Working condition and health status of 6,317 front line public health workers during the COVID-19 epidemic across 5 provinces in China: a cross-sectional study

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Abstract

Background: Public health workers at China CDCs and primary health care institutes (PHI) constitute one of the main workforces for implementing prevention and control measures to contain the COVID-19 epidemic, but their efforts and health status have not been well documented. We aimed to investigate the working conditions and health status of frontline public health workers in China during the epidemic.

Methods: Between February 18 to March 1, 2020, we conducted a cross-sectional survey among 2,313 CDC workers and 4,004 PHI workers in five provinces across China experiencing different scales of COVID-19 epidemic. We interviewed all participants about their work conditions, roles, burdens, perceptions, mental health, and self-rated health by self-constructed questionnaire and standardized measurements. To examine the independent associations between working conditions and health outcomes, we used multivariate regression models controlling for potential confounders.

Results: The prevalence of depression, anxiety, and poor self-rated health was 21.3%, 19.0%, and 9.8%, respectively, among public health workers (27.1%, 20.6% and 15.0% among CDC workers; and 17.5%, 17.9% and 6.8% among PHI workers). The majority (71.6%) participated in both field and non-field work and gave immense efforts. Nearly 20.0% have worked all night for more than 3 days and 45.3% had worked during the whole period of Chinese New Year. Three risk factors and two protective factors were found independently associated with all three health outcomes in our final multivariate models, including working all night for >3 days (ORm=1.67~1.75, p<0.001), concerns about being infected at work (ORm=1.46~1.89, p<0.001), perceived troubles at work (ORm=1.10~1.28, p<0.001), starting COVID-19 prevention work after January 23 (ORm=0.78~0.82, p=0.002~0.008), and capability to persist for more than 1 month at the current work intensity (ORm=0.44~0.55, p<0.001).

Conclusion: Chinese public health workers gave immense efforts and personal sacrifices to curb the COVID-19 epidemic and were exposed to risk of mental health problems. Efforts should be taken to improve the working condition and health status of public health workers to maintain the morale and effectiveness of public health workers in the fight against the epidemic.

Background

On December 29, 2019, a hospital in Wuhan, Hubei Province, China reported an outbreak of atypical pneumonia, [1] which was later officially named coronavirus disease 2019 (COVID-19) by the World Health Organization (WHO). Since then, COVID-19 has spread rapidly across China and now has become a global epidemic. As of March 7, 2020, a total of 80,695 confirmed cases and 3,097 deaths have been reported in China.[2] Despite some initial missteps, China implemented a series of draconian prevention and control measures which have been favourably assessed by the WHO-China joint mission,[3] and may have reduced the intensity of the epidemic in China.[4] Since January 27, 2020, the daily new cases in China have been steadily declining,[5] whereas community outbreaks of COVID-19 have quickly emerged in many other countries, leading to stretched health systems in containing the epidemic.[6]

Due to a lack of effective treatments and vaccines, preventive measures including controlling the source of infection, blocking transmission, and protecting the susceptible population are the most effective ways to contain the spread of diseases.[5, 7] In an outbreak of the scale of COVID-19, China has made an unprecedented effort to mobilize its public health workers in those containment efforts. Though public health systems vary across countries, [8-10] during the outbreak of COVID-19, different countries may share needs in COVID-19 prevention and control, and public health workers may face similar challenges. China's experiences can inform other countries of the types of public health workers who can be mobilized, the work roles and functions that they can effectively perform, the challenges that they encountered, and, in particular, the heavy toll of the work on their physical and mental health. With those lessons learned, other countries may better prepare their human resources in the fight against this epidemic.

In previous outbreaks and major public health emergencies, there were studies and reports on medical workers who joined the front line to treat patients to document their distress, difficulties, and health problems.[11-14] It was found that during public health emergencies, such as SARS, medical workers had a high prevalence of depression, anxiety and perceived poor physical health.[12, 15-17] Increased workload, fear of infection due to patient care, inadequate training and equipment, and lack of support were risk factors for poor mental and physical health.[18-22] Similar findings were reported in studies of medical workers who participated in the treatment of MERS patients.[23-25] However, we have identified no studies that focused on public health workers during outbreak control and prevention, despite their indispensable role in containing the epidemic.

China's current public health system was established after the 2003 SARS.[26] It is composed of specialized institutions (e.g., disease prevention and control, maternal and child health, mental health) for technical guidance, and primary health care institutes (PHIs) (i.e., community health centers/stations in urban areas and township health centers and village clinics in rural areas) for public health service delivery.[26] Structurally the Centers for Disease Control and Prevention (CDC) in China have units at national, provincial, municipal, and county/district levels, while PHIs operate at the town/subdistrict (i.e., community)-level. During the COVID-19 epidemic, CDCs and PHIs at all levels undertook various tasks for prevention and control, such as the development of technical instructions, epidemiological investigation of patients and close contacts, surveillance of high-risk populations, specimen collection and examination, data collection and reporting, health education and promotion, training and so forth.[27]

It is important to document the working and health status of public health workers in China during the outbreak and to harness China's experiences to improve the world's efforts in fighting this epidemic. In this study, we conducted a large survey among front line public health workers across 5 provinces of China, intended to address the following key questions concerning the effective mobilization and use of public health workers: (1) the types of public

health workers involved in the epidemic containment efforts, (2) the roles and job functions they played, (3) the challenges associated with their work, and (4) factors that were associated with their mental and physical health.

Methods

Study design

This cross-sectional study was conducted from February 18 to March 1, 2020. Data was collected from five provinces (Hubei, Guangdong, Sichuan, Jiangsu and Gansu) which were purposely selected to cover different levels of epidemic severity defined by numbers of reported cases (by March 5, 2020, 67466, 1351, 539, 631, and 102 COVID-19 cases were reported in the selected five provinces), and to cover different regions of the country (center, southern, western, eastern, and northern). In each province, 3-5 cities were selected; within selected cities, 3-5 districts/counties and 5-10 subdistricts/towns were further selected using similar methods to represent both different levels of the outbreak and to represent different regions. At province, city and district/county levels, CDCs workers were investigated, and at subdistrict/town level, PHI workers were investigated.

Participants recruitment

Eligible participants were: 1) aged 18 years old or above; 2) working at CDC or PHI of the selected places during the study period; 3) participated in COVID-19 control and prevention-related work. Site investigators (e.g., CDC workers) of each province distributed the survey link through their Wechat/QQ working groups. Wechat and QQ are popular communication/social networking mobile-phone applications used in China that are ubiquitous in workplace settings. All participants were informed of the background, aims, anonymous nature and length (about 8-12 minutes to complete) of the survey. They were also informed that completing the questionnaire signified their informed consent. No compensation was provided to the participants. The study was approved by the ethics committee of the School of Public Health, Sun Yat-sen University (Reference no.: 2020-012).

Measurements

Socio-demographic characteristics. Information about age, sex, job title, and whether they have children under 6 years old (i.e., the school age) were collected. Participants' areas of routine work before COVID-19 outbreak were collected in Guangdong Province. We only collected this information in Guangdong province, and it was deleted in other provinces due to the length of the questionnaire.

COVID-19 control and prevention work-related variables. We collected information from all participants about their work in terms of work contents, readiness for the work, and time of starting the work. Detailed variables included are listed below.

1) work contents. The preset list of work contents included 14 fieldwork questions covering for example face-to-face epidemiological investigation of the patients/close contacts, epidemiological investigation by phone or video call, medical observation of the close contacts, specimen collection and shipment, health education, and community-based investigation; and 11 non-field work topics covering for example preparation of technical guidelines, data analysis and report writing, laboratory test, comprehensive coordination and publicity, and technical training. Participants were asked to select work that they have been involved in from the preset list and fill in other contents that were not included on the list if any.

2) time spent in training on COVID-19, coded as none, 1-4 hours, 5-8 hours, 9-16 hours, and >16 hours.

3) knowledge of COVID-19 prevention and control, from 1 'adequate' to 5 'very inadequate'.

4) Date the participant started COVID-19 prevention and control work. In data analysis, we use chose the cut-off date of January 23 because it is the date of closure of Wuhan city and also it is the day just before the Chinese New Year.

5) severity of the epidemic in their provinces, from 1 'very low' to 5 'very high' according to confirmed cases in each province.

Efforts and sacrifices. Participants were asked about their efforts and sacrifices during the outbreak: 1) number of days that they have worked all night, 2) whether they have worked during the whole period of Chinese New Year, and 3) family sacrifices such as not going home or sending children to parents' home, to avoid infecting family members.

Perceptions related to COVID-19 and work were also collected. One item was used to assess their concerns about being infected at work, from 1 'none' to 5 'very worried'. One item was used to assess how long they can persist with their current work intensity, coded as 1-2 weeks, 3-4 weeks, 2-3 months, or >3 months.

Perceived support and *perceived troubles at work* were measured by self-constructed items which were developed after discussions with CDC and PHI workers and among the research team. The *perceived support* scale consisted of three items to measure perceived support from colleagues, family, and society rated on a Likert-type scale from 1 'none' to 5 'very much'. The three items showed acceptable internal consistency in this study (Cronbach's alpha = 0.760). *Perceived troubles at work* consisted of five items, which were rated on a 5-point Likert scale, from 1 'none' to 5 'very much'. For example, participants were asked how often they have been treated unfairly at work. The Cronbach's alpha for perceived troubles was 0.842 in this study.

Health outcomes included overall health status, depression, and anxiety. Overall health was measured by self-rated health status from 1 'very poor' to 5 'very good', which has been widely used globally and in China. [28, 29] The 9-item patient health questionnaire (PHQ-9) was used to assess the presence of

depressive symptoms. The Chinese version of the PHQ-9 has been validated for the general population, showing good internal reliability.[30] Participants were asked to rate how often they have experienced the depressive symptoms in the past two weeks, on a 4-point Likert scale, from 0 'none' to 3 'nearly every day'. The total score ranges from 0 to 27, with a higher score reflecting greater severity. A score of ten or more was classified as a major depressive disorder. In this study, the Cronbach's alpha value was 0.922.

The 7-item General Anxiety Disorder scale (GAD) was used to measure anxiety.[31] Each item was rated on a 4-point Likert scale ranging from 0 'never' to 3 'often (almost every day)'. The cutoff point of ten or above is used to define a probable case of moderate anxiety disorder. In this study, the Cronbach's alpha value was 0.937.

Statistical analysis

Descriptive analysis was conducted to characterize the study. Chi-square tests, *t*-tests, and rank sum tests were used to investigate differences among CDC workers and PHI workers. To explore potential factors of the three health outcomes (i.e., self-rated health, depression, and anxiety), three sets of logistic regression models were performed in parallel. First, bivariate logistic regression analyses were used to examine the associations between all variables of interest and the three outcomes. Then adjusted logistic regression models were performed to identify the associations between COVID-19 related variables (COVID-19 control and prevention work related variables, efforts and sacrifices during the outbreak, perceptions) and the three outcomes, after controlling for potential confounders (sex, age, having children under 6 years and job title). In the final models, multivariate forward stepwise logistic regression models were fitted, using all COVID-19 related variables that were found to be significant in the univariate analysis as candidates for selection, with sociodemographic variables entered in the model. Unadjusted odds ratios (ORu) from univariate logistic regression models, adjusted odds ratios (AOR) from multiple logistic regression models, and their respective 95% confidence intervals (CIs) were reported. IBM SPSS Statistics 25 was used for data analysis. Significance referred to p value <.05.

Results

Of the 7090 completed questionnaires, 528 (7.4%) did not pass the consistency checks and 245 (3.4%) did not report any COVID-19-related work. We performed the complete-data analysis based on the effective sample size of 6,317 (89.1%).

Socio-demographic characteristics of the participants

Of the 6,317 participants, 64.6% were female; the mean age was 38.7 (SD=9.43); 66.9% were 30-49 years old; 77.0% had an intermediate or Junior job title; and 27.9% had children under 6 years old (Table 1). More participants among CDC workers were male, younger and with senior job title than PHI workers.

Table 1 Descriptive statistics of public health workers during the COVID-19 epidemic (n, %)

s	All (N=6317)	CDC employees (N=2313)	PHI workers (N=4004)	*p* value
nographic characteristics				
nale)	2238(35.4)	987(42.7)	1251(31.2)	<0.001
ups				0.004
	1244(19.7)	392(16.9)	852(21.3)	
9	2093(33.1)	819(35.4)	1274(31.8)	
9	2132(33.8)	748(32.3)	1384(34.6)	
	848(13.4)	354(15.3)	494(12.3)	
children under 6 years (yes)	1765(27.9)	677(29.3)	1088(27.2)	0.074
				<0.001
	2880(45.6)	745(32.2)	2135(53.3)	
ediate	1984(31.4)	800(34.6)	1184(29.6)	
	712(11.3)	504(21.8)	208(5.2)	
(e.g., volunteers)	741(11.7)	264(11.4)	477(11.9)	
9 control and prevention work related variables				
ık severity (by province)[1]				<0.001
	591(9.4)	477(20.6)	114(2.8)	
m	3638(57.6)	1224(52.9)	2414(60.3)	
	830(13.1)	282(12.2)	548(13.7)	
high	1258(19.9)	330(14.3)	928(23.2)	
ontents				<0.001
ed in field work	1556(24.6)	352(15.2)	1204(30.1)	
ed in non-field work	235(3.7)	149(6.2)	86(2.1)	
ed in both field and non-field work	4526(71.6)	1812(78.3)	2714(67.8)	
training on COVID-19				<0.001
	180(2.8)	113(4.9)	67(1.7)	
urs	1128(17.9)	411(17.8)	717(17.9)	
urs	876(13.9)	339(14.7)	537(13.4)	
ours	939(14.9)	350(15.1)	589(14.7)	
ours	3194(50.6)	1100(47.6)	2094(52.3)	
sufficient knowledge of COVID-19 prevention and control				<0.001
ate	975(15.4)	275(11.9)	700(17.5)	
vely adequate	3700(58.6)	1397(60.4)	2303(57.5)	
ge	1537(24.3)	580(25.1)	957(23.9)	
uate/very inadequate	105(1.7)	61(2.6)	44(1.1)	
start participating in COVID-19 prevention and control work (after 23nd Jan,	3613(60.0)	1098(50.1)	2515(65.6)	<0.001
nd sacrifices during the outbreak				
of days worked all night				<0.001
	3617(57.3)	1073(46.4)	2544(63.5)	
vs	1459(23.1)	621(26.8)	838(20.9)	
vs	1241(19.6)	619(26.8)	622(15.5)	
during the whole period of Chinese New Year (yes)	2862(45.3)	1313(56.8)	1549(38.7)	<0.001
d infecting family members, chose not to live at home (yes)	878(13.9)	305(13.2)	573(14.3)	0.213
d infecting family members, send children to parents' homes (yes)	935(14.8)	338(14.6)	597(14.9)	0.749
ons				
about being infected at work				<0.001
mild	2461(39.0)	1023(44.2)	1438(35.9)	
m	2264(35.8)	795(34.4)	1469(36.7)	
orried	1592(25.2)	495(21.4)	1097(27.4)	

;	All (N=6317)	CDC employees (N=2313)	PHI workers (N=4004)	p value
ıg do you think you can persist with your current intensity of work (>=1	2315(36.6)	750(32.4)	1565(39.1)	<0.001
ived support from colleagues				0.098
ɜ/low	383(6.1)	143(6.2)	240(6.0)	
ıum	2448(38.8)	858(37.1)	1590(39.7)	
/very high	3486(55.2)	1312(56.7)	2174(54.3)	
ived support from family				<0.001
ɜ/low	122(1.9)	48(2.1)	74(1.8)	
ıum	1334(21.1)	410(17.7)	924(23.1)	
/very high	4861(77.0)	1855(80.2)	3006(75.1)	
ived support from society				0.014
ɜ/low	757(12.0)	323(14.0)	434(10.8)	
ıum	2779(44.0)	999(43.2)	1780(44.5)	
/very high	2781(44.0)	991(42.8)	1790(44.7)	
score of perceived support	10.99±1.95	11.02±1.91	10.98±1.97	0.360
ɜd troubles at work				
work was not understood				0.002
ıe/rare	2671(42.3)	918(39.7)	1753(43.8)	
ɜtimes	2490(39.4)	945(40.9)	1545(38.6)	
ı/very much	1156(18.3)	450(19.5)	706(17.6)	
have been treated unfairly at work				<0.001
ıe/rare	3471(54.9)	1191(51.5)	2280(56.9)	
ɜtimes	1997(31.6)	753(32.5)	1244(31.1)	
ı/very much	849(13.4)	369(16.0)	480(12.0)	
felt wronged at work				<0.001
ıe/rare	3022(47.8)	1030(44.5)	1992(49.8)	
ɜtimes	2245(35.5)	848(36.7)	1397(34.9)	
ı/very much	1050(16.6)	435(18.8)	615(15.4)	
family cannot understand your efforts				0.326
ıe/rare	4976(78.8)	1837(79.4)	3139(78.4)	
ɜtimes	1076(17.0)	384(16.6)	692(17.3)	
ı/very much	265(4.2)	92(4.0)	173(4.3)	
worried about routine works besides the COVID-19 epidemic				<0.001
ıe/rare	2730(43.2)	1085(46.9)	1645(41.1)	
ɜtimes	2527(40.0)	869(37.6)	1658(41.4)	
ı/very much	1060(16.8)	359(15.5)	701(17.5)	
core of perceived troubles at work	12.25±3.74	12.39±3.82	12.17±3.69	0.023
ealth status and self-perceived health				
)	5.94±5.59			
ssion (yes)	1034(21.3)	521(27.1)	513(17.5)	<0.001
	5.69±5.07			
y (yes)	920(19.0)	396(20.6)	524(17.9)	<0.001
erceived health				<0.001
good	974(15.4)	199(8.6)	775(19.4)	
l	2504(39.6)	841(36.4)	1663(41.5)	
age	2221(35.2)	926(40.0)	1295(32.3)	
	555(8.8)	303(13.1)	252(6.3)	
poor	63(1.0)	44(1.9)	19(0.5)	

ɜc severity (by province):1.Very low=0-19; 2.Low=20-199; 3.Midium=200-699; 4.High=700-9999; 5.Very high=over 10000. (According to the total number of conf ach province by February 25).

COVID-19 control and prevention work related variables

Overall, 19.9% of the participants were from the province with severe epidemic (i.e., Hubei), accounting for 14.3% of the CDC workers and 23.2% of the PHI workers (p<0.001). Nearly half (49.9) of CDC workers started COVID-19 prevention work before January 23, 2020, versus 34.4% among PHI workers (p<0.001). COVID-19 control and prevention work before January 20, 2020 for 22% of CDC workers and 9% of PHI workers increasing to 87% and 78% by January 27. Both CDC workers and PHI workers self-reported to have received training and had sufficient knowledge of COVID-19. Less than 2% of the participants reported inadequate knowledge (2.6% of CDC workers versus 1.1% of PHI workers) and more than half received training for >16 hours (2.6% of CDC workers versus 1.1% of PHI workers).

The majority (78.3% of CDC workers versus 67.8% of PHI workers, p<0.001) participated in both field and non-field work. Detailed information about work contents was shown in Table S1. Most noteworthy, 22.8% participated in face-to-face epidemiological investigation of patients (17.8% of CDC workers versus 25.8% of PHI workers, p<0.001); 22.8% participated in medical observation of close contacts (10.2% of CDC workers versus 30.1% of PHI workers, p<0.001); 22.7% of CDC workers and 52.2% of PHI workers conducted health education; and 26.0% of CDC workers and 9.0% of PHI workers were involved in epidemiological report writing.

Table S1 Work contents during the COVID-19 epidemic

	All		CDC workers		PHI workers		*p value*
	n	%	*n*	%	*n*	%	
Field work							
Epidemiological investigation of the patients (face-to-face)	1443	22.8	411	17.8	1032	25.8	<0.001
Epidemiological investigation of the patients (by phone/video)	1310	20.7	616	26.6	694	17.3	<0.001
Epidemiological investigation of the close contacts (face-to-face)	1495	23.7	441	19.1	1054	26.3	<0.001
Epidemiological investigation of the close contacts (by phone/video)	1295	20.5	558	24.1	737	18.4	<0.001
Medical observation of the close contacts	1440	22.8	236	10.2	1204	30.1	<0.001
On-site disinfection	1427	22.6	469	20.3	958	23.9	0.001
Specimen collection	694	11.0	405	17.5	289	7.2	<0.001
Specimen shipment	500	7.9	393	17.0	107	2.7	<0.001
Health education	2618	41.4	526	22.7	2092	52.2	<0.001
Logistic support	1322	20.9	486	21.0	836	20.9	0.901
Management and coordination of the isolation sites	822	13.0	195	8.4	627	15.7	<0.001
Supervision	1213	19.2	522	22.6	691	17.3	<0.001
Community-based investigation	249	3.9	15	0.6	234	5.8	<0.001
Fever detection and investigation at transportation hubs	469	7.4	43	1.9	426	10.6	<0.001
Non-field work							
Preparation of technical guidelines	269	4.3	163	7.0	106	2.6	<0.001
Case reporting directly to national data center	779	12.3	199	8.6	580	14.5	<0.001
Analysis and projection of the epidemic	519	8.2	341	14.7	178	4.4	<0.001
Report writing	962	15.2	601	26.0	361	9.0	<0.001
Laboratory test	375	5.9	223	9.6	152	3.8	<0.001
Information correction and publicity	1755	40.3	557	31.9	1198	45.9	<0.001
Technical training	659	10.4	281	12.1	378	9.4	0.001
Comprehensive coordination	1547	24.5	592	25.6	955	23.9	0.121

In Guangdong province, 88.6% of CDC workers involved in COVID-19 prevention work were public health concentrated, versus 37.0% of PHI workers (p<0.001, Table S2). Specifically, 63.0% of PHI workers engaged in COVID-19 prevention work were actually clinicians (27.6%), nurses (26.6%), pharmacists (5.1%), and clinical technicians (3.7%) as their routine work. The majority of CDC workers worked in a public health concentration in their routine works, such as infectious disease prevention and control (16.1%), non-communicable disease prevention and control (20.1%), health education (6.1%), and health inspection (9.3%).

Table S2 Areas of routine work of public health workers in Guangdong province during the COVID-19 epidemic

Areas of routine work	All		CDC workers		PHI workers		*p value*
	n	%	*n*	%	*n*	%	
Public health concentration	1023	51.9	506	88.6	517	37.0	<0.001
Infectious disease prevention and control (e.g., STD/HIV/TB)	134	6.8	92	16.1	42	3.0	
Non-communicable disease prevention and control	403	20.5	115	20.1	288	20.6	
Immunization	64	3.2	36	6.3	28	2.0	
Health education	55	2.8	35	6.1	20	1.4	
Health inspection	61	3.1	53	9.3	8	0.6	
Disinfection and prevention of vector-born diseases	43	2.2	43	7.5	0	0	
Maternal and child health	44	2.2	1	0.2	43	3.1	
Disease control/prevention (other diseases)	62	3.1	50	8.8	12	0.9	
Others	157	8.0	81	14.2	76	5.4	
Non-public health concentration	947	48.1	65	11.4	882	63.0	<0.001
Clinicians	419	21.3	33	5.8	386	27.6	
Nursing	380	19.3	8	1.4	372	26.6	
Pharmacist	72	3.7	0	0	72	5.1	
Clinical technician	76	3.9	24	4.2	52	3.7	

Efforts and sacrifices during the outbreak

More CDC workers (26.8%) reported that they have worked all night for >3 days than PHI workers (15.5%, *p*<0.001); 56.8% of CDC workers and 38.7% of PHI workers had worked during the whole period of Chinese New Year (*p*<0.001). There were no significant differences in sacrifices between CDC workers and PHI workers. To avoid infecting family members, 13.9% of all participants chose not to live at home and 14.8% sent their children to parents' homes.

Perceptions

More PHI workers (64.1%) perceived moderate to high level concerns about being infected at work than did CDC workers (55.8%, *p*<0.001). The majority (88%-98.1%) perceived medium to high level of support from colleagues, family, and society. There were no significant differences in total score of support between CDC workers and PHI workers (mean, 11.02 versus 10.98, *p*=0.360). CDC workers perceived higher level of troubles at work than PHI workers (mean, 12.39 versus 12.17, *p*=0.023). For example, 48.5% of CDC workers and 43.1% of PHI workers reported being treated unfairly at work (*p*<0.001); and 53.1% of CDC workers and 58.9% of PHI workers worried about their routine works beside the COVID-19 prevention work (*p*<0.001).

Self-rated health status and prevalence of mental health problems

Less than 10% had poor/very poor self-rated health (15.0% of CDC workers versus 6.8% of PHI workers, $p<0.001$). The prevalence of probable depression among CDC workers and PHI workers was 27.1% and 17.5% ($p<0.001$), respectively. The prevalence of anxiety was 20.6% among CDC workers versus 17.9% among PHI workers ($p<0.001$).

Factors associates with depression, anxiety, and poor self-rated health

Bivariate logistic regression analyses showed that women (OR=1.13~1.29) and participants with children under 6 years old (OR=1.12~1.41) were more likely to have depression and poor self-rated health. Participants with children under 6 years old (OR=1.39; 95% CI=1.18, 1.62) were also found to have higher risk of anxiety. Being aged above 30 (OR=0.63; 95% CI=0.53, 0.73) was found to be a protective factor against depression. Participants from Hubei had a higher level of anxiety but not depression and poor self-rated health than those from other provinces.

Adjusted for socio-demographic variables, 10 factors out of 14 factors of interest were significantly associated with all three health outcomes (i.e., depression, anxiety, and poor self-rated health), including three protective factors and seven risk factors (Table 2).

e 2 Associations between mental health status/self-perceived health status and background variables.

Variables	Depression		Anxiety	Poor self-perceived health					
	Row (%)	ORu	AOR (95%CI)	Row (%)	ORu	AOR (95 %CI)	Row (%)	ORu	AOR (95%CI)
Socio-demographic characteristics									
Sex									
Male	18.7	1.00	NA	17.8	1.00	NA	43.0	1.00	NA
Female	22.9	1.29**	NA	19.6	1.13	NA	46.0	1.13*	NA
Age group									
<30	28.0	1.00	NA	20.8	1.00	NA	44.0	1.00	NA
>=30	19.6	0.63***	NA	18.5	0.86	NA	45.2	1.05	NA
Having children under 6 years									
No	19.8	1.00	NA	17.6	1.00	NA	44.2	1.00	NA
Yes	25.8	1.41***	NA	22.9	1.39***	NA	47.0	1.12*	NA
Job title									
Junior	20.9	1.00	NA	19.4	1.00	NA	42.5	1.00	NA
Intermediate/senior	21.4	1.03	NA	18.4	0.94	NA	48.3	1.26***	NA
Others (e.g., volunteers)	22.7	1.11	NA	19.1	0.98	NA	42.0	0.98	NA
COVID-19 control and prevention work related variables									
Outbreak severity (by province)1									
Hubei	21.0	1.00	1.00	20.6	1.00	1.00	44.3	1.00	1.00
Other province	21.4	1.03	0.95(0.81,1.11)	18.4	0.87	0.83(0.70,0.98)*	45.1	1.03	1.01(0.89,1.14)
Work contents									
Involved in field work-only	19.2	1.00	1.00	17.3	1.00	1.00	38.1	1.00	1.00
Involved in non-field work-only	29.5	1.76**	1.57(1.10,2.23)*	16.4	0.94	0.88(0.58,1.35)	51.1	1.70***	1.64(1.24,2.16)***
Involved in both work	21.5	1.16	1.25(1.05,1.49)*	19.6	1.16	1.21(1.01,1.45)*	47.0	1.44***	1.46(1.29,1.64)***
Institutions									
CDC	27.1	1.00	1.00	20.6	1.00	1.00	55.0	1.00	1.00
PHI	17.5	0.57***	0.57(0.49,0.66)***	17.9	0.84*	0.84(0.72,0.97)*	39.1	0.53***	0.53(0.47,0.59)***
Have training on COVID-19									
None	28.9	1.00	1.00	22.5	1.00	1.00	56.7	1.00	1.00
Yes	21.1	0.66*	0.70(0.48,1.01)	18.9	0.80	0.83(0.56,1.24)	44.6	0.62**	0.62(0.46,0.84)**
Having sufficient knowledge of COVID-19 prevention and control									
Adequate/relatively adequate	19.2	1.00	1.00	17.6	1.00	1.00	39.8	1.00	1.00
Average	25.7	1.46***	1.41(1.21,1.65)***	21.7	1.30**	1.27(1.08,1.49)**	58.6	2.14***	2.19(1.94,2.46)***
Inadequate/very inadequate	43.5	3.23***	3.16(2.07,4.84)***	37.0	2.75***	2.68(1.74,4.14)***	76.2	4.85***	4.88(3.10,7.69)***

	Depression			Anxiety			Poor self-perceived health		
	Row (%)	ORu	AOR (95%CI)	Row (%)	ORu	AOR (95 %CI)	Row (%)	ORu	AOR (95%CI)
Time to start participating in COVID-19 prevention and control									
Before 23nd Jan, 2020	23.3	1.00	1.00	21.5	1.00	1.00	50.8	1.00	1.00
23nd Jan, 2020~	19.4	0.79**	0.71(0.62,0.83)***	16.9	0.74***	0.70(0.60,0.82)***	40.6	0.66***	0.64(0.58,0.72)***
Efforts and sacrifices during the outbreak									
Number of days worked all night									
0	17.4	1.00	1.00	14.6	1.00	1.00	39.3	1.00	1.00
1-3 days	23.3	1.45***	1.61(1.35,1.91)***	21.5	1.60***	1.71(1.43,2.05)***	50.1	1.55***	1.65(1.46,1.88)***
>3 days	28.0	1.85***	2.14(1.80,2.55)***	25.9	2.05***	2.25(1.88,2.70)***	55.3	1.91***	2.11(1.84,2.41)***
Worked during the whole period of Chinese New Year									
No	20.5	1.00	1.00	17.3	1.00	1.00	39.7	1.00	1.00
Yes	22.0	1.09	1.25(1.08,1.44)**	20.4	1.23**	1.31(1.13,1.52)***	51.3	1.61***	1.73(1.56,1.92)***
To avoid infecting family members, chose not to live at home									
No	20.0	1.00	1.00	18.2	1.00	1.00	43.6	1.00	1.00
Yes	28.2	1.57***	1.53(1.28,1.83)***	23.2	1.36**	1.36(1.13,1.64)**	53.3	1.48***	1.53(1.32,1.77)***
To avoid infecting family members, send children to parents' homes.									
No	20.7	1.00	1.00	18.1	1.00	1.00	44.4	1.00	1.00
Yes	24.8	1.26**	1.14(0.94,1.38)	23.8	1.41***	1.29(1.06,1.57)*	47.9	1.15*	1.11(0.96,1.29)
Perceptions									
Worried about being infected at work									
None/mild	13.0	1.00	1.00	9.7	1.00	1.00	35.1	1.00	1.00
Medium/very worried	26.9	2.46***	2.42(2.07,2.83)***	25.3	3.16***	3.12(2.63,3.71)***	51.2	1.94***	1.92(1.73,2.14)***
How long one can persist with your current intensity of work									
<1 month	26.7	1.00	1.00	23.4	1.00	1.00	54.1	1.00	1.00
>=1 month	11.5	0.36***	0.36(0.31,0.43)***	11.0	0.41***	0.40(0.34,0.48)***	29.2	0.35***	0.35(0.32,0.40)***
Perceived support		0.93***	0.94(0.90,0.97)***		0.98	0.98(0.95,1.02)		0.89***	0.89(0.87,0.92)***
Perceived troubles at work		1.29***	1.29(1.26,1.32)***		1.32***	1.32(1.29,1.35)***		1.16***	1.16(1.14,1.18)***

ku: Odds ratios of univariate analysis. AOR: Odds ratios adjusting for sociodemographic variables (sex, age, having child <6 and job title)

*<.05; **:p<.01; ***:p<.001; OR and 95%CI with p<.05 were in bold.

In our final multivariate models, five factors were found to be independently associated with depression, anxiety and poor self-rated health: 1) worked all night for >3 days (ORm=1.67~1.75, *p*<0.001), 2) worried about being infected at work (ORm=1.46~1.89, *p*<0.001), 3) perceived troubles at work (ORm=1.10~1.28, *p*<0.001), 4) started COVID-19 prevention work after January 23 (ORm=0.78~0.82, *p*=0.002~0.008), and 5) capability to persist for more than 1 month with the current work intensity (ORm=0.44~0.55, *p*<0.001). Involvement only in non-field work was positively associated with depression (ORm=1.89, *p*=0.002) and poor self-rated health (ORm=1.74, *p*<0.001). Perceived support (ORm=0.94, *p*<0.001) was negatively associated with poor self-rated health.

Table 3 Associations between mental health status/self-perceived health status and background variables (multivariate stepwise logistic regression)[a].

Variables	Depression		Anxiety		Poor self-perceived health	
	OR_m (95%CI)	p value	OR_m (95%CI)	p value	OR_m (95%CI)	p value
COVID-19 control and prevention work related variables						
Work contents						
Involved in field work-only	1.00		N.S.		1.00	
Involved in non-field work-only	**1.89(1.27,2.82)**	**0.002**	N.S.		**1.74(1.28,2.36)**	**<0.001**
Involved in both field and non-field work	1.04(0.85,1.27)	0.686	N.S.		**1.25(1.09,1.43)**	**0.001**
Having sufficient knowledge of COVID-19 prevention and control						
Adequate/relatively adequate	1.00		N.S.		1.00	
Average	1.18(0.99,1.41)	0.064	N.S.		**2.02(1.77,2.30)**	**<0.001**
Inadequate/very inadequate	**2.18(1.33,3.59)**	**0.002**	N.S.		**3.64(2.23,5.92)**	**<0.001**
Time to start participating in COVID-19 prevention and control work (23nd Jan, 2020~)	**0.80(0.68,0.94)**	**0.008**	**0.78(0.66,0.92)**	**0.004**	**0.82(0.72,0.93)**	**0.002**
Efforts and sacrifices during the outbreak						
Number of days worked all night						
0	1.00		1.00		1.00	
1-3 days	**1.42(1.16,1.72)**	**0.001**	**1.51(1.23,1.85)**	**<0.001**	**1.51(1.32,1.74)**	**<0.001**
>3 days	**1.67(1.37,2.05)**	**<0.001**	**1.75(1.42,2.16)**	**<0.001**	**1.67(1.43,1.96)**	**<0.001**
Worked during the whole period of Chinese New Year (yes)	N.S.		N.S.		**1.40(1.23,1.59)**	**<0.001**
To avoid infecting family members, chose not to live at home (yes)	N.S.		N.S.		**1.23(1.04,1.45)**	**0.014**
Perceptions						
Worried about being infected at work (Medium/very worried)	**1.49(1.25,1.78)**	**<0.001**	**1.89(1.56,2.28)**	**<0.001**	**1.46(1.30,1.65)**	**<0.001**
How long do you think you can persist with your current intensity of work (>=1 month)	**0.48(0.40,0.58)**	**<0.001**	**0.55(0.45,0.67)**	**<0.001**	**0.44(0.39,0.49)**	**<0.001**
Perceived support	N.S.		N.S.		**0.94(0.92,0.97)**	**<0.001**
Perceived troubles at work	**1.26(1.23,1.29)**	**<0.001**	**1.28(1.25,1.31)**	**<0.001**	**1.10(1.08,1.12)**	**<0.001**

variables which were significant in univariate analyses in Table 2 were used as candidates of forward stepwise models, after adjusting for sociodemographic variables (sex, age, having child <6 and job title)

riables which were non-significant for all outcome variables were not included in the Table 3, including trainings on COVID-19 and send children to parents' home to avoid infecting family members.

Variables with p<.05 were in bold.

Discussion

This is one of the few studies that timely documented working status and health-related conditions of public health workers during a new and emerging infectious disease epidemic. We found that the public health workers made a huge effort and personal or family sacrifice during the COVID-19 control and prevention response, with 27.1% and 20.6% having depression and anxiety. Public health workers' working conditions were associated with their health status.

Our survey found that China efficiently and effectively mobilized its public health workforce in preparation for the epidemic and the public health workers responded rapidly to the epidemic. Approximately 1 out of 5 CDC workers had already been called into the epidemic control program before January 20, 2020, even though by then most of the municipalities surveyed except for those in Hubei Province had not yet reported cases. In the following week, during the Chinese New Year, the participation rate increased substantially to 90%. Because the preventive work at the community level is coordinated by the CDCs, PHI workers' participation began slightly later than that of the CDC workers. Meanwhile, public health workers made huge efforts to curb the epidemic: about half of them worked throughout the whole period of Chinese New Year, the most important holiday in China, and one in five had worked all night for more than 3 days by the time of this survey. Again, CDC workers had a higher rate of working during the whole holiday period and had more work-nights.

The prompt response and great efforts made by public health workers likely helped hasten the decline of the epidemic, together with other important strategies implemented by the Chinese government. Modeling studies showed that highly effective contact tracing and case isolation can control a new outbreak of COVID-19 within 3 months,[32] suggesting the importance of the traditional epidemiological measures such as identification and isolation of infected cases, contact tracing, and health education on protective behaviors. Our survey confirmed that the Chinese public health workers were actively engaged in those traditional epidemiological roles that most likely contributed significantly to the quick control of the outbreak in China. As a part of the mobilization of the whole society to fight the epidemic, these results also reflect the status of many other governmental departments (such as transportation, communities, etc.) during the epidemic.

However, our survey also indicated a lack of appreciation of the communities toward the work performed by the public health workers.[33] Our data showed that support from family and colleagues is high, whereas the support from society is relatively low. Compared with physicians and nurses, the work by the public health workers is not widely understood and respected by the public.[33] During the epidemic, prevention and control work that they were engaged in, such as the isolation of close contacts (at home or designated hotels) and home inspections, was very likely to cause negative emotions and even objection in the community. Such negative emotions and conflicts not only hindered preventive work but also had negative impacts on the mental health of the public health workers. Our analysis found that the perceived troubles and difficulties (e.g., have been treated unfairly and concerns about routine works) at work were independent risk factors of mental health problems and poor self-assessed health after controlling for potential confounders. Therefore, to increase the understanding of the importance of public health work in the normal state and at the beginning of the epidemic is extremely important for both epidemic control and the health of public health staff.

The mental health status of public health workers during COVID-19 needs attention. Due to the lack of previous surveys on public health workers, we can only compare our results with those of medical workers, as a proxy for the public health workers. Self-reported depression (21.3%) and anxiety (19.0%) among participants in our study were substantially higher than those of hospital medical staff in daily work in China (18.3% and 14.7%), using the same measurements and cut-off points.[34] Furthermore, in our study, a larger proportion of CDC workers reported mental health problems and poor physical health than PHI workers, as they might bear more responsibilities in regional disease prevention,[26] and had longer working hours. In studies targeting medical workers during SARS epidemic, 38.5% of hospital workers dealing with SARS patients developed symptomatic depression,[12] while in MERS-Cov epidemic, two thirds of medical workers reported psychological problems.[24] Although findings of these studies are incomparable as different measurements were used, front line medical doctors and nurses treating patients may have higher prevalence of mental health problems than the public health workers. In addition to the immediate personal welfare concerns of these health works, mental health problems can in turn affect their work.[35] so mental health care is greatly warranted for these frontline health workers.

Longer working time and worrying about being infected were associated with mental health and self-rated health status, which were similar to the findings of other studies.[19, 20] Those involved in non-field work were more likely than others to have probable depression and poor self-reported health. It is possible that time-consuming paperwork, data analysis, and laboratory work, especially under emergency conditions, add to people's physical and mental health burden.[36] Our data also found that participants involved in non-field work had longer working hours. The health status of public health workers working at offices or laboratories in outbreak control should not be neglected.

Our survey suggests that to reduce stress and improve their commitment to work, child care support, which had been reported to be one of the top support needs among health care employees working in a disastrous event, is highly warranted in the future.[37] Approximate one third of the surveyed public health workers were parents of young children (28%). For health care workers, child care obligations can make it harder to commit to frontline work in the event of a catastrophic event.[38] A survey on health care workers who participated in the SARS epidemic response showed that living with children was significantly associated with an increased level of concern for personal or family health.[39] The high volume of work and concern about personal and family health can lead to burnout.[40] Other countries in preparation for the epidemic control must consider those support measures to ensure an effective public health workforce.

The epidemic outbreak is likely to lead to constrain the health workforce. In our study, we found 63% PHI workers involved in COVID-19 prevention were non-public health workers in their routine work. They were recruited into public health work from different fields (i.e., 27.6% clinicians, 26.6% nurses, and 5.1% pharmacists). Through some rapid training, they appeared to effectively take on the new role in community-based prevention during the outbreak. Furthermore, we found the training rate reached 98% and most training was conducted through web-based online modules. Meanwhile, in epidemiological surveys, the smartphone-based online survey was widely used in the field, suggesting that mobile technologies could improve the efficiency in outbreak prevention. China's experiences suggest that task-shifting in public health work is possible in an epidemic crisis, particularly when timely training and the use of technology are concurrently provided. There were several limitations to this study. First, selection bias may exist as this study used a non-random sample. Although our stratified sampling covered provinces with different levels of the epidemic from different regions of China, findings of this study might not be generalizable to all public health workers in China. Second, reporting bias may exist due to the nature of self-reported data. As the current study used an online questionnaire, people who are less skilled or have no access to the internet and smartphones may be underrepresented. Also people experiencing work strain may be less likely to engage with their Wechat group, and thus the people most at risk might not be recruited in this study. Third, the measurements of perceived support and perceived troubles at work were self-constructed and have not been validated, although the Cronbach's alpha for these self-constructed measurements was high for this study. Fourth, participants' areas of routine work were only investigated in Guangdong province. Though answers in other provinces may be similar under the national prevention strategy, this finding might not be generalizable to other provinces. Fifth, we cannot derive any conclusive causal relationship from a cross-sectional design.

Conclusions

In IIST OF summary, this study is among the first to document the working situation and health status in a relatively representative large sample of public health workers during the COVID-19 epidemic. With the rapid spread of the COVID-19 epidemic globally, all countries with different public health systems will face serious challenges. It is important to provide the necessary support to public health workers to ensure their health and working conditions, which is also the key to control the epidemic.

List Of Abbreviations

PHIs: primary health care institutes; COVID-19: coronavirus disease 2019; WHO: World Health Organization; CDC: Centers for Disease Control and Prevention; GAD: General Anxiety Disorder scale; ORu: Unadjusted odds ratios; AOR:adjusted odds ratios; Cis: confidence intervals (CIs).

Declarations

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Authors' contributions

JG, JL and DX conceived the research questions, designed the quesionnaire, assembled the team of collaborators, and conducted quality control. JX, HZ, HY, XW, YL (Yan Li), SL, YL (Yuan Liang) and LM coordinated the field work and collected data. JG, JX, JZ, HC, JX and CP conducted the statistical analysis. JL, JG, DX, JTL, SG and CH drafted the manuscript. JTL, DX, YH revised the manuscript and gave scientific comments. JL, JG, and DX finalized the manuscript. All authors assisted in questionnaire design, data collection, data interpretation, and gave comments to intellectual content of the manuscript.

Competing interests

The authors declares that they have no competing interests.

Ethics approval and consent to participate

The study was approved by the ethics committee of the School of Public Health, Sun Yat-sen University (Reference no.: 2020-012). All participants were informed of the background, aims, anonymous nature and length of the survey. Participants were well informed that completing the questionnaire signified their informed consent.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

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