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Factors Influencing the Willingness of Primary Care Physicians to Provide Care during the Coronavirus Disease Pandemic: A Nationwide Survey in Taiwan

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Abstract

Objectives:

The coronavirus disease (COVID-19) pandemic continues to advance worldwide with tremendous impact on public health, economy, and society. Primary healthcare is crucial in every country during the pandemic for an integrated and coordinated healthcare delivery system; hence, it is of paramount importance to maintain a sufficient frontline workforce. This study aimed to identify factors influencing the willingness of primary care physicians to provide care during the COVID-19 pandemic.

Design:

Cross sectional study

Setting:

Nationwide survey

Participants:

Primary care physicians working in the community in Taiwan were selected using a cluster sampling method based on practice region from May to June 2020.

Outcome measures:

The willingness of primary care physicians to provide care during the COVID-19 pandemic.

Results:

This study surveyed 1,000 primary care physicians nationwide, and 625 valid questionnaires were received and included in the final analysis, with an effective response rate of 62.5%. “Joining the Family Practice Integrated Care Project (FPICP)” (odds ratio [OR] = 2.05, 95% confidence interval [CI]: 1.40 – 2.98), “perceived more overall barriers to providing care” (0.47, 0.28 – 0.82), “higher knowledge scores about COVID-19” (1.09, 1.00 – 1.19), “physician’s major specialties as family physician or general practitioners” (p = 0.005), and “practice region in the suburban and rural areas” (p = 0.013 and 0.041) were the significant associated factors of willingness to provide care to COVID-19 patients, in the multiple logistic regression model.

Conclusions:

Building a comprehensive primary care system such as Taiwan’s FPICP and the Community Health Care Group, training of more healthcare professionals (family physicians or general practitioners), enhancing the connectedness with responsibilities toward the rural communities especially, and implementing psychological intervention and educational courses for primary care physicians by medical associations or governments worldwide, could effectively strengthen the healthcare system in combating the unprecedented COVID-19 pandemic.

Strengths and limitations of this study

- The study participants included primary care physicians in Taiwan, including different specialties and practice regions, selected using a nationwide cluster sampling method.
- The survey period was during the COVID-19 pandemic; the finding could be applied to the current COVID-19 pandemic situation as the unprecedented COVID-19 threats persisted.
- Taiwan implemented proactive strategies early in the pandemic to manage the crisis, and the effective response of the healthcare system may be informative to the world.
- The results may not be generalizable to other countries with different healthcare system.

Funding:

This study was supported by the Taiwan Medical Association.

Competing interests:

None declared.

INTRODUCTION

The coronavirus disease (COVID-19) pandemic continues to advance worldwide with tremendous impact on public health, economy, and society. Moreover, the pandemic continues to progress with flare-ups in several countries, and the risk of the second wave has become real.(1, 2) More than 80 million COVID-19 cases caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were confirmed with more than 1.8 million deaths reported globally as of January 1, 2021 by the World Health Organization.(3) While measures of infection control are gradually being relaxed, longitudinal and prolonged preparedness is necessary for the catastrophic possibility of resurgence in the coming years.(1, 4, 5)

The primary healthcare system response to the COVID-19 outbreak as the first level of contact is crucial, and is assigned a key role on the frontline in every country facing undifferentiated cases. Different functions, designated for general practice, such as screening, education, and home quarantine monitoring worldwide, are essential. Through integrated and coordinated healthcare delivery systems, primary care physicians could triage patients to specialized hospitals for proper care, to reduce overcrowding in the hospitals. Furthermore, at the primary healthcare system level, previous healthcare needs, such as chronic disease management, health promotion, or initial acute non-infectious disease consultation, need to be maintained even when the

system is besieged with consultation and testing needs for COVID-19 through walk-in clinics or telemedicine, worldwide.(6-8) Along with the specialists in the hospitals, the primary care physicians in the community are also dedicated to professional commitment, ensuring that patients receive proper care in the hospitals.(9, 10) Taiwan implemented proactive strategies early in the pandemic to manage the crisis, and the effective response of the healthcare system may be informative to the world.(11, 12) The Family Practice Integrated Care Project (FPICP) and Community Health Care Group (CHCG) were established in Taiwan after the previous severe acute respiratory syndrome (SARS) epidemic. These emphasize continuous, coordinated, and comprehensive care for patients, and could be a suitable primary healthcare infrastructure to combat the COVID-19 pandemic.(13, 14) It is of paramount importance to maintain adequate medical care capacity during the pandemic, and research regarding the influence of innovative primary healthcare models, such as FPICP and CHCG, on the control of the pandemic is essential.

As the unprecedented pandemic threat persists over a broad range of medical care, it is essential to understand and optimize the primary healthcare workforce.(15-17) It is of paramount importance to maintain sufficient frontline primary care physicians during the COVID-19 pandemic. Governments, worldwide, need to formulate better plans to recruit healthcare professionals during this public health crisis, since it is a high

priority to maintain a sufficient primary care workforce to ensure adequate healthcare coverage. However, previous reports revealed a high susceptibility to infection among healthcare workers because, more than 3,000 healthcare workers have been infected in China and 20% of responding healthcare workers were infected early in the COVID-19 pandemic in Italy.(18, 19) Moreover, a systemic review by Kisely et al. revealed that healthcare workers who had direct contact with patients had higher levels of both acute and posttraumatic stress (odds ratio [OR] 1.71, 95% confidence interval [CI] 1.28 to 2.29) and psychological distress (1.74, 1.50 to 2.03).(20) In addition, workforce problems might be exacerbated by the refusal to work due to the psychological factors and concern over their families.(21, 22) Up to 24% physicians and 26% nurses agreed to abandon their workplaces during a pandemic in a Germany survey during the H5N1 influenza outbreak, and absenteeism was as high as 85% during an influenza pandemic reported in a survey conducted in the UK.(23, 24) One study conducted in psychiatric hospitals at the peak of the COVID-19 pandemic revealed that about 23% of medical staff were unwilling to care for psychiatric patients with COVID-19.(25) Therefore, attitudes of healthcare workers toward COVID-19 occurrence such as perceived threats, benefits, or barriers, might influence the provision of care to COVID-19 patients.

In confronting COVID-19, there is an urgent need to analyze individual, environmental, and social factors that influence the willingness to provide healthcare

during the pandemic. This nationwide survey aimed to identify the factors influencing the willingness of primary care physicians to provide care in their communities during the COVID-19 pandemic. The findings of this study might enable the development of guidelines to successfully maintain the healthcare workforce and healthcare quality in the healthcare systems, globally, to combat the latest COVID-19 and other emerging infectious disease pandemic.

METHODS

Design

This cross-sectional survey was conducted from May to June 2020 during the COVID-19 pandemic. A structured questionnaire was mailed to the targeted primary care physicians selected using a nationwide cluster sampling method based on practice region in Taiwan. One month after the questionnaire was mailed, non-respondents were contacted again, and the questionnaire survey was resent. The return of the questionnaire represented consent to participate in the survey. The Medical Policy Committee of Taiwan Medical Association approved the study protocol.

Participants

The targeted participants were primary care physicians working in the community. Eligible respondents were recruited nationwide from the Taiwan Medical Association. The sample population comprised 1,000 physicians in total.

Measurements

The structured self-reported questionnaire consists of six parts including questions on demographic characteristics; knowledge of COVID-19; attitude towards providing care to COVID-19 patients including threats and stress related to the provision of care of COVID-19 patients; as well as the benefits and barriers to caring for COVID-19 patients; and the willingness to provide care during the COVID-19 pandemic.

Demographic characteristics assessed by the questionnaire included age, gender, religion, specialty, and information on current working conditions. The three other questionnaire parts are described as follows:

1. Knowledge of COVID-19: This measure is about the practical knowledge of COVID-19, and was based on three main parts after exploratory factor analysis: diagnosis, personal protective equipment, and management. This scale utilized the "true" (1) and "false/unknown" (0) scoring system. The internal consistency of this knowledge measure was assessed using the Cronbach' s alpha, which showed a coefficient of 0.5 - 0.6.
2. Attitude toward providing care for COVID-19 patients: This measure included the perception of threats, benefits, and barriers to providing care for COVID-19 patients. This 21-item measure is assessed using a five-point Likert scale, scored from "strongly disagree" (1) to "strongly agree" (5) and "Not important" (1) to "very important" (5). Bartlett's test of sphericity and the Kaiser– Meyer–Olkin (KMO) test were used to determine whether the attitude data were suitable for exploratory factor analysis. Therefore, the items were analyzed using principal component factor analysis followed by orthogonal varimax rotation. The content was constructed using threats (seven items), benefits (seven items), and barriers to providing care for COVID-19 patients (seven items). Internal consistency was

demonstrated with a Cronbach's alpha coefficient ranging from 0.89–0.96 in the attitude subscale. Two global rating items: "overall perceived benefits for providing care for COVID-19 patients" and "overall perceived barriers for providing care for COVID-19 patients" used a five-point Likert scale, scored from "strongly disagree" (1) to "strongly agree" (5).

3. Willingness. This measure was used to determine the primary care physician's willingness (yes or no) to provide care for COVID-19 patients in the community.

Statistical analysis

Data management and statistical analyses were performed using SPSS Statistics for Windows, version 10.0 (SPSS Inc., Chicago, Ill., USA). Demographic data and distribution of each variable were described using frequency distribution. Mean values and standard deviations (SDs) were used to analyze the degree, importance, and necessity of each "knowledge about COVID-19" and "attitude toward providing care to COVID-19 patients" variable. Physicians who scored above and below the mean ± SD scores in the global ratings ("overall perceived benefits for providing care for COVID-19 patients" and "overall perceived barriers for providing care for COVID-19 patients") were designated as the high- and low-scoring groups, respectively. A univariate comparison including the Student's t-test and chi-square test were carried out to determine differences in the variables related to willingness or unwillingness to

provide care. Statistical significance was set at $p < 0.05$. Stepwise logistic regression analysis was carried out to determine the relative values of the variables in the model where the willingness to provide care was the dependent variable.

Patient and public involvement

As the research aimed on professional perspectives, we only included physicians in the study. However, the need for the present study was clear for the significant influences on the public health.

RESULTS

Demographic characteristics

A total of 625 valid questionnaires were returned and included in the final analysis after removing incomplete questionnaires by the surveyed physicians, with an effective response rate of 62.5%.

As shown in Table 1, the 625 respondents had a mean age of 56.6 ± 10.6 (mean ± SD) years, and most respondents were male (85.4%). The respondents' registered practice was mainly concentrated in large (49.9%) and small (31.4%) cities. Respondents' average years of working experience was 28.4 ± 10.2 years. More than half of respondents participated in the CHCG (56.8%), with an average duration of 3.5 ± 4.6 years. Some of the respondents reported having encountered patients with fever (75.8%) and those with suspected COVID-19 (25.1%) in practice. Since the COVID-19 outbreak in January 2020, nearly a quarter of the respondents had ever assisted patients with suspected COVID-19 with referral (21.6%) or had ever sought help on the epidemic prevention hotline and health bureau for advice (22.7%).

Table 1. Background characteristics of the primary care physicians (n=625)

Items	Number	%
Gender		
Male	534	85.4
Female	83	13.3
Missing	8	1.3
Age (years)		
Average 56.6±10.6		

Items	Number	%
Education		
University	534	85.4
Master	59	9.4
PhD	22	3.5
Others	10	1.6
Religion		
Not specified	210	33.1
Folk beliefs	152	24.3
Buddhism	132	21.1
Taoism	24	3.8
Christianity	74	11.8
Catholics	19	3.0
Islam	0	0
Kuan Tao	5	0.8
Others	12	1.9
The importance of religion		
Very important	86	13.8
Important	155	24.8
Fair	277	44.3
Not that important	95	15.1
Not important at all	12	1.9
Practice region		
Urban	312	49.9
Suburban	196	31.4
Rural area	115	18.4
Others	2	0.3
Specialty		
General practitioner and family medicine	231	37.0
Internal medicine	71	11.4
Obstetrics and gynecology	26	4.2
Pediatrics	79	12.6
Otorhinolaryngologist	98	15.7
Surgery (surgery, ophthalmology, dermatology, Medical cosmetology, orthopedics)	86	13.8
Others (rehabilitation, neurology, psychiatry)	34	5.4
Years of service		
Average 28.36±10.169		
Participating in the Community Health Care Group		

Items	Number	%
project		
Yes	355	56.8
No	268	42.9
Manage the following condition since January:		
Fever patient	474	75.8
Suspected COVID-19 patient	157	25.1
Refer suspected COVID-19 patient to designated hospitals for further testing	135	21.6
Consult the central or local health bureau while having difficulty with referral	142	22.7
None of the above	123	19.7

Abbreviation: COVID-19, coronavirus disease

The 625 primary care physicians enrolled were divided into two groups: the "willing to provide care" (n = 428, 68.5%) and "unwilling to provide care" (n = 197, 31.5%) groups. Categorical variables in Table 2 and continuous variables in Table 3 indicate possible factors related to the respondents' willingness to provide COVID-19 care in the univariate comparison analysis. By chi square test, significant differences in factors between the two groups included "the practice regions" ($p = 0.018$), "major specialties" ($p < 0.001$), "participating in the CHCG" ($p < 0.001$), "experience in managing fever patients" ($p < 0.001$), "experience in managing suspected COVID-19 patients" ($p = 0.013$), "experience in referral of patients to designated hospitals or local health bureau" ($p = 0.002$), or "experience in consulting the health bureau" ($p = 0.001$) (Table 2). Table 3 demonstrates significant differences by t – test of factors including "the duration of participating in the CHCG" ($p < 0.001$), "knowledge score about COVID-19" (p =

0.004), "perceived benefits for providing care to COVID-19 patients" (p = 0.004), "overall perceived benefits for providing care" (p = 0.002), and "overall perceived barriers to providing care" (p = 0.002).

Table 2. Univariate analysis (χ^2) for comparing the characteristics between those willing (n = 428) and those unwilling (n = 197) to provide care

Variables	Willing	Not willing	χ^2	P value
	n (%)	n= (%)		
Gender			0.636	0.425
Male	360(67.5)	173(32.5)		
Female	59(72.0)	23(28.0)		
Education			0.822	0.844
University	362(68.0)	170(32.0)		
Master	43(72.9)	16(27.1)		
PhD	14(63.6)	8(36.4)		
Others	7(70.0)	3(30.0)		
Religion			8.433	0.296
Not specified	134(65.0)	72(35.0)		
Folk beliefs	106(69.7)	46(30.3)		
Buddhism	86(65.6)	45(34.4)		
Taoism	16(66.7)	8(33.3)		
Christianity	59(79.7)	15(20.3)		
Catholics	14(73.7)	5(26.3)		
Islam	0(0.0)	0(0.0)		
Kuan Tao	2(40.0)	3(60.0)		
Others	9(75.0)	3(25.0)		
Practice region	n=426	n=197	11.923	0.018*
Urban	194(62.6)	116(37.4)		
Suburban	145(74.0)	51(26.0)		
Rural area	75(74.8)	28(25.2)		
Others	1(50.0)	1(50.0)		
Specialty			35.563	<0.001***
General practitioner and family medicine	164(71.0)	67(29.0)		
Internal medicine	46(65.7)	24(34.3)		
Obstetrics and	15(57.7)	11(42.3)		

Variables	Willing n (%)	Not willing n= (%)	χ^2	P value
Gynecology				
Pediatrics	61(78.2)	17(21.8)		
Otorhinolaryngologist	80(81.6)	18(18.4)		
Surgery (including general surgery, ophthalmology, dermatology, orthopedics)	47(54.7)	39(45.3)		
Others (including rehabilitation, neurology, psychiatry)	13(38.2)	21(61.8)		
Participating in the Community Health Care Group project?			22.838	<0.001***
Yes	269(76.2)	84(23.8)		
No	156(58.2)	112(41.8)		
Experience in managing patients with fever, suspected COVID-19 patients, referring patients for further testing, consulting the central or local health bureau, since January 2020			17.385	<0.001***
Yes	361(72.3)	138(27.7)		
No	65(52.8)	58(47.2)		
Have you ever met other conditions since January			0.944	0.331
Yes	12(80.0)	3(20.0)		
No	414(68.2)	193(31.8)		
Overall perceived benefits for providing care for COVID-19 patients			9.017	0.003**
Low	166(61.9)	102(38.1)		
High	260(73.2)	95(26.8)		
Overall perceived barriers to providing care for COVID-19 patients			11.202	0.001**

Variables	Willing	Not willing	χ^2	P value
	n (%)	n= (%)		
Low	370(71.2)	150(28.8)		
High	56(54.4)	47(45.6)		

Abbreviation: COVID-19, coronavirus disease

Table 3. Univariate analysis (t test) for comparing the characteristics between those willing (n = 428) and those unwilling (n = 197) to provide care

Variables	Willing	Not willing	t	P value
	Mean (SD)	Mean (SD)		
Age (years)	56.8(9.3)	56.2(9.3)	-0.6	0.519
Years of service	28.3(10.0)	28.5(10.3)	0.2	0.853
Years of participating in the Community Health Care Group project	4.0(4.6)	2.6(4.1)	-3.6	<0.001***
Knowledge about COVID-19	14.9(2.1)	14.4(2.2)	-2.9	0.004**
Overall perceived benefits for providing care for COVID-19 patients	6.2(1.9)	5.6(2.1)	-3.0	0.002**
Overall perceived barriers to providing care for COVID-19 patients	3.8(1.9)	4.4(2.1)	3.1	0.002**

Abbreviations: SD Standard deviation; COVID-19, coronavirus disease
**P <0.01, ***P <0.001

The results of further stepwise logistic regression analysis to determine the relative values of variables associated with willingness are shown in Table 4. Factors, including "participating in the CHCG" (OR = 2.05, 95% CI: 1.40 – 2.98), "knowledge about COVID-19" (1.09, 1.00 – 1.19), "perceived overall barriers to providing care to COVID-19 patients" (0.47, 0.28 – 0.82), "major specialties including general

practitioners and family medicine practitioners" (p = 0.005), and "practice region in the suburban and rural areas" (p = 0.013 and 0.041) were independent predictors of the "willingness to provide care." For the fitness of the model, the p value of the Hosmer–Lemeshow goodness-of-fit test was 0.411.

Table 4. Logistic regression analysis results showing factors correlated with the willingness to provide care for COVID-19 patients.

Variables	B	S.E.	OR	95% CI	P value
Participating in the Community Health Care Group project					
Yes	0.715	0.192	2.045	1.404-2.979	<0.001***
No			1.000(ref)		
Knowledge about COVID-19	0.087	0.043	1.091	1.003-1.188	0.043*
Practice region					0.044*
Urban			1.000(ref)		
Suburban	0.530	0.214	1.700	1.116-2.588	0.013*
Rural area	0.550	0.269	1.733	1.024-2.934	0.041*
Others	0.197	1.531	1.218	0.061-24.501	0.898
Overall perceived benefits for providing care for COVID-19 patients					
Low			1.000(ref)		
High	0.295	0.217	1.342	0.877-2.055	0.175
Overall perceived barriers to providing care for COVID-19 patients					
Low			1.000(ref)		
High	-0.746	0.278	0.474	0.275-0.817	0.007**
Specialty					0.005**
General practitioner and family medicine			1.000(ref)		
Internal medicine	-0.195	0.305	0.823	0.453-1.496	0.523

OBGYN	-0.504	0.442	0.604	0.254-1.436	0.254
Pediatrics	0.425	0.327	1.530	0.805-2.905	0.194
ENT	0.562	0.312	1.755	0.952-3.236	0.072
Surgery (surgery, ophthalmology, dermatology, medical cosmetology, orthopedics)	-0.309	0.288	0.734	0.418-1.289	0.272
Others (rehabilitation, neurology, psychiatry)	-1.104	0.402	0.331	0.151-0.729	0.006**
Hosmer and Lemeshow test					0.411

Abbreviations: COVID-19, coronavirus disease; B, coefficients; SE, standard error; OR, odds ratio; CI, confidence interval; OBBGYN, obstetrics and gynecology; ENT, ear nose and throat; *P <0.05, **P <0.01, ***P <0.001

DISCUSSION

Effective primary healthcare is important in the battle against COVID-19, and the willingness of primary care physicians to provide care during the pandemic is vital. This study identified influencing factors of willingness to provide care during COVID-19 pandemic including "participating in the FPICP," "physician's major specialty was family physician or general practitioner," "perceived less overall barriers to providing care," "higher knowledge score on COVID-19," and "practice region in the suburban and rural areas." Efforts directed at these factors are fundamental for an improved community care system in combating the COVID-19 pandemic worldwide. Furthermore, it is of high priority to strengthen the capacity of local primary care physicians, in view of the upcoming resurgence of COVID-19 cases.

Participating in the FPICP was significantly associated with the willingness of primary care physicians to provide care during the COVID-19 pandemic. The innovative FPICP comprehensive primary healthcare system model was developed in Taiwan after the previous SARS outbreak and the disastrous 921 earthquake; because these created an awareness of the need to reinforce primary care under the tremendous public health threats.(13) The FPICP emphasizes the need for coordinated care between clinics and hospitals, and also provides continuous person-centered care for the patients. The FPICP establishes community care networks nationwide, with the basic unit of 5 to 10 clinics forming a CHCG team. Primary care physicians in the CHCG need to

collaborate with each other and with those in the backup hospitals. Under these circumstances, the physicians can provide services as a team and unite to perform group work. Taiwanese citizens who are enrolled as CHCG members for care showed a high level of satisfaction with their health consultation and received more preventive care services including influenza vaccination, which would be important in the prevention of COVID-19.(13) Furthermore, the physicians are required to take regular education courses together, and the mandatory courses for the physicians in the FPICP include topics on infection control. This would provide the physicians with confidence and ability to care for patients with COVID-19 during the pandemic. The design and successful implementation of FPICP and CHCG might be the reasons why the physicians participating in the FPICP are more willing to provide care during the COVID-19 pandemic. In addition, the finding that small city and rural area physicians were more willing to provide care than those of metropolitan areas might indicate better acceptance of responsibility and connection of small city and rural area physicians with their communities. The promotion of this type of primary healthcare model reinforces infection control in the communities and could be helpful in the prevention of the persistent COVID-19 pandemic.

Family physicians and general practitioners showed a higher willingness to provide care during the pandemic. This result might be due to the familiarity of these

practitioners with undetermined number of conditions compared to those of specialists who may be in fear or withdraw when faced with an uncertain acute illness. The clinical experiences of family physicians and general practitioners, which include diagnosing and management of flu-like fever symptoms, are important in the monitoring of viral illnesses in the community. Previous studies also revealed the willingness of general practitioners to provide care during the influenza pandemic when provided with adequate supply of personal protective equipment, and appropriate education and training.(26, 27) For a sustainable model, the added on task of patients with COVID-19 without overcrowding the original medical care facilities, would require the recruitment of family physicians and general practitioners who are willing to provide care in all healthcare systems worldwide. Moreover, in future, medical education and training need to put more emphasis on the adequate supply of the health workforce in these specialties including those with more experience of managing acute infectious illnesses.

The finding that physicians who perceived more threat, more stress, and who had lower knowledge scores on COVID-19 were less willing to provide care during the pandemic has important implications for policy makers. Infectious diseases pose threats to frontline healthcare professionals combating these diseases. A review that examined the psychological impact on healthcare professionals facing novel viral outbreaks

revealed that staff in contact with affected patients had greater levels of both acute and post-traumatic stress in comparison with controls. Risk factors for psychological distress include being younger, being more junior, being the parents of dependent children, or having an infected family member. Longer quarantine, lack of practical support, and stigma also contributed to the distress in this review.(20) To understand the impact of the COVID-19 pandemic on the mental health status of healthcare professionals, a Spanish study concluded that anxiety and depression are the most common symptoms among healthcare professionals. Insomnia, extreme fatigue, emotional exhaustion, and physical symptoms are also often reported.(28) Another study in China revealed that among healthcare professionals, those in the Wuhan area scored significantly higher than those outside Wuhan on several items in the Psychological Stress Questionnaire, including the thought of being in danger, worrying about self-illness and family infection, lack of psychological guidance, and poor sleep quality.(29) As this study results suggest, it is important for governments, worldwide, to provide psychological interventions to mitigate the threats and stress experienced by primary care physicians. Moreover, training sessions for primary healthcare staff to increase their level of knowledge about COVID-19 are necessary, to enhance their willingness to provide care to COVID-19 patients.

There are several limitations to this study. First, the response rate was moderate

(62.5%). This response rate might have been affected by the heavy workload of the primary care physicians during the COVID-19 pandemic, as well as the large volume of questionnaires that they might have received. Nonetheless, the response of the participants, nationwide, still provides important information for the governments and the healthcare system. Second, the healthcare system infrastructure and the health insurance reimbursement in Taiwan are unique; thus, these could limit the application of the results to other countries. However, the experiences learned from this study are paramount for the reform of primary healthcare systems that are confronted both by COVID-19 and other infectious disease pandemics. Third, differences in the level of strategies by governments to control the surge of COVID-19 and vaccinations may also impact the generalizability of the results. In addition, even though this study is a nationwide survey, the willingness to provide care may be affected by differences in the cultural backgrounds and values of physicians toward physicians' professionalism. These findings may require modifications when applied to other countries.

Enhancing the willingness of primary care physicians to provide care during the COVID-19 pandemic is essential in optimizing sustainable healthcare. Building a comprehensive primary care system such as Taiwan's FPICP with CHCG, training of more healthcare professionals including family physicians or general practitioners, enhancing the connectedness with responsibilities toward the communities, especially

in rural areas, implementing psychological intervention, and providing educational courses for primary care physicians by the medical associations or the governments worldwide, would effectively strengthen the community care workforce. The experiences learned are informative globally, to build a strong coordinated healthcare system to combat the persistent and unprecedented COVID-19 pandemic.

Authors' contributions

HH conceptualized the topic of the paper, conducted the analysis, and wrote the manuscript. CJ and BC conceptualized the topic of the paper and participated in the data collection. TC was the principal investigator for the project, conceptualized the topic, participated in data collection, conducted the analysis, and wrote the manuscript. All authors read and approved the final manuscript.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3-4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	8-9
Methods			
Study design	4	Present key elements of study design early in the paper	10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	10 - 12
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10 - 12
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	10 - 12
Bias	9	Describe any efforts to address potential sources of bias	*12*
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	12
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	10
		(*e*) Describe any sensitivity analyses	12
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	10, 13
		(b) Give reasons for non-participation at each stage	13
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	13 – 14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13 – 14
		(*b*) Report category boundaries when continuous variables were categorized	13 – 14
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 – 14
Discussion			
Key results	18	Summarise key results with reference to study objectives	15
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	18 - 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15 – 19
Generalisability	21	Discuss the generalisability (external validity) of the study results	15 - 19
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	5

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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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Factors Influencing the Willingness of Primary Care Physicians to Provide Care during the Coronavirus Disease Pandemic: A Nationwide Survey in Taiwan

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Factors Influencing the Willingness of Primary Care Physicians to Provide Care during the Coronavirus Disease Pandemic: A Nationwide Survey in Taiwan

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Abstract

Objectives:

The coronavirus disease (COVID-19) pandemic continues to advance worldwide with tremendous impact on public health, economy, and society. Primary healthcare is crucial in every country during the pandemic for an integrated and coordinated healthcare delivery system; hence, it is of paramount importance to maintain a sufficient frontline workforce. This study aimed to identify factors influencing the willingness of primary care physicians to provide care during the COVID-19 pandemic.

Design:

Cross sectional study

Setting:

Nationwide survey

Participants:

Primary care physicians working in the community in Taiwan were selected using a cluster sampling method based on practice region from May to June 2020.

Outcome measures:

The willingness of primary care physicians to provide care during the COVID-19 pandemic.

Results:

This study surveyed 1,000 primary care physicians nationwide, and 625 valid questionnaires were received and included in the final analysis, with an effective response rate of 62.5%. Factors significantly associated with physicians willingness to provide care during COVID-19 were "joining the Community Health Care Group (CHCG)" ($p < 0.001$), "perceived more overall benefits for providing care" ($p < 0.001$) "perceived less overall barriers to providing care" ($p < 0.001$), "higher knowledge scores about COVID-19" ($p = 0.049$), and "physician's major specialties" ($p = 0.009$) in the multivariate logistic regression model.

Conclusions:

Building a comprehensive primary care system such as Taiwan's CHCG, training of more family physicians or general practitioners, and protecting and supporting primary care physicians were important in response to infectious disease pandemics. The findings of this study inform the development of guidelines to support and maintain the primary healthcare workforces during the COVID-19 pandemic and for future events.

Strengths and limitations of this study

- The study participants included primary care physicians in Taiwan, including different specialties and practice regions, selected using a nationwide cluster sampling method.
- The survey period was during the COVID-19 pandemic; the finding could be applied to the current COVID-19 pandemic situation as the unprecedented COVID-19 threats persisted.
- Taiwan implemented proactive strategies early in the pandemic to manage the crisis, and the effective response of the healthcare system may be informative to the world.
- The response rate was only moderate, and the results may not be generalizable to other countries with different healthcare system and government control strategies.

INTRODUCTION

The coronavirus disease (COVID-19) pandemic continues to advance worldwide with tremendous impact on public health, economy, and society. Moreover, the pandemic continues to progress with flare-ups in several countries.(1, 2) More than 143 million COVID-19 cases caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were confirmed with more than 3 million deaths reported globally at the time of writing on April 17, 2021 by the World Health Organization.(3) While measures of infection control are gradually being relaxed, longitudinal and prolonged preparedness is necessary for the catastrophic possibility of resurgence in the coming years.(1, 4, 5)

The primary healthcare system response to the COVID-19 outbreak as the first level of contact is crucial, and is assigned a key role on the frontline in every country facing undifferentiated cases. Different functions, designated for general practice, such as screening, education, and home quarantine monitoring worldwide, are essential. Through integrated and coordinated healthcare delivery systems, primary care physicians could triage patients to specialized hospitals for proper care, to reduce overcrowding in the hospitals. Furthermore, at the primary healthcare system level, previous healthcare needs, such as chronic disease management, health promotion, or initial acute non-infectious disease consultation, need to be maintained even when the

system is besieged with consultation and testing needs for COVID-19 through walk-in clinics or telemedicine, worldwide.(6-8) Along with hospital specialists, primary care physicians have a professional commitment to ensure the appropriate care of their patients while in hospital.(9, 10) Taiwan implemented proactive strategies early in the pandemic to manage the crisis, and the effective response of the healthcare system may be informative to the world.(11, 12) The Family Practice Integrated Care Project (FPICP) and Community Health Care Group (CHCG) were established in Taiwan after the previous severe acute respiratory syndrome (SARS) epidemic. The FPICP emphasizes the need for coordinated care between clinics and hospitals, and also provides continuous person-centered care for the patients. The FPICP establishes community care networks nationwide, with the basic unit of 5 to 10 clinics forming a CHCG team. Primary care physicians in the CHCG need to collaborate with each other and with those in the backup hospitals. These emphasize continuous, coordinated, and comprehensive care for patients, and could be a suitable primary healthcare infrastructure to combat the COVID-19 pandemic.(13, 14) It is of paramount importance to maintain adequate medical care capacity during the pandemic, and research regarding the influence of innovative primary healthcare models, such as FPICP and CHCG, on the control of the pandemic is essential.

As the unprecedented pandemic threat persists over a broad range of medical care, it

is of paramount importance to understand and optimize the primary healthcare workforce, and to maintain sufficient frontline physicians.(15-18) However, previous reports revealed a high susceptibility to infection among healthcare workers because, more than 3,000 healthcare workers have been infected in China and 20% of responding healthcare workers were infected early in the COVID-19 pandemic in Italy.(19, 20) Moreover, a systemic review by Kisely et al. revealed that healthcare workers who had direct contact with patients had higher levels of both acute and posttraumatic stress and psychological distress.(21) In addition, workforce problems might be exacerbated by the refusal to work due to the psychological factors and concern over their families.(22, 23) Up to 24% physicians and 26% nurses agreed to abandon their workplaces during a pandemic in a Germany survey during the H5N1 influenza outbreak, and absenteeism was as high as 85% during an influenza pandemic reported in a survey conducted in the UK.(24, 25) One study conducted in psychiatric hospitals at the peak of the COVID-19 pandemic revealed that about 23% of medical staff were unwilling to care for psychiatric patients with COVID-19.(26) Therefore, attitudes of healthcare workers toward COVID-19 occurrence such as perceived threats, benefits, or barriers, might influence the provision of care to COVID-19 patients.

In confronting COVID-19, there is an urgent need to analyze individual, environmental, and social factors that influence the willingness to provide healthcare

during the pandemic. This nationwide survey aimed to identify the factors influencing the willingness of primary care physicians to provide care in their communities during the COVID-19 pandemic. The findings of this study will inform the development of guidelines to support and maintain the primary healthcare workforces during the COVID-19 pandemic and for future events.

METHODS

Design

This cross-sectional survey was conducted from May to June 2020 during the COVID-19 pandemic. The Medical Policy Committee of Taiwan Medical Association approved the study protocol.

Participants

The targeted participants were primary care physicians working in the community. Eligible respondents were recruited nationwide from the Taiwan Medical Association. The sample population comprised 1,000 physicians in total.

Recruitment

A structured questionnaire was mailed to the targeted primary care physicians selected using a nationwide cluster sampling method. The clusters were identified according to the twenty-two counties and cities in Taiwan. The targeted primary care physicians were selected randomly by computer program. One month after the questionnaire was mailed, non-respondents were contacted again, and the questionnaire survey was resent. The return of the questionnaire represented consent to participate in the survey.

Measurements

The structured self-reported questionnaire consists of six parts including questions on demographic characteristics; knowledge of COVID-19; attitude towards providing

care during COVID-19 including threats, benefits and barriers related to the provision of care during COVID-19 patients as well as the global rating of benefits and barriers to care during COVID-19; and the willingness to provide care. The entire six part questionnaire was tested for face and content validity by a panel comprised of five primary care physicians and two infection specialists. The physicians filled out the questionnaire to confirm its face validity and ease of application. Each item in the questionnaire was appraised from "very inappropriate and not relevant" (1) to "very appropriate and relevant" (5). A "content validity index" (CVI) was used to determine the validity of the structured questionnaire. The questionnaire yielded a CVI of 0.94 on all items. (the knowledge and attitude questionnaire was provided as supplementary file)

Demographic characteristics assessed by the questionnaire included age, gender, religion, specialty, and information on current working conditions. The other questionnaire parts are described as follows:

1. Knowledge of COVID-19: This measure is about the practical knowledge of COVID-19 consisted of three main parts epidemiology (3 items), diagnosis (9 items), personal protective equipment and management (8 items). The 20-item measure was designed by with careful scrutiny of the literature available in the beginning of the epidemic. This scoring system of this scale is "true" (1) and "false/unknown" (0). The internal consistency of this knowledge measure was

assessed using the Cronbach' s alpha, which showed a coefficient of 0.5 - 0.6.

2. Attitude toward providing care for COVID-19 patients: This measure included the perception of threats, benefits, and barriers to providing care during COVID-19. This 21-item measure is assessed using a five-point Likert scale, scored from "strongly disagree" (1) to "strongly agree" (5) and "Not important" (1) to "very important" (5). Bartlett's test of sphericity and the Kaiser– Meyer–Olkin (KMO) test were used to determine whether the attitude data were suitable for exploratory factor analysis. Therefore, the items were analyzed using principal component factor analysis followed by orthogonal varimax rotation. The content was constructed using threats (seven items), benefits (seven items), and barriers to providing care for COVID-19 patients (seven items). Internal consistency was demonstrated with a Cronbach's alpha coefficient ranging from 0.89–0.96 in the attitude subscale. Two global rating items: "overall perceived benefits for providing care during COVID-19" and "overall perceived barriers for providing care during COVID-19" used a ten-point Likert scale.

3. Willingness. This measure was used to determine the primary care physician's willingness (yes or no) to provide care during the COVID-19 pandemic.

Statistical analysis

Data management and statistical analyses were performed using SPSS Statistics for

Windows, version 10.0 (SPSS Inc., Chicago, Ill., USA). Demographic data and distribution of each variable were described using frequency distribution. Mean values and standard deviations (SDs) were used to analyze the degree, importance, and necessity of "knowledge about COVID-19" and "attitude toward providing care during COVID-19" variable. The attitude variables in the model were global ratings of "overall perceived benefits for providing care during COVID-19" and "overall perceived barriers for providing care during COVID-19". A univariate comparison including the Student's t-test and chi-square test were carried out to determine differences in the variables related to willingness or unwillingness to provide care. Statistical significance was set at $p < 0.05$. Stepwise logistic regression analysis was carried out to determine the relative values of the variables in the model where the willingness to provide care was the dependent variable. To avoid collineation of the variables "overall perceived benefits for providing care during COVID-19" and "overall perceived barriers for providing care during COVID-19", the two variables were analyzed in two different models, respectively.

Patient and public involvement

As the research aimed on professional perspectives, primary care physicians were involved in the development and amendment of the questionnaire.

RESULTS

Demographic characteristics

A total of 625 valid questionnaires were returned and included in the final analysis after removing incomplete questionnaires by the surveyed physicians, with an effective response rate of 62.5%.

As shown in Table 1, the 625 respondents had a mean age of 56.6 ± 10.6 (mean ± SD) years, and most respondents were male (85.4%). The respondents' registered practice was mainly concentrated in large (49.9%) and small (31.4%) cities. Respondents' average years of working experience was 28.4 ± 10.2 years. More than half of respondents participated in the CHCG (56.8%), with an average duration of 3.5 ± 4.6 years. Some of the respondents reported having encountered patients with fever (75.8%) and those with suspected COVID-19 (25.1%) in practice. Since the COVID-19 outbreak in January 2020, nearly a quarter of the respondents had ever assisted patients with suspected COVID-19 with referral (21.6%) or had ever sought help on the epidemic prevention hotline and health bureau for advice (22.7%).

Table 1. Background characteristics of the primary care physicians (n=625)

Items	Number	%
Gender		
Male	534	85.4
Female	83	13.3
Missing	8	1.3
Age (years)		
Average 56.6±10.6		

Items	Number	%
Education		
University	534	85.4
Master	59	9.4
PhD	22	3.5
Others	10	1.6
Religion		
Not specified	207	33.1
Folk beliefs	152	24.3
Buddhism	132	21.1
Taoism	24	3.8
Christianity	74	11.8
Catholics	19	3.0
Islam	0	0
Kuan Tao	5	0.8
Others	12	1.9
The importance of religion		
Very important	86	13.8
Important	155	24.8
Fair	277	44.3
Not that important	95	15.1
Not important at all	12	1.9
Practice region		
Urban	312	49.9
Suburban	196	31.4
Rural area	115	18.4
Others	2	0.3
Specialty		
General practitioner and family medicine	231	37.0
Internal medicine	71	11.4
Obstetrics and gynecology	26	4.2
Pediatrics	79	12.6
Otorhinolaryngologist	98	15.7
Surgery (surgery, ophthalmology, dermatology, Medical cosmetology, orthopedics)	86	13.8
Others (rehabilitation, neurology, psychiatry)	34	5.4
Years of service		
Average 28.4±10.2		
Participating in the Community Health Care Group		

Items	Number	%
Yes	355	56.8
No	268	42.9
Manage the following condition since January:		
Fever patient	474	75.8
Suspected COVID-19 patient	157	25.1
Refer suspected COVID-19 patient to designated hospitals for further testing	135	21.6
Consult the central or local health bureau while having difficulty with referral	142	22.7
None of the above	123	19.7

Abbreviation: COVID-19, coronavirus disease

The 625 primary care physicians enrolled were divided into two groups: the "willing to provide care" (n = 428, 68.5%) and "unwilling to provide care" (n = 197, 31.5%) groups. Categorical variables in Table 2 and continuous variables in Table 3 indicate possible factors related to the respondents' willingness to provide care during the COVID-19 pandemic in the univariate comparison analysis. By chi square test, significant differences in factors between the two groups included "the practice regions" ($p = 0.018$), "major specialties" ($p < 0.001$), "participating in the CHCG" ($p < 0.001$), "experience in managing fever patients" ($p < 0.001$), "experience in managing suspected COVID-19 patients' ($p = 0.013$), "experience in referral of patients to designated hospitals or local health bureau" ($p = 0.002$), or "experience in consulting the health bureau" ($p = 0.001$) (Table 2). Table 3 demonstrates significant differences by t – test of factors including "years of participating in the CHCG" ($p < 0.001$), "knowledge about COVID-19" ($p = 0.004$), "overall perceived benefits for providing

care during COVID 19" (p = 0.002), and "overall perceived barriers for providing care during COVID 19" (p = 0.002).

Table 2. Univariate analysis (χ^2) for comparing the characteristics between those willing (n = 428) and those unwilling (n = 197) to provide care

Variables	Willing	Not willing	χ^2	P value
	n (%)	n= (%)		
Gender			0.636	0.425
Male	360(67.5)	173(32.5)		
Female	59(72.0)	23(28.0)		
Education			0.822	0.844
University	362(68.0)	170(32.0)		
Master	43(72.9)	16(27.1)		
PhD	14(63.6)	8(36.4)		
Others	7(70.0)	3(30.0)		
Religion			8.433	0.296
Not specified	134(65.0)	72(35.0)		
Folk beliefs	106(69.7)	46(30.3)		
Buddhism	86(65.6)	45(34.4)		
Taoism	16(66.7)	8(33.3)		
Christianity	59(79.7)	15(20.3)		
Catholics	14(73.7)	5(26.3)		
Islam	0(0.0)	0(0.0)		
Kuan Tao	2(40.0)	3(60.0)		
Others	9(75.0)	3(25.0)		
Practice region	n=426	n=197	11.923	0.018*
Urban	194(62.6)	116(37.4)		
Suburban	145(74.0)	51(26.0)		
Rural area	75(74.8)	28(25.2)		
Others	1(50.0)	1(50.0)		
Specialty			35.563	<0.001***
General practitioner and family medicine	164(71.0)	67(29.0)		
Internal medicine	46(65.7)	24(34.3)		
Obstetrics and Gynecology	15(57.7)	11(42.3)		
Pediatrics	61(78.2)	17(21.8)		

Variables	Willing n (%)	Not willing n= (%)	χ^2	P value
Otorhinolaryngologist	80(81.6)	18(18.4)		
Surgery (including general surgery, ophthalmology, dermatology, orthopedics)	47(54.7)	39(45.3)		
Others (including rehabilitation, neurology, psychiatry)	13(38.2)	21(61.8)		
Participating in the Community Health Care Group?			22.838	<0.001***
Yes	269(76.2)	84(23.8)		
No	156(58.2)	112(41.8)		
Experience in managing patients with fever, suspected COVID-19 patients, referring patients for further testing, consulting the central or local health bureau, since January 2020			17.385	<0.001***
Yes	361(72.3)	138(27.7)		
No	65(52.8)	58(47.2)		

Abbreviation: COVID-19, coronavirus disease

Table 3. Univariate analysis (t test) for comparing the characteristics between those willing (n = 428) and those unwilling (n = 197) to provide care

Variables	Willing Mean (SD)	Not willing Mean (SD)	t	P value
Age (years)	56.8(9.3)	56.2(9.3)	-0.6	0.519
Years of service	28.3(10.0)	28.5(10.3)	0.2	0.853
Years of participating in the Community Health Care Group	4.0(4.6)	2.6(4.1)	-3.6	<0.001***
Knowledge about COVID-19	14.9(2.1)	14.4(2.2)	-2.9	0.004**
Overall perceived	6.2(1.9)	5.6(2.1)	-3.0	0.002**

benefits for providing care during COVID-19				
Overall perceived barriers for providing care during COVID-19	3.8(1.9)	4.4(2.1)	3.1	0.002**

Abbreviations: SD Standard deviation; COVID-19, coronavirus disease
**P <0.01, ***P <0.001

The results of further stepwise logistic regression analysis to determine the relative values of variables associated with willingness are shown in Table 4. "Overall perceived benefits for providing care during COVID-19" and "overall perceived barriers for providing care during COVID-19" were analyzed and demonstrated in two different models to avoid collineation. Factors including "participating in the CHCG" ($p < 0.001$), "knowledge about COVID-19" ($p = 0.049$), "major specialties" ($p = 0.009$), "perceived overall benefits to providing care during COVID-19" ($p < 0.001$), "perceived overall barriers to providing care during COVID-19" ($p < 0.001$) were independent association factors of the "willingness to provide care." For the suitability of the model, the p value of the Hosmer–Lemeshow goodness-of-fit test were 0.847 and 0.960.

Table 4. Logistic regression analysis results showing factors correlated with the willingness to provide care during COVID-19.

Variables	B	S.E.	OR	95% CI	P value
Model 1					
Participating in the Community Health Care Group					
Yes	0.689	0.195	1.991	1.359-2.917	<0.001***
No			1.000(ref)		

Variables	B	S.E.	OR	95% CI	P value
Knowledge about COVID-19	0.094	0.048	1.098	1.000-1.206	0.049*
Specialty					0.009**
General practitioner and family medicine			1.000(ref)		
Internal medicine	-0.276	0.307	0.759	0.416-1.385	0.369
OBGYN	-0.511	0.441	0.600	0.253-1.425	0.247
Pediatrics	0.401	0.328	1.493	0.786-2.838	0.221
ENT	0.580	0.319	1.787	0.957-3.336	0.068
Surgery (surgery, ophthalmology, dermatology, medical cosmetology, orthopedics)	-0.333	0.293	0.717	0.404-1.271	0.254
Others (rehabilitation, neurology, psychiatry)	-0.993	0.405	0.370	0.168-0.819	0.014*
Practice region					0.104
Urban			1.000(ref)		
Suburban	0.460	0.216	1.584	1.037-2.420	0.033*
Rural area	0.493	0.272	1.637	0.960-2.792	0.070
Others	0.021	1.506	1.021	0.053-19.543	0.989
Overall perceived benefits for providing care during COVID-19	0.173	0.047	1.189	1.083-1.304	<0.001***
Hosmer and Lemeshow test					0.847
Model 2					
Participating in the Community Health Care Group					
Yes	0.696	0.195	2.005	1.368-2.937	<0.001***
No			1.000(ref)		
Knowledge about COVID-19	0.094	0.048	1.099	1.001-1.207	0.049*
Specialty					0.009**
General practitioner and family medicine			1.000(ref)		
Internal medicine	-0.275	0.307	0.760	0.416-1.386	0.370
OBGYN	-0.507	0.442	0.602	0.253-1.431	0.251

Variables	B	S.E.	OR	95% CI	P value
Pediatrics	0.404	0.328	1.498	0.788-2.847	0.218
ENT	0.577	0.318	1.781	0.954-3.324	0.070
Surgery (surgery, ophthalmology, dermatology, medical cosmetology, orthopedics)	-0.329	0.293	0.720	0.406-1.277	0.261
Others (rehabilitation, neurology, psychiatry)	-0.990	0.405	0.372	0.168-0.822	0.014*
Practice region					0.108
Urban			1.000(ref)		
Suburban	0.462	0.216	1.587	1.039-2.425	0.033*
Rural area	0.482	0.273	1.620	0.949-2.764	0.077
Others	0.023	1.508	1.024	0.053-19.651	0.988
Overall perceived barriers for providing care during COVID-19	-1.74	0.048	0.840	0.766-0.923	<0.001***
Hosmer and Lemeshow test					0.960

Abbreviations: COVID-19, coronavirus disease; B, coefficients; SE, standard error; OR, odds ratio; CI, confidence interval; OBBGYN, obstetrics and gynecology; ENT, ear nose and throat; *P <0.05, **P <0.01, ***P <0.001

DISCUSSION

Effective primary healthcare is important in the battle against COVID-19, and the willingness of primary care physicians to provide care during the pandemic is vital. This study identified influencing factors of willingness to provide care during COVID-19 pandemic including "participating in the CHCG", "physician's major specialty", "perceived more overall benefits to providing care", "perceived less overall barriers to providing care", and "higher knowledge score on COVID-19". Efforts directed at these factors are fundamental for an improved community care system in combating the COVID-19 pandemic worldwide. Furthermore, it is of high priority to strengthen the capacity of local primary care physicians, in view of the upcoming resurgence of COVID-19 cases.

Participating in the CHCG was significantly associated with the willingness of primary care physicians to provide care during the COVID-19 pandemic. Lessons from past epidemics informed the important role of primary health care. Strategies such as strengthening the primary health care system and providing coordinated with reliable information to the physicians were essential.(18, 27, 28) The innovative CHCG comprehensive primary healthcare system model was developed in Taiwan after the previous SARS outbreak and the disastrous 921 earthquake. These conditions created an awareness of the need to reinforce primary care under the tremendous public health threats.(13) Under these circumstances, the physicians can provide services as a team

and unite to perform group work. Taiwanese citizens who are enrolled as CHCG members for care showed a high level of satisfaction with their health consultation and received more preventive care services including influenza vaccination, which would be important in the prevention of COVID-19.(13) Furthermore, the physicians are required to take regular education courses together, and the mandatory courses for the physicians in the CHCG include topics on infection control. This would provide the physicians with confidence and ability to care for patients with COVID-19 during the pandemic. The design and successful implementation of FPICP and CHCG might be the reasons why the physicians participating in the CHCG are more willing to provide care during the COVID-19 pandemic. The promotion of this type of primary healthcare model reinforces infection control in the communities and could be helpful in the prevention of the persistent COVID-19 pandemic.

Physician's major specialties was an association factor to the willingness of providing care, and specialties as family physician or general practitioners had higher willingness to provide care than the specialty of rehabilitation, neurology, and psychiatry. This result might be due to the familiarity of these practitioners with undetermined number of conditions compared to those of specialists who may be in fear or withdraw when faced with an uncertain acute illness. The clinical experiences of family physicians and general practitioners, which include diagnosing and

management of flu-like fever symptoms, are important in the monitoring of viral illnesses in the community. Previous studies also revealed the willingness of general practitioners to provide care during the influenza pandemic when provided with adequate supply of personal protective equipment, and appropriate education and training.(29-32) For a sustainable model, the added on task of patients with COVID-19 without overcrowding the original medical care facilities, would require the recruitment of family physicians and general practitioners who are willing to provide care in all healthcare systems worldwide. Moreover, in future, medical education and training need to put more emphasis on the adequate supply of the health workforce in these specialties including those with more experience of managing acute infectious illnesses.

The finding that physicians who perceived more threat, more stress, and who had lower knowledge scores on COVID-19 were less willing to provide care during the pandemic has important implications for policy makers. Infectious diseases pose threats to frontline healthcare professionals combating these diseases. A review that examined the psychological impact on healthcare professionals facing novel viral outbreaks revealed that staff in contact with affected patients had greater levels of both acute and post-traumatic stress in comparison with controls. Risk factors for psychological distress include being younger, being more junior, being the parents of dependent children, or having an infected family member. Longer quarantine, lack of practical

support, and stigma also contributed to the distress in this review.(21) To understand the impact of the COVID-19 pandemic on the mental health status of healthcare professionals, a Spanish study concluded that anxiety and depression are the most common symptoms among healthcare professionals. Insomnia, extreme fatigue, emotional exhaustion, and physical symptoms are also often reported.(33) Another study in China revealed that among healthcare professionals, those in the Wuhan area scored significantly higher than those outside Wuhan on several items in the Psychological Stress Questionnaire, including the thought of being in danger, worrying about self-illness and family infection, lack of psychological guidance, and poor sleep quality.(34) As this study results suggest, it is important for governments, worldwide, to provide psychological interventions to mitigate the threats and stress experienced by primary care physicians. Moreover, training sessions for primary healthcare staff to increase their level of knowledge about COVID-19 are necessary, to enhance their willingness to provide care to COVID-19 patients.

There are several limitations to this study. First, the response rate was moderate (62.5%). This response rate might have been affected by the heavy workload of the primary care physicians during the COVID-19 pandemic, as well as the large volume of questionnaires that they might have received. Nonetheless, the response of the participants, nationwide, still provides important information for the governments and

the healthcare system. Second, the healthcare system infrastructure and the health insurance reimbursement in Taiwan are unique; thus, these could limit the application of the results to other countries. However, the experiences learned from this study are paramount for the reform of primary healthcare systems that are confronted both by COVID-19 and other infectious disease pandemics. Third, differences in the level of strategies by governments to control the surge of COVID-19 and vaccinations may also impact the generalizability of the results. Fourth, even though this study is a nationwide survey, the willingness to provide care may be affected by differences in the cultural backgrounds and values of physicians toward physicians' professionalism. These findings may require modifications when applied to other countries. In addition, the Cronbach's alpha of "knowledge about COVID 19" measure was only 0.5 – 0.6. However, the questionnaire was designed by five primary care physicians and two infection specialists with careful scrutiny of the literature available in the beginning of the epidemic. Because the COVID 19 was started from an unknown SARS-CoV-2 pathogen, there were still many pathways, transmission, or prevention needed to be studied.

Enhancing the willingness of primary care physicians to provide care during the COVID-19 pandemic is essential in optimizing sustainable healthcare. Building a comprehensive primary care system such as Taiwan's FPICP with CHCG, training of

more healthcare professionals especially family physicians or general practitioners, implementing psychological intervention, and providing educational courses for primary care physicians by the medical associations or the governments worldwide, would effectively strengthen the community care workforce. The experiences learned are informative globally, to build a strong coordinated healthcare system to combat the persistent and unprecedented COVID-19 pandemic.

Authors' contributions

HH conceptualized the topic of the paper, conducted the analysis, and wrote the manuscript. CJ and BC conceptualized the topic of the paper and participated in the data collection. TC was the principal investigator for the project, conceptualized the topic, participated in data collection, conducted the analysis, and wrote the manuscript. All authors read and approved the final manuscript.

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Competing interests:

None declared.

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Data sharing statement

Data are available upon reasonable request

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B. Knowledge of Coronavirus disease 2019 (COVID-19)

	True	False	Don't know
1. As long as medical staffs are alert enough for patients with respiratory symptoms during treatment, medical staff can avoid COVID-19 infection.	☐	☐	☐
2. As long as the patient provides a health insurance card or identity card, physicians can understand the complete TOCC history.	☐	☐	☐
3. At this stage, it has moved into the period of disaster reduction from confinement period and gradually into community spread period. TOCC does not matter anymore.	☐	☐	☐
4. If the patient complained of aching and fever without travel history and the clinical diagnosis shows suspected influenza, the patient should avoid taking off the mask for quick screening during the current pandemic situation. It is better to prescribe influenza medication (eg Tamiflu), and require the patient to take the medication home with self-health management as well as monitoring.	☐	☐	☐
5. Since the COVID-19 pandemic is spreading rapidly, participating in primary care physicians' smartphone web networks (such as LINE, etc.) is the most immediate way to obtain correct information.	☐	☐	☐
6. The key factor in successful blocking "community- hospital- community" transmission mode is "maintaining hospital(including clinics) secures and medical staff safeties."	☐	☐	☐
7. If my specialty is not related to respiratory diseases nor fever, I just need to refer the patients who were suspected of COVID-19 to the hospital.	☐	☐	☐
8. If infected with SARS-COV-2, the most sensitive detection is through sample of the lower respiratory tract secretions.	☐	☐	☐
9. The surgical mask consists of three layers of material: the outer layer is splash-proof; the middle layer has a filtering effect; the inner layer absorbs moisture.	☐	☐	☐
10. If the N95 face mask can be well adhered to the face, it can still block more than 95% of the 0.3μm dust particles that are the most difficult to filter.	☐	☐	☐
11. Generally, children and adolescents have milder symptoms of COVID-19 than adults, and are less likely to spread the virus.	☐	☐	☐
12. Liver function was tested abnormally in half of the mild COVID 19 cases.	☐	☐	☐
13. If IgG antibody of SARS-CoV-2 virus is detected in the blood of a pneumonia patient, it means a confirmed diagnosis of COVID-19 and should be isolated immediately.	☐	☐	☐
14. COVID-19 is a coronavirus resembling to SARS.	☐	☐	☐
15. The main lethal cases of COVID-19 is young children with poor immunity.	☐	☐	☐
16. 80% of COVID-19 infections are mild.	☐	☐	☐
17. It is important to be alert while visiting patients, whether it is an adult or a child. If the patient has respiratory symptoms, the physicians should pay more attention to the COVID-19.	☐	☐	☐
18. At this stage, it has moved into the period of disaster reduction from confinement period and gradually into community spread period. The increasing number of imported cases highlights the importance of travel and	☐	☐	☐

contact history of TOCC.

19. When all medical staff wears protective measures and washes hands while visiting the patients, the clinic environment is regularly disinfected, it is not so important whether the patient wears a mask. ☐ ☐ ☐

20. Once symptoms like fever, sore throat or general weakness are found in primary clinic, and the patient returned to Taiwan from France a week ago, they should be referred to the medical center for COVID-19 screen. ☐ ☐ ☐

C. Attitude to provide care for COVID-19

	Agreement					Importaant				
	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Not important at all	Not important	Fair	Important	Very important
1. Threats of providing care for suspect COVID-19 patients:										
(1) Worried about being infected	□	□	□	□	□	□	□	□	□	□
(2) Worried about infecting family members	□	□	□	□	□	□	□	□	□	□
(3) Worried about not being competent to participate in pandemic prevention	□	□	□	□	□	□	□	□	□	□
(4) Worried about insufficient protective equipment	□	□	□	□	□	□	□	□	□	□
(5) Worried about being disliked by neighboring residents	□	□	□	□	□	□	□	□	□	□
(6) Most of the symptoms of physical discomfort of confirmed (or suspected) patients are difficult to control	□	□	□	□	□	□	□	□	□	□
(7) Worried about influencing the care for other patients	□	□	□	□	□	□	□	□	□	□
2. Benefits of providing care for suspect COVID-19 patients:										
(1) Help our country to improve the prevention of pandemic	□	□	□	□	□	□	□	□	□	□
(2) Competent of taking care of consulting patients	□	□	□	□	□	□	□	□	□	□
(3) Make the community more secure	□	□	□	□	□	□	□	□	□	□
(4) Make the pandemic being better controlled in Taiwan	□	□	□	□	□	□	□	□	□	□
(5) Achieve the value of being a physician	□	□	□	□	□	□	□	□	□	□
(6) Family members can also receive timely care	□	□	□	□	□	□	□	□	□	□
(7) Let medical staff have a sense of accomplishment and be more positive in their work	□	□	□	□	□	□	□	□	□	□

3. Barriers of providing care for suspect COVID-19 patients:

(1) The inconvenience of wearing protective equipment	□	□	□	□	□	□	□	□	□	□
(2) The risk of getting infection when caring patients	□	□	□	□	□	□	□	□	□	□
(3) Family dislike the care of suspect patients	□	□	□	□	□	□	□	□	□	□
(4) Caring suspect patients will decrease the number of patients in my outpatient clinic	□	□	□	□	□	□	□	□	□	□
(5) Participating in pandemic prevention work requires high costs	□	□	□	□	□	□	□	□	□	□
(6) Worried that the knowledge is insufficient to support pandemic prevention work	□	□	□	□	□	□	□	□	□	□
(7) Have a deeper sense of powerlessness or helplessness in life	□	□	□	□	□	□	□	□	□	□

4. Overall, when I consider providing care to suspect COVID-19 patients (0 – 10)

(1) Benefits: _____ point

(2) Barriers: _____ point

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3-4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	8-9
Methods			
Study design	4	Present key elements of study design early in the paper	10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	10 - 12
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10 - 12
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	10 - 12
Bias	9	Describe any efforts to address potential sources of bias	*12*
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	12
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	10
		(*e*) Describe any sensitivity analyses	12
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	10, 13
		(b) Give reasons for non-participation at each stage	13
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	13 – 14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13 – 14
		(*b*) Report category boundaries when continuous variables were categorized	13 – 14
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 – 14
Discussion			
Key results	18	Summarise key results with reference to study objectives	15
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	18 - 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15 – 19
Generalisability	21	Discuss the generalisability (external validity) of the study results	15 - 19
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	5

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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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Factors Influencing the Willingness of Primary Care Physicians to Provide Care during the Coronavirus Disease Pandemic: A Nationwide Survey in Taiwan

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Abstract

Objectives:

The coronavirus disease (COVID-19) pandemic continues to advance worldwide with tremendous impact on public health, economy, and society. Primary healthcare is crucial in every country during the pandemic for an integrated and coordinated healthcare delivery system; hence, it is of paramount importance to maintain a sufficient frontline workforce. This study aimed to identify factors influencing the willingness of primary care physicians to provide care during the COVID-19 pandemic.

Design:

Cross sectional study

Setting:

Nationwide survey

Participants:

Primary care physicians working in the community in Taiwan were selected using a cluster sampling method based on practice region from May to June 2020.

Outcome measures:

The willingness of primary care physicians to provide care during the COVID-19 pandemic.

Results:

This study surveyed 1,000 primary care physicians nationwide, and 625 valid questionnaires were received and included in the final analysis, with an effective response rate of 62.5%. Factors significantly associated with physicians willingness to provide care during COVID-19 were "joining the Community Health Care Group (CHCG)" ($p < 0.001$), "perceived more overall benefits for providing care" ($p < 0.001$) "perceived less overall barriers to providing care" ($p < 0.001$), "higher knowledge scores about COVID-19" ($p = 0.049$), and "physician's major specialties" ($p = 0.009$) in the multivariate logistic regression model.

Conclusions:

Building a comprehensive primary care system such as Taiwan's CHCG, training of more family physicians or general practitioners, and protecting and supporting primary care physicians were important in response to infectious disease pandemics. The findings of this study inform the development of guidelines to support and maintain the primary healthcare workforces during the COVID-19 pandemic and for future events.

Strengths and limitations of this study

- The study participants included primary care physicians in Taiwan, including different specialties and practice regions, selected using a nationwide cluster sampling method.
- The survey period was during the COVID-19 pandemic; the finding could be applied to the current COVID-19 pandemic situation as the unprecedented COVID-19 threats persisted.
- Taiwan implemented proactive strategies early in the pandemic to manage the crisis, and the effective response of the healthcare system may be informative to the world.
- The response rate was only moderate, and the results may not be generalizable to other countries with different healthcare system and government control strategies.

INTRODUCTION

The coronavirus disease (COVID-19) pandemic continues to advance worldwide with tremendous impact on public health, economy, and society. Moreover, the pandemic continues to progress with flare-ups in several countries.(1, 2) More than 143 million COVID-19 cases caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were confirmed with more than 3 million deaths reported globally at the time of writing on April 17, 2021 by the World Health Organization.(3) While measures of infection control are gradually being relaxed, longitudinal and prolonged preparedness is necessary for the catastrophic possibility of resurgence in the coming years.(1, 4, 5)

The primary healthcare system response to the COVID-19 outbreak as the first level of contact is crucial, and is assigned a key role on the frontline in every country facing undifferentiated cases. Different functions, designated for general practice, such as screening, education, and home quarantine monitoring worldwide, are essential. Through integrated and coordinated healthcare delivery systems, primary care physicians could triage patients to specialized hospitals for proper care, to reduce overcrowding in the hospitals. Furthermore, at the primary healthcare system level, previous healthcare needs, such as chronic disease management, health promotion, or initial acute non-infectious disease consultation, need to be maintained even when the

system is besieged with consultation and testing needs for COVID-19 through walk-in clinics or telemedicine, worldwide.(6-8) Along with hospital specialists, primary care physicians have a professional commitment to ensure the appropriate care of their patients while in hospital.(9, 10) Taiwan implemented proactive strategies early in the pandemic to manage the crisis, and the effective response of the healthcare system may be informative to the world.(11, 12) The Family Practice Integrated Care Project (FPICP) and Community Health Care Group (CHCG) were established in Taiwan after the previous severe acute respiratory syndrome (SARS) epidemic. The FPICP emphasizes the need for coordinated care between clinics and hospitals, and also provides continuous person-centered care for the patients. The FPICP establishes community care networks nationwide, with the basic unit of 5 to 10 clinics forming a CHCG team. Primary care physicians in the CHCG need to collaborate with each other and with those in the backup hospitals. These emphasize continuous, coordinated, and comprehensive care for patients, and could be a suitable primary healthcare infrastructure to combat the COVID-19 pandemic.(13, 14) It is of paramount importance to maintain adequate medical care capacity during the pandemic, and research regarding the influence of innovative primary healthcare models, such as FPICP and CHCG, on the control of the pandemic is essential.

As the unprecedented pandemic threat persists over a broad range of medical care, it

is of paramount importance to understand and optimize the primary healthcare workforce, and to maintain sufficient frontline physicians.(15-18) However, previous reports revealed a high susceptibility to infection among healthcare workers because, more than 3,000 healthcare workers have been infected in China and 20% of responding healthcare workers were infected early in the COVID-19 pandemic in Italy.(19, 20) Moreover, a systemic review by Kisely et al. revealed that healthcare workers who had direct contact with patients had higher levels of both acute and posttraumatic stress and psychological distress.(21) In addition, workforce problems might be exacerbated by the refusal to work due to the psychological factors and concern over their families.(22, 23) Up to 24% physicians and 26% nurses agreed to abandon their workplaces during a pandemic in a Germany survey during the H5N1 influenza outbreak, and absenteeism was as high as 85% during an influenza pandemic reported in a survey conducted in the UK.(24, 25) One study conducted in psychiatric hospitals at the peak of the COVID-19 pandemic revealed that about 23% of medical staff were unwilling to care for psychiatric patients with COVID-19.(26) Therefore, attitudes of healthcare workers toward COVID-19 occurrence such as perceived threats, benefits, or barriers, might influence the provision of care to COVID-19 patients.

In confronting COVID-19, there is an urgent need to analyze individual, environmental, and social factors that influence the willingness to provide healthcare

during the pandemic. This nationwide survey aimed to identify the factors influencing the willingness of primary care physicians to provide care in their communities during the COVID-19 pandemic. The findings of this study will inform the development of guidelines to support and maintain the primary healthcare workforces during the COVID-19 pandemic and for future events.

METHODS

Design

This cross-sectional survey was conducted from May to June 2020 during the COVID-19 pandemic. The Medical Policy Committee of Taiwan Medical Association approved the study protocol.

Participants

The targeted participants were primary care physicians working in the community. Eligible respondents were recruited nationwide from the Taiwan Medical Association. The sample population comprised 1,000 physicians in total.

Recruitment

A structured questionnaire was mailed to the targeted primary care physicians selected using a nationwide cluster sampling method. The clusters were identified according to the twenty-two counties and cities in Taiwan. The targeted primary care physicians were selected randomly by computer program. One month after the questionnaire was mailed, non-respondents were contacted again, and the questionnaire survey was resent. The return of the questionnaire represented consent to participate in the survey.

Measurements

The structured self-reported questionnaire consists of six parts including questions on demographic characteristics; knowledge of COVID-19; attitude towards providing

care during COVID-19 including threats, benefits and barriers related to the provision of care during COVID-19 as well as the global rating of benefits and barriers to care during COVID-19; and the willingness to provide care. The entire six part questionnaire was tested for face and content validity by a panel comprised of five primary care physicians and two infection specialists. The physicians filled out the questionnaire to confirm its face validity and ease of application. Each item in the questionnaire was appraised from "very inappropriate and not relevant" (1) to "very appropriate and relevant" (5). A "content validity index" (CVI) was used to determine the validity of the structured questionnaire, and the items were highly relevant if CVI higher than 0.8.(27, 28) The questionnaire yielded a CVI of 0.94 on all items. (the knowledge and attitude questionnaire was provided as supplementary file)

Demographic characteristics assessed by the questionnaire included age, gender, religion, specialty, and information on current working conditions. The other questionnaire parts are described as follows:

1. Knowledge of COVID-19: This measure is about the practical knowledge of COVID-19 consisted of three main parts epidemiology (3 items), diagnosis (9 items), personal protective equipment and management (8 items). The 20-item measure was designed by with careful scrutiny of the literature available in the beginning of the epidemic. This scoring system of this scale is "true" (1) and

"false/unknown" (0). The internal consistency of this knowledge measure was assessed using the Cronbach' s alpha, which showed a coefficient of 0.5 - 0.6.

2. Attitude toward providing care for COVID-19 patients: This measure included the perception of threats, benefits, and barriers to providing care during COVID-19. This 21-item measure is assessed using a five-point Likert scale, scored from "strongly disagree" (1) to "strongly agree" (5) and "Not important" (1) to "very important" (5). Bartlett's test of sphericity and the Kaiser– Meyer–Olkin (KMO) test were used to determine whether the attitude data were suitable for exploratory factor analysis. Therefore, the items were analyzed using principal component factor analysis followed by orthogonal varimax rotation. The content was constructed using threats (seven items), benefits (seven items), and barriers to providing care for COVID-19 patients (seven items). Internal consistency was demonstrated with a Cronbach's alpha coefficient ranging from 0.89–0.96 in the attitude subscale. Two global rating items: "overall perceived benefits for providing care during COVID-19" and "overall perceived barriers for providing care during COVID-19" used a ten-point Likert scale.

3. Willingness. This measure was used to determine the primary care physician's willingness (yes or no) to provide care during the COVID-19 pandemic.

Statistical analysis

Data management and statistical analyses were performed using SPSS Statistics for Windows, version 10.0 (SPSS Inc., Chicago, Ill., USA). Demographic data and distribution of each variable were described using frequency distribution. Mean values and standard deviations (SDs) were used to analyze the degree, importance, and necessity of "knowledge about COVID-19" and "attitude toward providing care during COVID-19" variable. The attitude variables in the model were global ratings of "overall perceived benefits for providing care during COVID-19" and "overall perceived barriers for providing care during COVID-19". A univariate comparison including the Student's t-test and chi-square test were carried out to determine differences in the variables related to willingness or unwillingness to provide care. Statistical significance was set at $p < 0.05$. Stepwise logistic regression analysis was carried out to determine the relative values of the variables in the model where the willingness to provide care was the dependent variable. To avoid collineation of the variables "overall perceived benefits for providing care during COVID-19" and "overall perceived barriers for providing care during COVID-19", the two variables were analyzed in two different models, respectively.

Patient and public involvement

As the research aimed on professional perspectives, primary care physicians were

involved in the development and amendment of the questionnaire.

RESULTS

Demographic characteristics

A total of 625 valid questionnaires were returned and included in the final analysis after removing incomplete questionnaires by the surveyed physicians, with an effective response rate of 62.5%.

As shown in Table 1, the 625 respondents had a mean age of 56.6 ± 10.6 (mean ± SD) years, and most respondents were male (85.4%). The respondents' registered practice was mainly concentrated in large (49.9%) and small (31.4%) cities. Respondents' average years of working experience was 28.4 ± 10.2 years. More than half of respondents participated in the CHCG (56.8%), with an average duration of 3.5 ± 4.6 years. Some of the respondents reported having encountered patients with fever (75.8%) and those with suspected COVID-19 (25.1%) in practice. Since the COVID-19 outbreak in January 2020, nearly a quarter of the respondents had ever assisted patients with suspected COVID-19 with referral (21.6%) or had ever sought help on the epidemic prevention hotline and health bureau for advice (22.7%).

Table 1. Background characteristics of the primary care physicians (n=625)

Items	Number	%
Gender		
Male	534	85.4
Female	83	13.3
Missing	8	1.3

Items	Number	%
Age (years)		
Average 56.6±10.6		
Education		
University	534	85.4
Master	59	9.4
PhD	22	3.5
Others	10	1.6
Religion		
Not specified	207	33.1
Folk beliefs	152	24.3
Buddhism	132	21.1
Taoism	24	3.8
Christianity	74	11.8
Catholics	19	3.0
Islam	0	0
Kuan Tao	5	0.8
Others	12	1.9
The importance of religion		
Very important	86	13.8
Important	155	24.8
Fair	277	44.3
Not that important	95	15.1
Not important at all	12	1.9
Practice region		
Urban	312	49.9
Suburban	196	31.4
Rural area	115	18.4
Others	2	0.3
Specialty		
General practitioner and family medicine	231	37.0
Internal medicine	71	11.4
Obstetrics and gynecology	26	4.2
Pediatrics	79	12.6
Otorhinolaryngologist	98	15.7
Surgery (surgery, ophthalmology, dermatology, Medical cosmetology, orthopedics)	86	13.8
Others (rehabilitation, neurology, psychiatry)	34	5.4
Years of service		
Average 28.4±10.2		

Items	Number	%
Participating in the Community Health Care Group		
Yes	355	56.8
No	268	42.9
Manage the following condition since January:		
Fever patient	474	75.8
Suspected COVID-19 patient	157	25.1
Refer suspected COVID-19 patient to designated hospitals for further testing	135	21.6
Consult the central or local health bureau while having difficulty with referral	142	22.7
None of the above	123	19.7

Abbreviation: COVID-19, coronavirus disease

The 625 primary care physicians enrolled were divided into two groups: the "willing to provide care" (n = 428, 68.5%) and "unwilling to provide care" (n = 197, 31.5%) groups. Categorical variables in Table 2 and continuous variables in Table 3 indicate possible factors related to the respondents' willingness to provide care during the COVID-19 pandemic. Table 2 and 3 also demonstrated factors with significant differences by chi square test and t – test from univariate comparison analysis.

Table 2. Univariate analysis (χ^2) for comparing the characteristics between those willing (n = 428) and those unwilling (n = 197) to provide care

Variables	Willing n (%)	Not willing n= (%)	χ^2	P value
Gender			0.636	0.425
Male	360(67.5)	173(32.5)		
Female	59(72.0)	23(28.0)		
Education			0.822	0.844
University	362(68.0)	170(32.0)		
Master	43(72.9)	16(27.1)		

Variables	Willing	Not willing	χ^2	P value
	n (%)	n= (%)		
PhD	14(63.6)	8(36.4)		
Others	7(70.0)	3(30.0)		
Religion			8.433	0.296
Not specified	134(65.0)	72(35.0)		
Folk beliefs	106(69.7)	46(30.3)		
Buddhism	86(65.6)	45(34.4)		
Taoism	16(66.7)	8(33.3)		
Christianity	59(79.7)	15(20.3)		
Catholics	14(73.7)	5(26.3)		
Islam	0(0.0)	0(0.0)		
Kuan Tao	2(40.0)	3(60.0)		
Others	9(75.0)	3(25.0)		
Practice region			11.923	0.018*
Urban	194(62.6)	116(37.4)		
Suburban	145(74.0)	51(26.0)		
Rural area	75(74.8)	28(25.2)		
Others	1(50.0)	1(50.0)		
Specialty			35.563	<0.001***
General practitioner and family medicine	164(71.0)	67(29.0)		
Internal medicine	46(65.7)	24(34.3)		
Obstetrics and Gynecology	15(57.7)	11(42.3)		
Pediatrics	61(78.2)	17(21.8)		
Otorhinolaryngologist	80(81.6)	18(18.4)		
Surgery (including general surgery, ophthalmology, dermatology, orthopedics)	47(54.7)	39(45.3)		
Others (including rehabilitation, neurology, psychiatry)	13(38.2)	21(61.8)		
Participating in the Community Health Care Group?			22.838	<0.001***
Yes	269(76.2)	84(23.8)		
No	156(58.2)	112(41.8)		
Experience in managing			17.385	<0.001***

Variables	Willing n (%)	Not willing n= (%)	χ^2	P value
patients with fever, suspected COVID-19 patients, referring patients for further testing, consulting the central or local health bureau, since January 2020				
Yes	361(72.3)	138(27.7)		
No	65(52.8)	58(47.2)		

Abbreviation: COVID-19, coronavirus disease

Table 3. Univariate analysis (t test) for comparing the characteristics between those willing (n = 428) and those unwilling (n = 197) to provide care

Variables	Willing Mean (SD)	Not willing Mean (SD)	t	P value
Age (years)	56.8(9.3)	56.2(9.3)	-0.6	0.519
Years of service	28.3(10.0)	28.5(10.3)	0.2	0.853
Years of participating in the Community Health Care Group	4.0(4.6)	2.6(4.1)	-3.6	<0.001***
Knowledge about COVID-19	14.9(2.1)	14.4(2.2)	-2.9	0.004**
Overall perceived benefits for providing care during COVID-19	6.2(1.9)	5.6(2.1)	-3.1	0.002**
Overall perceived barriers for providing care during COVID-19	3.8(1.9)	4.4(2.1)	3.1	0.002**

Abbreviations: SD Standard deviation; COVID-19, coronavirus disease
**P <0.01, ***P <0.001

The results of further stepwise logistic regression analysis to determine the relative values of variables associated with willingness are shown in Table 4. "Overall perceived benefits for providing care during COVID-19" and "overall perceived

barriers for providing care during COVID-19" were analyzed and demonstrated in two different models to avoid collineation. Factors including "participating in the CHCG" ($p < 0.001$), "knowledge about COVID-19" ($p = 0.049$), "major specialties" ($p = 0.009$), "perceived overall benefits to providing care during COVID-19" ($p < 0.001$), "perceived overall barriers to providing care during COVID-19" ($p < 0.001$) were independent association factors of the "willingness to provide care." For the suitability of the model, the p value of the Hosmer–Lemeshow goodness-of-fit test were 0.847 and 0.960.

Table 4. Logistic regression analysis results showing factors correlated with the willingness to provide care during COVID-19.

Variables	B	S.E.	OR	95% CI	P value
Model 1					
Participating in the Community Health Care Group					
Yes	0.689	0.195	1.991	1.359-2.917	<0.001***
No			1.000(ref)		
Knowledge about COVID-19[a]	0.094	0.048	1.098	1.000-1.206	0.049*
Specialty					0.009**
General practitioner and family medicine			1.000(ref)		
Internal medicine	-0.276	0.307	0.759	0.416-1.385	0.369
OBGYN	-0.511	0.441	0.600	0.253-1.425	0.247
Pediatrics	0.401	0.328	1.493	0.786-2.838	0.221
ENT	0.580	0.319	1.787	0.957-3.336	0.068
Surgery (surgery, ophthalmology, dermatology, medical cosmetology, orthopedics)	-0.333	0.293	0.717	0.404-1.271	0.254

Variables	B	S.E.	OR	95% CI	P value
Others (rehabilitation, neurology, psychiatry)	-0.993	0.405	0.370	0.168-0.819	0.014*
Practice region					0.104
Urban			1.000(ref)		
Suburban	0.460	0.216	1.584	1.037-2.420	0.033*
Rural area	0.493	0.272	1.637	0.960-2.792	0.070
Others	0.021	1.506	1.021	0.053-19.543	0.989
Overall perceived benefits for providing care during COVID-19[a]	0.173	0.047	1.189	1.083-1.304	<0.001***
Hosmer and Lemeshow test					0.847
Model 2					
Participating in the Community Health Care Group					
Yes	0.696	0.195	2.005	1.368-2.937	<0.001***
No			1.000(ref)		
Knowledge about COVID-19[a]	0.094	0.048	1.099	1.001-1.207	0.049*
Specialty					0.009**
General practitioner and family medicine			1.000(ref)		
Internal medicine	-0.275	0.307	0.760	0.416-1.386	0.370
OBGYN	-0.507	0.442	0.602	0.253-1.431	0.251
Pediatrics	0.404	0.328	1.498	0.788-2.847	0.218
ENT	0.577	0.318	1.781	0.954-3.324	0.070
Surgery (surgery, ophthalmology, dermatology, medical cosmetology, orthopedics)	-0.329	0.293	0.720	0.406-1.277	0.261
Others (rehabilitation, neurology, psychiatry)	-0.990	0.405	0.372	0.168-0.822	0.014*
Practice region					0.108
Urban			1.000(ref)		
Suburban	0.462	0.216	1.587	1.039-2.425	0.033*
Rural area	0.482	0.273	1.620	0.949-2.764	0.077

Variables	B	S.E.	OR	95% CI	P value
Others	0.023	1.508	1.024	0.053-19.651	0.988
Overall perceived barriers for providing care during COVID-19[a]	-0.174	0.048	0.840	0.766-0.923	<0.001***
Hosmer and Lemeshow test					0.960

Abbreviations: COVID-19, coronavirus disease; B, coefficients; SE, standard error; OR, odds ratio; CI, confidence interval; OBBGYN, obstetrics and gynecology; ENT, ear nose and throat; *P <0.05, **P <0.01, ***P <0.001

[a] These variables were scores as continuous variables in the model

DISCUSSION

Effective primary healthcare is important in the battle against COVID-19, and the willingness of primary care physicians to provide care during the pandemic is vital. This study identified influencing factors of willingness to provide care during COVID-19 pandemic including "participating in the CHCG", "physician's major specialty", "perceived more overall benefits to providing care", "perceived less overall barriers to providing care", and "higher knowledge score on COVID-19". Efforts directed at these factors are fundamental for an improved community care system in combating the COVID-19 pandemic worldwide. Furthermore, it is of high priority to strengthen the capacity of local primary care physicians, in view of the upcoming resurgence of COVID-19 cases.

Participating in the CHCG was significantly associated with the willingness of primary care physicians to provide care during the COVID-19 pandemic. Lessons from past epidemics informed the important role of primary health care. Strategies such as strengthening the primary health care system and providing coordinated with reliable information to the physicians were essential.(18, 29, 30) The innovative CHCG comprehensive primary healthcare system model was developed in Taiwan after the previous SARS outbreak and the disastrous 921 earthquake. These conditions created an awareness of the need to reinforce primary care under the tremendous public health threats.(13) Under these circumstances, the physicians can provide services as a team

and unite to perform group work. Taiwanese citizens who are enrolled as CHCG members for care showed a high level of satisfaction with their health consultation and received more preventive care services including influenza vaccination, which would be important in the prevention of COVID-19.(13) Furthermore, the physicians are required to take regular education courses together, and the mandatory courses for the physicians in the CHCG include topics on infection control. This would provide the physicians with confidence and ability to care for patients with COVID-19 during the pandemic. The design and successful implementation of FPICP and CHCG might be the reasons why the physicians participating in the CHCG are more willing to provide care during the COVID-19 pandemic. The promotion of this type of primary healthcare model reinforces infection control in the communities and could be helpful in the prevention of the persistent COVID-19 pandemic.

Physician's major specialties was an association factor to the willingness of providing care, and specialties as family physician or general practitioners had higher willingness to provide care than the specialty of rehabilitation, neurology, and psychiatry. This result might be due to the familiarity of these practitioners with undetermined number of conditions compared to those of specialists who may be in fear or withdraw when faced with an uncertain acute illness. The clinical experiences of family physicians and general practitioners, which include diagnosing and

management of flu-like fever symptoms, are important in the monitoring of viral illnesses in the community. Previous studies also revealed the willingness of general practitioners to provide care during the influenza pandemic when provided with adequate supply of personal protective equipment, and appropriate education and training.(31-34) For a sustainable model, the added on task of patients with COVID-19 without overcrowding the original medical care facilities, would require the recruitment of family physicians and general practitioners who are willing to provide care in all healthcare systems worldwide. Moreover, in future, medical education and training need to put more emphasis on the adequate supply of the health workforce in these specialties including those with more experience of managing acute infectious illnesses.

The finding that physicians who perceived more threat, more stress, and who had lower knowledge scores on COVID-19 were less willing to provide care during the pandemic has important implications for policy makers. Infectious diseases pose threats to frontline healthcare professionals combating these diseases. A review that examined the psychological impact on healthcare professionals facing novel viral outbreaks revealed that staff in contact with affected patients had greater levels of both acute and post-traumatic stress in comparison with controls. Risk factors for psychological distress include being younger, being more junior, being the parents of dependent children, or having an infected family member. Longer quarantine, lack of practical

support, and stigma also contributed to the distress in this review.(21) To understand the impact of the COVID-19 pandemic on the mental health status of healthcare professionals, a Spanish study concluded that anxiety and depression are the most common symptoms among healthcare professionals. Insomnia, extreme fatigue, emotional exhaustion, and physical symptoms are also often reported.(35) Another study in China revealed that among healthcare professionals, those in the Wuhan area scored significantly higher than those outside Wuhan on several items in the Psychological Stress Questionnaire, including the thought of being in danger, worrying about self-illness and family infection, lack of psychological guidance, and poor sleep quality.(36) As this study results suggest, it is important for governments, worldwide, to provide psychological interventions to mitigate the threats and stress experienced by primary care physicians. Moreover, training sessions for primary healthcare staff to increase their level of knowledge about COVID-19 are necessary, to enhance their willingness to provide care to COVID-19 patients.

There are several limitations to this study. First, the response rate was moderate (62.5%). This response rate might have been affected by the heavy workload of the primary care physicians during the COVID-19 pandemic, as well as the large volume of questionnaires that they might have received. Nonetheless, the response of the participants, nationwide, still provides important information for the governments and

the healthcare system. Second, the healthcare system infrastructure and the health insurance reimbursement in Taiwan are unique; thus, these could limit the application of the results to other countries. However, the experiences learned from this study are paramount for the reform of primary healthcare systems that are confronted both by COVID-19 and other infectious disease pandemics. Third, differences in the level of strategies by governments to control the surge of COVID-19 and vaccinations may also impact the generalizability of the results. Fourth, even though this study is a nationwide survey, the willingness to provide care may be affected by differences in the cultural backgrounds and values of physicians toward physicians' professionalism. These findings may require modifications when applied to other countries. In addition, the Cronbach's alpha of "knowledge about COVID 19" measure was only 0.5 – 0.6. However, the questionnaire was designed by five primary care physicians and two infection specialists with careful scrutiny of the literature available in the beginning of the epidemic. Because the COVID 19 was started from an unknown SARS-CoV-2 pathogen, there were still many pathways, transmission, or prevention needed to be studied.

Enhancing the willingness of primary care physicians to provide care during the COVID-19 pandemic is essential in optimizing sustainable healthcare. Building a comprehensive primary care system such as Taiwan's FPICP with CHCG, training of

more healthcare professionals especially family physicians or general practitioners, implementing psychological intervention, and providing educational courses for primary care physicians by the medical associations or the governments worldwide, would effectively strengthen the community care workforce. The experiences learned are informative globally, to build a strong coordinated healthcare system to combat the persistent and unprecedented COVID-19 pandemic.

Authors' contributions

HH conceptualized the topic of the paper, conducted the analysis, and wrote the manuscript. CJ and BC conceptualized the topic of the paper and participated in the data collection. TC was the principal investigator for the project, conceptualized the topic, participated in data collection, conducted the analysis, and wrote the manuscript. All authors read and approved the final manuscript.

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Competing interests:

None declared.

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Data sharing statement

Data are available upon reasonable request

Ethics approval statement

The Medical Policy Committee of Taiwan Medical Association approved the study protocol. The document had no number/ID but was attached as the supplement file with the title "TMA Certified IRB exemption Documents_2020".

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B. Knowledge of Coronavirus disease 2019 (COVID-19)

	True	False	Don't know
1. As long as medical staffs are alert enough for patients with respiratory symptoms during treatment, medical staff can avoid COVID-19 infection.	☐	☐	☐
2. As long as the patient provides a health insurance card or identity card, physicians can understand the complete TOCC history.	☐	☐	☐
3. At this stage, it has moved into the period of disaster reduction from confinement period and gradually into community spread period. TOCC does not matter anymore.	☐	☐	☐
4. If the patient complained of aching and fever without travel history and the clinical diagnosis shows suspected influenza, the patient should avoid taking off the mask for quick screening during the current pandemic situation. It is better to prescribe influenza medication (eg Tamiflu), and require the patient to take the medication home with self-health management as well as monitoring.	☐	☐	☐
5. Since the COVID-19 pandemic is spreading rapidly, participating in primary care physicians' smartphone web networks (such as LINE, etc.) is the most immediate way to obtain correct information.	☐	☐	☐
6. The key factor in successful blocking "community- hospital- community" transmission mode is "maintaining hospital(including clinics) secures and medical staff safeties."	☐	☐	☐
7. If my specialty is not related to respiratory diseases nor fever, I just need to refer the patients who were suspected of COVID-19 to the hospital.	☐	☐	☐
8. If infected with SARS-COV-2, the most sensitive detection is through sample of the lower respiratory tract secretions.	☐	☐	☐
9. The surgical mask consists of three layers of material: the outer layer is splash-proof; the middle layer has a filtering effect; the inner layer absorbs moisture.	☐	☐	☐
10. If the N95 face mask can be well adhered to the face, it can still block more than 95% of the 0.3μm dust particles that are the most difficult to filter.	☐	☐	☐
11. Generally, children and adolescents have milder symptoms of COVID-19 than adults, and are less likely to spread the virus.	☐	☐	☐
12. Liver function was tested abnormally in half of the mild COVID 19 cases.	☐	☐	☐
13. If IgG antibody of SARS-CoV-2 virus is detected in the blood of a pneumonia patient, it means a confirmed diagnosis of COVID-19 and should be isolated immediately.	☐	☐	☐
14. COVID-19 is a coronavirus resembling to SARS.	☐	☐	☐
15. The main lethal cases of COVID-19 is young children with poor immunity.	☐	☐	☐
16. 80% of COVID-19 infections are mild.	☐	☐	☐
17. It is important to be alert while visiting patients, whether it is an adult or a child. If the patient has respiratory symptoms, the physicians should pay more attention to the COVID-19.	☐	☐	☐
18. At this stage, it has moved into the period of disaster reduction from confinement period and gradually into community spread period. The increasing number of imported cases highlights the importance of travel and	☐	☐	☐

contact history of TOCC.

19. When all medical staff wears protective measures and washes hands while visiting the patients, the clinic environment is regularly disinfected, it is not so important whether the patient wears a mask.	☐	☐	☐
20. Once symptoms like fever, sore throat or general weakness are found in primary clinic, and the patient returned to Taiwan from France a week ago, they should be referred to the medical center for COVID-19 screen.	☐	☐	☐

C. Attitude to provide care for COVID-19

	Agreement					Importaant				
	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Not important at all	Not important	Fair	Important	Very important
1. Threats of providing care for suspect COVID-19 patients:										
(1) Worried about being infected	□	□	□	□	□	□	□	□	□	□
(2) Worried about infecting family members	□	□	□	□	□	□	□	□	□	□
(3) Worried about not being competent to participate in pandemic prevention	□	□	□	□	□	□	□	□	□	□
(4) Worried about insufficient protective equipment	□	□	□	□	□	□	□	□	□	□
(5) Worried about being disliked by neighboring residents	□	□	□	□	□	□	□	□	□	□
(6) Most of the symptoms of physical discomfort of confirmed (or suspected) patients are difficult to control	□	□	□	□	□	□	□	□	□	□
(7) Worried about influencing the care for other patients	□	□	□	□	□	□	□	□	□	□
2. Benefits of providing care for suspect COVID-19 patients:										
(1) Help our country to improve the prevention of pandemic	□	□	□	□	□	□	□	□	□	□
(2) Competent of taking care of consulting patients	□	□	□	□	□	□	□	□	□	□
(3) Make the community more secure	□	□	□	□	□	□	□	□	□	□
(4) Make the pandemic being better controlled in Taiwan	□	□	□	□	□	□	□	□	□	□
(5) Achieve the value of being a physician	□	□	□	□	□	□	□	□	□	□
(6) Family members can also receive timely care	□	□	□	□	□	□	□	□	□	□
(7) Let medical staff have a sense of accomplishment and be more positive in their work	□	□	□	□	□	□	□	□	□	□

3. Barriers of providing care for suspect COVID-19 patients:

(1) The inconvenience of wearing protective equipment	□	□	□	□	□	□	□	□	□	□
(2) The risk of getting infection when caring patients	□	□	□	□	□	□	□	□	□	□
(3) Family dislike the care of suspect patients	□	□	□	□	□	□	□	□	□	□
(4) Caring suspect patients will decrease the number of patients in my outpatient clinic	□	□	□	□	□	□	□	□	□	□
(5) Participating in pandemic prevention work requires high costs	□	□	□	□	□	□	□	□	□	□
(6) Worried that the knowledge is insufficient to support pandemic prevention work	□	□	□	□	□	□	□	□	□	□
(7) Have a deeper sense of powerlessness or helplessness in life	□	□	□	□	□	□	□	□	□	□

4. Overall, when I consider providing care to suspect COVID-19 patients (0 – 10)

(1) Benefits: _____ point

(2) Barriers: _____ point

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 3-4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any prespecified hypotheses	8-9
Methods			
Study design	4	Present key elements of study design early in the paper	10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	10 - 12
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10 - 12
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	10 - 12
Bias	9	Describe any efforts to address potential sources of bias	*12*
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	12
		(*b*) Describe any methods used to examine subgroups and interactions	12
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	10
		(*e*) Describe any sensitivity analyses	12
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	10, 13
		(b) Give reasons for non-participation at each stage	13
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	13 – 14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	13 – 14
		(*b*) Report category boundaries when continuous variables were categorized	13 – 14
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 – 14
Discussion			
Key results	18	Summarise key results with reference to study objectives	15
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	18 - 19
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15 – 19
Generalisability	21	Discuss the generalisability (external validity) of the study results	15 - 19
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	5

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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.