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Title page

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Low back pain of emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study

Abstract

Objective

Low back pain (LBP) has become increasingly common among healthcare providers and could cause serious consequences among nurses. Studies about the prevalence of and risk factors for LBP among emergency ambulance workers are scarce in China, and even the world. The study aimed to determine the prevalence of LBP among ambulance workers including doctors, nurses, and drivers and to explore the risk factors for ambulance nurses' chronic LBP.

Design

Cross-sectional study.

Setting

Emergency ambulance systems from 38 tertiary hospitals were selected by random cluster sampling.

Participants

1560 ambulance workers completed the study.

Outcome measures

A paper-based questionnaire including the Nordic Musculoskeletal Questionnaire evaluating LBP, Dutch Musculoskeletal Questionnaire assessing ergonomic factors and Job Content Questionnaire assessing stress was used. Multivariate logistic

regression analysis was conducted to quantify the association of potential risk factors with chronic LBP among ambulance nurses.

Results

The one-year prevalence of LBP lasting for at least 24 hours, seven days, three years was 86.1%, 50.6% and 21.1% respectively among 498 ambulance nurses, 70.5%, 36.4% and 15.8% among 519 doctors and 57.5%, 23.8% and 12.3% among 543 drivers. Factors contributing to chronic LBP among nurses were bending the trunk frequently, heavy or awkward lifting, shift work, low job satisfaction, high psychological fatigue, high psychological job demand, low job control (decision-making authority and skill discretion), low workplace supervisor support, old age, female sex and obesity.

Conclusions

LBP was extremely prevalent among ambulance nurses. Many factors, especially psychosocial and ergonomic factors contributed to ambulance nurses' chronic LBP.

Strengths and limitations of this study

This is the first large-scale study on the prevalence of low back pain (LBP) among emergency ambulance workers and risk factors of ambulance nurses' chronic LBP in China.

Various factors including individual, psychosocial, ergonomic and organizational factors were collected and analyzed in the study.

The cross-sectional design and subjective measures of the study limited the causal

directions.

Keywords

low back pain; ambulance; nurse

What this paper adds?

1. What is already known about this subject?

Low back pain (LBP) is prevalent among nurses and other healthcare providers. Chronic or long-term LBP could cause serious consequences. But little is known about the current LBP situation of emergency ambulance workers. Many factors such as ergonomic, individual, organizational and psychological factors could contribute to LBP but the effects were not the same in a certain working group.

2. What are the new findings?

This is the first large-scale survey concerning LBP prevalence among emergency ambulance workers and the risk factors among ambulance nurses in China and even the first in the world. Ambulance nurses suffered LBP more than ambulance doctors and drivers, and more than the general nursing population. Ergonomic and psychological factors played important roles in the development of chronic LBP.

3. How might this impact on policy or clinical practice in the foreseeable future?

The LBP prevalence differences in different position of ambulance workers and the chronic LBP risk factors among ambulance nurses screened out, especially

ergonomic and psychological factors, would provide guideline information for future intervention measures and for policy makers.

Introduction

During the past decades, low back pain (LBP), has become one of the most common musculoskeletal disorders and one of the most common occupational health problems among nurses and other healthcare providers around the world [1 2] and been one of the most leading causes of disease burden across the developed and developing countries [3]. Chronic or severe LBP might have serious consequences such as reduced quality of life, loss of working days, occupational disability and changing and/or leaving a profession [4].

Emergency ambulance service, as an essential part of the healthcare system, provides pre-hospital medical emergency service for patients including carrying, moving and transporting patients to an emergency center and treating in the ambulance such as performing cardiopulmonary resuscitation. Ambulance workers seemed to have more musculoskeletal disorders than the general working force [5]. Worldwide, attention has been paid to the musculoskeletal disorders of ambulance workers over the last decade [5 6]. But there has been limited data about the LBP prevalence and risk factors among ambulance workers worldwide. Due to musculoskeletal disorders, especially LBP, ambulance workers were reported to suffer from a higher standardized early retirement than other healthcare providers and

the general working force [5 7]. In Mainland China, scarce attention has been paid to the emergency ambulance workers and no study so far has explored the prevalence of LBP among ambulance workers and their risk factors.

Studies [8] have reported that many factors could contribute to LBP including individual, psychosocial, physical and organizational work factors. Psychosocial factors including low job support, job dissatisfaction, and occupational stress, and individual factors such as high BMI and being female could contribute to musculoskeletal disorders of the back region revealed by a systematic review with strong evidence[9]. But as to the LBP among a special occupational group, the above factors do not have the same effects. Psychosocial factors at work such as stress, fatigue and job dissatisfaction have been demonstrated to largely contribute to the development of LBP in a follow-up study of 4500 Iranian industrial workers [10]. Emergency ambulance workers, especially nurses, are faced up with demanding nursing skills, rapid work rhythms, violence episodes, threats, increased risks of contracting infectious diseases and increasing demands on medical competence [11]. Therefore, ambulance nurses may also suffer from LBP resulted from psychosocial factors and the effect was not known. The current study aimed to evaluate the prevalence of LBP among the ambulance workers of different work position and to determine and quantify the association of influencing factors including occupational stress and other well-known factors such as ergonomic and individual factors with chronic LBP among ambulance nurses.

Methods

Participants

A cross-sectional survey was implemented from September to November in 2018. Considering LBP prevalence, number of independent variables in logistic regression and response rate, 38 hospitals were selected first by random cluster sampling from among all the tertiary hospitals in Shandong, China. Then, of the selected 38 hospitals, all the emergency ambulance workers who had at least one years of work experience as an ambulance worker were invited to participate. Exclusion criteria were as follows: workers who experienced trauma injury or serious diseases, part-time workers. A total of 1560 ambulance workers (498 nurses, 519 doctors and 543 drivers) completed our questionnaire and 158 (65 nurses, 49 doctors and 44 drivers) failed to participate due to long leaves for vacation, sick leave, maternity leave and personal affaires. As to the questionnaires filled incompletely, the participants were contacted and completed the questionnaire later. The response rate of the study was 90.8%.

The study was approved by the Ethics Committee of Shouguang People's Hospital. Informed consent was obtained before the participants were invited to participate.

Questionnaire

A self-administered questionnaire was designed and revised after pilot study. The paper-based questionnaire consisted of four sections. Section one dealt with demographic information including age, sex, height, weight, marital status, smoking,

alcohol consumption, educational level, marital status, children in household and exercise.

Section two was a modified version of the Standardized Nordic Musculoskeletal Questionnaire [12] which has been developed to collect the prevalence information of musculoskeletal disorders in different parts of the body. The Chinese version of the Nordic questionnaire has been validated and widely used by previous national studies [13 14]. The participants were asked whether they had suffered from pain or discomfort in the low back region lasting for at least 24 hours, lasting for at least seven days and lasting for at least three months respectively in the preceding twelve months.

Section three dealt with work information and ergonomic factors mainly derived from Dutch Musculoskeletal Questionnaire [15], which has been validated [13]. Ergonomic factors were measured using a dichotomous scale (Yes/No), and the assessment of risk factors was qualitative in this study [13 15]. Participants were asked whether they were often exposed to the ergonomic risk factors during their work. Work information included work position (doctor, nurse, or driver), work shift (shift work or day work), work age and employment status.

Section four dealt with psychosocial factors including job satisfaction (high, medium, low), self-perceived health status (very good, generally good, generally bad, very bad), psychological fatigue (low, medium, high) and occupational stress assessed by the Job Content Questionnaire (JCQ) which has been widely used in different groups of numerous studies and showed good reliability and validity[16] . In our study,

22 items of the original 49-item JCQ were applied and consisted of three dimensions: psychological job demand (five items), job control including skill discretion (six items) and decision-making authority (three items), and workplace social support including supervisor social support (four items) and coworker social support (four items). Each item was scored on a four-point Likert scale from "strongly disagree" to "strongly agree".

Data analysis

The Statistical Package for Social Sciences (SPSS), version 18.0 was used to perform statistical analysis. Single-factor chi-square test, independent t-test, or rank sum test was used to examine the differences between different groups of participants. The association of physical, psychosocial, organizational and individual factors with chronic LBP was first examined by univariate analysis such as t- test, chi-square test or rank sum test. The significant factors selected in the univariate analysis then entered into multivariate logistic regression analysis. Odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated to evaluate the effect of risk factors with chronic LBP. In order to avoid an inaccurate and unstable logistic regression model, the significant variable 'work age' in the univariate analysis was removed, and 'age' was kept for the multivariate analysis as they showed collinearity in relationships ($\rho > 0.6$) diagnosed by Spearman correlation matrix. The statistics for variable entry and removal were set at $P < 0.05$ and $P > 0.1$ respectively in the multivariate analysis. A 0.05 statistical significance level was set for all tests.

Results

The mean age of the 498 ambulance nurses was 31.1±7.6 years, statistically younger than the ambulance doctors (35.7±6.9) and drivers(38.4±9.5). Most of the ambulance nurses were female, while most of the ambulance doctors and drivers were male. Most nurses never smoked. Ambulance nurses had a statistically younger work age as an ambulance worker than ambulance doctors and drivers. Ambulance nurses had a statistically higher educational level than drivers and lower than doctors. Nurses exercised less than doctors and drivers in their leisure time.

The one-year prevalence of LBP lasting for at least 24 hours, 7 days and 3 months was 86.1%, 50.6% and 21.1% respectively among ambulance nurses, 70.5%, 36.4% and 15.8% among doctors, and 57.5%, 23.8% and 12.3% among drivers. For more details, see Table 1.

Nurses with old age, female sex, higher BMI, shift work, more work years as an ambulance nurse or temporary/contract employment status, seemed to suffer from chronic LBP more. As to the ergonomic factors, walking for long periods of time, bending the trunk frequently, heavy or awkward lifting, bending or twisting the neck and maintaining shoulder abduction for long periods of time were all statistically associated with chronic LBP. For more details, see Table 2.

As to the psychosocial factors, scores of psychological job demand was positive associated with chronic LBP while scores of skill discretion, decision-making authority, workplace supervisor support and workplace coworker support were

negatively associated with chronic LBP among ambulance nurses. Univariate analysis also showed that health status, job satisfaction and psychological fatigue were all associated with Chronic LBP. For more details, see Table 3.

Multivariate logistic regression analysis reveal that age, sex, BMI, work shift, bending the trunk frequently, heavy or awkward lifting, psychological fatigue, job satisfaction, psychological job demand, skill discretion, decision-making authority and workplace supervisor support were independently associated with chronic LBP among ambulance nurses. For more details, see Table 4.

Discussion

To our knowledge, this is the first large-scale survey aimed to explore the LBP prevalence among ambulance workers and the risk factors for chronic LBP among ambulance nurses in China, even maybe the first in the world. The ambulance workers participated in the study were randomly selected in Shandong, China and the response rate of 90.8% was acceptable. We found the prevalence of LBP lasting for at least 24 hours, for at least 7 days, and for at least three months was 86.1%, 50.6% and 21.1% respectively among ambulance nurses, 70.5%, 36.4% and 15.8% respectively among ambulance doctors, and 57.5%, 23.8% and 12.3% respectively among ambulance drivers. The risk factors screened out for the ambulance nurses' chronic LBP were ergonomic factors (bending the trunk frequently, heavy or awkward lifting), occupational stress (high psychological job demand, low job control and low

workplace supervisor support), high psychological fatigue, low job satisfaction, shift work and individual factors (age, sex, obese).

Limitations of our study included the use of self-reported measures and retrospective questionnaire. Therefore, it is inevitable to suffer from measurement bias. The cross-sectional design of the study precluded causal conclusions and a prospective cohort study might be needed in the future.

In our study, the prevalence rates of LBP lasting for at least 24 hours, for at least 7 days, and for at least three months among ambulance nurses were all statistically higher than that among ambulance doctors and drivers. To our knowledge, after searching several databases such as Medline, Embase, CNKI and Wanfang, research about the prevalence of LBP among ambulance workers was very limited so that comparison between different countries was not made. As to LBP lasting for at least 24 hours, the prevalence was higher among ambulance nurses than that among the general nursing personal in Greece (75%) [17], Nepal (67%) [18], Chinese Taiwan (66.0%)[19]and other countries [8 17 20]. As to chronic LBP (lasting for at least three months), the prevalence among ambulance nurses was higher than that among the nursing personal in Dutch (12%), Greek (11%) [17], and Taiwan (8.6%) [19]. Although prevalence variance may exist between the above studies, more attention should be paid to the ambulance nurses' LBP and its risk factors need to be pinpointed.

Just as reported that most individuals would suffer from short-term or minor LBP in their whole life [21], serious or chronic LBP was caused mainly due to work and

other factors. Therefore, we analyzed the risk factors of chronic LBP other than short-term LBP.

Epidemiological studies have reported that LBP could be caused by combinations of physical factors alone [22]. A cross-sectional study [19] in Taiwan found that certain manual patient-transfer tasks played important roles in severe LBP (such as care seeking, intense pain, and sick leave) than in minor LBP (pain lasting for at least 24 hours). Tasks such as often with twisted or bent posture or heavy lifting have been demonstrated to cause high spinal stress [23]. Patient-handling, as one of the main tasks of nurses, could generate a burden of severe biomechanical load on spinal parts of the body and could impose compressive and shear forces on nurses' low spine [24]. Different from a cohort study [25] in Norway which found prolonged standing and awkward lifting were important factors of the ergonomic factors for LBP, our study found bending the trunk frequently and heavy or awkward lifting contributed to chronic LBP, which again confirmed the above findings among ambulance nurses. Musculoskeletal loads and injuries resulted from patient-handling tasks need to be reduced and could be reduced by efficient and cost-effective ergonomic intervention measures including LBP knowledge learning, transferring equipments, lifting teams and training on safe patient transfer techniques reported by previous studies[26]. For example, in an intervention study [27] conducted in Turkey, ergonomic training was proved to be an acceptable method to prevent LBP. Therefore, in order to prevent chronic LBP among ambulance nurses, ergonomic intervention measures need to be taken.

Psychosocial factors are perceived feelings of the work environment which could bring about psychological fatigue, job dissatisfaction and occupational stress [28]. Our study found that high psychological job demand, low job control and low supervisor support were independently associated with chronic LBP, consistent with other studies [29 30 31 23]. A cross-sectional study [29] in Brazil confirmed that both physical and psychosocial work demands were independently associated with LBP. In a prospective study [30], an increased risk of hospitalization due to musculoskeletal disorders and an increased rate of musculoskeletal sickness absence were reported to be associated with lack of job control. In other studies [31 23], poor job content and low workplace social support were also shown to be risk factors for back pain. In our study, workplace coworker support was noted to be significantly associated with chronic LBP in the univariate analysis but did not remain in the multivariate logistic regression analysis, probably because the ambulance workers as a group to some extent worked collaboratively and the factor of coworker support was not that significantly important like other psychological factors. Our study also found that psychological fatigue and job satisfaction were all associated with chronic LBP, consistent with other studies [6 32] which showed that employees dissatisfied with their work were more prone to complain of back pain. High psychological fatigue could not only increase the possibility of worker injuries and medical errors, but also negatively affect one's physical and mental work performance [33]. A cohort study [25] of the general working population in Norway showed that psychosocial factors such as high psychological job demands and low job control were reported as the most consistent

and important predictors of LBP, in addition to ergonomic factors of prolonged standing and awkward lifting. Emergency ambulance nursing work not only needs high-intensity physical activity, but also demanding professional skills and rapid response in emergencies, which increased their psychological demand. As is known to us all, a perfect job without any negative psychosocial work factors does not exist. Therefore, an optimal job design proposed by Smith and Carayon-Sainfort was recommended for ambulance nurses. And negative psychosocial work factors should be decreased to an acceptable level in order to control chronic LBP among ambulance nurses.

Multivariate logistic regression analysis also revealed that work shift (shift work vs. day work) was independently associated with chronic LBP, which surprised us. However, another cross-sectional study [34] of including 1203 Iranian petrochemical employees also reported that musculoskeletal disorders in shift workers were statistically more prevalent than in day workers. In a prospective study [35] of nurses' aides, LBP related sick leaves were revealed to be correlated with working night shifts. A study in Japan [36] found that a short rest or nap at night could help reduce musculoskeletal pain. Proper management of shift work was reported to be important in reducing health problems experienced by nurses [37]. Although the mechanism between night shift work and chronic LBP has not been illuminated, measures such as short rests at night and adequate nurses in shift work should be considered to reduce exposure of LBP risk factors.

Female ambulance nurses were noted to suffer from chronic LBP statistically more than male nurses. Since most of the ambulance nurses were female around the world, more attention should be given to the female nurses' health when introducing interventions.

Age was found to be associated with chronic LBP but the effect was slight, consistent with previous studies, probably because aging is associated with muscle weakness and muscle atrophy which would lead to LBP[38]. Obesity was correlated with chronic LBP, probably because excess abdominal weight pressure on the vertebrae might trigger chronic spasms in the low back region [39].Therefore, maintaining a normal body weight seems important for preventing LBP among ambulance nurses.

As to the many risk factors of chronic LBP among ambulance nurses, one simple intervention measure alone may not inadequate. To achieve the aim of decreasing musculoskeletal disorders in healthcare professionals, a multi-component intervention was required revealed by previous reviews [40]. Therefore, comprehensive measures need to be considered in order to prevent chronic LBP.

Conclusions

This study suggests a pretty high prevalence of LBP among ambulance nurses. Psychosocial factors such as stress and fatigue, and ergonomic factors such as bending the trunk frequently and heavy or awkward lifting played important roles in

the development of chronic LBP. Many factors including ergonomic, psychosocial, organizational and individual factors contributed to chronic LBP among ambulance nurses. Comprehensive intervention measures might be needed when to explore prevention methods.

Contributors HD designed the study and drafted the manuscript. QZ participated in the design of the work, data analysis and revising it. All authors participated in the data collection, paper revising and final approval of the version to be published.

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Patient consent Obtained.

Ethics approval The Ethics Committee of Shouguang People's Hospital.

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Table 1 Characteristics of emergency ambulance workers in tertiary hospitals

	Nurses	Doctors	P (between nurses and doctors)	Drivers	P (between nurses and drivers)
Total number of subjects	498	519		543	
Age (M±SD)	31.1±7.6	35.7±6.9	<0.001	38.4±9.5	<0.001
Sex			<0.001		<0.001
Male	73	396		471	
Female	425	123		72	
BMI			0.009		<0.001
＜ 18.5 (Underweight)	43	45		21	
18.5～23.9 (Normal weight)	276	249		291	
24.0～27.9 (Overweight)	125	129		93	
≥ 28.0 (Obesity)	54	96		138	
Marital status			<0.001		<0.001
Never married	75	91		32	
Married/cohabiting	363	402		471	
Divorced/separated/widowed	60	26		40	
Smoking			<0.001		<0.001
Never smoked	485	159		75	
Ex-smoker	10	147		111	
Current smoker	3	213		357	
Workage as an ambulance worker (M±SD)	8.3±8	12.8±9.3	<0.001	14.5±8.8	<0.001
Educational level			<0.001		<0.001
Lower than junior college	111	33		539	
Junior college	261	97		3	
Bachelor	96	259		1	
Master or above	30	132		0	
Exercise in leisure time			<0.001		<0.001
Never/almost never	295	198		219	
Sometimes	97	185		159	
Often	106	136		165	
LBP lasting for at least					
24 hours	429(86.1)	366(70.5)	<0.001	312(57.5)	<0.001
7 days	252(50.6)	189(36.4)	<0.001	129(23.8)	<0.001
3 months	105(21.1)	82(15.8)	0.030	67(12.3)	<0.001

T-test for “age” and “Workage as an ambulance worker”. Chi-square test for “Sex”, “Marital status”, “Smoking” and “LBP”. Rank sum test for “BMI”, “Educational level” and “Exercise in leisure time”.

Table 2 Univariate analysis of individual and ergonomic factors with chronic LBP among ambulance nurses.

Factors	Chronic LBP sufferers	Non-chronic-LBP sufferers	P
Number of subjects	105	393	
Age	36.5±7.7	29.7±6.7	<0.001
Sex			0.022
Male	8	65	
Female	97	328	
BMI			<0.001
＜ 18.5 (Underweight)	4	39	
18.5～23.9 (Normal weight)	45	231	
24.0～27.9 (Overweight)	29	96	
≥ 28.0 (Obesity)	27	27	
Work shift			<0.001
Shift work	60	129	
Day work	45	264	
Workage as an ambulance nurse	13.8±8.7	6.8±7.2	<0.001
Employment status			0.014
Permanent	39	199	
Temporary/contract	66	194	
Ergonomic factors			
Walking for long periods of time (Yes/No)	54/51	154/239	0.024
Bending the trunk frequently (Yes/No)	66/39	93/300	<0.001
Heavy or awkward lifting (Yes/No)	75/30	112/281	<0.001
Bending or twisting the neck (Yes/No)	39/66	97/296	0.011
Maintaining shoulder abduction for long periods of time (Yes/No)	48/57	136/257	0.036

T-test for “age” and “workage as an ambulance nurse”. Chi-square test for “Sex”, “Work shift”, “Employment status” and ergonomic factors. Rank sum test for BMI.

Table 3 Univariate analysis of psychosocial factors with chronic LBP among ambulance nurses.

Psychosocial factors	Chronic LBP sufferers	Non-chronic-LBP sufferers	P
Number of subjects	105	393	
Occupational stress			
Psychological job demand	14.5±4.1	11.1±3.2	<0.001
Decision-making authority	5.8±3.8	8.1±2.5	<0.001
Skill discretion	11.7±5.3	16.2±4.6	<0.001
Supervisor social support	6.8±3.2	9.8±2.2	<0.001
Coworker social support	8.7±3.8	10.3±2.6	<0.001
Health status			0.043
Very good	19	89	
Generally good	25	109	
Generally bad	29	117	
Very bad	32	78	
Psychological fatigue			0.004
Low	27	127	
Medium	45	207	
High	33	59	
Job satisfaction			0.025
High	42	187	
Medium	33	144	
Low	30	62	

T-test for components of occupational stress. Rank sum test for “Job satisfaction”, “Psychological fatigue” and “Health status”.

Table 4 Multivariate logistic regression analysis of Chronic LBP risk factors among ambulance nurses.

Factors	B	SE	P	OR (95% C.I.)
Age	0.912	0.453	0.023	2.489 (1.024-6.049)
Sex (1=female, 0=male)	0.891	0.381	0.017	2.438 (1.155-5.144)
BMI				
18.5～23.9 (Normal weight)				Reference
＜ 18.5 (Underweight)	−0.641	0.546	0.513	0.527 (0.181-1.536)
24.0～27.9 (Overweight)	0.439	0.263	0.329	1.551 (0.926-2.597)
≥ 28.0 (Obesity)	1.638	0.313	<0.001	5.145 (2.786-9.502)
Work shift (1=shift work, 0=day work)	1.005	0.223	<0.001	2.732 (1.765-4.229)
Ergonomic factors				
Bending the trunk frequently	1.701	0.232	<0.001	5.479 (3.477-8.634)
Heavy or awkward lifting	1.838	0.242	<0.001	6.284 (3.911-10.098)
Psychosocial factors				
Psychological fatigue				
Low				Reference
Medium	0.021	0.267	0.214	1.021 (0.605-1.723)
High	0.968	0.296	<0.001	2.633 (1.474-4.703)
Job satisfaction				
High				Reference
Medium	0.031	0.262	0.154	1.031 (0.617-1.724)
Low	0.768	0.279	<0.001	2.155 (1.248-3.724)
Occupational stress				
Psychological job demand	1.031	0.414	<0.001	2.804 (1.246-6.312)
Decision-making authority	−0.924	0.411	<0.001	0.397 (0.177-0.888)
Skill discretion	−0.973	0.402	<0.001	0.378 (0.172-0.831)
Supervisor social support	−1.213	0.393	<0.001	0.297 (0.138-0.642)

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Low back pain in emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study

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Title page

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Low back pain in emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study

Abstract

Objective

Low back pain (LBP) could cause serious consequences and has been shown to be prevalent among emergency ambulance workers. Studies on the prevalence of and risk factors for LBP among emergency ambulance workers are scarce in China. The study aimed to determine the prevalence of LBP among ambulance workers, including doctors, nurses, and drivers, and to explore the risk factors for ambulance nurses' chronic LBP.

Design

Cross-sectional study.

Setting

Emergency ambulance systems from 38 tertiary hospitals were selected by random cluster sampling.

Participants

A total of 1560 ambulance workers completed the study.

Outcome measures

A paper-based questionnaire that included the Nordic Musculoskeletal Questionnaire, which evaluated LBP, the Dutch Musculoskeletal Questionnaire, which assessed ergonomic factors, and the Job Content Questionnaire, which assessed

stress, was used. Multivariate logistic regression analysis was conducted to quantify the association of potential risk factors with chronic LBP among ambulance nurses.

Results

The one-year prevalence of LBP lasting for at least 24 hours, seven days and three months was 86.1%, 50.6% and 21.1%, respectively, among 498 ambulance nurses; 70.5%, 36.4% and 15.8% among 519 doctors; and 57.5%, 23.8% and 12.3% among 543 drivers. The factors contributing to chronic LBP among ambulance nurses were the frequent bending of the trunk, heavy or awkward lifting, shift work, low job satisfaction, high psychological fatigue, high psychological job demand, low job control (decision-making authority and skill discretion), low workplace supervisor support, older age, female sex and obesity.

Conclusions

LBP was more prevalent among ambulance nurses than among ambulance doctors and drivers in Shandong, China. Many factors, especially psychosocial and ergonomic factors, contributed to ambulance nurses' chronic LBP. Comprehensive measures might be needed to control chronic LBP.

Strengths and limitations of this study

This is the first large-scale study on the prevalence of low back pain (LBP) among emergency ambulance workers and risk factors for ambulance nurses' chronic LBP in China.

Various factors, including individual, psychosocial, ergonomic and organizational

factors, were collected and analysed in the study.

The cross-sectional design and subjective measures of the study limited the establishment of causal directions.

Keywords

low back pain; ambulance; nurse

Introduction

Emergency ambulance service, as an essential part of the healthcare system, provides pre-hospital medical emergency service for patients, including carrying, moving and transporting patients to an emergency centre and treating them in the ambulance, such as performing cardiopulmonary resuscitation. Ambulance workers have been reported to experience more musculoskeletal disorders than the general workforce [1-4]. In Denmark, data from a nationwide study showed that a substantially high proportion (42%) of 1689 ambulance personnel reported musculoskeletal pain, which was significantly higher than corresponding reports from the core workforce of 14,175 individuals (29%) [5]. In Australia, ambulance officers and paramedics had the highest rates for musculoskeletal injury compared with other healthcare workers in the 2003-2012 time period[6]. Worldwide, attention has been paid to the musculoskeletal disorders of ambulance workers over the last decade because of serious consequences, such as reduced quality of life, loss of working days,

occupational disability and the need to change and/or leave a profession [7]. Due to musculoskeletal disorders, especially low back pain (LBP), ambulance workers have been reported to suffer from a higher standardized early retirement than other healthcare providers and the general workforce [1 8]. In mainland China, scarce attention has been paid to emergency ambulance workers, and no study thus far has explored the prevalence of LBP among ambulance workers and their risk factors.

Studies [9] have reported that many factors could contribute to LBP, including individual, psychosocial, physical and organizational work factors. Psychosocial factors, including low job support, job dissatisfaction, and occupational stress, and individual factors, such as high BMI and being female, could contribute to musculoskeletal disorders of the back region, as revealed by a systematic review with strong evidence[10]. However, regarding the LBP among a special occupational group, the above factors do not have the same effects. Psychosocial factors at work, such as stress, fatigue and job dissatisfaction, have been demonstrated to largely contribute to the development of LBP in a follow-up study of 4500 Iranian industrial workers [11]. Emergency ambulance workers, especially nurses, are faced with demanding nursing skills, rapid pace of work, episodes of violence, threats, increased risks of contracting infectious diseases and increasing demands on medical competence [12]. Therefore, ambulance nurses may also suffer from LBP resulting from psychosocial factors, and this effect is not known. The current study aimed to evaluate the prevalence of LBP among ambulance workers in different work positions and to determine and quantify

the association between influencing factors, including individual, physical and psychosocial factors, and chronic LBP among ambulance nurses.

Methods

A cross-sectional survey was implemented from September to November 2018. The study was approved by the Ethics Committee of Shouguang People's Hospital. Informed consent was obtained before the participants were invited to participate.

Participants

Given the prevalence of LBP, the number of independent variables in the logistic regression and the response rate, 38 hospitals were selected first by random cluster sampling from among all the tertiary hospitals (182 tertiary-level hospitals in total) in Shandong, China. Then, of the selected 38 hospitals, all the emergency ambulance workers who had at least one year of work experience as an ambulance worker were invited to participate with the help of the management departments and the directors of emergency departments. The exclusion criteria were as follows: part-time workers or workers who had experienced trauma, injury, or serious diseases. A total of 1560 ambulance workers (498 nurses, 519 doctors and 543 drivers) completed our questionnaire, and the response rate of the study was 90.8%.

Questionnaire

A self-administered questionnaire that included the Standardized Nordic

Musculoskeletal Questionnaire[13], the Dutch Musculoskeletal Questionnaire[14] and the Job Content Questionnaire[15], was designed and revised after a pilot study. The paper-based questionnaire consisted of four sections. Section one addresses demographic information, including age, sex, height, weight, marital status, smoking, alcohol consumption, educational level, marital status, children in the household and exercise.

Section two was a modified version of the Standardized Nordic Musculoskeletal Questionnaire. The Chinese version of the Nordic questionnaire has been widely used, validated and contextualized by previous national studies according to a cross-cultural understanding of the Chinese population[16-18]. The participants were asked whether they had suffered from pain or discomfort in the low back region lasting for at least 24 hours, for at least seven days and lasting for at least three months in the preceding twelve months. If a participant reported LBP lasting for at least three months in the past twelve months, he or she was considered to have chronic LBP [19].

Section three addresses work information and ergonomic factors mainly derived from Dutch Musculoskeletal Questionnaire [14], which has been systematically translated into Chinese [16]and validated [17]. Ergonomic factors were measured using a dichotomous scale (yes/no), and the assessment of risk factors was qualitative in this study [14 17]. Participants were asked whether they were often exposed to the ergonomic risk factors during their work without further explanation. Work information included work position (doctor, nurse, or driver), work shift (shift work or day work), work

experience and employment status (permanent *vs.* temporary/contract).

Section four addresses psychosocial factors, including job satisfaction (high, medium, low), self-perceived health status (very good, generally good, generally bad, very bad), psychological fatigue (low, medium, high) and occupational stress assessed by the Job Content Questionnaire (JCQ), which has been widely used in different groups of numerous studies and has shown good reliability and validity in the Chinese working population [15]. In our study, 22 items of the original 49-item JCQ, whose content validity indices were all above 0.80, were applied and consisted of three dimensions: psychological job demand (five items); job control, including skill discretion (six items) and decision-making authority (three items); and workplace social support, including supervisor social support (four items) and co-worker social support (four items). Each item was scored on a four-point Likert scale from "strongly disagree" to "strongly agree", with higher scores indicating higher psychological job demand, higher job control and higher workplace social support. In this study, Cronbach's α coefficients for psychological job demand, job control and workplace social support were 0.79, 0.87 and 0.90, respectively.

Data analysis

The Statistical Package for Social Sciences (SPSS), version 18.0, was used to perform statistical analysis. A single-factor chi-square test, independent t-test, or rank-sum test was used to examine the differences between different groups of participants. The association of physical, psychosocial, organizational and individual

factors with chronic LBP (lasting for at least three months) was first examined with univariate analysis, such as t-tests, chi-square tests or rank-sum tests. The significant factors selected in the univariate analysis were then entered into multivariate logistic regression analysis. Odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated to evaluate the effect of risk factors on chronic LBP. To avoid an inaccurate and unstable logistic regression model, the significant variable 'work experience' in the univariate analysis was removed, and 'age' was kept for the multivariate analysis, as it showed collinearity in relationships ($\rho > 0.6$) diagnosed by Spearman correlation matrix. The statistics for variable entry and removal were set at $P < 0.05$ and $P > 0.1$, respectively, in the multivariate analysis. A 0.05 statistical significance level was set for all tests.

Patient and public involvement

No patients or members of the public were involved in the design or implementation of the study. The results of the study were disseminated to the health authorities and the selected 38 hospitals.

Results

All 1560 questionnaires (498 ambulance nurses, 519 doctors and 543 drivers) were included in the study, and with respect to the questionnaires that were not fully completed, the participants were contacted again and completed the questionnaire later. Approximately 158 individuals (65 ambulance nurses, 49 doctors and 44 drivers) failed to participate in the survey due to long leaves for vacation, sick leave, maternity

leave and personal affairs.

The mean age of the 498 ambulance nurses was 31.1±7.6 years, which was significantly younger than the mean age of the ambulance doctors (35.7±6.9) and drivers(38.4±9.5). Most of the ambulance nurses were female, while most of the ambulance doctors and drivers were male. Most nurses never smoked. Ambulance nurses had significantly less work experience as an ambulance worker (8.3±8.0 years) than did ambulance doctors (12.8±9.3 years) and drivers (14.5±8.8 years). Ambulance nurses had an educational level that was significantly higher than that of drivers and lower than that of doctors, and the rank-sum test is shown in Table 1. Nurses exercised less than doctors and drivers did in their leisure time (Table 1).

The twelve-month prevalence of LBP lasting for at least 24 hours, 7 days and 3 months was 86.1%, 50.6% and 21.1%, respectively, among ambulance nurses; 70.5%, 36.4% and 15.8% among doctors; and 57.5%, 23.8% and 12.3% among drivers. For more details, see Table 1.

Table 1 Characteristics of emergency ambulance workers in tertiary hospitals

	Nurses	Doctors	P^1	Drivers	P^2
Total number of subjects	498	519		543	
Age (M±SD)	31.1±7.6	35.7±6.9	<0.001	38.4±9.5	<0.001
Sex			<0.001		<0.001
Male	73 (14.7%)	396 (76.3%)		471 (86.7%)	
Female	425 (85.3%)	123 (23.7%)		72 (13.3%)	
BMI			0.009		<0.001
＜ 18.5 (Underweight)	43 (8.6%)	45 (8.7%)		21 (3.9%)	
18.5～23.9 (Normal weight)	276 (55.4%)	249 (48.0%)		291 (53.6%)	
24.0～27.9 (Overweight)	125 (25.1%)	129 (24.9%)		93 (17.1%)	
≥ 28.0 (Obesity)	54 (10.8%)	96 (18.5%)		138 (25.4%)	

Marital status			<0.001		<0.001
Never married	75 (15.1%)	91 (17.5%)		32 (5.9%)	
Married/cohabiting	363 (72.9%)	402 (77.5%)		471 (86.7%)	
Divorced/separated/widowed	60 (12.0%)	26 (5.0%)		40 (7.4%)	
Smoking			<0.001		<0.001
Never smoked	485 (97.4%)	159 (30.6%)		75 (13.8%)	
Ex-smoker	10 (2.0%)	147 (28.3%)		111 (20.4%)	
Current smoker	3 (0.6%)	213 (41.0%)		357 (65.7%)	
Work experience as an ambulance worker (M±SD)	8.3±8.0	12.8±9.3	<0.001	14.5±8.8	<0.001
Educational level			<0.001		<0.001
Lower than junior college	111 (22.3%)	33 (6.4%)		539 (99.3%)	
Junior college	261 (52.4%)	96 (18.5%)		3 (0.6%)	
Bachelor	96 (19.3%)	258 (49.7%)		1 (0.2%)	
Master or above	30 (6.0%)	132 (25.4%)		0 (0.0%)	
Exercise in leisure time			<0.001		<0.001
Never/almost never	295 (59.2%)	198 (38.2%)		219 (40.3%)	
Sometimes	97 (19.5%)	185 (35.6%)		159 (29.3%)	
Often	106 (21.3%)	136 (26.2%)		165 (30.4%)	
LBP lasting for at least					
24 hours	429(86.1%)	366(70.5%)	<0.001	312(57.5%)	<0.001
7 days	252(50.6%)	189(36.4%)	<0.001	129(23.8%)	<0.001
3 months	105(21.1%)	82(15.8%)	0.030	67(12.3%)	<0.001

1 P value between ambulance nurses and doctors. 2 P value between ambulance nurses and drivers. T-test for “age” and “work experience as an ambulance worker”. Chi-square test for “sex”, “marital status”, “smoking” and “LBP”. Rank-sum test for “BMI”, “educational level” and “exercise in leisure time”.

Ambulance nurses who were older in age, were female, had higher BMI, performed shift work, and had worked longer as an ambulance worker or in temporary/contract employment seemed to suffer from chronic LBP more. Regarding ergonomic factors, walking for long periods of time, the frequent bending of the trunk, heavy or awkward lifting, bending or twisting the neck and maintaining shoulder abduction for long periods of time were all statistically associated with chronic LBP. For more details,

see Table 2.

Table 2 Univariate analysis of individual and ergonomic factors with chronic LBP among ambulance nurses.

Factors	Chronic LBP	Non-chronic-LBP	*P*
Number of subjects	105	393	
Age	36.5±7.7	29.7±6.7	<0.001
Sex			0.022
Male	8	65	
Female	97	328	
BMI			<0.001
＜ 18.5 (Underweight)	4	39	
18.5～23.9 (Normal weight)	45	231	
24.0～27.9 (Overweight)	29	96	
≥ 28.0 (Obesity)	27	27	
Work shift			<0.001
Shift work	60	129	
Day work	45	264	
Work experience as an ambulance worker	13.8±8.7	6.8±7.2	<0.001
Employment status			0.014
Permanent	39	199	
Temporary/contract	66	194	
Ergonomic factors			
Walking for long periods of time (Yes/No)	54/51	154/239	0.024
Frequent bending of the trunk (Yes/No)	66/39	93/300	<0.001
Heavy or awkward lifting (Yes/No)	75/30	112/281	<0.001
Bending or twisting the neck (Yes/No)	39/66	97/296	0.011
Maintaining shoulder abduction for long periods of time (Yes/No)	48/57	136/257	0.036

T-test for “age” and “work experience as an ambulance worker”. Chi-square test for “sex”, “work shift”, “employment status” and ergonomic factors. Rank-sum test for BMI.

Regarding the psychosocial factors, scores on psychological job demand were positively associated with chronic LBP, while scores on skill discretion, decision-making authority, workplace supervisor support and workplace co-worker support were negatively associated with chronic LBP among ambulance nurses.

Univariate analysis also showed that self-perceived health status, job satisfaction and psychological fatigue were all associated with chronic LBP. For more details, see Table 3.

Table 3 Univariate analysis of psychosocial factors with chronic LBP among ambulance nurses.

Psychosocial factors	Chronic LBP	Non-chronic-LBP	*P*
Number of subjects	105	393	
Occupational stress			
Psychological job demand	14.5±4.1	11.1±3.2	<0.001
Decision-making authority	5.8±3.8	8.1±2.5	<0.001
Skill discretion	11.7±5.3	16.2±4.6	<0.001
Supervisor social support	6.8±3.2	9.8±2.2	<0.001
Coworker social support	8.7±3.8	10.3±2.6	<0.001
Health status			0.043
Very good	19	89	
Generally good	25	109	
Generally bad	29	117	
Very bad	32	78	
Psychological fatigue			0.004
Low	27	127	
Medium	45	207	
High	33	59	
Job satisfaction			0.025
High	42	187	
Medium	33	144	
Low	30	62	

T-test for components of occupational stress. Rank-sum test for “job satisfaction”, “psychological fatigue” and “health status”.

Multivariate logistic regression analysis revealed that age, sex, BMI, work shift, frequent bending of the trunk, heavy or awkward lifting, psychological fatigue, job satisfaction, psychological job demand, skill discretion, decision-making authority and workplace supervisor support were independently associated with chronic LBP among ambulance nurses. For more details, see Table 4.

Table 4 Multivariate logistic regression analysis of chronic LBP risk factors among ambulance nurses.

Factors	B	SE	*P*	OR (95% C.I.)
Age	0.912	0.453	0.023	2.489 (1.024-6.049)
Sex (1=female, 0=male)	0.891	0.381	0.017	2.438 (1.155-5.144)
BMI				
18.5～23.9 (Normal weight)				Reference
＜ 18.5 (Underweight)	−0.641	0.546	0.513	0.527 (0.181-1.536)
24.0～27.9 (Overweight)	0.439	0.263	0.329	1.551 (0.926-2.597)
≥ 28.0 (Obesity)	1.638	0.313	<0.001	5.145 (2.786-9.502)
Work shift (1=shift work, 0=day work)	1.005	0.223	<0.001	2.732 (1.765-4.229)
Ergonomic factors				
Frequent bending of the trunk	1.701	0.232	<0.001	5.479 (3.477-8.634)
Heavy or awkward lifting	1.838	0.242	<0.001	6.284 (3.911-10.098)
Psychosocial factors				
Psychological fatigue				
Low				Reference
Medium	0.021	0.267	0.214	1.021 (0.605-1.723)
High	0.968	0.296	<0.001	2.633 (1.474-4.703)
Job satisfaction				
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Medium	0.031	0.262	0.154	1.031 (0.617-1.724)
Low	0.768	0.279	<0.001	2.155 (1.248-3.724)
Occupational stress				
Psychological job demand	1.031	0.414	<0.001	2.804 (1.246-6.312)
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Skill discretion	−0.973	0.402	<0.001	0.378 (0.172-0.831)
Supervisor social support	−1.213	0.393	<0.001	0.297 (0.138-0.642)

Multivariate logistic regression analysis also revealed that age, sex, BMI, frequent bending of the trunk and psychological job demand were associated with chronic LBP among ambulance doctors and that age, BMI, sitting for long periods of time and psychological fatigue were associated with chronic LBP among ambulance drivers. For more details, see Table 5.

Table 5 Multivariate logistic regression analysis of chronic LBP risk factors among ambulance

doctors and among ambulance drivers.

Factors	B	SE	*P*	OR (95% C.I.)
For doctors' chronic LBP				
Age	1.031	0.448	<0.001	2.804 (1.165-6.747)
Sex (1=female, 0=male)	0.502	0.253	0.034	1.652 (1.006-2.713)
BMI				
18.5～23.9 (Normal weight)				Reference
＜ 18.5 (Underweight)	−0.537	0.512	0.427	0.584 (0.214-1.594)
24.0～27.9 (Overweight)	0.556	0.309	0.141	1.744 (0.952-3.195)
≥ 28.0 (Obesity)	1.571	0.322	<0.001	4.811 (2.560-9.044)
Ergonomic factors				
Frequent bending of the trunk	1.313	0.352	<0.001	3.717 (1.865-7.411)
Psychosocial factors				
Occupational stress				
Psychological job demand	1.055	0.401	<0.001	2.872 (1.309-6.303)
For drivers' chronic LBP				
Age	1.115	0.501	0.004	3.050 (1.142-8.141)
BMI				
18.5～23.9 (Normal weight)				Reference
＜ 18.5 (Underweight)	−0.722	0.473	0.643	0.486 (0.192-1.228)
24.0～27.9 (Overweight)	0.948	0.305	<0.001	2.581 (1.419-4.692)
≥ 28.0 (Obesity)	1.804	0.354	<0.001	6.074 (3.035-12.156)
Ergonomic factors				
Sitting for long periods of time	1.936	0.315	<0.001	6.931 (3.738-12.851)
Psychosocial factors				
Psychological fatigue				
Low				Reference
Medium	0.557	0.275	0.002	1.745 (1.018-2.992)
High	1.011	0.311	<0.001	2.748 (1.494-5.056)

Discussion

To our knowledge, this is the first large-scale survey aimed at exploring the LBP prevalence among ambulance workers and the risk factors for chronic LBP among ambulance nurses in China. The ambulance workers participating in the study were randomly selected in Shandong, China, and the response rate of 90.8% was acceptable.

We found that the twelve-month prevalence of LBP lasting for at least 24 hours, for at least 7 days, and for at least three months was 86.1%, 50.6% and 21.1%, respectively, among ambulance nurses; 70.5%, 36.4% and 15.8%, respectively, among ambulance doctors; and 57.5%, 23.8% and 12.3%, respectively, among ambulance drivers. The risk factors that were found for the ambulance nurses' chronic LBP were ergonomic factors (frequent bending of the trunk, heavy or awkward lifting), occupational stress (high psychological job demand, low job control and low workplace supervisor support), high psychological fatigue, low job satisfaction, shift work and individual factors (age, sex, obesity). The limitations of our study included the use of self-reported measures and retrospective questionnaires. Therefore, it is inevitable to suffer from measurement bias. The cross-sectional design of the study precluded causal conclusions, and a prospective cohort study might be needed in the future. Some of the 158 subjects who failed to participate in the study might suffer from LBP, and the subjects who had left their ambulance position due to serious LBP were not included in the study. Therefore, the prevalence of LBP and the extent of its risk factors might be underestimated accordingly.

In our study, the prevalence of LBP lasting for at least 24 hours, for at least 7 days, and for at least three months among ambulance nurses was statistically higher than that among ambulance doctors and drivers. Regarding LBP lasting for at least 24 hours, the prevalence was higher among ambulance nurses than among the general nursing personnel in Greece (75%) [20], Nepal (67%) [21], Chinese Taiwan (66.0%)[22]and other countries [9 20 23]. Regarding chronic LBP (lasting for at least three months), the

prevalence among ambulance nurses was higher than that among the nursing personnel in the Netherlands (12%), Greece (11%) [20], and Taiwan (8.6%) [22]. Although measurement variance, cultural differences and differences in the perception of terminology may exist among the above mentioned studies, more attention should be paid to the ambulance nurses' LBP and its risk factors need to be identified.

As reported, most individuals suffer from short-term or minor LBP at some point in their lives [24], and most acute LBP is a self-limiting symptom with a recovery rate of 90% within six weeks [19 25]. Serious or chronic LBP was caused mainly by work and other factors. Therefore, we analysed the risk factors of chronic LBP other than short-term LBP. Epidemiological studies have reported that LBP could be caused by combinations of physical factors alone [26]. A cross-sectional study [22] in Taiwan found that certain manual patient-transfer tasks played important roles in severe LBP (such as care seeking, intense pain, and sick leave). Tasks that are often performed with twisted or bent posture or tasks involving heavy lifting have been demonstrated to cause high spinal stress [27]. Patient handling, as one of the main tasks of nurses, could generate a severe biomechanical load on spinal parts of the body and could impose compressive and shear forces on nurses' low spine [28]. In contrast to the ergonomic factors for chronic LBP among ambulance doctors (frequent bending of the trunk) and drivers (sitting for long periods of time) and in contrast to the findings of a cohort study [29] in Norway that showed that prolonged standing and awkward lifting were important factors of the ergonomic factors for LBP, our study found the frequent

bending of the trunk and heavy or awkward lifting contributed to chronic LBP, which again confirmed the above findings among ambulance nurses. Musculoskeletal loads and injuries resulting from patient-handling tasks need to be reduced and could be reduced by efficient and cost-effective ergonomic intervention measures, including sharing LBP knowledge, transferring equipment, lifting teams and training in safe patient-transfer techniques reported by previous studies[30]. Therefore, to prevent chronic LBP among ambulance nurses, ergonomic intervention measures need to be taken.

Psychosocial factors are perceived feelings of the work environment that could bring about psychological fatigue, job dissatisfaction and occupational stress [31]. Our study found that high psychological job demand, low job control and low supervisor support were independently associated with chronic LBP, consistent with the findings of other studies [27 32-34]. A cross-sectional study [32] in Brazil reported that both physical and psychosocial work demands were independently associated with LBP. In a prospective study [33], an increased risk of hospitalization due to musculoskeletal disorders and an increased rate of musculoskeletal sickness were reported to be associated with a lack of job control. In other studies [27 34], poor job content and low workplace social support were also shown to be risk factors for back pain. In our study, workplace co-worker support was noted to be significantly associated with chronic LBP in the univariate analysis but this association did not remain in the multivariate logistic regression analysis, probably because the ambulance workers as a group, worked collaboratively, to some extent, and the factor of co-worker support

was not as significantly important as other psychological factors. Our study also found that psychological fatigue and job satisfaction were all associated with chronic LBP, consistent with the findings of other studies [35 36] that showed that employees dissatisfied with their work were more prone to complain of back pain. High psychological fatigue could not only increase the possibility of worker injuries and medical errors but could also negatively affect one's physical and mental work performance [37]. A cohort study [29] of the general working population in Norway showed that psychosocial factors such as high psychological job demands and low job control were reported as the most consistent and important predictors of LBP, in addition to ergonomic factors. Emergency ambulance nursing work not only requires high-intensity physical activity, but also demands professional skills and rapid responses in emergencies, which affect individuals' social psychology. Therefore, negative psychosocial work factors also need to be decreased to an acceptable level to control chronic LBP among ambulance nurses.

We also found that age, sex, BMI and work shift (shift work *vs.* day work) were associated with chronic LBP. Another cross-sectional study [38] of 1203 Iranian petrochemical employees also reported that musculoskeletal disorders were statistically more prevalent in shift workers than in day workers. In a prospective study [39] of nurses' aides, LBP-related sick leaves were revealed to be correlated with working night shifts. Regarding the many risk factors of chronic LBP among ambulance nurses, one simple intervention measure alone may not be adequate [40]. To

achieve the aim of decreasing chronic LBP in ambulance nurses, multi-component comprehensive measures might be considered in the future.

Conclusions

This study suggests a relatively high prevalence of LBP among ambulance nurses. Psychosocial factors, such as stress and fatigue, and ergonomic factors, such as the frequent bending of the trunk and heavy or awkward lifting, played important roles in the development of chronic LBP. Comprehensive intervention measures might be needed in explorations of prevention methods.

Contributors

HD designed the study, participated in the data collection, and drafted and revised the manuscript. QZ participated in the design of the work, data collection, data analysis, interpretation of findings and revising the manuscript. CZ and GL contributed to data collection, interpretation of findings, and revisions. All authors contributed to the paper revising and final approval of the version to be published.

Competing interests None declared.

Patient consent Obtained.

Ethics approval

The study was approved by the Ethics Committee of Shouguang People's Hospital (2016SD02011).

Data sharing statement

The raw data used in the study are not publicly available due to ethical restrictions and privacy protection but are available from the corresponding author on reasonable request.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-9*
Bias	9	Describe any efforts to address potential sources of bias	8-9
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	9, results
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	8-9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	6, 9
		(c) Consider use of a flow diagram	no
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	9
Outcome data	15*	Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	10-14

		which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	10-11, tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	no
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	14
Discussion			
Key results	18	Summarise key results with reference to study objectives	15-16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	15-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1, title page

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Low back pain in emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study

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Title page

Title

Low back pain in emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study

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Low back pain in emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study

Abstract

Objective

Low back pain (LBP) could cause serious consequences and has been shown to be prevalent among emergency ambulance workers. Studies on the prevalence of and risk factors for LBP among emergency ambulance workers are scarce in China. The study aimed to determine the prevalence of LBP among ambulance workers, including doctors, nurses, and drivers, and to explore the risk factors for ambulance nurses' chronic LBP (lasting for at least three months).

Design

Cross-sectional study.

Setting

Emergency ambulance systems from 38 tertiary hospitals in Shandong, China were selected by random cluster sampling.

Participants

A total of 1560 ambulance workers completed the study.

Outcome measures

A paper-based questionnaire that included the Nordic Musculoskeletal Questionnaire, which evaluated LBP, the Dutch Musculoskeletal Questionnaire, which assessed ergonomic factors, and the Job Content Questionnaire, which assessed

stress, was used. Multivariate logistic regression analysis was conducted to quantify the association of potential risk factors with chronic LBP among ambulance nurses.

Results

The one-year prevalence of LBP lasting for at least 24 hours, seven days and three months was 86.1%, 50.6% and 21.1%, respectively, among 498 ambulance nurses; 70.5%, 36.4% and 15.8% among 519 doctors; and 57.5%, 23.8% and 12.3% among 543 drivers. The factors contributing to chronic LBP among ambulance nurses were the frequent bending of the trunk, heavy or awkward lifting, shift work, low job satisfaction, high psychological fatigue, high psychological job demand, low job control, low supervisor support, older age, female sex and obesity.

Conclusions

LBP was more prevalent among ambulance nurses than among ambulance doctors and drivers. Many factors, especially psychosocial and ergonomic factors, contributed to ambulance nurses' chronic LBP. Comprehensive measures might be needed to control LBP.

Strengths and limitations of this study

This is the first large-scale study on the prevalence of low back pain (LBP) among emergency ambulance workers and risk factors for ambulance nurses' LBP in China.

Various factors, including individual, psychosocial, ergonomic and organizational factors, were collected and analysed in the study.

The cross-sectional design and subjective measures of the study limited the

establishment of causal directions.

Those subjects having left ambulance position due to LBP were not included in the study, which might underestimate the prevalence of LBP and the extent of its risk factors.

Keywords

low back pain; ambulance workers; nurse

Introduction

Emergency ambulance service, as an essential part of the healthcare system, provides pre-hospital medical emergency service for patients, including carrying, moving and transporting patients to an emergency centre and treating them in the ambulance, such as performing cardiopulmonary resuscitation. Ambulance workers have been reported to experience more musculoskeletal disorders than the general workforce [1-4]. In Denmark, data from a nationwide study showed that a substantially high proportion (42%) of 1689 ambulance personnel reported musculoskeletal pain, which was significantly higher than corresponding reports from the core workforce of 14,175 individuals (29%) [5]. In Australia, ambulance officers and paramedics had the highest rates for musculoskeletal injury compared with other healthcare workers in the 2003-2012 time period [6]. Worldwide, attention has been paid to the musculoskeletal disorders of ambulance workers over the last decade because of

serious consequences, such as reduced quality of life, loss of working days, occupational disability and the need to change and/or leave a profession [7] . Due to musculoskeletal disorders, especially low back pain (LBP), ambulance workers have been reported to suffer from a higher standardized early retirement than other healthcare providers and the general workforce [1 8]. In mainland China, scarce attention has been paid to emergency ambulance workers, and no study thus far has explored the prevalence of LBP among ambulance workers and their risk factors.

Studies [9-11] have reported that many factors could contribute to LBP, including individual, psychosocial, physical and organizational work factors. Psychosocial factors, including low job support, job dissatisfaction, and occupational stress, and individual factors, such as high BMI and being female, could contribute to musculoskeletal disorders of the back region, as revealed by a systematic review with strong evidence[12]. However, regarding the LBP among a special occupational group, the above factors do not have the same effects. Psychosocial factors at work, such as stress, fatigue and job dissatisfaction, have been demonstrated to largely contribute to the development of LBP in a follow-up study of 4500 Iranian industrial workers [13]. Emergency ambulance workers, especially nurses, are faced with demanding nursing skills, rapid pace of work, episodes of violence, threats, increased risks of contracting infectious diseases and increasing demands on medical competence [14-18]. Therefore, ambulance nurses may also suffer from LBP resulting from psychosocial factors, and this effect is not well known. Besides, in mainland China, during the process of

transporting patients to emergency center, most often, ambulance nurse needs to do the lifting, sometimes with the help of ambulance doctor while ambulance driver is only responsible for driving the ambulance vehicle, which might contribute to prevalence variance of LBP among ambulance workers. The current study aimed to evaluate the prevalence of LBP among ambulance workers in different work positions and to determine and quantify the association between influencing factors, including individual, physical and psychosocial factors, and chronic LBP (lasting for at least three months) among ambulance nurses.

Methods

A cross-sectional survey was implemented from September to November 2018. The study was approved by the Ethics Committee of Shouguang People's Hospital. Informed consent was obtained before the participants were invited to participate.

Participants

Given the prevalence of LBP, the number of independent variables in the logistic regression and the response rate, 38 hospitals were selected first by random cluster sampling from among all the tertiary hospitals (182 tertiary-level hospitals in total) in Shandong, China. Then, of the selected 38 hospitals, all the emergency ambulance workers who had at least one year of work experience in this job were invited to participate in collaboration with the the management departments and the directors of emergency departments. The exclusion criteria were as follows: part-time workers or

workers who had experienced trauma, injury, or serious diseases. A total of 1560 ambulance workers (498 nurses, 519 doctors and 543 drivers) completed our questionnaire, and the response rate of the study was 90.8%.

Questionnaire

A self-administered questionnaire that included the Standardized Nordic Musculoskeletal Questionnaire[19], the Dutch Musculoskeletal Questionnaire [20] and the Job Content Questionnaire [21], was revised after a pilot study. The paper-based questionnaire consisted of four sections. Section one addresses demographic information, including age, sex, height, weight, marital status, smoking, alcohol consumption, educational level, marital status, the presence of the children at home and exercise.

Section two was a modified version of the Standardized Nordic Musculoskeletal Questionnaire. The participants were asked whether they had suffered from pain or discomfort in the low back region lasting for at least 24 hours, seven days and three months in the preceding twelve months. If a participant reported LBP lasting for at least three months in the past twelve months, he or she was considered to have chronic LBP [22]. The Chinese version of the Nordic questionnaire has been widely used, validated and contextualized by previous national studies according to a cross-cultural understanding of the Chinese population[23-25].

Section three addresses work information and ergonomic factors mainly derived

from Dutch Musculoskeletal Questionnaire [20], which has been systematically translated into Chinese [23] and validated [24]. Ergonomic factors, which were directly selected from the Chinese version Dutch Musculoskeletal Questionnaire, were measured using a dichotomous scale (yes/no), and the assessment of risk factors was qualitative in this study [20 23]. Participants were asked whether they were often exposed to the ergonomic risk factors during their work. Work information included work position (doctor, nurse, or driver), shift work or day work, work experience and employment status (permanent *vs.* temporary/contract).

Section four addresses psychosocial factors, including job satisfaction (high, medium, low), self-perceived health status (very good, generally good, generally bad, very bad), psychological fatigue (low, medium, high) and occupational stress assessed by the Job Content Questionnaire (JCQ), which has been widely used in different groups of numerous studies and has shown good reliability and validity in the Chinese working population [21]. In our study, 22 items of the original 49-item JCQ were applied and consisted of three dimensions: psychological job demand (five items); job control, including skill discretion (six items), decision-making authority (three items); and workplace social support, including supervisor social support (four items) and co-worker social support (four items). Each item was scored on a four-point Likert scale from "strongly disagree" to "strongly agree", with higher scores indicating higher psychological job demand, job control and workplace social support. In this study, Cronbach's α coefficients for psychological job demand, job control and workplace social support were 0.79, 0.87 and 0.90, respectively. The validity of the

Chinese version JCQ has been confirmed in previous Chinese studies [21].

Data analysis

The SPSS, version 18.0, was used to perform statistical analysis. A single-factor chi-square test, independent t-test, or rank-sum test was used to examine the differences between different groups of participants. The association of physical, psychosocial, organizational and individual factors with chronic LBP (lasting for at least three months) was first examined with univariate analysis. The significant factors selected at the *p*-value of 0.25 in the univariate analysis were then entered into multivariate logistic regression analysis. Odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated to evaluate the effect of risk factors on chronic LBP. To avoid an inaccurate and unstable logistic regression model, the significant variable 'work experience' in the univariate analysis was removed, and 'age' was kept for the multivariate analysis, as it showed collinearity in relationships ($\rho > 0.6$) diagnosed by Spearman correlation matrix. The statistics for variable entry and removal were set at $P < 0.05$ and $P > 0.1$, respectively, in the multivariate analysis. And the multivariate logistic regression analysis was also conducted separately in ambulance doctors and drivers, in addition to ambulance nurses. A 0.05 statistical significance level was set for all tests.

Patient and public involvement

No patients or members of the public were involved in the design or implementation of the study. The results of the study were disseminated to the health

authorities and the selected 38 hospitals.

Results

All 1560 participants (498 ambulance nurses, 519 doctors and 543 drivers) were included in the study, and with respect to the questionnaires that were not fully completed, the participants were contacted again and completed them later. Approximately 158 individuals (65 ambulance nurses, 49 doctors and 44 drivers) failed to participate in the survey due to long leaves for vacation, sick leave, maternity leave and personal affairs.

The mean age of the 498 ambulance nurses was 31.1±7.6 years, which was significantly younger than ambulance doctors (35.7±6.9) and drivers(38.4±9.5). Most of the ambulance nurses were female, while most of the ambulance doctors and drivers were male. Most nurses never smoked. Ambulance nurses had significantly less work experience as an ambulance worker (8.3±8.0 years) than did ambulance doctors (12.8±9.3 years) and drivers (14.5±8.8 years). Ambulance nurses had an educational level that was significantly higher than that of drivers and lower than that of doctors, and the rank-sum test is shown in Table 1. Nurses exercised less than doctors and drivers did in their leisure time (Table 1).

The twelve-month prevalence of LBP lasting for at least 24 hours, seven days and three months was 86.1%, 50.6% and 21.1%, respectively, among ambulance nurses; 70.5%, 36.4% and 15.8% among doctors; and 57.5%, 23.8% and 12.3% among drivers. For more details, see Table 1.

Table 1 Characteristics of emergency ambulance workers in tertiary hospitals

	Nurses	Doctors	P^a	Drivers	P^b
Total number of subjects	498	519		543	
Age (years)[c]	31.1±7.6	35.7±6.9	<0.001*	38.4±9.5	<0.001*
Sex			<0.001†		<0.001†
Male	73 (14.7%)	396 (76.3%)		471 (86.7%)	
Female	425 (85.3%)	123 (23.7%)		72 (13.3%)	
BMI			0.009‡		<0.001‡
＜ 18.5 (Underweight)	43 (8.6%)	45 (8.7%)		21 (3.9%)	
18.5～23.9 (Normal weight)	276 (55.4%)	249 (48.0%)		291 (53.6%)	
24.0～27.9 (Overweight)	125 (25.1%)	129 (24.9%)		93 (17.1%)	
≥ 28.0 (Obesity)	54 (10.8%)	96 (18.5%)		138 (25.4%)	
Marital status			<0.001†		<0.001†
Never married	75 (15.1%)	91 (17.5%)		32 (5.9%)	
Married/cohabiting	363 (72.9%)	402 (77.5%)		471 (86.7%)	
Divorced/separated/widowed	60 (12.0%)	26 (5.0%)		40 (7.4%)	
Smoking			<0.001†		<0.001†
Never smoked	485 (97.4%)	159 (30.6%)		75 (13.8%)	
Ex-smoker	10 (2.0%)	147 (28.3%)		111 (20.4%)	
Current smoker	3 (0.6%)	213 (41.0%)		357 (65.7%)	
Work experience as an ambulance worker (years)[c]	8.3±8.0	12.8±9.3	<0.001*	14.5±8.8	<0.001*
Educational level			<0.001‡		<0.001‡
Lower than junior college	111 (22.3%)	33 (6.4%)		539 (99.3%)	
Junior college	261 (52.4%)	96 (18.5%)		3 (0.6%)	
Bachelor	96 (19.3%)	258 (49.7%)		1 (0.2%)	
Master or above	30 (6.0%)	132 (25.4%)		0 (0.0%)	
Exercise in leisure time			<0.001‡		<0.001‡
Never/almost never	295 (59.2%)	198 (38.2%)		219 (40.3%)	
Sometimes	97 (19.5%)	185 (35.6%)		159 (29.3%)	
Often	106 (21.3%)	136 (26.2%)		165 (30.4%)	
LBP lasting for at least					
24 hours	429(86.1%)	366(70.5%)	<0.001†	312(57.5%)	<0.001†
7 days	252(50.6%)	189(36.4%)	<0.001†	129(23.8%)	<0.001†
3 months	105(21.1%)	82(15.8%)	0.030†	67(12.3%)	<0.001†

a: P value between ambulance nurses and doctors, b: P value between ambulance nurses and drivers, c: mean± standard deviation; ∗t-test, †Chi-square test, ‡Rank-sum test.

Ambulance nurses who were older in age, were female, had higher BMI, performed shift work, and had worked longer as an ambulance worker and in temporary/contract employment seemed to suffer from chronic LBP more. Regarding ergonomic factors, walking for long periods of time, the frequent bending of the trunk, heavy or awkward lifting, bending or twisting the neck and maintaining shoulder abduction for long periods of time were all statistically associated with chronic LBP. For more details, see Table 2.

Table 2 Univariate analysis of individual and ergonomic factors with chronic LBP among ambulance nurses.

Factors	Chronic LBP	Non-chronic-LBP	*P*
Number of subjects	105	393	
Age (years)[a]	36.5±7.7	29.7±6.7	<0.001*
Sex			0.022†
Male	8	65	
Female	97	328	
BMI			<0.001‡
＜ 18.5 (Underweight)	4	39	
18.5～23.9 (Normal weight)	45	231	
24.0～27.9 (Overweight)	29	96	
≥ 28.0 (Obesity)	27	27	
Whether takes shift work?			<0.001†
Yes (Shift work)	60	129	
No (Day work)	45	264	
Work experience as an ambulance worker (years)[a]	13.8±8.7	6.8±7.2	<0.001*
Employment status			0.014†
Permanent	39	199	
Temporary/contract	66	194	
Ergonomic factors			
Walking for long periods of time (Yes/No)	54/51	154/239	0.024†
Frequent bending of the trunk (Yes/No)	66/39	93/300	<0.001†
Heavy or awkward lifting (Yes/No)	75/30	112/281	<0.001†
Bending or twisting the neck (Yes/No)	39/66	97/296	0.011†
Maintaining shoulder abduction for long periods of	48/57	136/257	0.036†

time (Yes/No)

a: mean± standard deviation; ∗t-test, †Chi-square test, ‡Rank-sum test.

Regarding the psychosocial factors, scores on psychological job demand were positively associated with chronic LBP, while scores on skill discretion, decision-making authority, workplace supervisor support and co-worker support were negatively associated with chronic LBP among ambulance nurses. Univariate analysis also showed that self-perceived health status, job satisfaction and psychological fatigue were all associated with chronic LBP. For more details, see Table 3.

Table 3 Univariate analysis of psychosocial factors with chronic LBP among ambulance nurses.

Psychosocial factors	Chronic LBP	Non-chronic-LBP	*P*
Number of subjects	105	393	
Occupational stress			
Psychological job demand[a]	14.5±4.1	11.1±3.2	<0.001*
Decision-making authority[a]	5.8±3.8	8.1±2.5	<0.001*
Skill discretion[a]	11.7±5.3	16.2±4.6	<0.001*
Supervisor social support[a]	6.8±3.2	9.8±2.2	<0.001*
Coworker social support[a]	8.7±3.8	10.3±2.6	<0.001*
Health status self-perceived			0.043‡
Very good	19	89	
Generally good	25	109	
Generally bad	29	117	
Very bad	32	78	
Psychological fatigue			0.004‡
Low	27	127	
Medium	45	207	
High	33	59	
Job satisfaction			0.025‡
High	42	187	
Medium	33	144	
Low	30	62	

a: mean± standard deviation; ∗t-test, ‡Rank-sum test.

Multivariate logistic regression analysis revealed that age, sex, BMI, work shift,

frequent bending of the trunk, heavy or awkward lifting, psychological fatigue, job satisfaction, psychological job demand, skill discretion, decision-making authority and workplace supervisor support were independently associated with chronic LBP among ambulance nurses. For more details, see Table 4.

Table 4 Multivariate logistic regression analysis of chronic LBP risk factors among ambulance nurses.

Factors	B	SE	*P*	OR (95% C.I.)
Age (years)	0.912	0.453	0.023	2.489 (1.024-6.049)
Sex (1=female, 0=male)	0.891	0.381	0.017	2.438 (1.155-5.144)
BMI				
18.5～23.9 (Normal weight)				Reference
＜ 18.5 (Underweight)	−0.641	0.546	0.513	0.527 (0.181-1.536)
24.0～27.9 (Overweight)	0.439	0.263	0.329	1.551 (0.926-2.597)
≥ 28.0 (Obesity)	1.638	0.313	<0.001	5.145 (2.786-9.502)
Whether takes shift work (1=shift work, 0=day work)	1.005	0.223	<0.001	2.732 (1.765-4.229)
Ergonomic factors				
Frequent bending of the trunk (1=yes, 0=no)	1.701	0.232	<0.001	5.479 (3.477-8.634)
Heavy or awkward lifting (1=yes, 0=no)	1.838	0.242	<0.001	6.284 (3.911-10.098)
Psychosocial factors				
Psychological fatigue				
Low				Reference
Medium	0.021	0.267	0.214	1.021 (0.605-1.723)
High	0.968	0.296	<0.001	2.633 (1.474-4.703)
Job satisfaction				
High				Reference
Medium	0.031	0.262	0.154	1.031 (0.617-1.724)
Low	0.768	0.279	<0.001	2.155 (1.248-3.724)
Occupational stress				
Psychological job demand	1.031	0.414	<0.001	2.804 (1.246-6.312)
Decision-making authority	−0.924	0.411	<0.001	0.397 (0.177-0.888)
Skill discretion	−0.973	0.402	<0.001	0.378 (0.172-0.831)
Supervisor social support	−1.213	0.393	<0.001	0.297 (0.138-0.642)

Multivariate logistic regression analysis also revealed that age, sex, BMI, frequent

bending of the trunk and psychological job demand were associated with chronic LBP among ambulance doctors and that age, BMI, sitting for long periods of time and psychological fatigue were associated with chronic LBP among ambulance drivers. For more details, see Table 5.

Table 5 Multivariate logistic regression analysis of chronic LBP risk factors among ambulance doctors and among ambulance drivers.

Factors	B	SE	*P*	OR (95% C.I.)
For doctors' chronic LBP				
Age (years)	1.031	0.448	<0.001	2.804 (1.165-6.747)
Sex (1=female, 0=male)	0.502	0.253	0.034	1.652 (1.006-2.713)
BMI				
18.5～23.9 (Normal weight)				Reference
＜ 18.5 (Underweight)	−0.537	0.512	0.427	0.584 (0.214-1.594)
24.0～27.9 (Overweight)	0.556	0.309	0.141	1.744 (0.952-3.195)
≥ 28.0 (Obesity)	1.571	0.322	<0.001	4.811 (2.560-9.044)
Ergonomic factors				
Frequent bending of the trunk (1=yes, 0=no)	1.313	0.352	<0.001	3.717 (1.865-7.411)
Psychosocial factors				
Occupational stress				
Psychological job demand	1.055	0.401	<0.001	2.872 (1.309-6.303)
For drivers' chronic LBP				
Age (years)	1.115	0.501	0.004	3.050 (1.142-8.141)
BMI				
18.5～23.9 (Normal weight)				Reference
＜ 18.5 (Underweight)	−0.722	0.473	0.643	0.486 (0.192-1.228)
24.0～27.9 (Overweight)	0.948	0.305	<0.001	2.581 (1.419-4.692)
≥ 28.0 (Obesity)	1.804	0.354	<0.001	6.074 (3.035-12.156)
Ergonomic factors				
Sitting for long periods of time (1=yes, 0=no)	1.936	0.315	<0.001	6.931 (3.738-12.851)
Psychosocial factors				
Psychological fatigue				
Low				Reference
Medium	0.557	0.275	0.002	1.745 (1.018-2.992)
High	1.011	0.311	<0.001	2.748 (1.494-5.056)

Discussion

In this study, we found that the twelve-month prevalence of LBP lasting for at least 24 hours, seven days, and three months was 86.1%, 50.6% and 21.1%, respectively, among ambulance nurses; 70.5%, 36.4% and 15.8%, respectively, among ambulance doctors; and 57.5%, 23.8% and 12.3%, respectively, among ambulance drivers. The risk factors that were found for the ambulance nurses' chronic LBP were ergonomic factors (frequent bending of the trunk, heavy or awkward lifting), occupational stress (high psychological job demand, low job control and low workplace supervisor support), high psychological fatigue, low job satisfaction, shift work and individual factors (age, sex, obesity).

In our study, the prevalence of LBP lasting for at least 24 hours, seven days, and three months among ambulance nurses was statistically higher than that among ambulance doctors and drivers. Regarding LBP lasting for at least 24 hours, the prevalence was higher among ambulance nurses than the general nursing personnel in Greece (75%) [26], Nepal (67%) [27], Chinese Taiwan (66.0%)[28]and other countries [26 29 30]. Regarding chronic LBP (lasting for at least three months), the prevalence among ambulance nurses was higher than nursing personnel in the Netherlands (12%)[26], Greece (11%) [26], and Taiwan (8.6%) [28]. Although measurement variance, cultural differences and differences in the perception of terminology may exist among the above mentioned studies, more attention should be paid to the ambulance nurses' LBP. As reported by the COST B13 Working Group on Guidelines for the Management of

Acute Low Back Pain in Primary Care, over 70% of people in industrialized countries suffer from short-term or minor LBP at some point in their lives [22 31], and most acute LBP is a self-limiting symptom with a recovery rate of 90% within six weeks [22 32]. Serious or chronic LBP was caused mainly by work and other factors. Therefore, we analysed the risk factors of chronic LBP other than short-term LBP.

We found that ergonomic factors (the frequent bending of the trunk, heavy or awkward lifting and sitting for long periods of time) were associated with chronic LBP. In line with our study, a cross-sectional study [28] in Taiwan found that certain manual patient-transfer tasks played important roles in severe LBP (such as care seeking, intense pain, and sick leave). Patient handling, as one of the main tasks of nurses, could generate a severe biomechanical load on spinal parts of the body and could impose compressive and shear forces on nurses' low spine [33]. In contrast to the ergonomic factors for chronic LBP among ambulance doctors (frequent bending of the trunk) and drivers (sitting for long periods of time) and in contrast to the findings of a cohort study [34] in Norway that showed that prolonged standing and awkward lifting were important factors of the ergonomic factors for LBP, our study found the frequent bending of the trunk and heavy or awkward lifting contributed to chronic LBP, which again confirmed the above findings among ambulance nurses. Musculoskeletal loads and injuries resulting from patient-handling tasks need to be reduced and could be reduced by efficient and cost-effective ergonomic intervention measures, including sharing LBP knowledge, transferring equipment, lifting teams and training in safe patient-transfer techniques reported by previous studies[35].

Therefore, to prevent chronic LBP among ambulance nurses, ergonomic intervention measures need to be taken.

Psychosocial factors are perceived feelings of the work environment that could bring about psychological fatigue, job dissatisfaction and occupational stress [36]. Firstly, our study found that psychological fatigue and job satisfaction were all associated with chronic LBP, consistent with the findings of other studies [37 38]that showed that employees dissatisfied with their work were more prone to complain of back pain. High psychological fatigue could not only negatively affect one's physical and mental work performance but also increase the possibility of medical errors and worker injuries [39-42]. Secondly, our study found that occupational stressors, including high psychological job demand, low job control and low supervisor support, were independently associated with chronic LBP, consistent with the findings of other studies [43 44]. A cohort study [34] of the general working population in Norway showed that psychosocial factors such as high psychological job demands and low job control were reported as the most consistent and important predictors of LBP, in addition to ergonomic factors. In a prospective study [43], an increased risk of hospitalization due to musculoskeletal disorders and an increased rate of musculoskeletal sickness were reported to be associated with a lack of job control. In other studies [44], poor job content and low workplace social support were also shown to be risk factors for back pain. Thirdly, in our study, workplace co-worker support was noted to be significantly associated with chronic LBP in the univariate analysis but this association did not remain in the multivariate logistic regression analysis, probably because the

ambulance workers as a group, worked collaboratively, to some extent, and the factor of co-worker support was not as significantly important as other psychological factors. Emergency ambulance nursing work not only requires high-intensity physical activity, but also demands professional skills and rapid responses in emergencies, which affect individuals' social psychology. Therefore, negative psychosocial work factors also need to be decreased to an acceptable level to control chronic LBP among ambulance nurses.

We also found that age, sex, BMI and work shift (shift work *vs.* day work) were associated with chronic LBP. Another cross-sectional study [45] of 1203 Iranian petrochemical employees also reported that musculoskeletal disorders were statistically more prevalent in shift workers than in day workers. In a prospective study [46] of nurses' aides, LBP-related sick leaves were revealed to be correlated with working night shifts. Regarding the many risk factors of chronic LBP among ambulance nurses, one simple intervention measure alone may not be adequate [47]. To achieve the aim of decreasing chronic LBP in ambulance nurses, multi-component comprehensive measures, including ergonomic and psychosocial intervention measures, might be considered in the future.

To our knowledge, this is the first large-scale survey aimed at exploring the LBP prevalence among ambulance workers and the risk factors for chronic LBP among ambulance nurses in China. The ambulance workers participating in the study were randomly selected in Shandong, China, and the response rate of 90.8% was acceptable.

The limitations of our study included the use of self-reported measures and retrospective questionnaires. Therefore, it is inevitable to suffer from measurement bias. The cross-sectional design of the study precluded causal conclusions, and a prospective cohort study might be needed in the future. Some of the 158 subjects who failed to participate in the study might suffer from LBP, and the subjects who had left their ambulance position due to serious LBP were not included in the study. Therefore, the prevalence of LBP and the extent of its risk factors might be underestimated accordingly.

Conclusions

This study suggests a relatively higher prevalence of LBP among ambulance nurses than ambulance doctors and drivers. Psychosocial factors, such as occupational stress and psychological fatigue, and ergonomic factors, such as the frequent bending of the trunk and heavy or awkward lifting, played important roles in the development of chronic LBP. Comprehensive intervention measures, including ergonomic and occupational health intervention measures, might be suggested for LBP prevention.

Contributors

HD designed the study, participated in the data collection, and drafted and revised the manuscript. QZ participated in the design of the work, data collection, data analysis, interpretation of findings and revising the manuscript. CZ and GL contributed to data collection, interpretation of findings, and revisions. All authors

contributed to the paper revising and final approval of the version to be published.

Competing interests None declared.

Patient consent Obtained.

Ethics approval

The study was approved by the Ethics Committee of Shouguang People's Hospital (2016SD02011).

Data sharing statement

The raw data used in the study are not publicly available due to ethical restrictions and privacy protection but are available from the corresponding author on reasonable request.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	4-6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*8-9*
Bias	9	Describe any efforts to address potential sources of bias	8-9
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	9, 10, results
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	8-9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6, 10
		(b) Give reasons for non-participation at each stage	6, 10
		(c) Consider use of a flow diagram	no
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-11
		(b) Indicate number of participants with missing data for each variable of interest	10
Outcome data	15*	Report numbers of outcome events or summary measures	10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	10-14

		which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	10-11, tables
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	no
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	14, 15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	19-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	19-20
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1, title page

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.