Internet hospitals help prevent and control the epidemic of COVID-19 in China: a multicenter user profiling study

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Abstract

Background: Along with the spread of novel coronavirus disease (COVID-19), internet hospitals in China were engaged in the epidemic prevention and control, offering epidemic-related online services and medical supports to the public.

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Results: 4913 consultations were enrolled for analysis with the median age of the counselees 28 years (inter-quartile range: 22-33 years). There were 104(2.1%) healthy counselees, 147(3.0%) hypochondriacal counselees, 34(0.7%) exposed counselees, 853(17.4%) mildly suspicious counselees, 42(0.9%) moderately suspicious counselees, 3550(72.3%) highly suspicious counselees and 183(3.7%) severely suspicious counselees. 94.2% counselees had epidemic-related symptoms with a distribution similar to those of COVID-19. The hypochondriacal suspicion mode (44.1%) was common. The counselees' motivation and the doctors' recommendation for offline visit were inconsistent (P<0.001) with Cohen Kappa score 0.039, indicating irrational medical-seeking behaviors. Adult counselees (OR=1.816, P<0.001) with epidemiological exposure (OR= 7.568, P<0.001), shortness of breath (OR=1.440, P=0.001), diarrhea (OR=1.272, P=0.04) and unrelated symptoms (OR=1.509, P<0.001) were more likely to have hypochondriacal suspicion. Counselees with severe illnesses (OR= 2.303, P<0.001), fever (OR= 1.660, P<0.001), epidemiological exposure history (OR=1.440, P=0.012) and hypochondriacal suspicion (OR= 4.826, P<0.001) were more likely to attempt for offline visit. Re-attended counselees (OR=0.545, P=0.002) were less motivated to go to the offline clinic.

Conclusions: Internet hospitals can serve different types of epidemic counselees, offer essential medical supports to the public during COVID-19, further release the social panic, promote social distancing, enhance the public's ability of self-protection, correct irrational medical seeking behaviors, reduce the chance of nosocomial cross infection, facilitate epidemiological screening, thus play an important role on preventing and controlling COVID-19.

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Keywords: Internet hospital; Telemedicine; Novel coronavirus disease; Pandemics; Prevention and control

Introduction

From late 2019 to early 2020, an outbreak of novel coronavirus disease (COVID-19) spread throughout China and soon became a global concern [1-3]. The Chinese government had adopted a series of administrative measures to stop the spread of the epidemic [4], including promulgating decrees that required the domestic internet hospitals to vigorously carry out remote medical services in response to the epidemic [5]. Under such circumstances, the internet hospitals in China, which is a new approach to outpatient health care, providing health services via internet technologies [6], were engaged in the epidemic prevention and control, opening up free COVID-19 consultation service as the main form of remote medical services for the public during the epidemic. This is the first time that internet hospital has been involved in the response to infectious public health incidents. Its role during the epidemic prevention and control has yet to be explored. This study analyzed the details of the free epidemic consultations from multicenter internet hospitals in China during COVID-19. Through user profiling, we assessed the social panic and the public's medical needs during COVID-19, revealed the effects of internet hospitals on the epidemic prevention and control, expounded

and explored the managing strategies to make the internet hospitals play a greater role in the infectious public health emergency responses.

Method

Data Sources

We collected 8913 consecutive de-identified free online consultations generated between January 25, 2020 and February 25, 2020 from 30 general public internet hospitals in 11 provinces of China outside of Hubei area. The consultants were certified doctors from the general public hospitals and the counselees were local residents who were not admitted to the offline hospitals and supposed to have epidemic related questions. All of the data were extracted from the platform of Zoenet Health Company limited (www.zoenet.cn), which cooperates with public hospitals to run the online medical services. 405 invalid consultations containing duplicated or non-medical contents were removed. Through semantic analysis, 563 repetitive and 3032 unrelated consultations in which the counselees had no related symptoms and asked completely epidemic-irrelevant questions were further excluded. Each of the left consultations were analyzed artificially by one trained researcher and rechecked by another. Any divergence from this procedure was resolved by discussion with all researchers.

Study Definitions

Variables including age, sex, symptoms, re-attendance, epidemiological exposure history, hypochondriacal suspicion, offline-visit recommendation and offline-visit motivation were recorded. The epidemic-related symptoms were classified into common and uncommon epidemic symptoms. Fever (axillary temperature of 37.5°C or higher), cough, expectoration, myalgia and fatigue were classified into common symptoms from which most of the COVID-19 patients outside of Wuhan in China suffered as described by Xiao-Wei Xu etc. [7]. Symptoms including mild fever (axillary temperature between 37°C and 37.5°C), nasal congestion, headache, sore throat, shortness of breath, diarrhea, chills, nausea and vomiting were recognized as uncommon epidemic symptoms which may potentially be caused by COVID-19 [8-10] . Other symptoms, including palpitation, dizziness, unexplained abdominal pain, eye discomfort etc., were also recorded and categorized as unrelated symptoms. Re-attendance means the counselees had once consulted doctors no matter through online or offline

approaches before the current consultation. Epidemiological exposure refers to the history of travel or residence in Wuhan and surrounding areas within Hubei province, or other communities with case reports; as well as the history of contact with COVID-19 patients or contact with people with epidemic-related symptoms from Wuhan and surrounding areas, or from communities with case reports. All of the above epidemiological exposure should happen within 14 days before the onset of illness. Hypochondriacal suspicion means whether the counselees had clearly expressed their concern of being potentially infected by the novel coronavirus. Offline-visit recommendation means whether the online doctors had suggested of offline consultation. The counselees who had received offline-visit recommendations were considered as being in severe condition. Offline-visit motivation means whether the counselees had expressed their attempts to go to the offline clinics.

We classified the counselees into seven types, including healthy counselees, hypochondriacal counselees, exposed counselees, mildly suspicious counselees, moderately suspicious counselees, highly suspicious counselees and severely suspicious counselees (Figure 1). The healthy counselees had neither epidemic-related symptoms nor any epidemiological exposure history, simply asking epidemic-related questions without hypochondriacal suspicion. The hypochondriacal counselees had hypochondriacal suspicion without any epidemic exposure nor any epidemic related symptoms. The exposed counselees had epidemiological exposure history without epidemic related symptoms. The mildly suspicious counselees had certain uncommon epidemic symptoms without any common epidemic symptoms nor epidemiological exposure history. The moderately suspicious counselees had both uncommon epidemic symptoms and epidemiological exposure history without any common epidemic symptoms. The highly suspicious counselees had common epidemic symptoms without epidemiological exposure history. The severely suspicious counselees had both the common epidemic symptoms and the epidemiological exposure history.

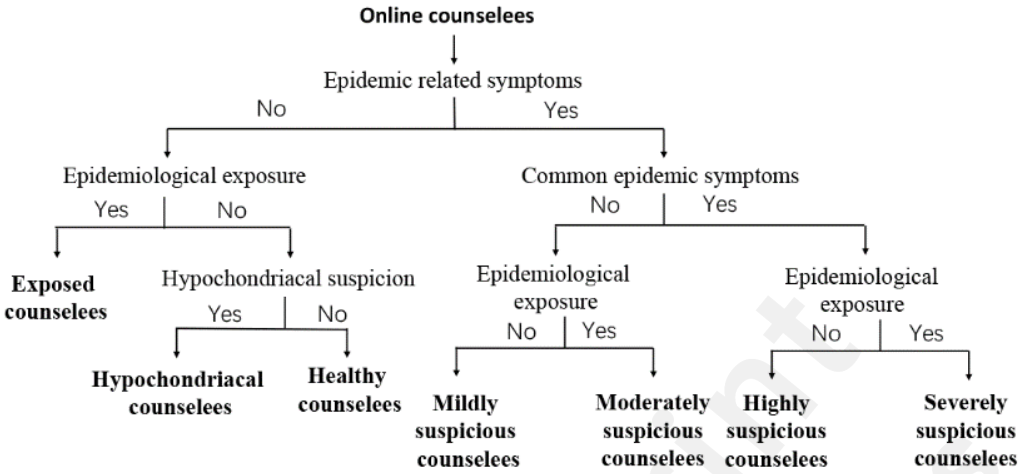

Figure 1: Classification of different counselees

Statistical Analysis

The amount and the percentage of counselees with positive hypochondriacal suspicion, offline-visit motivation and offline-visit recommendation were counted and calculated within different counselees' type groups. All symptoms were extracted and compared with reported COVID-19 patients [10]. Categorical variables were compared using Chi-square test. Cohen's kappa score was calculated to assess the consistency of the counselees' motivation and the doctors' recommendation for offline visit.

Univariate and multivariate logistical regression analyses were conducted to predict the risk factors for hypochondriacal suspicion and offline-visit motivation. Predictors that represented statistically significant in the univariate analyses ($P < 0.05$) were included in multivariate logistic regression models, with odds ratios (OR) and confidence intervals (CI) calculated. Epidemiological exposure history, adulthood, sex, severe illness condition, re-attendance and symptoms were considered as the predictors of hypochondriacal suspicion; all the above predictors, with the addition of hypochondriacal suspicion, were considered as the predictors of offline-visit motivation.

Statistical analysis was done by python (version = 3.6). The forest figure showing the results of logistic regressions was drawn by R (version = 3.6.2). $P<0.05$ was considered statistically significant.

Ethics Statement

Ethic approval was obtained from medical research ethics committee of the first affiliated hospital of Xiamen university, Xiamen, China (protocol number 3502Z2020YJ05) before execution.

Result

Characteristics of the Counselees

4913 consultations were finally enrolled for analysis including 2031 (41.3%) males and 2882 (58.7%) females. The median age was 28 years (inter-quartile range: 22-33 years). All children under 12 years old had completed online consultations by their guardians. 259 (5.3%) counselees had epidemiological exposure history. 4628 (94.2%) counselees had epidemic-related symptoms, among whom, 3733 (76.0%) had common-epidemic symptoms. 2165 (44.1%) counselees had hypochondriacal suspicion; and 869 (17.7%) were motivated for offline visit. 190 (3.9%) were in severe condition with affirmative offline-visit recommendation. Only 2 severe cases had no epidemic-related symptoms but both of them had hypochondriacal suspicion, with a 39-year-old male who felt precordial discomfort and a 2-year-old girl was found in the drowsy state by her parents. Most severe counselees were children less than 10 years old (102/190, 53.7%).

After classification, of all the counselees, 104 (2.1%) were healthy counselees, 147 (3.0%) were hypochondriacal counselees, 34 (0.7%) were exposed counselees, 853 (17.4%) were mildly suspicious counselees, 42 (0.9%) were moderately suspicious counselees, 3550 (72.3%) were highly suspicious counselees and 183 (3.7%) were severely suspicious counselees. Hypochondriacal suspicion and offline-visit motivation were common within different types of counselees. However, much fewer counselees had received affirmative offline-visit recommendations (Table 1).

Table 1: Hypochondriacal suspicion, offline motivation and offline recommendation in different counselees' type groups.

Counselees' type	Hypochondriacal suspicion		Offline-visit motivation		Offline-visit recommendation	
	n	%	n	%	n	%
Healthy counselees	0	0.0%	3	2.9%	0	0.0%
Hypochondriacal counselees	147	100.0%	18	12.2%	2	1.4%
Exposed counselees	32	94.1%	12	35.3%	0	0.0%
Mildly suspicious counselees	419	49.1%	132	15.5%	1	0.1%
Moderately suspicious counselees	38	90.5%	18	42.9%	0	0.0%

Highly suspicious counselees	1378	38.8%	635	17.9%	185	5.2%
Severely suspicious counselees	151	82.5%	51	27.9%	2	1.1%
Total number	2165	44.1%	869	17.7%	190	3.9%

Distribution of the Counselees' Symptoms

For counselees with epidemic-related symptoms, cough (2118/4628, 45.8%) was the most common symptom, following by fever (2021/4628, 43.7%), nasal congestion (981/4628, 21.2%), expectoration (752/4628, 16.2%), sore throat (735/4628, 15.9%), headache (443/4628, 9.6%), fatigue (415/4628, 9.0%), shortness of breath (365/4628, 7.9%), diarrhea (350/4628, 7.6%), myalgia (301/4628, 6.5%), nausea and vomiting (282/4628, 6.1%) , chills (16/4628, 0.3%) (see figure 2).

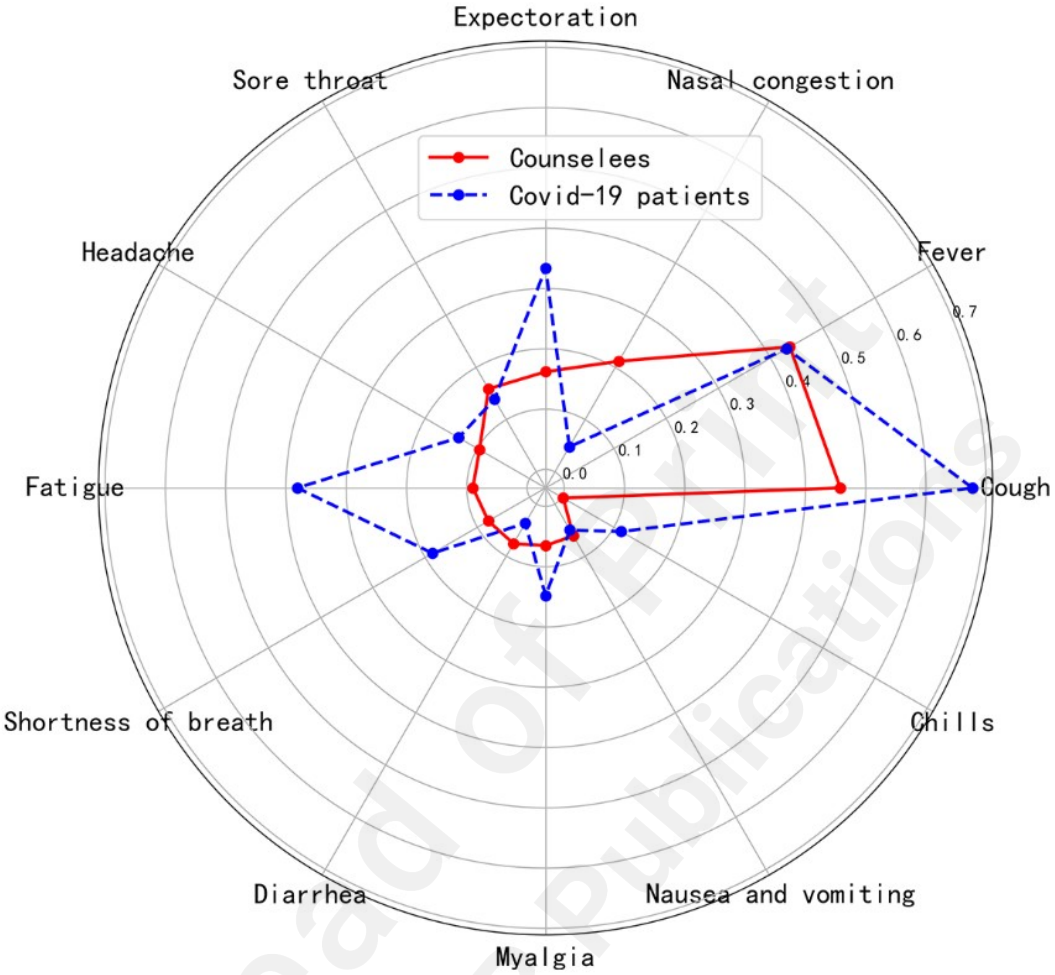

Figure 2: The symptom distribution of online counselees and COVID-19 patients

Improper Medical Seeking Behaviors

The counselees' motivation and the doctors' recommendation for offline visit were significantly different ($\chi 2=13.4230$, df=1, $p<0.001$) with Cohen Kappa score 0.039. There were 137 counselees who were in the severe condition but did not attempt for offline visit for further treatment, accounting for 72.1% of the total number of severe cases; as well as 816 counselees with mild conditions motivating for offline medical care without affirmative recommendation, accounting for 17.3% of the total number of non-severe cases.

Risk Factors for Hypochondriacal Suspicion and Offline-visit Motivation

The multivariate logistic regression models showed that epidemiological exposure, adulthood, shortness of breath, diarrhea and unrelated symptoms can independently increase the

probability of hypochondriacal suspicion; fever and cough can reduce the probability of hypochondriacal suspicion. Severe illness, fever, epidemiological exposure and hypochondriacal suspicion can increase the probability of offline-visit motivation; while re-attendant counselees were less likely to have offline-visit motivation (Figure 3).

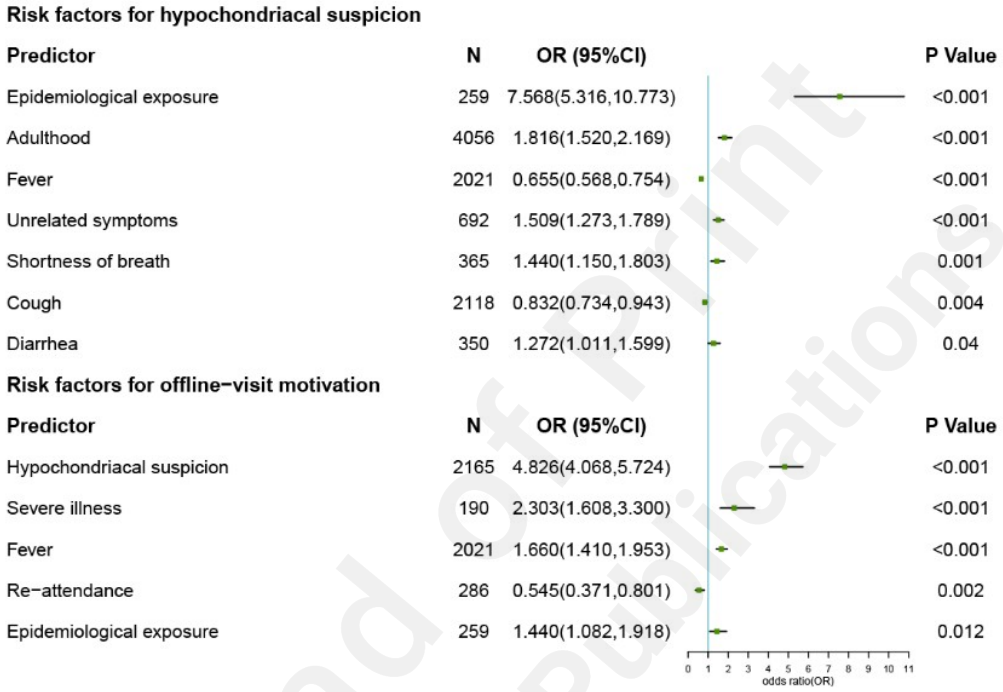

Figure 3: The independent risk factors for hypochondriacal suspicion and offline-visit motivation.

Discussion

Our results showed that the epidemic of COVID-19 brought panic and hypochondriacal mode to the public, further inducing improper health seeking behaviors and increased demand of medical care services. Along with the arrival of information times, the traditional management style could not adapt to the public's needs during the period of COVID-19. Internet hospitals may serve different type of epidemic counselees, helping prevent and control the epidemic of COVID-19 in China.

Medical Contradictions Brought by COVID-19

As the epidemic of COVID-19 in China overlapped with the high incidence for common cold and seasonal influenza [11], many of the residents got certain respiratory or other symptoms

similar with COVID-19 (Figure 2). A recent large epidemiological study found that physical symptoms (e.g., myalgia, dizziness, coryza), and poor self-rated health status were significantly associated with a greater psychological impact of the COVID-19 outbreak and higher levels of stress, anxiety, and depression among Chinese [12]. Our results showed that, nearly half of the counselees had hypochondriacal suspicion; besides epidemiological exposure, both epidemic-related and unrelated symptoms can exacerbate hypochondriacal mode, which can promote counselees' unnecessary motivation for offline visit. That's why a considerable proportion of counselees were motivated for offline visit without the doctors' recommendation. On the contrary, most of the counselees in severe conditions were reluctant to go offline clinic for fear of cross-infection. The counselees' motivation was significantly different with the doctors' recommendation, leading to improper health seeking behaviors, further bringing harm to the public health.

Under the stress of the epidemic, increasing number of people need professional medical guidance whereas the offline hospital visits should be strictly restricted to cut off nosocomial transmission routes. The demanding medical services and the inaccessibility of medical care became one outstanding contradiction during COVID-19. The internet hospitals may solve this dilemma by offering equitable and inclusive online services to assist the epidemic control [13].

Internet Hospitals in China During the Epidemic of COVID-19

After recent years of development, the internet hospitals in China now can break through the limitations of time and space with excellent accessibility, providing varieties of medical services to all citizens [14]. Through internet connections, interdisciplinary and cross-regional collaborations can be accomplished to improve the capability of dealing with emerging diseases. The Chinese government had encouraged internet hospitals to join the epidemic prevention and control at the very beginning of COVID-19 [5] and confirm their role as one important part of the joint epidemic prevention and control system [15]. On March 15, 2020, the first professional standard named "Specification for online consultation service for infectious disease epidemic situation" was published on the national group standard information platform of China [16], requiring the internet hospitals to provide 7*24 hours online services in response to the epidemic including pre-hospital services such as initial screening and medical education, intra-hospital services such as offline service appointment

and offline visit guidance, as well as post-hospital services such as psychological counseling, post services for medical records, report interpretation for re-attendant patients and drug delivery services for patients with chronic diseases. These services should cover all potential public's medical needs during the epidemic. Meanwhile, the internet hospitals were required to establish intact traceable health files for each counselee and share the data with the supervision departments including centers for disease control (CDC) and local health commissions.

Effects of Internet Hospitals on the Epidemic Prevention and Control

Through the above measures, internet hospitals may help prevent and control the epidemic of COVID-19 with both primary and auxiliary functions. In terms of primary functions, firstly, internet hospitals may reduce the crowd gathering in offline hospitals through multiple approaches. Through online education and propaganda [17], as well as psychological interventions, the online medical services not only teach the public essential epidemic-protective skills, but also alleviate the social panic and help release the public's hypochondriacal suspicion, thus reduce the unnecessary offline-hospital visits and enhance psychological resilience [18]. This is consistent with our results that there was less offline-visit motivation for the re-attendant counselees. Meanwhile, the various handy services provided by internet hospitals may reduce the patients' repeated visiting. These measures together may effectively reduce people gathering in offline hospitals [19]. Furthermore, internet hospitals run by public hospitals can connect the online services with the offline medical procedures, offering online triage services and guiding the counselees to the corresponding offline departments according to their symptoms [20, 21], making the suspected cases walk through isolated channels to the specialized out-patient clinic, thus reducing people's contact within hospitals, further reducing the chance of getting infected [7], what's more, protecting our medical stuffs, who are the major force to confront the epidemic [22], from massive offline workload and unnecessary occupational exposure [23, 24]. Secondly, the internet hospitals may play a greater role through the integration of online resources and offline epidemic-control efforts. As most of the provinces in China have initiated a level-1 public health response to control COVID-19, a joint prevention and control system with online information and offline screening network was established [25]. By information sharing, internet hospitals

can help recognize individuals with high probability of getting infected. Combined with the offline screening conducted by the epidemiologic investigation organizations and the community offices, online consultations and following up may reduce the risk of missed screening. Meanwhile, self-isolation [26, 27] was required for all symptomatic counselees and epidemiologically close contacts [28]. By identifying these counselees, the internet hospitals can facilitate offline supervision for potential undocumented cases and promote social distancing [29].

In the aspect of auxiliary functions, internet hospitals provide basic medical support to the public during the epidemic. Affected by the outbreak, numerous non-emergency outpatient departments got closed in Chinese hospitals, causing most of offline clinics unavailable for the public. Through internet hospitals, the patients could keep in touch with their attending doctors. For those who had new mild symptoms, the doctors may give professional advice on self-management of care and treatment. For those in severe conditions, online doctors may guide them to visit offline hospitals as soon as possible in case of deterioration. Besides, during the period of individual self-isolation, internet hospitals may join the social capital, improving life quality by reducing anxiety and stress [30].

Limitations of Internet Hospitals

While fully understanding the positive role played by internet hospitals during the epidemic, we should also realize their limitations. Firstly, online consultation is an indirect way of communication. Due to the lack of information such as physical and auxiliary examinations, online doctors may only give rough medical advices in general for primary-care patients. Secondly, most of the internet hospitals in China currently offer only passive order-based services to the public. In terms of epidemic screening, it is necessary to cooperate with offline approaches to make better use of the internet hospitals' online advantages. Thirdly, the audience of internet hospitals has not yet covered all the population due to the difference in public acceptance, which can be reflected by the unbalanced distribution of the counselees' age. Furthermore, the accessibility of internet is another limitation of internet hospitals.

Directions for Future Efforts

To make better use of internet hospitals during the epidemic, more efforts are needed, such as recruiting more doctors, especially psychologists [31] and pediatricians, to join the online

services while ensuring that each attending doctor has mastered the latest epidemic prevention and control knowledge; discovering the public's needs in a timely manner to adjust our response strategies; improving the usability of the internet-hospital applications and strengthening the propaganda to expand the user base; cooperating with the communities and the centers for disease control to improve joint control and prevention mechanism [32]. Meanwhile, a more standardized consultation service guideline is needed, enacting different response strategies according to different counselee's types. In our study, online education and propaganda are needed for all counselees; self-isolation guidance is needed for all suspicious and exposed counselees; psychological intervention is badly needed for hypochondriacal counselees; offline-visit recommendation is essential when the counselees were in severe conditions; the data of the suspicious counselees and the corresponding risk levels should be highlighted and shared through the joint control and prevention system run by the official agencies for further interventions.

Limitations and Conclusions

This study has some limitations. Firstly, our data was collected outside of Hubei province. In relatively low-prevalence areas, the hypochondriacal mode and the panic rate might be underestimated. Meanwhile, the characteristics of the counselees were collected according to their description rather than standardized questionnaires. Some symptoms might be neglected by the counselees, thus also be underestimated. Secondly, there are other forms of online consultation services, including paid services held by general public hospitals or private companies [33], which need further estimation. Besides, the following-up information after the online consultations were unavailable due to privacy reasons. More longitudinal studies are required to evaluate the counselees' compliance to the online services. Further studies may focus on how to optimize the online services during the epidemic and expand internet hospitals' beneficial influences to the public [34]. As COVID-19 has quickly became a global threat, all countries should consider a combination of response measures with telemedicine platforms involved [35]. According to our results, remote medical services are badly needed for the panic public. Internet hospitals can make targeted and tailored medical interventions for various types of counselees and help prevent and control the epidemic of COVID-19 in China.

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Authors' Contributions

Zhanxiang Wang contributed to the study concept and design. Zhefeng Cai and Yuxiu Chen contributed to acquisition of data. Kai Gong and Zhong Xu contributed to the semantic and statistical analysis. Kai Gong drafted the manuscript. All authors contributed to interpretation of the results and final approval of the manuscript.

Conflicts of Interest

Zhefeng Cai and Yuxiu Chen are employees of Zoenet Health Company limited which cooperated with public hospitals to offer the free online consultation services.

Abbreviations

COVID-19: novel coronavirus disease

OR: odds ratio

CI: confidence interval

CDC: centers for disease control

Multimedia Appendix 1

The complete results of logistic regression models.

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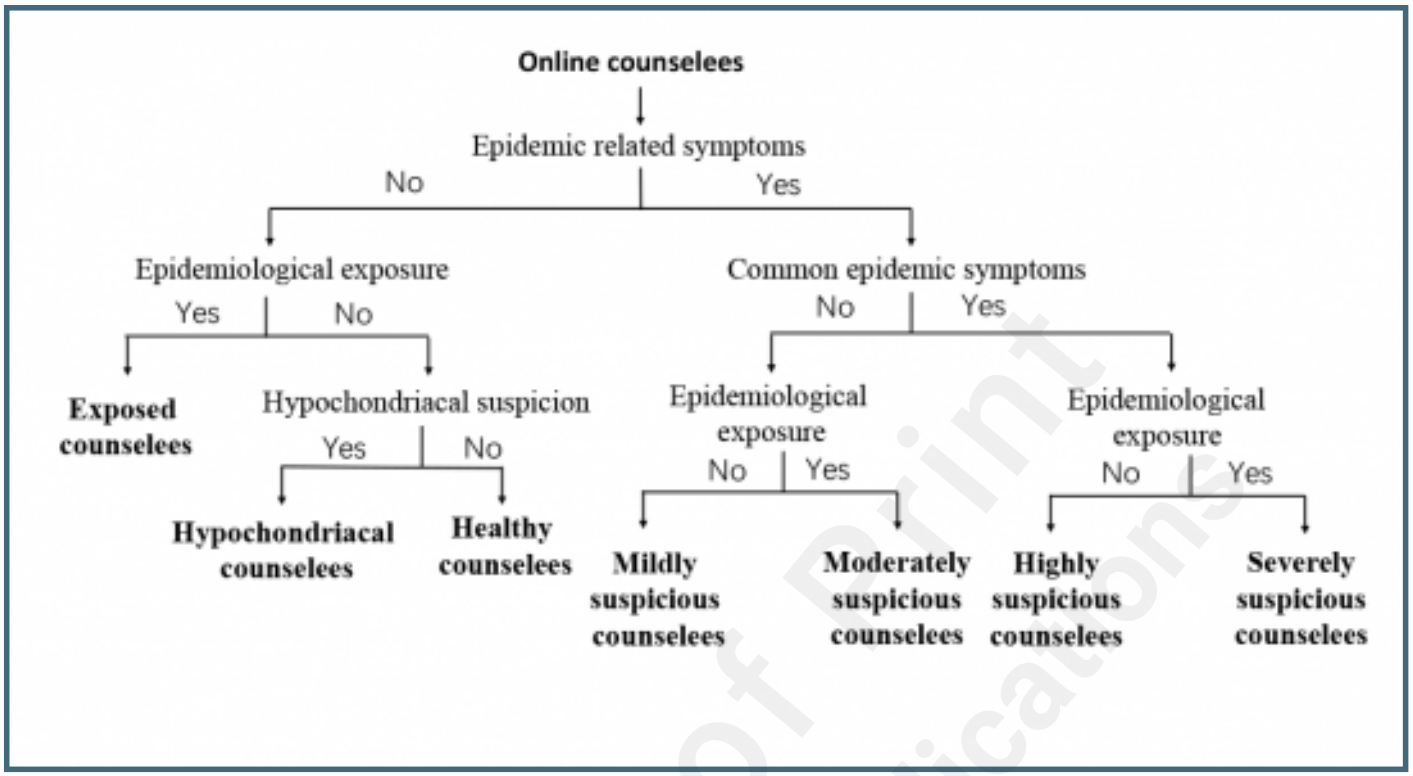
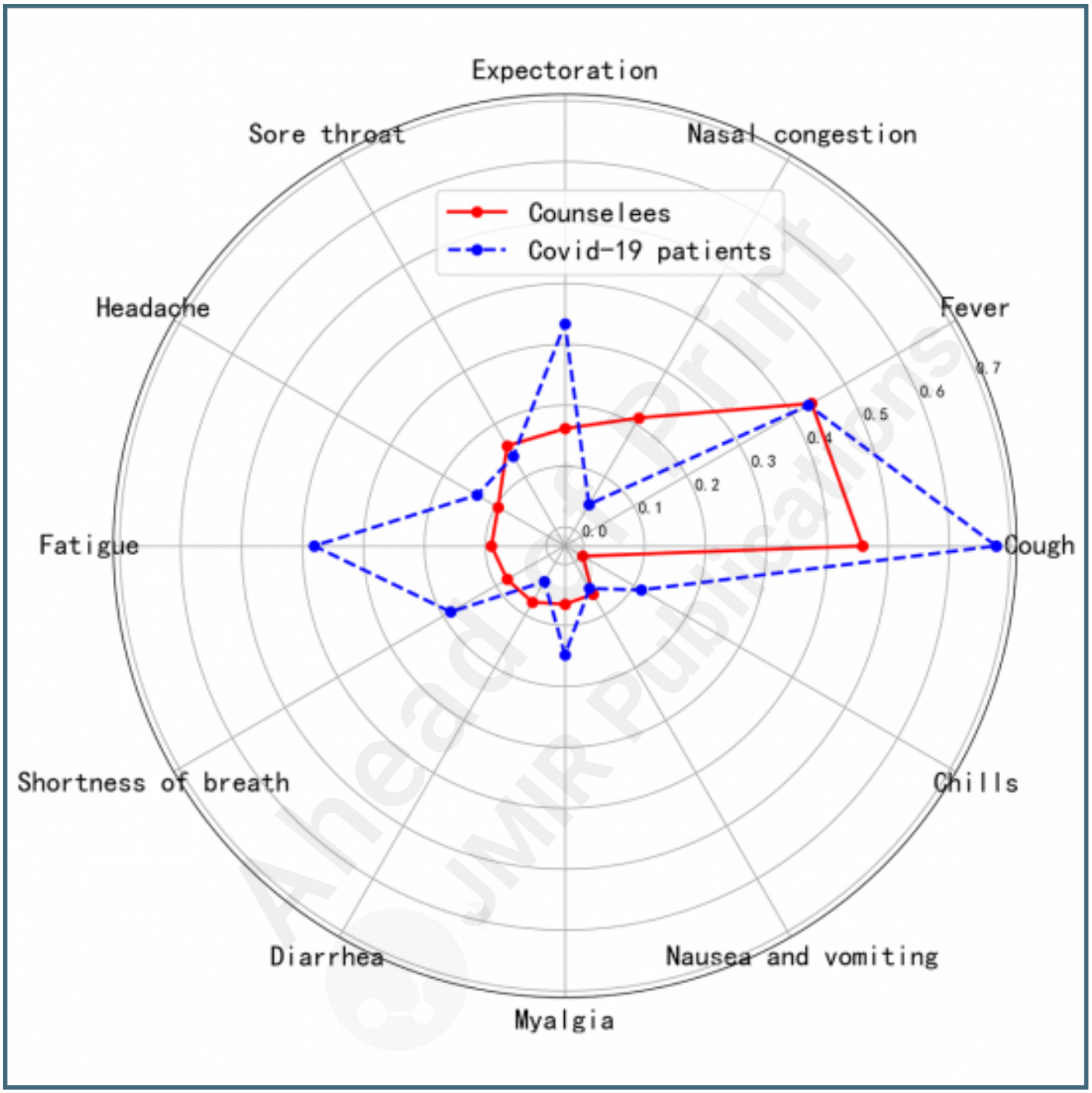
Supplementary Files

Figures

Classification of different counselees.



The symptom distribution of online counselees and COVID-19 patients. COVID-19: coronavirus disease.



The independent risk factors for hypochondriacal suspicion and offline visit motivation.

Risk factors for hypochondriacal suspicion

Predictor	N	OR (95%CI)	P Value
Epidemiological exposure	259	7.568(5.316,10.773)	<0.001
Adulthood	4056	1.816(1.520,2.169)	<0.001
Fever	2021	0.655(0.568,0.754)	<0.001
Unrelated symptoms	692	1.509(1.273,1.789)	<0.001
Shortness of breath	365	1.440(1.150,1.803)	0.001
Cough	2118	0.832(0.734,0.943)	0.004
Diarrhea	350	1.272(1.011,1.599)	0.04

Risk factors for offline−visit motivation

Predictor	N	OR (95%CI)	P Value
Hypochondriacal suspicion	2165	4.826(4.068,5.724)	<0.001
Severe illness	190	2.303(1.608,3.300)	<0.001
Fever	2021	1.660(1.410,1.953)	<0.001
Re−attendance	286	0.545(0.371,0.801)	0.002
Epidemiological exposure	259	1.440(1.082,1.918)	0.012

Other materials for editor/reviewers onlies

Revised manuscript with tracked changes.
URL: https://asset.jmir.pub/assets/3aacf8cbf903ce08e519ad32a5b05ef0.doc

Multimedia Appendixes

The complete results of logistic regression models.
URL: https://asset.jmir.pub/assets/f657d0f7a01240fc5d18e4185bd934d1.doc