Exploring the Impact of Doctors' Gratuitous Treatment Behavior on Their Online Consultations during the Covid-19 Epidemic

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Abstract: In 2019, the COVID-19 (Corona Virus Disease 2019) erupts. The outbreak of the epidemic has almost cut off the offline consultation channels across the region, while the Online Health Community (OHC) has relieved the urgent needs of patients seeking high-quality medical resources. To explore the influence of prosocial behaviors such as online gratuitous treatment by doctors on consultation volume during the COVID-19 epidemic, this study builds a model based on the prosocial theory and the Stressor-Strain-Outcome theory and applies Python data crawler and empirical analysis to the normative research method. The results indicate that the gratuitous treatment provided by doctors had a positive impact on the online consultation of patients, and the COVID-19 severity also had a moderating effect on this relationship. The results can not only provide theoretical innovation for online medical research but also provide new theoretical and practical perspectives for the continuous improvement of the user experience of OHCs.

1 INTRODUCTION

1.1 Background and Motivation

The COVID-19 broke out as a major threat to the health of the world. Countries involved in the outbreak introduced quarantine policies. However, the isolation measures adopted also cut off the normal access of many patients with non-epidemic diseases (Cheng-Wei, Xiu-Fen, & Zhi-Fang 2020). For some patients who are physically ill but cannot go to offline hospitals, online health communities (OHCs) can relieve the medical pressure brought by offline consultation through online treatment, reduce the risk of cross-infection, and provide people with timely, professional, and effective health guidance.

After the outbreak of the epidemic, the visits of OHCs kept rising. When there are major public disasters or health emergencies occur, gratuitous treatment plays a unique role in providing social assistance and spreading altruistic public welfare culture. As a kind of public welfare behavior under the theory of prosocial behavior, gratuitous medical consultation can save costs for patients, provide health guidance and prescription reference, and also play a positive role in the effective control of the COVID-19. Exploring how doctors' gratuitous treatment behavior in OHCs affects patients' consultation since the outbreak of the COVID-19 can not only help doctors get more attention and revenue from online consultation services but also help OHCs acquire and retain more high-quality doctor resources to achieve sustainable development.

2 LITERATURE REVIEW

As the importance of e-health becomes more obvious, a lot of studies related to OHC are emerging, and the research field is expanding (Alam, Wang, & Uddin 2020). The OHC is changing the way patients see a doctor and providing them with more access to medical knowledge. In addition, OHC can provide more health guidance for patients, including information guidance and emotional assistance (Kucukyazici, Verter, & Mayo 2011). Different from the traditional offline medical treatment mode, OHC can help allocate medical resources reasonably, free from time and space constraints, and open interaction process, which greatly increases the type of medical procedures and the reference value for others.

2.1 Online Consultation

Previous studies have focused on the factors influencing users' attention and selection of doctors in OHC. With the emergence of more and more online public welfare behaviors, scholars have gradually made incisive studies on doctors' gratuitous treatment under prosocial behavior and its impact on consultation and attention. Qing Liu et al. (Liu, Hong, Shen, & Juan 2019) collected doctors' data and conducted an empirical analysis to explore how online gratuitous treatment affects patients' choice, however, due to time limitations, the impact of the COVID-19 on them was not mentioned. The research of Abidin, Z. et al. aims to explore the factors influencing information sharing in OHCs from the perspective of social support, commitment-trust theory, and trust transfer theory.

2.2 Gratuitous Treatment

Xing Chen et al. (Chen, Zhang, Zeng, & Hu 2017) studied the potential benefits and spillover effects of contributors providing public welfare services on their own from the perspective of the motivation of prosocial behaviors. Research related to gratuitous treatment also paid more attention to what factors bring spillover effects of gratuitous treatment. Johnston et al. (Johnston, Worrell, Gangi, & Wasko 2013) explored that information utility and social support are two beneficial utilities obtained by participants in OHCs, which gives enlightenment to the study. In addition, Zhang Xing et al. (Zhang, Liu, Deng, & Chen 2017) investigated the external reputation, internal self-efficacy, altruism, and compassion motivation of doctors and users to build models and further research, which expanded the understanding of the motivations that may affect the free sharing of knowledge in the context of OHC.

3 MODEL CONSTRUCTION AND RESEARCH HYPOTHESES

3.1 Theory

3.1.1 Prosocial Theory and Cost-benefit Model of Helping

Prosocial behavior mostly refers to the benevolent behavior consistent with altruism. Wispé was the first to conceptualize prosocial behavior (Wispé 2010). With further development, Marjorie believes that prosocial behavior can not only bring benefits to others but also provide ways for individuals to integrate into social situations, thus promoting the improvement of their relationships. In addition, Penner discussed from the social level that prosocial behavior represents positive social value, is the embodiment of social service and responsibility, and is a vital part of building a harmonious society (Penner, Dovidio, Piliavin, & Schroeder 2005). Doctors and other public service providers carry out gratuitous treatment either out of compassion or out of potential benefits and spillover effects. Based on social exchange Theory, Dovidio (Dovidio, Piliavin, Schroeder, & Penner 2017) proposed to combine helping behavior with cost-benefit theory to explain individual helping motivation and behavior. According to this model, when people are in the situation of helping others, they will analyze and measure the possible benefits and costs of helping others to maximize their interests.

3.1.2 SSO Model

The "stressor-strain-outcome" (SSO) model was first proposed by Koeske in 1993, and has been widely recognized by the Academy of Psychology (Koeske & Koeske 1993). The model consists of three parts: all kinds of events are visualized as stressors, stressors bring about strain, and finally, people bring feedback with psychological or physical outcomes. If a patient has a cold, cough, fever, respiratory problems and other physical problems during this period, the public will feel extremely anxious and worry, and they are eager to seek guidance on health problems. But at the same time, isolation measures also block offline access to medical treatment, and people tend to choose professional doctors in online health communities for health assessment and self-diagnosis of diseases. In this study, major public health emergencies such as the COVID-19 can be regarded as stressors, psychological pressure brought by it and users' anxiety can be regarded as stress, and the treatment choices made by patients can be regarded as the outcomes.

3.2 Research Hypothesis

3.2.1 Influence of Doctors' Gratuitous Treatment on Their Consultations

According to prosocial theory and the cost-benefit theory of helping others, when doctors show altruistic behavior, especially when medical treatment is urgently needed in a major public crisis event, their

image leaves a good impression in the public mind, which helps personal impression management and reputation gain. For example, patients are more likely to choose gratuitous treatments providers than indifferent ones, because people are more likely to communicate and engage with altruists than self-interested ones.

Starting from prosocial behavior and cost-benefit theory, this study proposes the hypothesis that physicians who conduct charity consultation will receive more attention and consultation. In this report, the number of total physicians' gratuitous graphic consultations is used as an indicator of volunteer services, based on the theory that existing literature (Cheng-Yu 2016) uses physician service visits as a quantitative indicator to indicate the degree of physician participation, and the following hypothesis is proposed:

H1: *The number of a doctor's gratuitous treatments positively affects the number of online consultations by the users of that doctor.*

3.2.2 Influence of the COVID-19 Epidemic Severity on User Consultation

In the case of physiological problems and non-urgent diseases that can be solved by remote diagnosis, patients who have made online voluntary consultations have reported that it is difficult to go to offline hospitals because of the epidemic(Liu, Xi-Xiang, & Lei 2007), and they prefer online medical treatment. As the epidemic continues, people's irrational emotions will be stimulated to a deeper degree, while patients of all types will want to receive a lot of health guidance through online consultations. As a result, people are more likely to choose online counseling and consultation in the pandemic. This research proposes the following hypothesis:

H2: *The severity of the COVID-19 pandemic positively affects the number of online consultations of a doctor.*

3.2.3 Moderating Effect of the COVID-19 Epidemic Severity

Based on the OHC, doctors can protect themselves and make a great contribution to the fight against the pandemic by guiding patients with the advantages of convenient and rapid Internet remote communication and their professional skills. When the pandemic is severe, the impact of gratuitous treatment on online consultation services will increase, and conversely, when the pandemic is effectively contained, the impact of gratuitous treatment on online consultation services will moderate. This is because when the

pandemic is severe, various OHCs provide a platform for gratuitous treatment services to a wide range of users for reasons such as platform reputation enhancement and public service, which will prompt doctors to perform more online gratuitous treatment services, while under the SSO theoretical model, patients will be upset and thirsty for guidance on health issues during this period due to the fear of getting contaminated. It can be said that the epidemic has had an extremely broad impact on the public's way of accessing and choosing medical care. Therefore, this study proposes the following hypothesis.

H3: *The severity of the COVID-19 pandemic positively moderates the effect of doctors' gratuitous treatments on their online consultations.*

3.3 Model Construction

3.3.1 Model

This report investigates the impact of physician-provided volunteer services on the volume of user online consultations in OHCs during the COVID-19 epidemic.

Firstly, to investigate the effect of doctors' voluntary consultation behavior on users' online consultation volume. Secondly, investigate the effect of the severity of the epidemic on the number of online consultations by users. Lastly, investigate whether the severity of the COVID-19 epidemic affects the online consultation volume of users in OHCs.

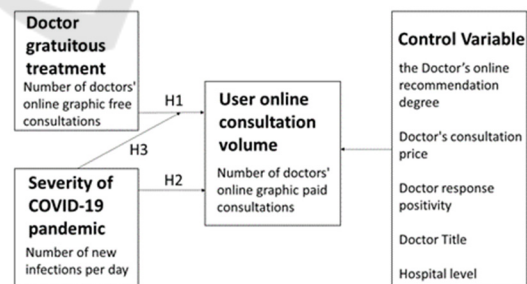Based on the research hypotheses constructed above, the conceptual model is proposed as below:

Figure 1: Model of the effect of physicians' online gratuitous treatment on their user consultations during the COVID-19.

3.3.2 Independent Variable and Dependent Variable

In this study, the number of doctors' daily voluntary graphic consultation is used as the independent

variable measure of gratuitous treatment behavior; the number of new confirmed COVID-19 cases per day is used as the independent variable measure of the severity of the COVID-19 pandemic, and the number of doctors' gratuitous treatment services in haodf.com is used as the dependent variable measure of users' online consultation volume.

Dependent variable: the number of online consultations.

Independent variables: severity of the COVID-19 pandemic and physician gratuitous treatment behavior.

3.3.3 Control Variable

The online consultation volume is influenced by many factors. In addition to the influence of the gratuitous treatment behavior under the severity of the COVID-19 pandemic, the doctor's online recommendation degree, online service satisfaction and service quality evaluation, doctor's consultation price, the doctor's title, and the level of the hospital where he/she is located all can influence the user's choice. In this research, we need to consider these control variables to reduce the error and establish a fairer and more objective model. The following variables are selected as the **control variables**:

The doctor's online recommendation degree: The feedback mechanism of list recommendation in OHCs can convey useful information to users and help patients to make their choices.

The doctor's consultation price: As patients do not have comprehensive information about the true quality of the service before they consult online (Baker 2015), they pay more attention to the doctor's popularity, reputation, etc., and use the price of the doctor's service as one of the criteria for their choice (Baker 2015). Since the asymmetry of information also brings uncertainty about the quality of the service (Akerlof 1978), the price is also an indicator for patients to measure and choose a doctor.

The doctors' response positivity: Doctors' motivation for online gratuitous treatments varies widely due to their wishes, such as medical ethics, work intensity, compensation patterns, and family situations. Information asymmetry can cause adverse selection and moral hazard (Akerlof 1978), while if doctors actively participate in consultation responses to mitigate patients' perceived risk, the positivity of doctors' responses can also be a measure of whether to choose that doctor's services.

The doctor's title: In this study, the doctor's title is set as 1 for resident; 2 for attending physician; 3 for the associate chief physician; and 4 for chief physician according to the title.

Hospital level: According to the Grading Management Standards for General Hospitals (Trial Draft), hospitals are divided into 3 grades, and each grade is further divided into 3 levels, A, B, and C. Due to the different medical levels, allocation of resources and hospital reputation, patients may prefer to choose doctors in high-grade hospitals, such as doctors in 3A hospitals, which indicates that hospital level may also be a factor influencing users' consultation. Due to the doctors' hospitals in our target OHC are mostly tertiary hospitals and above, so we set 3A hospitals as 1 and non-3A hospitals as 0.

3.3.4 Measurement Model

In this study, the ordinary least squares (OLS) model is used to test the hypothesis. This method is widely used in many disciplines of data processing such as error estimation, uncertainty, system identification and forecasting and prediction.

This section develops a multiple regression model based on the conceptual model described above.

$$\ln(Purchases_t - Purchases_{t-1}) \qquad (1)$$

is the dependent variable, indicating the number of daily paid online consultations by doctors in six months.

$$\ln(Purchases_t - Purchases_{t-1}) \qquad (2)$$

And

$$\ln Covid19_{t-1} \qquad (3)$$

are explanatory variables, denoting the number of physician visits per day and the number of new confirmed diagnoses per day of the new coronary pneumonia outbreak, respectively.

The control variables indicate the recommendation hotness, online consultation price, telephone consultation price, doctor's response positivity, doctor's title, and hospital level. In addition, β_o denotes the intercept in the multiple linear regression model, β_1 to β_9 denote the regression coefficients of each variable and interaction term, and ε_0 denotes the error term.

$$\ln(Purchases_t - Purchases_{t-1}) = \beta_o + \beta_1 \ln Free\ Services_{t-1} + \beta_2 \ln Covid19_{t-1} + \beta_3 \ln Free\ Services_{t-1} \times \ln Covid19_{t-1} + \beta_4 Recommendation_{t-1} + \beta_5 Online\ Price_{t-1} + \beta_6 Telephone\ Price_{t-1} + \beta_7 Response\ Positivity_{t-1} + \beta_8 Hospital\ title_{t-1} + \beta_9 Hospital\ level_{t-1} + \varepsilon_0$$

$$(4)$$

4 METHODOLOGY

4.1 Data Collection

The sample data for this article were collected from Haodf.com. It has become one of the fastest, largest and most competitive websites in the domestic OHC market. Its services and design and construction are increasingly perfect, and established the most mature and effective set of online appointment, consultation, registration, referral services and other functional mechanisms in China. In addition, Haodf.com with its detailed hospital, doctor reference information, timely high-quality consultation information transmission, reasonable and effective service guarantee, good service feedback mechanism in the current online medical market enjoys a high-quality and efficient reputation. Up to July 2021, it has collected 785,264 doctors from 9,683 regular hospitals and 240,515 doctors from public hospitals.

It can be seen that the research on OHC based on it is sufficient and persuasive.

This study uses Python for data crawling and statistics. The data sources of this study are mainly the online consultation data and gratuitous treatment data of pneumonia doctors with high reputation from January 22, 2020, to July 23, 2020, with a total of 6,202 items. The COVID-19 data are from the daily surveillance data provided by the National Health Commission and Netease News.

4.2 Data Analysis

By matching each variable according to the date and the doctor's name, delete the missing samples of the online recommendation degree in the past two years, and the recommendation outliers with a degree of 0 or negative and incomplete doctor data with too much missing information are deleted. The main variables are tailed at the one-hundredth level, and the logarithmic value is taken.

Table 1: Descriptive Statistics.

variable	N	mean	sd	min	max
Purchases	6202	5.026	0.574	4.077	6.410
Free Services	6202	2.513	1.376	0	5.069
Covid19	6202	3.793	2.119	0.693	9.626
Title	6202	3.450	0.730	1	4
Hospital level	6202	0.971	0.169	0	1
Recommendation	6202	3.752	0.374	3.300	5
Response positivity	6202	4.329	1.577	0	7.559
Online price	6202	4.665	1.079	1.792	7.090
Telephone price	6202	4.844	0.965	2.303	7.313

In the 6,202 valid data after cleaning, the average value of a doctor's online recommendation in the range of 3.3 to 5 is 3.752, and the average difference is 0.374, indicating that overall doctors' recommendation is relatively ordinary and average. The average level of doctors' professional titles is very high, reaching 3.450 within the division range of 1 to 4, indicating that the doctors who conduct online consultations in Haodf.com are mostly chief physicians and associate chief physicians with intermediate and senior professional titles. The average level of the doctor's hospital is 0.971, which shows that doctors on Haodf.com generally work in the top three hospitals. It reflects that the OHC provides a platform for high-level doctors from major hospitals to serve, consult and guide their patients' health and develop themselves.

4.3 Empirical Analysis

We use Stata as a tool to perform OLS regression statistical analysis. The empirical model results are

shown in Table 2 and Table 3. This work adopts stepwise regression.

Model 1 is the original model without regulating variables and other control variables. Model 2 adds gratuitous treatment* epidemic situation as the regulating variable for analysis, and model 3 adds other control variables for analysis. Model 1 shows that two variables, the number of online gratuitous treatments by doctors, and the severity of the new crown epidemic have a significant positive impact on the amount of online paid consultations by users. Among them, the number of online gratuitous treatments by doctors significantly positively affects the amount of online paid consultations (β=0.178***, p<0.01), and H1 has been verified; the severity of the new crown epidemic has a significant positive impact on the amount of online paid consultations (β= 0.146***, p<0.01), H2 is verified. Model 2 adds an interaction term to consider the moderating effect of the severity of the new crown epidemic on doctors' gratuitous treatment behavior. According to Table 3, the severity of the new crown epidemic significantly positively regulates the impact of gratuitous

Table 2: Correlation coefficient matrix.

	Purchases	Free Service	Covid19	Title	Hospital level	Recommendation	Response positivity	Online price	Telephone price
Purchases	1								
Free Services	0.8426*	1							
Covid19	0.8679*	0.7720*	1						
Title	-0.0356	-0.0371	-0.034	1					
Hospital level	0.0297	0.0398	0.0288	0.0074	1				
Recommendation	0.0673*	0.0652*	0.0644*	0.0819*	0.1362*	1			
Response positivity	0.0754*	0.0689*	0.0661*	0.0095	0.1512*	0.2914*	1		
Online price	-0.0788*	-0.0727*	-0.0718*	0.2678*	0.0646*	0.039	0.4013*	1	
Telephone price	-0.0811*	-0.0740*	-0.0715*	0.2313*	0.0472*	-0.0555*	0.3287*	0.8724*	1

* means p<0.01

Table 3. Regression model results.

	(1)	(2)	(3)
Free Services	0.178***	0.176***	0.075***
	(37.12)	(36.88)	(14.95)
Covid19	0.146***	0.144***	0.043***
	(44.07)	(41.60)	(3.95)
Covid19* Free Services		0.005***	0.030***
		(4.92)	(14.18)
Title			-0.002**
			(-0.52)
Hospital level			0.019**
			(1.15)
Recommendation			0.002**
			(0.25)
Response positivity			0.004**
			(1.96)
Online price			0.002
			(0.36)
Telephone price			-0.005
			(-0.68)
_cons	4.026***	4.033***	4.333***
	(626.62)	(605.96)	(97.02)
N	6202	6202	6202
r2_a	0.827	0.827	0.842

* means p<0.10, ** means p<0.05, *** means p<0.01, the heteroscedasticity robust standard error is in parentheses

treatments on the amount of online paid consultations (β=0.005***, p<0.01), and H3 has been verified. Compared with Model 1, Model 3 adds more control variables to improve the explanatory ability of the model, including the doctor's position, whether the hospital is a top three, online recommendation, doctor's response enthusiasm, graphic consultation price, telephone consultation price. The results show that among the selected adjustment variables, the doctor's title, whether the hospital is a top three, the degree of online recommendation, and the doctor's response enthusiasm all significantly affect the amount of online paid consultations, and the effect of the price of the consultation on the amount of online paid consultations Not significant. The fit has risen slightly, which also verifies the hypothesis.

5 CONCLUSIONS

5.1 Discussions

Based on the prosocial theory and SSO theory, this study constructs a model of the influence of doctors' gratuitous treatment behavior on their consultation volume under the COVID-19 epidemic. It enriches the empirical research on the influence of prosocial behaviors (public welfare services) on the consultation of service providers under public health emergencies, and at the same time proves the significant strengthening effect brought by the pressure of the epidemic. Supplements-related research on gratuitous treatment and public service in the OHC.

The results showed that the number of doctors participating in gratuitous treatments is positively affecting the number of doctors' online paid consultations. If doctors provide effective and reliable gratuitous treatment services, people will be impressed by them and will be more willing to follow up online consultations. At the same time, the more doctors are consulted, people tend to think that the services of such doctors are efficient and quality, which can alleviate the potential risks of patients, so they can choose to provide health guidance and improve doctors' benefits. Therefore, if doctors want to increase the income of paid consultation services, they can provide gratuitous treatment services in their spare time, such as free guidance and public consultations for patients in backward areas or patients with a specific disease.

5.2 Implications and Limitations

5.2.1 Suggestions for Doctors

In the face of a major public emergency crisis represented by the COVID-19 epidemic, doctors in the OHC, as service providers, actively participate in gratuitous treatments, establish a public image, and make contributions to society within their capabilities, which can attract more patients. The results of this study show that before patients choose counseling services, patients will take into account factors such as online recommendation, response enthusiasm, job title, service price and other factors, they will also refer to doctors' enthusiasm for participating in public welfare consultations. The reason is that the more doctors participate in gratuitous treatments, the more they are willing to give, get close to society, and be kind to others, and they have the ability and enthusiasm to provide consultation services.

5.2.2 Suggestions for the OHC

The OHC can improve the incentive mechanism and incentive policies, and call for the promotion of more free clinic activities that serve the society. The results of the study indicate that doctors' participation in public welfare consultations is beneficial for patients to choose online paid consultation services; The OHC managers should encourage doctors to participate more in gratuitous treatment services. At the same time, incentive mechanisms and incentive policies need to be designed and improved to encourage word-of-mouth doctors to participate more. The free clinic service of the company fulfills social responsibility and sets an example; at the same time, it also encourages doctors with lower reputations or standards to improve their abilities and provide better and more popular consultation services. This will not only help maintain the retention of high-quality doctors but also enable the website to enjoy a public good image, improve reputation and word of mouth and enhance its competitiveness.

5.2.3 Limitations

Due to the design of the Haodf.com, the service quality evaluation for a single consultation cannot be obtained, and it can be supplemented and researched according to other OHCs in the future. In addition, the cross-sectional data is used in this article for discussion. In the future, panel data can be used to track changes in online consultations to obtain more accurate results.

5.3 Conclusions

In the context of the OHC, this study explores the influence of prosocial behaviors such as online doctors' online gratuitous treatments on the number of consultations during the COVID-19 epidemic. The results confirmed that the provision of gratuitous treatment services by doctors has a positive impact on patient online consultation. At the same time, doctors are affected by the COVID-19 epidemic and have carried out more online public service behaviors. This behavior also has an impact on the increase in online consultations. The results can not only provide theoretical innovations for research in the online medical field but also provide practical guidance for public welfare behavior and OHC development.

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