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TEACHER STRESS AMONG PUBLIC PRIMARY AND SECONDARY SCHOOLTEACHERS IN DATONG, A CITY OF SHANXI PROVINCE, CHINA: ASSOCIATION BETWEEN TEACHER STRESS AND STANDARDIZED WORKLOAD

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Abstract
Objectives: The policy of the standardized workload has been implemented among primary and secondary schoolteachers in Shanxi Province. The aim of this cross-sectional cohort study is to assess teacher stress among primary and secondary schoolteachers in Datong, a city of Shanxi Province and the association between teacher stress and the quantified workload. **Material and Methods:** Three hundred and fifty schoolteachers in 10 public primary schools, 187 schoolteachers in 6 secondary schools and 268 non-teachers in 21 education institutes were recruited. A single-item rating assessment of work-related stress was completed by using the *Exposure to Job Stress* measure with modification. The quantified workload included class size, teaching hours, and subjects. Descriptive and logistic regression analyses were carried out. **Results:** In 805 participants, the proportion of primary and secondary schoolteachers with moderate stress was significantly greater. The results of Spearman's correlation and logistic regression analyses showed that the occupations of the primary and secondary schoolteachers had higher stress risk. Further, the stratified results showed that among the primary schoolteachers, the independent stress risk factor was larger class size; while among the secondary schoolteachers, the stress associated factor was more weekly teaching hours. **Conclusions:** After standardization of the workload, there remain higher levels of work stress among primary and secondary schoolteachers. Notwithstanding, the stress state in teachers is manageable and they may be faced with controllable stressors. Int J Occup Med Environ Health. 2023;36(2)

Key words:
stress, occupational health, China, workload, primary and secondary schoolteachers, occupational health strategy

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INTRODUCTION

In China, the mental health of primary and secondary schoolteachers is worrying [1]. There is a large population of primary and secondary schoolteachers in China; by 2020, there were about 6 434 200 full-time primary schoolteachers and 3 860 700 full-time secondary schoolteachers, respectively. Moreover, China implements a 9-year compulsory education system, including 6-year primary and 3-year secondary educations. Teacher stress may influence on mental health and lead to mental disorders, including suicidality, depression, and anxiety [2–4]. Further, stress of the educators may interfere to the quality of teaching and learning activities. It is necessary to formulate and implement intervention strategies to relieve stress in Chinese primary and secondary schoolteachers.

Teacher stress is defined as the "unpleasant, negative emotions, such as anger, anxiety, frustration, or depression," associated with the work of teaching [5]. In routine work, teachers face multiple and interacting demands from students, parents, colleagues, and administrators. An imbalance between a teacher's perceptions of environmental demands in comparison with a teacher's perception of his or her capacity to meet those demands results in the development of stress. In this process, stress, stressors, and coping strategies are interrelated. Comprehensive surveys of teacher stress were conducted to explore the dimensionality of the sources of teacher stress. The majority of the evidence for identifying the main work stressors facing teachers points to specific factors: heavy workload, relationships with colleagues and management, poor working environment, pupil misbehavior, long working hours, providing cover for teacher shortages and absences, pressure of school targets and inspections, coping with change and administrative duties [6–8]. Of note, it was consistently described that workload accounted for most of the variance in predicting teaching stress [9]. Hence, the effect of workload on teacher stress has been focused.

Coping is defined as the behavioral and psychological responses to these environmental demands [10]. Coping strategies may directly address the source of stress or may help a person tolerate the experience of stress [11]. Successful coping can buffer against the negative effects of environmental stressors [12]. At the individual level, stress management and counseling interventions emphasize training in coping strategies in an effort to alter either the physiological, emotional, or behavioral responses to potential stressors, or all of them. At the organizational level, emphasis is placed on changing those aspects of the teacher's work environment that are potential sources of stress. Currently, most interventions for reducing work-related stress, are directed at the individual level, and do not tackle the causes of stress in the workplace. Noteworthy, organizational-level interventions are a potential avenue in this regard [13]. One study with 961 teachers in eight schools reported that changes in tasks of teachers combined with stress management training resulted in a small reduction in work stress levels after 1-year follow-up compared to no intervention. There was also a small increase in work ability, meaning how well a worker is able to perform his or her work, although the authors did not report how they changed teachers' tasks, limiting the results' usefulness elsewhere [13]. It is speculated that redesigning the workload may be a potential approach to reduce work-related stress by organizational interventions.

It is well known that the workload of teachers is multifactorial and multidimensional. Most studies regarding identification of teacher stress associated workload were based on the empirical data [9] involving subjective complaint of teachers' job characteristics, such as heave workload and long working hours, while there is a little studies to objectively evaluate quantified workload, consequently, to propose appropriate strategies to relieve

stress at the organizational level. Fortunately, Shanxi Province Education Department implemented interventions to standardize and quantify the workload of primary and secondary schoolteachers. The items of policy included that:

- primary schools gave their teachers 14–16 teaching h/week for Chinese and mathematics, 16–18 teaching h/week for English, moral education, science and physical education, and 18–20 teaching h/week for other subjects;
- secondary schools arranged for teachers to teach 10–12 h/week for Chinese, mathematics, English, physics, chemistry and biology, 12–14 h/week for moral education, history, and geography, and 14–16 h/week for other subjects;
- the standard class size (number of students in a class) was not more than 45 and 50 students in primary and secondary schools, respectively.

There were several suggestions in the policy, including standard weekly teaching hours and class size, and the change of teaching hours by subject categories. The authors hypothesize that primary and secondary schoolteachers received standardized workload are characterized by low levels of stress; and the levels of teacher stress are associated with quantified workload.

To the authors' knowledge, no data about teacher stress among primary and secondary schoolteachers in Shanxi Province and the association between teacher stress and the quantified workload were reported after the policy of the standardized workload was implemented. Hence, the aim of this cross-sectional cohort study is to assess:

- whether there are higher levels of stress among teachers, compared with non–teachers in Datong public primary and secondary schools;
- what factors were related to stress, especially, quantitative data about teaching hours, class size and subject categories;
- what strategies on a daily basis could cope with stress.

MATERIAL AND METHODS

Participants and study design

Data of the cross-sectional cohort study were from an unofficial and academic survey. The faculty members of public education institutes in Datong, a city of Shanxi Province, were recruited between October–December, 2019. The inclusion criteria for the study were as follows:

- full-time faculty members of public education institutes in Datong,
- submission of the written questionnaires,
- completion of a physical examination.

The exclusion criteria were as follows: the participant was a teacher, but did not teach in primary or secondary schools.

Each participant was enrolled, anonymously and received a unique identified number. A total of 805 participants were recruited from public education institutes. There were 350 schoolteachers from 10 public primary schools, 187 schoolteachers from 6 public secondary schools and 268 non-teachers from 21 education institutes. The whole study population was divided into the primary schoolteachers, secondary schoolteachers and non-teachers according to the occupations. Teachers were recruited from public education institutes not from private public education institutes to prevent them from taking extra time for teaching demands outside of school hours, because public school teachers are not allowed to private supplementary tutoring in China [14]. Non-teachers in education institutes were as a control group. The occupations of non-teachers were administrators, research staff, laboratory workers, office clerks, accounting and librarians in primary and secondary schools and other public education institutes.

The study protocol and informed consent were reviewed and approved by the ethics committee of Nanjing Medical University Affiliated Brain Hospital. All methods were performed in accordance with the relevant guidelines and regulations. Written informed consents were been submitted by all participants.

Variables and measurement

Data collection was from a questionnaire and a physical examination. The questionnaire included sociodemographic characteristics (age, gender, marital status, number of children, and educational level) and stressed status, as well as life habits on a daily basis (smoking, alcohol consumption, and physical exercise). The added items about occupational characteristics (years of teaching, the number of teaching classes, class size, teaching hours, and subjects) in the questionnaire were applicable for the schoolteachers. The physical examination consisted of body mass index (BMI), and levels of blood pressure and fasting serum glucose. Data collection was performed by 2 independent observers, without any knowledge of this study through the identified number.

A single-item rating assessment of work-related stress was completed by using the *Exposure to Job Stress* measure with modification [15]. The options of the answer were 1 – "normal" ("In my job, I do not feel I am under great stress"), 2 –"moderate" ("In my job, I feel I am under great stress") and 3 – "severe" ("I am unable to cope with the stress of my job on a daily basis"). The single-item measure provides a valuable global summary of the overall experience of work-related stress; it has the advantage of brevity to complete larger surveys; and it is appropriate to measure general work-related stress including teacher and non-teacher populations [16]. The quantified workload included class size, teaching hours, and subjects. Subject categories were trichotomized: major subjects, minor subjects and other subjects. According to the content of the policy, in primary schools, major subjects included Chinese and mathematics; minor subjects included English, moral education, science and physical education, and other subjects were defined as other subjects; and in secondary schools, major subjects were Chinese, mathematics, English, physics, chemistry and biology; minor subjects were moral education, history, and geography; and other subjects were defined as other subjects.

The data of physical examination were collected, because obesity and diabetes, as well as faulty lipoprotein metabolism, and atherosclerosis, were associated with stress [9]. The physical examination was performed by independent experienced psychiatrists in Datong Beiguan Community Healthcare Center, China. Body mass index was categorized as normal ($\geq$18.5 kg/m^2 and <24 kg/m^2), overweight ($\geq$24 kg/m^2 and <28 kg/m^2), mild obesity ($\geq$28 kg/m^2 and <30 kg/m^2), and moderate obesity ($\geq$30 kg/m^2). Levels of blood pressure ($\leq$140/90 mm Hg and >140/90 mm Hg) and fasting serum glucose ($\leq$6.1 mmol/l and >6.1 mmol/l) were classified into dichotomy, respectively. The parameters were measured and used to control for confounding.

Statistical analyses

The statistical analyses were carried out with the SPSS, v. 19 (IBM, Armonk, NY, USA). The participators' characteristics of continuous variables were checked for data normality using the Shapiro-Wilk test. Descriptive analyses included the calculations of mean (standard deviation [SD]) or median (interquartile range [IQR]) for continuous variables, as appropriate, and frequencies and percentages for categorical variables. The comparison analyses of categorical variables used the χ^2 test or the Fisher exact test. A Kruskal-Wallis test or a student t-test was used to compare the differences in continuous variables.

Spearman's correlation coefficients were used to assess the relation of occupation and stress status in the total group and the associations between stress status and quantified workload in the occupation subgroups when other potential associated risk factors were taken into consideration. In this study, stress status was defined as a dependent variable, while other parameters were defined as independent variables. Stress status, gender, educational level, marital status, alcohol consumption status, smoking status, exercise intensity, high fasting serum glucose, BMI, high blood pressure, and subject categories were in a nominal

fashion; and other variables were in a continuous fashion. These analyses were undertaken for the total group, also across categories of the occupation subgroups.

Possible associations of occupation and stress risk were assessed in the whole study population. Binary logistic regression modeling was used, because nobody answered that they were severely stressed. Stress status was an ordinal category and divided into a dichotomy (normal and moderate), with the first section serving as the referent category. The variable of the occupations was divided into trisection (non-teachers, primary schoolteachers and secondary schoolteachers), with the first section serving as the referent category. The other variables, including age, gender, marital status, educational levels, high fasting serum glucose, BMI, high blood pressure, alcohol consumption status, smoking status and physical exercise, were taken into consideration. After the logistic regression in the whole study population, the authors conducted the serial binary logistic regression stratified by the occupations to assess the associated risk factors of stress in the primary and secondary schoolteacher subgroups, especially, teaching hours, class size and subject categories. All models were fitted using entry stepwise elimination. When p values of the unadjusted and adjusted parameters were both above the significant level, the associated factor was determined the stress risk factor. Odds ratios (ORs) and 95% confidence intervals (CIs) were reported for adjusted parameter estimates.

Last, the authors conducted Receiver Operating Characteristic (ROC) analysis to assess a threshold of determined stressors among the schoolteachers with normal or moderate stress. The ROC curves were created by plotting the range of sensitivity and specificity pairs with stress status (0 – normal and 1 – moderate) as the classifier variable. To determine the threshold, Youden's index was used to discriminate between the schoolteachers with normal and moderate stress. When Youden's index reached the maximum value, the corresponding value was considered the optimum cut-off threshold. Youden's index value was calculated as:

$$\text{Youden's index value (\%)} = \text{specificity (\%)} + \text{sensitivity (\%)} - 100\% \quad (1)$$

The discriminatory value of a test can be calculated in means of an area under the curve (AUC).

RESULTS

The study inclusion and exclusion processes are shown in Figure 1. There were 926 participants recruited and met inclusion criteria. The exclusion criteria were met by 121 participants, because they were teachers in other public education institutes but not in primary schools and secondary schools. Then, this cross-sectional cohort study included a total of 805 participants (33.3% male and 66.7% female) from public education institutes in Datong.

The participants' socio-demographic characteristics, stress status, occupational characteristics, data of physical examination and life habits are presented in Table 1. Table 1 shows 157 (44.9%) primary schoolteachers and 94 (50.3%) secondary schoolteachers reported that they felt great stress, but the stress can be coped with. The proportions of primary and secondary schoolteachers with moderate

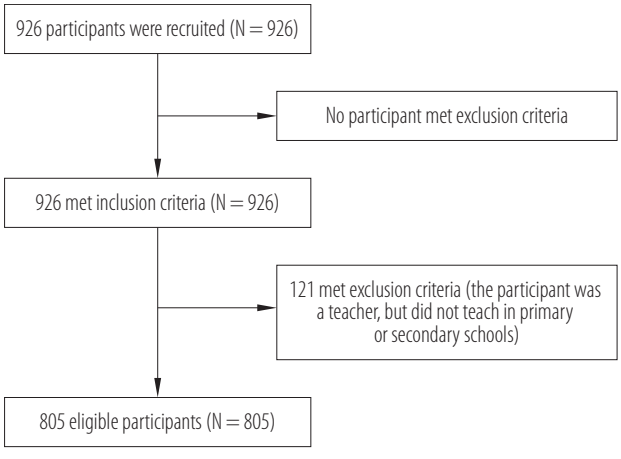


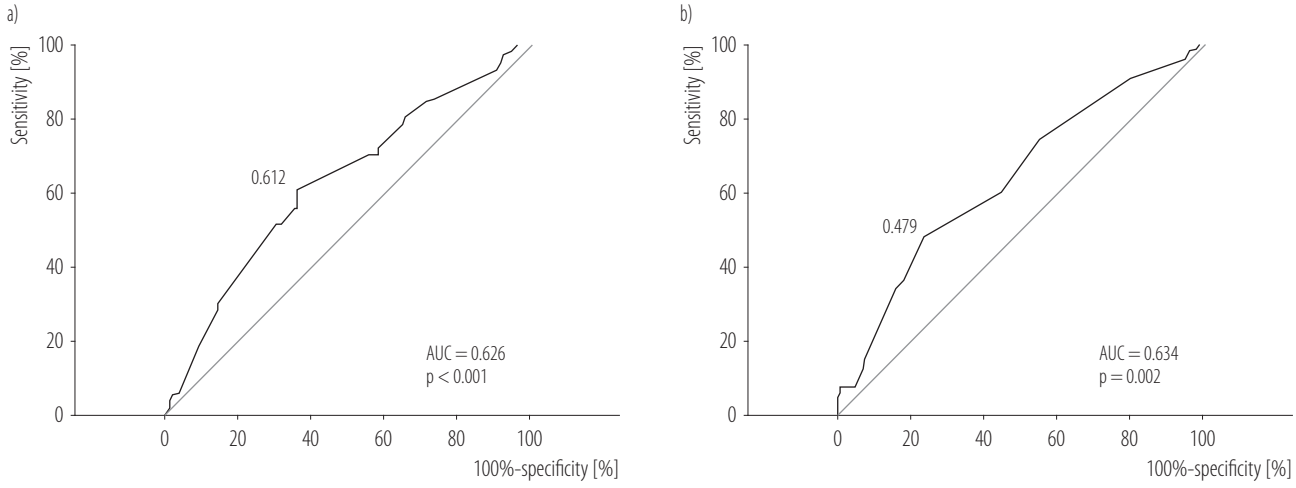
Figure 1. The study inclusion and exclusion process, Datong, China, October–December 2019

Table 1. Characteristic of cohort among primary and secondary school teachers and non-teacher control in Datong, China, October–December 2019

Variable	Participants (N = 805)											
	non-teacher control (N = 268)			primary school teachers (N = 350)			p[a]	secondary school teachers (N = 187)			p[a]	p[b]
	n (%)	Me	IQR	n (%)	Me	IQR		n (%)	Me	IQR		
Sociodemographic factor												
age [years]		48	40–53		41	37–49	<0.001**		43	36–48	<0.001**	–
gender (male)	129 (48.1)			69 (19.7)			<0.001**	70 (37.4)			0.026*	–
educational level												
high school	15 (5.6)			15 (4.3)			0.608	0 (0.0)			<0.001**	–
junior college	90 (33.6)			128 (36.6)				15 (8.0)				
bachelor	163 (60.8)			207 (59.1)				171 (91.4)				
master	0 (0.0)			0 (0.0)				1 (0.5)				
marital status (yes)	267 (99.6)			327 (93.4)			<0.001**	178 (95.2)			0.001**	–
children [n]		1	1–2		1	1–2	0.023*		1	1–1	0.001**	–
Lifestyle												
stress status												
normal	185 (69.0)			193 (55.1)			<0.001**	93 (49.7)			<0.001**	–
moderate	83 (31.0)			157 (44.9)				94 (50.3)				
severe	0 (0.0)			0 (0.0)				0 (0.0)				
alcohol consumption												
status (yes)	264 (98.5)			342 (97.7)			0.479	181 (96.8)			0.217	–
frequency [times/week]		1	1–2		1	1–1	<0.001**		1	1–1	0.014*	–
smoking												
status (yes)	69 (25.7)			24 (6.9)			<0.001**	33 (17.6)			0.043*	–
cigarette smoking [packs/day]		0	0–2		0	0–0	<0.001**		0	0–0	0.025*	–
time [years]		0	0–6		0	0–0	<0.001**		0	0–0	0.024*	–
physical exercise												
frequency [times/week]		2	0–7		1.5	0–7	0.562		2	0–7	0.808	–
duration [min/session]		30	0–40		20	0–30	0.019*		20	0–40	0.661	–

time [years]		1	0–3		1	0–2	0.069		1	0–3	0.836	–
intensity – heart rate												
normal (60–120 bpm)	115 (42.9)			169 (48.3)			0.339	81 (43.3)			0.993	–
mild (121–140 bpm)	117 (43.7)			133 (38.0)				80 (42.8)				
moderate (141–160 bpm)	36 (13.4)			48 (13.7)				25 (13.4)				
intense (>160 bpm)	0 (0.0)			0 (0.0)				1 (0.5)				
Health status												
high fasting serum glucose (>6.1 mmol/l)	19 (7.1)			24 (6.9)			0.91	5 (2.7)			0.028*	–
BMI												
normal (≥18.5 and <24 kg/m^2)	129 (48.1)			222 (63.4)			0.002**	119 (63.6)			0.007**	–
overweight (≥24 and <28 kg/m^2)	117 (43.7)			106 (30.3)				58 (31.0)				
mild obesity (≥28 and <30 kg/m^2)	20 (7.5)			20 (5.7)				10 (5.3)				
moderate obesity (≥30 kg/m^2)	2 (0.7)			2 (0.6)				0 (0.0)				
high blood pressure (>140/90 mm Hg)	54 (20.1)			50 (14.3)			0.053	36 (19.3)			0.828	–
Teaching												
time [years]					20	13–29	–		20	13–27		0.063
classes [n]					1	1–2	–		2	1–3		<0.001**
class size [n/class]					20	12–31	–		40	35–45		<0.001**
time [h/week]					14	10–17	–		8	6–12		<0.001**
subject category[c]												
major				244 (69.7)			–	121 (64.7)				0.004**
minor				43 (12.3)				20 (10.7)				
other				43 (12.3)				46 (24.6)				

[a] Versus non-teachers control; [b] Versus the primary schoolteachers; [c] The information about subject category of 20 teachers is missing.
* $p < 0.05$; ** $p < 0.01$.



AUC – area under the curve.

Figure 2. The results of receiver operating characteristic (ROC) curve analysis the cut-off values of stressors a) class size in primary schoolteachers and b) teaching time in secondary schoolteachers, Datong, China, October–December 2019

stress were significantly greater: 44.9% ($p < 0.001$), 50.3% ($p < 0.001$), respectively, vs. 31.0% for the proportion of non-teachers with moderate stress. Comparisons between the participants with normal and moderate stress in the 2 schoolteacher groups, the participants' characteristics in associated risk factors are showed in Table 2. As depicted, the primary schoolteachers with moderate stress had a larger class size (30 vs. 20, $p < 0.001$). Among secondary schoolteachers with moderate stress, there were more weekly teaching hours (8 vs. 7, $p = 0.001$) and more teachers who were responsible for major subjects (70.2% vs. 59.1%, $p = 0.048$). In addition, when comparing with schoolteachers without stress, the primary schoolteachers with moderate stress exhibited a lower physical exercise frequency (2 vs. 0, $p < 0.001$), shorter physical exercise duration per session (30 min vs. 0 min, $p < 0.001$) and fewer years of physical exercise (1 vs. 0, $p < 0.001$). And these significant differences did not repeat in comparison between the secondary schoolteachers with normal and moderate stress.

Spearman's correlation coefficients were determined to investigate for potential relation between stress status and the occupation. Table 3 shows that the occupations of schoolteachers were positively correlated with higher levels of stress ($r = 0.151$, $p < 0.001$) in the total group. The results from logistic regression showed that the occupation of schoolteachers led to an increased risk of stress (OR = 2.143, $p < 0.001$ in the primary schoolteachers; OR = 2.321, $p < 0.001$ in the secondary schoolteachers) (Table 4).

Then, the association of stress status and associated risk factors, especially, teaching hours, and class size in the 2 schoolteacher subgroups (Table 3 and 4) was investigated. The results of Spearman's correlation showed that in primary schoolteachers, a larger class size was positively correlated with higher levels of stress ($r = 0.217$, $p < 0.001$). There was a significant negative correlation between the levels of stress and physical exercise frequency ($r = -0.236$, $p < 0.001$), physical exercise duration ($r = -0.188$, $p = 0.001$), years of physical exercise ($r = -0.204$, $p < 0.001$) and exercise intensity ($r = -0.169$, $p = 0.002$). The level of stress was significantly and positively related to age ($r = 0.160$, $p = 0.029$), years of teaching ($r = 0.175$, $p = 0.017$) and weekly teaching hours ($r = 0.234$, $p = 0.001$) among secondary schoolteachers. When the association of stress status and associated risk factors on bivariate-analysis controlling for other variables was investigated, it was found that a larger class size

Table 2. Comparisons between the participants with normal and moderate stress in associated risk factors in the schoolteacher groups in Datong, China, October–December 2019

Variable	Participants[a] (N = 805)													
	primary school teachers (N = 350)							secondary school teachers (N = 187)						
	normal stress (N = 193)			moderate stress (N = 157)			p[a]	normal stress (N = 93)			moderate stress (N = 94)			p[b]
	n (%)	Me	IQR	n (%)	Me	IQR		n (%)	Me	IQR	n (%)	Me	IQR	
Lifestyle														
alcohol consumption														
status (yes)	191 (99)			151 (96.2)			0.083	90 (96.8)			91 (96.8)			0.989
frequency [times/week]		1	1–1		1	1–1	0.724		1	1–1		1	1–1	0.276
smoking	17 (8.8)			7 (4.5)			0.109	15 (16.1)			18 (19.1)			0.588
status (yes)														
amount of cigarette [packs/day]		0	0–0		0	0–0	0.061		0	0–0		0	0–0	0.568
time [years]		0	0–0		0	0–0	0.113		0	0–0		0	0–0	0.465
physical exercise														
frequency [times/week]		2	0–7		0	0–3	<0.001**		3	0–7		2	0–7	0.547
duration [min/session]		30	0–30		0	0–30	<0.001**		20	0–60		16	0–30	0.103
time [years]		1	0–3		0	0–2	<0.001**		1	0–3		1	0–4	0.597
intensity – heart rate														
normal (60–120 bpm)	75 (38.9)			94 (59.9)			<0.001**	37 (39.8)			44 (46.8)			0.313
mild (121–140 bpm)	92 (47.7)			41 (26.1)				40 (43.0)			40 (42.6)			
moderate (141–160 bpm)	26 (13.5)			22 (14.0)				16 (17.2)			9 (9.6)			
intense (>160 bpm)	0 (0.0)			0 (0.0)				0 (0.0)			1 (1.1)			
Health status														
high fasting serum glucose (>6.1 mmol/l)	13 (6.7)			11 (7.0)			0.921	4 (4.3)			1 (1.1)			0.17
BMI														
normal (≥18.5 kg/m^2 and <24 kg/m^2)	115 (59.6)			107 (68.2)			0.262	63 (67.7)			56 (59.6)			0.282
overweight (≥24 kg/m^2 and <28 kg/m^2)	64 (33.2)			42 (26.8)				24 (25.8)			34 (36.2)			
mild obesity (≥28 kg/m^2 and <30 kg/m^2)	12 (6.2)			8 (5.1)				6 (6.5)			4 (4.3)			
moderate obesity (≥30 kg/m^2)	2 (1.0)			0 (0.0)				0 (0.0)			0 (0.0)			
high blood pressure (>140/90 mm Hg)	28 (14.5)			22 (14.0)			0.895	19 (20.4)			19 (20.2)			0.684

Table 2. Comparisons between the participants with normal and moderate stress in associated risk factors in the schoolteacher groups in Datong, China, October–December 2019 – cont.

Variable	Participants[a] (N = 805)													
	primary school teachers (N = 350)							secondary school teachers (N = 187)						
	normal stress (N = 193)			moderate stress (N = 157)			p[a]	normal stress (N = 93)			moderate stress (N = 94)			p[b]
	n (%)	Me	IQR	n (%)	Me	IQR		n (%)	Me	IQR	n (%)	Me	IQR	
Teaching														
time [years]		20	13–29		20	13–29	0.546		18	12–24		21	14–27	0.18
classes [n]		1	1–2		1	1–2	0.941		2	1–3		2	1–2	0.204
class size [n/class]		20	10–30		30	15–35	<0.001**		40	30–45		43	39–45	0.158
time [h/week]		14	10–17		14	10–17	0.516		7	6–8		8	6–12	0.001**
subject category														
major	134 (69.4)			110 (70.1)			0.762	55 (59.1)			66 (70.2)			0.048*
minor	26 (13.5)			17 (10.8)				8 (8.6)			12 (12.8)			
other	25 (13)			18 (11.5)				30 (32.3)			16 (17.0)			

[a] Number of all participants in the study, including 268 non-teachers from 21 education institutes not included in this table.
[b] Versus schoolteachers with normal stress control.
* $p < 0.05$; ** $p < 0.01$.

Table 3. The Spearman correlations analysis between stress status and associated risk factors, in the schoolteacher groups in Datong, China, October–December 2019

Factor	Spearman correlation					
	whole study population (N = 805)		primary school teachers (N = 350)		secondary school teachers (N = 187)	
	R	p	R	p	R	p
Age	–0.049	0.166	0.007	0.889	0.160	0.029*
Gender	0.042	0.237	–0.014	0.798	0.040	0.585
Educational level	0.084	0.018*	0.027	0.613	–0.035	0.633
Marital status	0.034	0.332	0.031	0.569	0.126	0.085
The number of children	–0.078	0.027*	–0.098	0.066	–0.040	0.591
Alcohol consumption status	–0.060	0.088	–0.093	0.083	0.001	0.989
Alcohol consumption frequency	0.018	0.619	–0.019	0.725	0.080	0.278
Smoking status	0.019	0.593	–0.086	0.110	0.040	0.590
Amount of cigarette smoking	0.016	0.656	–0.100	0.061	0.042	0.569
Years of smoking	0.022	0.541	–0.085	0.113	0.054	0.467
Physical exercise frequency	–0.147	<0.001**	–0.236	<0.001**	–0.044	0.549
Physical exercise duration	–0.144	<0.001**	–0.188	<0.001**	–0.120	0.103
Years of physical exercise	–0.116	0.001**	–0.204	<0.001**	–0.039	0.598
Exercise intensity	–0.102	0.004**	–0.169	0.002**	–0.091	0.217
High fasting serum glucose	–0.028	0.650	0.005	0.921	–0.100	0.172
BMI	0.047	0.439	–0.090	0.092	0.071	0.333
High blood pressure	0.046	0.455	–0.007	0.896	–0.03	0.686
Subject categories	–	–	–0.037	0.508	–0.141	0.055
Years of Teaching	–	–	0.033	0.546	0.175	0.017*
The number of classes	–	–	–0.004	0.941	–0.093	0.205
Class size	–	–	0.217	<0.001**	0.104	0.159
Teaching hours	–	–	0.035	0.517	0.234	0.001**
Occupations	0.151	<0.001**	–	–	–	–

* p <0.05, ** p <0.01.

(OR = 1.037, p = 0.001) was an independent risk factor of moderate stress in primary schoolteachers. That is, every one student added to a class resulted in a 3.7% increased risk of moderate stress. On contrary, physical exercise frequency (OR = 0.860, p = 0.026) was an effective coping style, i.e., every one more time physical exercise per week led to a 14.0% decreased risk of moderate stress. In secondary schoolteachers, longer weekly teaching hours (OR = 1.204, p = 0.001) predicted the higher risk of moderate stress; and a more physical exercise duration (OR = 0.985, p = 0.107) could cope with stress, but there was no significant difference.

After determining stressors, the correspondent cut-off values were evaluated based on the results of ROC curve analyses (Figure 2). In primary schoolteachers, class size of 20.5 students/class yielded the maximum Youden's index value at sensitivity of 61.2% and specificity of 63.0%. In the secondary schoolteacher cohort, weekly teaching hours of 8.5 h/week was corresponding to the maximum Youden's index value at sensitivity of 47.9% and specificity of 76.1%.

Table 4. Logistic regression analyses of associated risk factors, in the schoolteacher groups in Datong, China, October–December 2019

Factor	p		OR	95%CI
	unadjusted	adjusted		
Studied population				
occupation (ref. non-teacher control)				
primary schoolteachers	0.010**	<0.001**	2.143	1.473–3.117
secondary schoolteachers	0.005**	<0.001**	2.321	1.525–3.532
physical exercis				
frequency	<0.001**	0.008**	0.900	0.832–0.973
duration	<0.001**	0.011	0.989	0.980–0.997
Schoolteachers				
primary				
class size	<0.001**	0.001**	1.037	1.016–1.060
physical exercise frequency	<0.001**	0.026*	0.86	0.753–0.982
secondary				
teaching hours	0.001**	0.001**	1.204	1.079–1.344
physical exercise duration	0.033*	0.107	0.985	0.967–1.003

* $p < 0.05$; ** $p < 0.01$.

DISCUSSION

The present study is the first to assess teacher stress among public primary and secondary schoolteachers in Datong, a city of Shanxi Province, China, after the policy of the standardized workload was implemented. The results of the survey were not consistent with the authors' hypothesis, i.e. either in primary schools or in secondary schools, a greater proportion of schoolteachers felt great stress in their jobs when compared with that of non-teachers. When compared with the schoolteachers without stress, the primary schoolteachers with moderate stress taught in larger size classes, the secondary schoolteachers with moderate stress were responsible for more teaching hours. After controlling for confounding, it was found that larger size class increased the stress risk among the primary schoolteachers, while longer teaching hours predicted the increased risk of stress in secondary schoolteachers.

Among the previous surveys in China, it was reported that 56.6% of teachers in primary and secondary schools perceived stress, and 4.9% of teachers even constituted psychological diseases, though without a control population. Wang et al. revealed that 20.3% of primary and secondary school teachers had moderate psychological distress and 5.8% of teachers had severe psychological distress, in Henan Province, China, and the proportion of schoolteachers with mental health problems was significantly larger than that of the general population [17]. In the authors' study, 44.9% of primary schoolteachers, 50.3% of secondary schoolteachers and only 31.1% of non-teachers reported that they were under great stress. The percentage of schoolteachers reported that they were under great stress in their jobs were larger than the percentage of the non-teachers. The non-teachers were defined as the control group. Non-teachers were recruited from faculty members of public education institutes, but they came from non-teaching occupations. Except the occupational characteristics, non-teachers and schoolteachers were faced with the similar and relatively stable causes of stress in the workplace, including relationships with colleagues and

management, student behavior, performance bonus pay, job promotion opportunities and mentoring. Of note, these stressors in the workplace were not objective external conditions and difficult to be quantified. Hence, non-teachers in education institutes as the control group may avoid the bias and benefit to assess the relation of teacher stress status in teachers, and association between teacher stress and standardized and quantified workload, objectively. Further, results of Spearman's correlation coefficients and logistic regression showed that the occupation of schoolteachers was positively correlated with the levels of stress and the schoolteachers had a higher risk of stress. Then, the results indicated that occupation is related to teacher stress. There remain higher levels of stress among primary and secondary schoolteachers. Notwithstanding, it was observed none of the schoolteachers with great stress reported that they could not cope with the stress of their jobs on a daily basis, which indicates that the state of stress among teachers is manageable, and they may be faced with controllable stressors.

Correlated with stressor controllability is predictability and this may be the more important property for stress adaptation [18]. Identifying the stressors may influence the government and school interventions and benefit to relieve stress in teachers to the level of organizational intervention. The present results showed that the primary schoolteachers with moderate stress taught larger size classes than those with normal stress (30 vs. 20, $p < 0.001$). The levels of stress were significantly and positively correlated with class size in primary schools ($r = 0.217$, $p < 0.001$). These findings remained significant after controlling for potential confounding factors. The findings indicate that after implementation of the policy in Shanxi province, the prominent stressor in primary schoolteachers is a large class size, not excessive teaching hours or major subjects. In the previous surveys, the effects of class size differences were examined in terms of several dimensions. It is speculated that there are potential causes to result in teacher stress. First, larger class size product more workloads, such as more marking and responsibility for students. It is considered that the overload faced in a teacher's daily routine may lead to an imbalance between work and mental health, resulting in the development of stress [19]. Second, children in large classes are more likely to show off-task behavior of all kinds, and more likely to interact with their peers in terms of off-task behavior, social, and also on-task behaviors [20]. Moreover, larger class size can decrease student achievement. The evidence from Project STAR indicated that on average smaller classes had positive effects on students' achievement [21]. The students' misbehavior and achievement are associated to teacher stress and impact on teacher stress [22]. Previous research has demonstrated how and class size can be associated to the development of teacher stress, indirectly, while these results are to find that a large class size is an associated factor of stress in primary schoolteachers, directly. And class-size reduction to ≤20 students per class in primary schools could decrease the risk of teacher stress.

After the implementation of policy, secondary schoolteachers in this study were responsible for a median of 8 teaching h/week, and the median class size was 40 students. Most of them (64.7%) taught major subjects. The significant associated factor of stress among them is weekly teaching hours. Generally, longer weekly teaching hours, just like larger class size are able to product more workloads, such as more lesson preparation, marking and longer working hours, and then cause stress. Interesting, compared with primary schoolteachers, secondary schoolteachers had fewer weekly teaching hours, greater class size, and more classes. However, the dominant stressor among secondary schoolteachers is not class size and the number of classes, but weekly teaching hours. To the authors' knowledge, there are differences between primary and secondary school education in objects, aims, and contents. First, in secondary school, objects of education are 13–15-year-old students. They are in their adolescence, which makes more instable individuals' emotion than primary school students. Second, the prominent task of secondary education is not similar as that of primary educa-

tion any more. They have to pass the entrance examination of high middle schools, except for development of the all-round development-morally, intellectually and physically. Third, the contents of secondary school education, especially, major subjects are more professional and more obscure. The basic characteristics of secondary education make that the differences between primary and secondary schools in class size, the number of classes, and weekly teaching hours are unable to reflect workload change, comprehensively. As such, it is necessary to evaluate associated risk factors of primary and secondary schoolteachers, separately. The results of statistics analyses indicate that the secondary schoolteachers who are in charge of longer teaching hours are prone to perceived stress. The authors suggest that ≤8 weekly teaching hours in secondary schools are beneficial for teachers to reduce the stress risk.

Apart from organizational intervention, life habits daily may help for individual stress management. The present results showed a more physical exercise frequency, and a longer physical exercise duration were determined as effective coping styles in the whole study population. The cope strategies remained effective in schoolteachers. It was found that more physical exercise frequency and longer physical exercise duration could decrease the stress risk, respectively in primary and secondary schoolteachers. Based on these findings, the independent and effective coping strategy is the physical exercise. Currently, a growing body of supportive evidence has confirmed that exercise such as aerobic exercise, qigong and yoga is an approach for coping with psychological stress [18,23,24]. Wunsch et al. [25] concluded that a reduction in stress activation was found for both acute and habitual exercise, and both types of exercise were positively related to stress reactivity. Findings of a randomized controlled trial suggested that both exercise training and mindfulness can improve global mental health, including adaptive responses to stress. Garber [26] pointed out that exercise as a stress coping mechanism in a pharmacy student population according to the results of the web survey that exercise coping mechanisms were significantly associated with lower perceived stress scores in 368 pharmacy students with 81% response rate. Furthermore, the meta-analysis data of Stubbs et al. [27] suggested that exercise was effective in improving anxiety symptoms in people with a current diagnosis of anxiety and/or stress-related disorders. The hitherto research works reveal that the effect of exercise is to increase the stress resistance and reduce vulnerability to stress [28]. Nevertheless, it remains inconclusive and it is unclear which associated factors of exercise could modulate stress. Even the meta-analytic data are difficult to identify significant stressors, including sample characteristics (gender and age) and exercise intervention variables (length of the trial, frequency, and dropout) that could impact the effects of exercise on anxiety symptoms due to moderate levels of heterogeneity [27]. The authors' data observe that a more physical exercise frequency and longer physical exercise duration could effectively cope with stress either in the whole population or in primary and secondary schoolteachers.

The present research is involved in an important area of study, especially with the current educational policy changes in China. Further, teacher mental health and wellness have practical implications that likely apply to a wide variety of countries, cultures and settings. The quantitative data will help relevant authorities to plan, institute and improve policies and preventive measures; thereby enabling teachers to work in low-risk environments, and help teachers develop positive stress coping strategies. In the further, the authors will investigate both risk factors for excessive stress and coping methods, e.g. physical exercise.

Limitations

Despite using the most appropriate instruments to measure stress in a large cohort study, there is the possibility of reporting bias that the single-item rating assessment of work-related stress was not sufficiently sensitive. In additional, it is better to discuss other possible strategies to manage stress in teachers.

CONCLUSIONS

The present research has demonstrated that occupation remains to be associated with teacher stress, after standardization of the workload. There are higher levels of stress among primary and secondary schoolteachers. In 805 participants, the proportion of primary and secondary schoolteachers with moderate stress was significantly greater. The results of Spearman's correlation and logistic regression analyses showed that the primary and secondary schoolteachers, as a type of occupations, presented higher stress risk. Notwithstanding, the state of stress among teachers is manageable, and they may be faced with the controllable stressors. Based on the quantitative data, it was found that larger size class increased the stress risk among the primary schoolteachers, and every one student added into a class resulted in a 3.7% increased risk of moderate stress; while among the secondary school teachers, the stress associated factor was more weekly teaching hours, longer weekly teaching hours predicted the higher risk of moderate stress (OR = 1.204, p = 0.001). Moreover, more physical exercise frequency and longer physical exercise duration could effectively cope with stress either in the whole population or in primary and secondary school teachers.

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