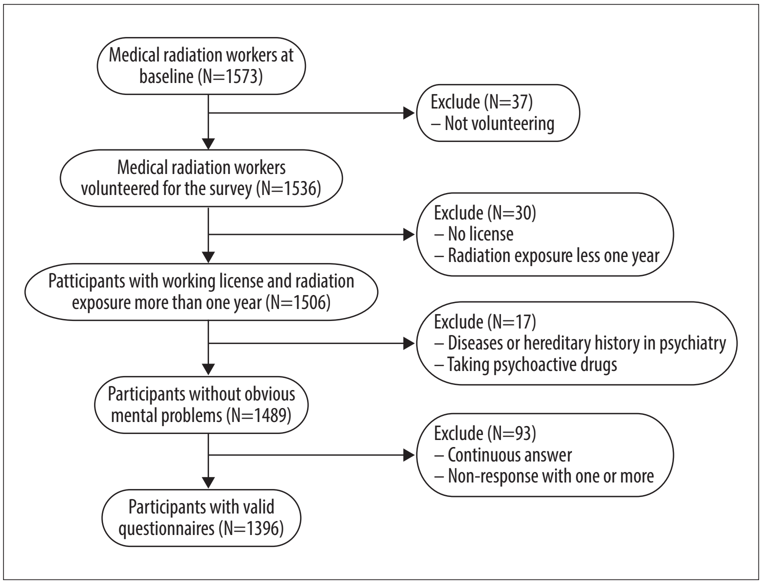

Figure 1. Definition of the study participants.

Job stress

The Effort-Reward Imbalance (ERI) questionnaire has been widely used in assessing job stress [28,29]. This questionnaire was developed by Siegrist [30] on the basis of the imbalance between effort and reward causing a series of changes in physiological, psychological, cognitive functions, and body health. In our study, Cronbach's alpha and split half reliability were used to test the internal consistency, and factor analysis was used to test the structure validity of ERI. The Cronbach α of ERI was 0.88, the split-half reliability coefficient was 0.78, and Kaiser-Meyer-Olkin statistics (KMO)=0.893. The ERI questionnaire consisted of 23 items with 3 dimensions: effort (E), reward (R), and overcommitment. Each item was assigned a score ranging from 1 (completely unfitting) to 5 (completely fitting). The ERI ratio was calculated by formula ERI=E/(R×C), and C was the ratio of the number of E items to the number of R items; C=6/11 in this paper. The ERI ratio at >1, 1, and <l indicated a high effort/low reward return, a balanced effort-reward return, and a low effort/high reward return, respectively. An ERI ratio >1 suggested job stress [31].

Job burnout

The Chinese Maslach Burnout Inventory (CMBI) was established by Li [32] on the basis of the Maslach Burnout Inventory and had good reliability and validity [33]. In our study, the Cronbach α of CMBI was 0.79, the split-half reliability coefficient was 0.81, and KMO=0.911. The CMBI consisted of 15 items in 3 dimensions: emotional exhaustion, depersonalization, and reduced personal accomplishment. Each item was assigned a score ranging from 1 (completely fitting) to 7 (completely unfitting). According to the critical values (emotional exhaustion ≥25, depersonalization ≥11, and reduced personal accomplishment ≥16), job burnout was divided into 4 levels: none (each dimension was lower than the critical value), mild (any 1 dimension was equal to or higher than the critical value), moderate (any 2 dimensions were equal to or higher than the critical values), and severe (3 dimensions were equal to or higher than the critical values) [34, 35].

Quality control

The pre-investigation was conducted before the formal investigation, and all the investigators were trained before the survey. Written informed consent was provided to each respondent to explain the purpose of the questionnaire survey and the principle of voluntary participation. The investigators distributed and collected questionnaires on site. Questionnaires with the continuous answers or nonresponse for 1 or more items were excluded.

Statistical analysis

All survey data were input into an Epidata3.1 database, and statistical analysis was performed using R (Version 3.4.4). The comparison of categorical data was conducted by the chi-squared test. Multivariate analysis was conducted by multiple logistics regression. The significance level (α) was set at 0.05.

Results

General demographic characteristics of medical radiation staff

Among the 1396 medical radiation staff, 796 were men (57.02%) and 600 were women (42.98%); 834 were doctors

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(59.74%), 208 were nurses (14.90%), 320 were radiographers (22.92%), and 34 held other positions (2.44%). The radiation work types involved diagnostic radiology (58.09%), nuclear medicine (2.72%), radiotherapy (10.53%), interventional radiology (23.21%), and others (5.44%), respectively. ERIs of ≤1 and >1 were 655 (46.92%) and 741 (53.08%). CMBIs of none, mild, moderate, and severe were 512 (36.68%), 459 (32.88%), 341 (24.43%), and 84 (6.02%) (Table 1).

Comparison of job stress of medical radiation staff in different populations

The results showed that job stress increased with age before 50 years old and then appeared to decline slightly ($P<0.001$). Job stress increased with advancements in professional title ($P<0.001$). Married and divorced or widowed individuals had higher levels of job stress compared with unmarried individuals ($P<0.001$). Job stress was the highest in the interventional radiology group among all the radiation work types ($P=0.015$). The variation in job stress based on working years was similar to that in age ($P<0.001$). There were statistically significant differences in job stress among medical radiation staff in association with family history ($P<0.001$), smoking ($P=0.029$), drinking ($P=0.001$), hypertension ($P<0.001$), and obesity ($P<0.001$) (Table 2).

Comparison of job burnout levels of medical radiation staff in different populations

The results showed that the total rate of job burnout among medical radiation staff was 63.32%, with mild and moderate levels of job burnout as the majority. Job burnout was higher for individuals with a middle professional title and an undergraduate degree than for those with other professional titles ($P=0.022$) and educational levels ($P=0.047$). Job burnout was higher for doctors than nurses and radiographers ($P<0.001$). Job burnout was the highest in the interventional radiology group and second highest in the diagnostic radiology group ($P<0.001$). Job burnout increased along with the number of radiation working years before 20 years and then decreased slightly ($P<0.001$). There were statistically significant differences in job burnout among medical radiation staff in association with family history ($P=0.003$), hypertension ($P=0.002$), diabetes ($P<0.001$), and obesity ($P=0.001$) (Table 3).

Exploration of factors related to job burnout of medical radiation staff

Multiple logistic regression analysis was used to evaluate the effects of general demographic characteristics and job stress on job burnout of medical radiation staff. All independent variables were stratified. The results showed that sex ($P=0.034$), senior professional title ($P=0.029$), radiation work type in nuclear medicine ($P<0.001$) and radiotherapy ($P=0.002$), and ERI ($P<0.001$) affected job burnout of medical radiation staff. Female, senior professional title, and radiation work types of nuclear medicine and radiotherapy were protective factors and ERI was a risk factor related to job burnout of medical radiation staff (Table 4).

Discussion

Occupational health is a diverse specialization of health care for improving the relationship between work and the physical and psychological health of employees [25]. Several studies have confirmed that job stress is a risk factor for adverse physiological function and psychological reaction [36,37]. Health care workers have been reported to experience high levels of job stress and job burnout in the United States, the United Kingdom, Australia, and Germany, and long working hours, rigid routines, emotional nature of patient demands, and heavy tasks in clinical and teaching were the main contributory factors [38–40]. With the continuous expansion of radiation technology and its application in medicine, increasingly more medical staff in different work types engage in radiation diagnostics and treatment. Long-term radiation exposure aggravates the psychological burden and thereby exacerbates the job stress and job burnout in this occupational group. Our research indicated that 53.08% and 63.32% of medical radiation staff experienced job stress and job burnout, and these rates were higher than those of nonmedical workers in China (copper-nickel miners, job stress 42.65% [41]; civil servants, job burnout 45.0% [42]) and physicians in the United States based a survey of 15 000 individuals (job burnout 42%) [43]. A survey of 1054 oncology physicians in the MENA showed a similar prevalence of burnout of around 68% [44]. Some studies suggested that requirements of the National Health Service, such as increasing volume of examinations, increased range of procedures but reduced waiting times, and multidisciplinary team work, have increased demands on the radiography departments, leading to more pressure on medical radiation workers [45].

This survey investigated job stress among medical staff in different types of radiation work. The results showed that medical radiation staff over 30 years old were more likely to develop job stress, and a similar development was observed for radiation working years, which was in agreement with a previous report of radiographers in Jordan [26]. Ahn et al. [46] showed that exposure to occupational hazards adversely affects individuals' health and exacerbates job insecurity. Thus, the increase of radiation working years aggravated the occupational psychological burden of medical radiation staff. The job stress among individuals with middle and senior professional titles was significantly higher than among those with a

Table 1. Demographic characteristics of medical radiation staff.

Items	Groups	*N*	Percentage (%)
Total		1396	
Age	<30	311	22.28
	<40	571	40.90
	<50	353	25.29
	≥50	161	11.53
Sex	Male	796	57.02
	Female	600	42.98
Ethnicity	Han	995	71.28
	Minority	401	28.72
Professional title	None or primary	521	37.32
	Middle	501	35.89
	Senior	374	26.79
Educational level	Junior college and below	317	22.71
	Undergraduate	683	48.93
	Postgraduate	396	28.37
Marital status	Unmarried	275	19.70
	Married	1090	78.08
	Divorced or widowed	31	2.22
Job post	Doctor	834	59.74
	Nurse	208	14.90
	Radiographer	320	22.92
	Others	34	2.44
Radiation work type	Diagnostic radiology	811	58.09
	Nuclear medicine	38	2.72
	Radiotherapy	147	10.53
	Interventional radiology	324	23.21
	Others	76	5.44
Radiation working years (years)	<5	422	30.23
	<10	465	33.31
	<20	302	21.63
	≥20	207	14.83
Family history	No	1292	92.55
	Yes	104	7.45
Hypertension	No	1224	87.68
	Yes	172	12.32

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Table 1 continued. Demographic characteristics of medical radiation staff.

Items	Groups	*N*	Percentage (%)
Diabetes	No	1360	97.42
	Yes	36	2.58
Obesity	BMI <24	1205	86.32
	BMI ≥24	191	13.68
Smoking	No	1000	71.63
	Yes	396	28.37
Drinking	No	622	44.56
	Yes	774	55.44
ERI	No	655	46.92
	Yes	741	53.08
CMBI	None	512	36.68
	Mild	459	32.88
	Moderate	341	24.43
	Severe	84	6.02

primary professional title or below, which was similar to findings on other medical workers in the wider literature [47]. Like other general medical workers, medical radiation staff with a higher professional title are usually responsible for more difficult parts in operations, which require intense concentration and involve greater radiation exposure. Moreover, individuals with higher professional titles often have the additional workload of teaching and training clinical students, which adds to job stress [48]. Nurses have often been reported to have higher stress compared with other health professionals due to their lower hierarchy of decision-making in patient care, disruptions to circadian rhythms, and lower income [49]. Although nurses had higher job stress in our study, the difference among doctors, nurses, radiographers, and other positions was not statistically significant. As to the radiation work types, the interventional radiology group had the highest job stress, and the radiotherapy group came second. A study about radiographers and physiotherapists also found excess symptoms of stress [50]. In particular, Siegal et al. [51] found that frequent use of heavy lead aprons and imaging equipment in the interventional radiology group increased the risk for repetitive stress injury. The detection rate of job stress was significantly higher in those with family history, hypertension, or obesity. It was suggested that radiation workers might need more support in health care and protection education from employers.

This survey investigated job burnout levels among medical radiation staff. The results showed that medical staff who had longer radiation working years had a higher rate of job burnout, especially those with 10–20 years and more than 20 years. A survey of 15 000 physicians also reported the greatest incidence of burnout in the 45- to 54-year-old age group [43]. This finding can be explained by the fact that, these groups are at the peak of work productivity and practices and are more eager to increase personal income or seek promotion opportunities. However, meeting expectations is difficult and thereby increases the risk of job burnout, which was previously noted in similar studies [52]. The rates of job burnout among different job posts were all at a correspondingly high level. A study of radiation oncology departments in New Zealand also showed high scores in burnout among oncologists, therapists, nurses, and physicists [53]. In our study, the rate of job burnout in the other job positions was the highest, followed by doctors. For medical staff in the other job positions, they were not only responsible for medical work, but also many trivial duties in their own departments. As for doctors, Shanafelt et al. [54] confirmed that doctors experience symptoms of burnout at significantly higher rates compared with doctoral-level professionals in other fields. Doctors interact with colleagues or patients every day, but the focus of communication is almost always on the disease development, leaving them little time and few tools to relieve stress [8]. As to the radiation work types, interventional radiology was the largest group with job burnout, followed by diagnostic radiology. Radiation exposure is a recognized risk factor for medical staff performing fluoroscopically guided cardiovascular procedures due to the highest radiation

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Table 2. Comparison of job stress in different populations.

Items	N	ERI		Detection rate (%)	Chi-squared value	*P*-value
		No	Yes			
Age						
<30	311	222	89	28.62	116.202	**0.000**
<40	571	259	312	54.64		
<50	353	107	246	69.69		
≥50	161	67	94	58.39		
Sex						
Male	796	371	425	53.39	0.046	0.830
Female	600	284	316	52.67		
Ethnicity						
Han	995	447	548	55.08	5.261	**0.022**
Minority	401	208	193	48.13		
Professional title						
None or primary	521	323	198	38.00	76.313	**0.000**
Middle	501	195	306	61.08		
Senior	374	137	237	63.37		
Educational level						
Junior college and below	317	165	152	47.95	4.570	0.102
Undergraduate	683	314	369	54.03		
Postgraduate	396	176	220	55.56		
Marital status						
Unmarried	275	180	95	34.55	47.846	**0.000**
Married	1090	464	626	57.43		
Divorced or widowed	31	11	20	64.52		
Job post						
Doctor	834	387	447	53.60	3.589	0.309
Nurse	208	89	119	57.21		
Radiographer	320	163	157	49.06		
Others	34	16	18	52.94		
Radiation work type						
Diagnostic radiology	811	387	424	52.28	12.307	**0.015**
Nuclear medicine	38	18	20	52.63		
Radiotherapy	147	68	79	53.74		
Interventional radiology	324	134	190	58.64		
Others	76	48	28	36.84		

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Table 2 continued. Comparison of job stress in different populations.

Items	N	ERI		Detection rate (%)	Chi-squared value	*P*-value
		No	Yes			
Radiation working years (years)						
<5	422	294	128	30.33	153.461	**0.000**
<10	465	213	252	54.19		
<20	302	84	218	72.19		
≥20	207	64	143	69.08		
Family history						
No	1292	629	663	51.32	20.738	**0.000**
Yes	104	26	78	75.00		
Hypertension						
No	1224	601	623	50.90	18.279	**0.000**
Yes	172	54	118	68.60		
Diabetes						
No	1360	644	716	52.65	3.327	0.068
Yes	36	11	25	69.44		
Obesity						
BMI <24	1205	595	610	50.62	20.647	**0.000**
BMI ≥24	191	60	131	68.59		
Smoking						
No	1000	488	512	51.20	4.741	**0.029**
Yes	396	167	229	57.83		
Drinking						
No	622	323	299	48.07	10.944	**0.001**
Yes	774	332	442	57.11		

dose in the application of diagnostic X-rays [12,55]. Long-term radiation exposure in bedside manipulation increased the psychological uneasiness of medical staff, resulting in the increase of job burnout. In the diagnostic radiology group, most workers were alone in an equipment operation room that was shielded by radiation protection but narrow in space and poor in air circulation. Chronic diseases, such as hypertension, diabetes, and obesity, could cause changes in the body's functioning that could make workers feel more tired at work [56].

The results of multiple logistic regression analysis showed that the risk of job burnout for women and individuals with a senior professional title were 0.75 and 0.64 times those of men and individuals with a primary professional title and below, respectively. This could be attributed to women being more likely to relieve stress by communicating with others, and people with senior professional titles having a better ability to control their work [57]. The risks of job burnout in the nuclear medicine group and the radiotherapy group were 0.15 times and 0.54 times that of the diagnostic radiology group. A lower burnout rate among radiation oncologists compared with diagnostic radiologists was also reported by Harolds et al. [58]. This finding could be explained by the fact that compared with the diagnostic radiology group, medical physicists of nuclear medicine and radiotherapy were highly involved in the performance of individual diagnosis and treatment, and played a leading role in the implementation and safe utilization of advanced technologies [59,60], which enhanced job control and

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Table 3. Comparison of job burnout levels in different populations.

Items	N	CMBI				Detection rate (%)	Chi-squared value	*P*-value
		None	Mild	Moderate	Severe			
Age								
<30	311	142	89	69	11	54.34	23.336	**0.005**
<40	571	192	190	143	46	66.37		
<50	353	129	120	83	21	63.46		
≥50	161	49	60	46	6	69.57		
Sex								
Male	796	268	254	220	54	66.33	14.727	**0.002**
Female	600	244	205	121	30	59.33		
Ethnicity								
Han	995	348	318	255	74	65.03	17.279	**0.001**
Minority	401	164	141	86	10	59.10		
Professional title								
None or primary	521	210	150	133	28	59.69	14.770	**0.022**
Middle	501	169	181	111	40	66.27		
Senior	374	133	128	97	16	64.44		
Educational level								
Junior college and below	317	121	110	74	12	61.83	12.768	**0.047**
Undergraduate	683	237	219	171	56	65.30		
Postgraduate	396	154	130	96	16	61.11		
Marital status								
Unmarried	275	122	69	75	9	55.64	18.768	**0.005**
Married	1090	376	381	260	73	65.50		
Divorced or widowed	31	14	9	6	2	54.84		
Job post								
Doctor	834	298	297	201	38	64.27	39.269	**0.000**
Nurse	208	78	75	49	6	62.50		
Radiographer	320	124	83	77	36	61.25		
Others	34	12	4	14	4	64.71		
Radiation work type								
Diagnostic radiology	811	279	281	183	68	65.60	61.867	**0.000**
Nuclear medicine	38	28	4	4	2	26.32		
Radiotherapy	147	68	50	27	2	53.74		
Interventional radiology	324	108	104	102	10	66.67		
Others	76	29	20	25	2	61.84		

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Table 3 continued. Comparison of job burnout levels in different populations.

Items	N	CMBI				Detection rate (%)	Chi-squared value	*P*-value
		None	Mild	Moderate	Severe			
Radiation working years (years)								
<5	422	193	120	98	11	54.27	43.802	**0.000**
<10	465	165	151	113	36	64.52		
<20	302	90	113	69	30	70.20		
≥20	207	64	75	61	7	69.08		
Family history								
No	1292	487	424	310	71	62.31	14.094	**0.003**
Yes	104	25	35	31	13	75.96		
Hypertension								
No	1224	470	397	289	68	61.60	14.860	**0.002**
Yes	172	42	62	52	16	75.58		
Diabetes								
No	1360	508	442	334	76	62.65	25.400	**0.000**
Yes	36	4	17	7	8	88.89		
Obesity								
BMI <24	1205	460	394	289	62	61.83	17.316	**0.001**
BMI ≥24	191	52	65	52	22	72.77		
Smoking								
No	1000	382	320	240	58	61.80	3.601	0.308
Yes	396	130	139	101	26	67.17		
Drinking								
No	622	242	204	148	28	61.09	5.991	0.112
Yes	774	270	255	193	56	65.12		

accomplishment. In this study, the risk of job burnout was 4.57 times higher among medical radiation staff with job stress. A high stress level can be a predictor of burnout at the workplace. Similar results have been reported for emergency room physicians, anesthesiologists, general internists, general surgeons, radiologists, oncologists, and even medical students and residents [61]. The excess stress and high responsibility of medical staff have been shown to lead to mismanagement of their psychological and physiological health and to cause adverse physiological function and psychological reaction, resulting in medical errors, job attrition, lack of professionalism, and even substance abuse [62].

Effective prevention and intervention of occupational health management for medical radiation staff should be implemented from social medicine and occupational medicine. First, strengthening occupational physical examination, personal dose monitoring, and continuing education are beneficial for improving the coping ability and thereby reducing the job stress of medical radiation staff. Second, employers should promote education about occupational health to enhance workers' awareness about self-protection in long-term occupational radiation exposure. Third, the safety of the working environment, reasonable arrangement of workload and working hours, and optimization of the promotion system should be taken into consideration to improve the job satisfaction of medical radiation staff.

The present study has some limitations that could be addressed in future studies. First, because of the imbalance of economic development, the distribution of hospitals and medical radiation staff were uneven, resulting in a larger number

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Table 4. Effects of general demographic characteristics and job stress on job burnout of medical radiation staff according to the results of multiple logistics regression.

Variable	β (CI 95%)		S.E.	OR (CI 95%)		Wald	*P*-value
Intercept	−0.01	(−0.35, 0.34)	0.18	0.99	(0.70, 1.40)	−0.043	0.966
Sex							
Male							
Female	−0.29	(−0.55, −0.02)	0.14	0.75	(0.58, 0.98)	−2.121	0.034
Professional title							
None or primary							
Middle	−0.22	(−0.53, 0.10)	0.16	0.80	(0.59, 1.10)	−1.342	0.179
Senior	−0.45	(−0.85, −0.05)	0.20	0.64	(0.43, 0.96)	−2.180	**0.029**
Marital status							
Unmarried							
Married	0.22	(−0.14, 0.58)	0.18	1.25	(0.87, 1.79)	1.211	0.226
Divorced or widowed	−0.39	(−1.26, 0.47)	0.44	0.68	(0.28, 1.60)	−0.891	0.373
Job post							
Doctor							
Nurse	−0.05	(−0.43, 0.32)	0.19	0.95	(0.65, 1.37)	−0.287	0.774
Radiographer	−0.05	(−0.37, 0.27)	0.16	0.95	(0.69, 1.31)	−0.325	0.745
Others	0.05	(−0.81, 0.91)	0.44	1.05	(0.44, 2.49)	0.116	0.908
Radiation work type							
Diagnostic radiology							
Nuclear medicine	−1.92	(−2.71, −1.12)	0.41	0.15	(0.07, 0.33)	−4.717	**0.000**
Radiotherapy	−0.62	(−1.01, −0.23)	0.20	0.54	(0.36, 0.79)	−3.136	**0.002**
Interventional radiology	−0.05	(−0.36, 0.26)	0.16	0.95	(0.70, 1.30)	−0.328	0.743
Others	0.12	(−0.44, 0.69)	0.29	1.13	(0.64, 1.99)	0.430	0.667
Radiation working years (years)							
<5							
<10	0.10	(−0.24, 0.43)	0.17	1.11	(0.79, 1.54)	0.570	0.568
<20	0.29	(−0.13, 0.71)	0.21	1.34	(0.88, 2.03)	1.362	0.173
≥20	0.24	(−0.24, 0.73)	0.25	1.27	(0.78, 2.07)	0.976	0.329
ERI							
No							
Yes	1.52	(1.27, 1.78)	0.13	4.57	(3.55, 5.91)	11.685	**0.000**

of participants in relatively developed areas. In addition, the sample sizes of all the radiation work types were not uniform due to the different workload of radiation diagnosis and treatment, which may cause bias in groups with small sample size. Second, the cross-sectional investigation cannot prove causality between variables; the relationship between the factors and job burnout need further investigation. Third, some influencing factors, such as radiation dose value, frequency of shift work, and monthly income, were not considered in this study. Finally, further study will be conducted to compare the status of medical staff who are exposed to and not exposed to occupational radiation in the same department.

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Conclusions

Health care providers around the world are under pressure and face increasing expectations and requirements to provide evidence-based and high-quality health service. Although the development and application of radiation medicine has brought great benefits for the prevention and treatment of diseases, the mental health of medicine radiation staff, who are one of the most stressed professional groups as well as the largest occupational group exposed to artificial radiation sources, should get more attention not only for the demands of occupational health management, but also for the safe use of radioisotopes and ionizing radiation. Similar levels of job stress and job burnout of medical radiation staff were demonstrated in Xinjiang, China, compared with many other countries. Radiation working types and increasing radiation working years contributed to high job stress and job burnout, and job stress significantly aggravated job burnout of medical radiation staff. Familiarity with the factors influencing mental health can be conductive to developing strategies from both social and occupational medicine for promoting health and wellness of medical radiation staff.

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