BMJ Open

Determinants of physicians' online medical services uptake: a cross-sectional study applying social ecosystem theory

Xueqing Peng,[1] Zhiguang Li,[2,3] Chi Zhang,[4] Rui Liu,[5] Yongzhi Jiang,[5] Jiayu Chen,[3] Zixin Qi,[5] Jinjin Ge ,[1] Shiqi Zhao,[1] Meng Zhou,[4] Hua You [1,4]

To cite: Peng X, Li Z, Zhang C, *et al*. Determinants of physicians' online medical services uptake: a cross-sectional study applying social ecosystem theory. *BMJ Open* 2021;**11**:e048851. doi:10.1136/bmjopen-2021-048851

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2021-048851).

XP, ZL and CZ contributed equally.

Received 08 January 2021
Accepted 06 September 2021

Check for updates

© Author(s) (or their employer(s)) 2021. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to
Dr Hua You;
youhua98@163.com

ABSTRACT

Objective To investigate the determinants of willingness and practice of physicians' online medical services (OMS) uptake based on social ecosystem theory, so as to formulate OMS development strategies.

Design Cross-sectional survey.

Setting Research was conducted in two comprehensive hospitals and two community hospitals in Jiangsu, China, and the data were gathered from 1 June to 31 June 2020.

Participants With multistage sampling, 707 physicians were enrolled in this study.

Outcome measure Descriptive statistics were reported for the basic characteristics. χ^2 test, Mann-Whitney U test and Spearman's correlation analysis were used to perform univariate analysis. Linear regression and logistic regression were employed to examine the determinants of physicians' OMS uptake willingness and actual uptake, respectively.

Results The mean score of the physicians' OMS uptake willingness was 17.33 (range 5–25), with an SD of 4.39, and 53.3% of them reported having conducted OMS. In the micro system, factors positively associated with willingness included holding administrative positions (b=1.03, p<0.05), OMS-related awareness (b=1.32, p<0.001) and OMS-related skills (b=4.88, p<0.001); the determinants of actual uptake included holding administrative positions (OR=2.89, 95% CI 1.59 to 5.28, p<0.01), OMS-related awareness (OR=1.90, 95% CI 1.22 to 2.96, p<0.01), OMS-related skills (OR=2.25, 95% CI 1.35 to 3.74, p<0.01) and working years (OR=2.44, 95% CI 1.66 to 3.59, p<0.001). In the meso system, the hospital's incentive mechanisms (b=0.78, p<0.05) were correlated with willingness; hospital advocated for OMS (OR=2.34, 95% CI 1.21 to 4.52, p<0.05), colleagues' experiences (OR=3.81, 95% CI 2.25 to 6.45, p<0.001) and patients' consultations (OR=2.93, 95% CI 2.02 to 4.25, p<0.001) were determinants of actual uptake. In the macro system, laws and policies were correlated with willingness (b=0.73, p<0.05) and actual uptake (OR=1.98, 95% CI 1.31 to 2.99, p<0.01); media orientation was also associated with willingness (b=0.74, p<0.05).

Conclusion Multiple determinants influence physicians' OMS application. Comprehensive OMS promotion strategies should be put forward from multidimensional perspectives including the micro, meso and macro levels.

Strengths and limitations of this study

- ► This study is one of the first to interpret the determinants of online medical services (OMS) uptake among physicians.
- ► Social ecosystem theory was applied as the theoretical framework to explore the multidimensional determinants of OMS uptake.
- ► This was a cross-sectional study; no causal relationships were identified.
- ► The causes that can explain the correlations still need to be verified through qualitative research.

INTRODUCTION

'Universal health coverage' (UHC) is the primary goal of the WHO; the key to achieving it is to ensure that everyone has timely access to necessary healthcare services.[1] Online medical services (OMS) refers to health services and information delivered or enhanced through the Internet and related technologies, including disease consultation, telemedicine, online re-examination, chronic disease management, rehabilitation guidance and so on.[2 3] Generally, there are many ways to conduct OMS, such as videoconferencing, telephone audio, text information exchange.[4] In China, OMS are usually carried out on specific internet medical platforms (eg, Doctor Chunyu, WeDoctor, haodf.com, and the internet hospitals built by physical medical institutions), which can provide varieties of ways to conduct OMS.

As a novel medical service mode that uses the internet as the carrier, and which integrates both traditional medical and health services, OMS plays a vital role in narrowing the gap between medical resources and realising UHC. Due to a vast territory and large population, the uneven development of medical services between urban and rural zones has become a long-term, disturbing

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

issue in China; the emergence of OMS provides an effective solution. Cao and Wang[5] found that OMS can promote the flow of health resources from urban to rural areas and reduce the health gap between them. Moreover, OMS have exerted great effects on reducing the risk of cross-infection[6] and delaying the spread of pandemics such as COVID-19.[7] There is a rapid expansion of OMS during the COVID-19 pandemic,[8] but many barriers of OMS uptake and expansion still exist, especially during the post-pandemic.

In spite of developing OMS has crucial practical value for building health services (eg, reducing healthcare costs, improving the medical services' efficiency,and increasing access to services, etc), in China, however, the OMS employed have always been at a low level. According to the 46th China Statistical Report on Internet Development,[3] among the country's 276 million netizens, only 29.4% have participated in OMS. A number of studies have been conducted to try to identify the causes of the underuse of OMS. An extensive body of research has focused on the OMS demand side (patients),[9–11] but ignored OMS providers. As a direct provider of OMS, physician's application of OMS is crucial for OMS development.

Physicians tend to have a positive view of OMS.[12 13] For example, Levine *et al*[14] carried out a study where primary care providers were interested in applying telemedicine when caring for older adults with chronic, non-cancer pain for cost and time efficiency. However, certain factors hindered the physicians from adopting OMS. Prior research has discovered that these obstacles primarily include physicians' deficits in cognition[15 16] and skills[17] as well as inadequate external funding and equipment support.[18] Since the factors discussed in existing studies are relatively scattered, there is a lack of holistic exploration. Moreover, preceding research tends to focus on individual factors,[12 19] but comparatively lacks an investigation of external factors, so the revealed factors are not sufficient.

Social ecosystem theory (SET) involves humans and their living environments and states that individual behaviour is affected by many internal and environmental factors, forming micro, meso and macro ecosystems, respectively.[20] In the micro system, it pertains to individual demographics, health conditions, awareness of information and others; the meso system mainly entails those directly related to individuals, such as families, communities, organisations, institutions and so on; and the macro system usually includes policies, culture, social norms and so on.[21] Inspired by SET, multilevel interventions have been carried out that seek to create changes on diverse levels; for instance, by increasing individuals' health literacy, as well as by modifying social norms within communities.[22] In one study, researchers used programmes based on the social ecological framework to enrich their understanding of the behaviour of complying with a children's asthma action plan among caregivers and providers. They inferred that such comprehensive intervention programmes are suitable for other health behaviours.[23] A previous study had applied the social-ecological framework to explore the individual and contextual determinants of telemedicine utilisation among Senegal's physicians. And the meso and macro level determinants were merely explored by qualitative interview.[24] To the best of our knowledge, however, there has been little research on SET's application to enriching social and cultural dimensions in grasping the behaviour of OMS offerings.

This study comprehensively explores the determinants of OMS application among physicians from three levels on the basis of SET (micro, meso and macro systems) and provides an insightful, comprehensive foundation for the development of OMS.

METHODS

Study design and participants

A cross-sectional survey was carried out from 1 June to 31 June 2020 in Jiangsu Province, China. Multistage sampling was used to select the participants. In the first stage, two cities were randomly selected (Nanjing and Huai'an in northern and southern Jiangsu province, respectively). In the second phase, two large comprehensive hospitals and two community hospitals were randomly selected from each city. Finally, in the sampled hospitals, physicians (with the job title of resident physician and above) were summoned to department conference rooms together to participate in our survey. After trained investigators have explained the purpose of the study to participants and obtained their informed consent, all these participants were required to complete a structured questionnaire anonymously within 30 min. About 719 entitled physicians were recruited for our investigation. After excluding incomplete questionnaires, a total of 707 completed questionnaires were gathered for analysis, with an effective response rate of 98.3%.

Measurement tools

This study adopted a self-designed questionnaire. To develop the questionnaire, our research team first formulated the initial questions pool by learning the SET framework and referencing the OMS utilisation-related published studies. Through multiple discussions between study team members, we drafted the first version of questionnaire. To ensure the content validity of the questionnaire, we invited experts to review the first draft of the questionnaire and modified it according to their comments. Then, we piloted the questionnaire among 20 physicians from different hospitals to test whether the questions were understandable and clear. After re-review by experts, we formed the latest version of questionnaire.

Specifically, the questionnaire consists of two parts.

Questions based on SET

The micro system contains basic characteristics, awareness of OMS-related information and OMS-related skills, with a total of 18 questions. Basic demographic characteristics

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

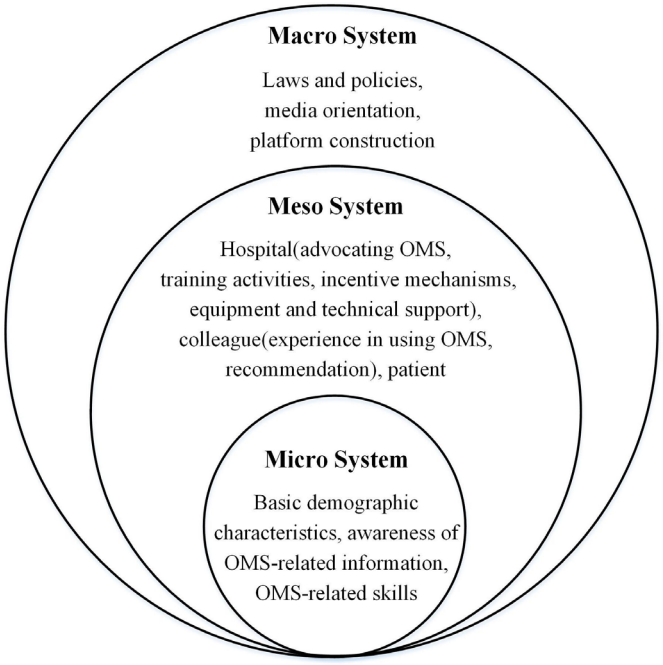


Figure 1 The constructs of the online medical services (OMS) uptake questionnaire based on social ecosystem theory.

(seven questions) include gender, age, education, job title, years of work experience, department and administrative positions[25 26]; for awareness of OMS-related information, five items were used to measure whether physicians sufficiently know about it.[27] For example, 'Physicians can conduct OMS in multiple online medical platforms at the same time', with choices of Yes/No/I don't know; and the OMS-related skills refer to some of the skills necessary to offer OMS,[28 29] and five items were used to measure whether physicians sufficiently possessed these skills. For example, 'Can you operate the online medical platform proficiently?', with choices of Yes/No (figure 1).

The meso system mainly involves influencing factors from the environment directly related to physicians, such as patients, colleagues, hospitals and so on. It entails whether hospitals advocate for OMS, hold training activities for physicians, formulate incentive mechanisms, and have adequate equipment and technical support; colleagues' experience in using OMS, colleagues' recommendation for OMS uptake; patients' consultations[30–33]; with a total of seven questions. For example, 'Has the hospital ever conducted OMS training activities?', 'Have the colleagues or leaders recommended OMS to you?', and 'Have offline patients asked about your experience in providing OMS?'. All of those were Yes/No questions.

The macro system refers to the outer environmental factors that affect physicians' OMS uptake, such as culture, laws and policies and so on. In this study, we measured it from three aspects, including the laws and policies on medical disputes, media orientation and the platform construction,[29 34 35] with a total of five questions. The first two aspects include only one Yes/No question. For example, 'Whether the laws and policies can well solve the medical disputes occurred in the online medical process will affect you conducting OMS?'. Platform construction refers to the features of the platforms used to conduct OMS; it was tested by three Yes/No questions, including legitimacy, humanistic care for physicians, and the proportion of withdrawing diagnostic fees. For example, 'Whether the legitimacy of the online medical platform will affect you conducting online medical services?'.

OMS uptake by physicians

The content of this part mainly includes two measurement contents, that is, OMS uptake willingness and actual OMS uptake. The measurement of OMS uptake willingness includes five scaled items. For example, 'I will provide OMS to patients when needed'. Each item comprises a Likert scale ranging from absolutely disagree (1 point) to absolutely agree (5 points), with a total score ranging from 5 to 25. A higher score signals a greater level of OMS uptake willingness. To test the internal consistency and reliability, we calculated this scale's Cronbach's alpha, which was 0.94. The actual OMS uptake was measured by one question—'Have you used OMS to provide medical services to patients before?'. If the physicians answered 'Yes', it meant that they have actually provided OMS; otherwise, they have not provided.

See online supplemental file 1 for all the above questionnaire questions.

Data analysis

There were two dependent variables for this study; one was the OMS uptake willingness, and another was actual OMS uptake.

The independent variables were micro, meso and macro system-related factors based on SET. Participants were considered to possess sufficient OMS-related awareness and skills if they correctly answered three or more questions in the sections on information and skills, respectively. If the answer to any one of the questions in the section on platform construction was affirmative, then the participant was deemed to be affected by platform construction.

In the descriptive analysis, frequency, percentage, mean and SD were used. Kolmogorov-Smirnov was used to test the normality of continuous variables. In the univariate analysis, according to the normality test outcomes, Mann-Whitney U tests were performed to compare OMS uptake willingness among different categorical independent variables groups; Spearman's correlation analyses were used to test the correlations between continuous independent variable and OMS uptake willingness. The comparisons of continuous independent variable among two actual OMS uptake groups were conducted by Mann-Whitney U test, and χ^2 test was used to compare categorical independent variables among two actual OMS uptake groups. Taking these independent variables with $p<0.1$ in the univariate analysis as candidate variables for the stepwise selection procedure of multivariate analysis is a standard statistical method commonly employed to screen independent

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

variables.[36] Hence, in this study, those independent variables with p<0.1 in the univariate analysis were taken as candidate variables for the next multivariate analysis. Multivariate, linear, stepwise regression was performed to explore the determinants of the OMS uptake willingness, and multivariate, forward, stepwise logistic regression was carried out to explore the determinants of actual OMS uptake.

Data were statistically examined using the software SPSS, V.25.0. All statistical tests were two-tailed, and p<0.05 was considered statistically significant.

Patient and public involvement

The public and patients were not involved in the survey design, administration of the survey, reporting or the dissemination plans of this research.

RESULTS

Basic characteristics

Based on the 707 valid questionnaires, the participants were, on average, 35.53 years old; 51.8% were male and 48.2% were female. Nearly half (45.7%) of them reported having a master's degree. Attending physicians comprised the majority of job titles (35.6%). The share of physicians and surgeons was not much different. Years of work experience varied; 22.9% reported having worked less than 3 years, 13.0% 3–5 years, 25.7% 5–10 years, 15.7% 10–15 years, and the remaining 22.6% more than 15 years. Only 12.4% held administrative positions. Stratified, the basic demographic characteristics of physicians in community and comprehensive hospitals were similar. But the education level of physicians in comprehensive hospitals is higher than that of community hospitals physicians. The mean score for OMS uptake willingness was 17.33±4.39. 377 physicians stated they had offered OMS, accounting for 53.3%; the proportion of OMS uptake among comprehensive hospital physicians (54.5%) was higher than that among community hospital physicians (28.1%). (See table 1 for details.)

SET-related determinants (except for demographic characteristics)

Table 2 displays the participants' answers to SET-related determinants. Micro system-related factors (besides the basic characteristics of the participants mentioned in table 1) accounted for 1/4 of the participants who did not possess sufficient OMS-related awareness. Nearly 1/5 of them did not have sufficient OMS-related skills. For meso system-related factors, the participants mostly gave affirmative answers. For macro system-related factors, they mainly gave negative answers, except for factors related to media orientation and the legitimacy of the platform. After stratified by hospital level, almost all SET-related determinants had similar compositions except for 'OMS advocated by hospitals'. 68.8% of community hospital physicians reported that hospitals do not advocate for OMS, compared with only 8.4% in comprehensive hospitals.

Univariate analysis

Univariate analysis demonstrated that physicians' OMS uptake willingness was not statistically affected by their age, education, years of work experience, job title, hospital level and online medical platform construction. The physicians' education and online medical platform construction did not show a significant difference in actual OMS uptake. The factors with statistical differences were presented in table 3.

Determinants of OMS uptake willingness

Table 4 depicts the results of the multivariate linear regression for physicians' OMS uptake willingness. In the micro system, physicians who held administrative positions were more willing to offer OMS (b=1.03, p<0.05). Possessing sufficient awareness of OMS-related information (b=1.32, p<0.001) can increase physicians' OMS uptake willingness, and likewise with possessing sufficient OMS-related skills (b=4.88, p<0.001). In the meso system, incentive mechanisms in hospitals (b=0.78, p<0.05) could have boosted physicians' OMS uptake willingness. In the macro system, physicians who believed that laws and policies can resolve medical disputes in OMS were more willing to offer OMS (b=0.73, p<0.05). Those who reported that they would be influenced by media orientation (b=0.74, p<0.05) were also more willing to offer OMS. The six variables explained 31.4% of the variance in physicians' intentions to offer OMS.

Determinants of actual OMS uptake

Table 5 portrays the outcomes of the multivariate logistic regression for physicians' actual OMS uptake. In the micro system, significant differences were observed for years of work experience, holding administrative positions, and possessing sufficient awareness of OMS-related information and OMS-related skills. Physicians with more than 5 years of work experience (OR=2.44, 95% CI 1.66 to 3.59) reported a higher uptake of OMS than physicians with less than 5 years. Physicians who held administrative positions were more likely to offer OMS (OR=2.89, 95% CI 1.59 to 5.28) than physicians without them. Possessing sufficient awareness of OMS-related information (OR=1.90, 95% CI 1.22 to 2.96) and skills (OR=2.25, 95% CI 1.35 to 3.74) were facilitating factors for OMS. In the meso system, the likelihood of offering OMS was significantly higher for physicians from hospitals that advocated for OMS. Physicians who heard about their colleagues' experiences with OMS (OR=3.81, 95% CI 2.25 to 6.45) were more likely to offer OMS. Physicians who had been asked by their offline patients about OMS reported a higher use of OMS than those who had never been asked. In the macro system, laws and policies were significantly associated with OMS uptake. Physicians who believed that laws and

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

Table 1 Basic characteristics and OMS uptake of participants

	Total		Community hospital		Comprehensive hospital	
Characteristics	**n**	**%**	**n**	**%**	**n**	**%**
Gender						
Male	366	51.8	16	50.0	350	51.9
Female	341	48.2	16	50.0	325	48.1
Education*						
Junior college or below	9	1.3	5	15.6	4	0.6
Undergraduate	209	29.6	22	68.8	187	27.7
Postgraduate	323	45.7	2	6.3	321	47.6
Doctorate	155	21.9	3	9.4	152	22.5
Post-doctorate	11	1.6	0	0.0	11	1.6
Hospital level						
Community hospital	32	4.5		—	—	—
Comprehensive hospital	675	95.5		—	—	—
Working years						
<3	162	22.9	4	12.5	158	23.4
3–5	92	13	5	15.6	87	12.9
5–10	182	25.7	8	25.0	174	25.8
10–15	111	15.7	6	18.8	105	15.6
>15	160	22.6	9	28.1	151	22.4
Job title						
Resident physician	233	33	19	59.4	214	31.7
Attending physician	252	35.6	9	28.1	243	36.0
Deputy chief physician	160	22.6	4	12.5	156	23.1
Chief physician	62	8.8	0	0.0	62	9.2
Departments						
Surgery	204	28.9	4	12.5	200	29.6
Internal medicine	255	36.1	16	50.0	239	35.4
Others	248	35.1	12	37.5	236	35.0
Administrative positions						
Yes	88	12.4	5	15.6	83	12.3
No	619	87.6	27	84.4	592	87.7
Experience in OMS uptake						
Yes	377	53.3	9	28.1	368	54.5
No	330	46.7	23	71.9	307	45.5
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age (years)†	35.53	7.03	36.19	8.9	34.45	6.93
OMS uptake willingness†	17.33	4.39	16.56	4.39	17.34	4.40

Data are presented as mean and SD for continuous variables and n and % for categorical variables.
*In China, becoming a physician requires only an undergraduate or master's degree.
†Age (years) and OMS uptake willingness are not normally distributed; however, they are approximately normally distributed.
OMS, online medical services.

policies can resolve medical disputes that occur in OMS reported higher OMS uptake. The Hosmer-Lemeshow test was performed (χ^2=4.517, p=0.808), and the model fitted well.

DISCUSSION

Physicians were generally willing to offer OMS, but the usage rate was only 53.3%, which is still relatively low compared with other developed nations.[37] Based on SET, this study provides fresh insight into the determinants of physicians' OMS uptake. There were corresponding influencing factors in the micro, meso and macro systems according to SET, which indicated that physicians' OMS uptake was not only determined by individuals, but also affected by the external environment (such as communities, organisations, policies and culture).

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

Table 2 Participants' answers to the SET-related determinants

SET-related determinants	In total		Community hospital		Comprehensive hospital	
	n	%	n	%	n	%
Micro system						
Awareness of OMS-related information						
Yes	530	75.0	20	62.5	510	75.6
No	177	25.0	12	37.5	165	24.4
OMS-related skills						
Yes	571	80.8	22	68.8	549	81.3
No	136	19.2	10	31.3	126	18.7
Meso system						
OMS advocated by hospitals						
Yes	628	88.8	10	31.3	618	91.6
No	79	11.2	22	68.8	57	8.4
OMS training in hospitals						
Yes	569	80.5	16	50.0	553	81.9
No	138	19.5	16	50.0	122	18.1
Colleagues' experience in OMS uptake						
Yes	563	79.6	18	56.3	545	80.7
No	144	20.4	14	43.8	130	19.3
Recommendations from colleagues						
Yes	529	74.8	15	46.9	514	76.1
No	178	25.2	17	53.1	161	23.9
Inquiries from offline patients						
Yes	411	58.1	15	46.9	396	58.7
No	296	41.9	17	53.1	279	41.3
Hospitals' equipment and technical support						
Yes	582	82.3	9	28.1	573	84.9
No	125	17.7	23	71.9	102	15.1
Hospitals' incentive mechanism						
Yes	348	49.2	11	34.4	337	49.9
No	359	50.8	21	65.6	338	50.1
Macro system						
Influence of media orientation						
Yes	589	83.3	22	68.8	567	84.0
No	118	16.7	10	31.3	108	16.0
Laws and policies on medical disputes						
Yes	216	30.6	7	21.9	209	31.0
No	491	69.4	25	78.1	466	69.0
Integrity of platform construction						
Yes	412	58.3	14	43.8	398	59.0
No	295	41.7	18	56.3	277	41.0

Data are presented as n and % for categorical variables.
OMS, online medical services; SET, social ecosystem theory.

Micro system factors

Good cognition is a prerequisite for the formation of, and changes in, human behaviour.[38] Relevant skills should also be mastered to facilitate actual behaviour.[39] Cognition and skills are essential for physicians' uptake of OMS, and an extensive body of research has confirmed this.[40 41] Similar to previous studies, the current one has verified this as well; that is, awareness of OMS-related information and skills are common facilitating factors for physicians' OMS uptake willingness (and actual OMS uptake).

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

Table 3 Univariate analysis for physicians' OMS uptake willingness and actual uptake

	OMS uptake willingness*				Actual OMS uptake†			
Variables	**n**	**Mean±SD**	**z/r_s**	**P value**	**Yes**	**No**	**χ^2/z**	**P value**
Micro system								
Gender								
Male	366	17.76±4.41	−3.16	0.002	151	215	8.95	0.003
Female	341	16.82±4.35			179	162		
Age (years)		17.33±4.39	0.01	0.889	33.36±6.73	35.55±7.14	−4.53	<0.001
Education								
Undergraduate or below	218	17.04±4.32	−1.76	0.079	106	112	0.48	0.488
Postgraduate or above	489	17.43±4.44			224	265		
Hospital level								
Community hospital	32	16.56±4.39	−1.49	0.136	23	9	8.55	0.003
Comprehensive hospital	675	17.34±4.40			307	368		
Working years								
<5	254	17.37±4.18	−0.40	0.691	145	109	17.26	<0.001
≥5	453	17.27±4.52			185	268		
Job title								
Lower	485	17.19±4.39	−1.02	0.308	258	227	26.38	<0.001
Higher	222	17.55±4.42			72	150		
Departments								
Surgery	204	18.31±4.16	−2.77	0.006	87	117	8.31	0.016
Internal medicine	255	17.22±4.22			109	146		
Others	248	16.57±4.63			134	114		
Administrative positions								
No	619	17.17±4.32	−2.10	0.036	305	314	13.48	<0.001
Yes	88	18.24±4.83			25	63		
Awareness of OMS-related information								
No	177	14.81±5.12	−7.86	<0.001	120	57	42.32	<0.001
Yes	530	18.14±3.79			210	320		
OMS-related skills								
No	136	12.61±4.28	−12.99	<0.001	100	36	48.79	<0.001
Yes	571	18.43±3.62			230	341		
Meso system								
OMS advocated by hospitals								
No	79	15.70±4.63	−3.78	0.001	59	20	28.03	<0.001
Yes	628	17.51±4.33			271	357		
OMS training in hospitals								
No	138	15.70±4.52	−4.59	<0.001	93	45	29.56	<0.001
Yes	569	17.70±4.28			237	332		
Colleagues' experience in OMS uptake								
No	144	15.66±4.34	−5.49	<0.001	119	25	93.97	<0.001
Yes	563	17.73±4.32			211	352		
Recommendations from colleagues								
No	178	15.87±4.28	−5.40	<0.001	132	46	72.18	<0.001
Yes	529	17.79±4.34			198	331		
Inquiries from offline patients								
No	296	16.32±4.31	−5.59	<0.001	201	95	92.2	<0.001
Yes	411	18.02±4.33			129	282		

Continued

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

Table 3 Continued

Variables	OMS uptake willingness* n	Mean±SD	z/r_s	P value	Actual OMS uptake† Yes	No	χ^2/z	P value
Hospitals' equipment and technical support								
No	125	15.69±4.34	−4.99	<0.001	83	42	23.73	<0.001
Yes	582	17.65±4.34			247	335		
Hospitals' incentive mechanism								
No	359	16.35±4.16	−6.64	<0.001	204	155	30.18	<0.001
Yes	348	18.30±4.43			126	222		
Macro system								
Influence of media orientation								
No	118	16.03±4.73	−3.40	0.001	73	45	13.128	<0.001
Yes	589	17.56±4.29			257	332		
Laws and policies on medical disputes								
No	491	16.73±4.20	−5.88	<0.001	264	227	32.47	<0.001
Yes	216	18.63±4.57			66	150		
Integrity of platform construction								
No	295	17.68±4.30	−2.12	0.034	141	154	0.26	0.613
Yes	412	17.04±4.46			189	223		

Data are presented as mean±SD for continuous variables and n for categorical variables.
*Spearman correlation analysis was performed for the age (years); Mann-Whitney U test was performed for the remaining variables.
†Mann-Whitney U test was performed for the age(years); χ^2 was performed for the remaining variables.
OMS, online medical services.

Nevertheless, many studies have reported that physicians have trouble with cognitive impairment and lack skills. For instance, a British study pointed out that healthcare professionals have misconceptions about telehealth.[42] A study in Germany showed that more than 80% of participants expressed that their cognition regarding the legal aspects and data safety of medical apps and cloud computing was insufficient.[15] For the future implementation of OMS, physicians should recognise the importance of improving information and skills, such as the application and specific operation of health information technology.

The results also indicated that physicians in administrative positions are more willing (and more likely to actually) to offer OMS than those without administrative positions, suggesting that physicians in administrative positions have a positive attitude towards offering OMS. Leadership support is an important factor promoting physicians offering OMS.[43] A study in Senegal reported that years of work experience was negatively correlated

Table 4 Multivariate analysis of OMS uptake willingness

Variables	Unstandardised coefficients b	SE	Standardised coefficients β	t	P value
Constant	11.03	0.44	–	24.84	<0.001
Micro system					
Administrative positions (ref=No)	1.03	0.42	0.08	2.47	0.014
Awareness of OMS related information (ref=No)	1.32	0.35	0.13	3.81	<0.001
OMS related skills (ref=No)	4.88	0.38	0.44	12.77	<0.001
Meso system					
Hospitals' incentive mechanism (ref=No)	0.78	0.31	0.09	2.50	0.013
Macro system					
Laws and policies on medical disputes (ref=No)	0.73	0.34	0.08	2.16	0.031
Influence of media orientation (ref=No)	0.74	0.37	0.06	1.96	0.049

OMS, online medical services.

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

Table 5 Multivariate analysis of actual OMS uptake

Variables	OR	95% CI	P value
Constant	0.012	–	<0.001
Micro system			
Working years (ref=<5 years)			
≥5 years	2.44	1.66 to 3.59	<0.001
Administrative positions (ref=No)			
Yes	2.89	1.59 to 5.28	0.001
Awareness of OMS-related information (ref=No)			
Yes	1.90	1.22 to 2.96	0.005
OMS-related skills (ref=No)			
Yes	2.25	1.35 to 3.74	0.002
Meso system			
OMS advocated by hospitals (ref=No)			
Yes	2.34	1.21 to 4.52	0.011
Colleagues' experience in OMS uptake (ref=No)			
Yes	3.81	2.25 to 6.45	<0.001
Inquiries from offline patients (ref=No)			
Yes	2.93	2.02 to 4.25	<0.001
Macro system			
Laws and policies on medical disputes (ref=No)			
Yes	1.98	1.31 to 2.99	0.001

OMS, online medical services.

with physicians' OMS uptake willingness.[44] However, unlike their results, in this study, years of work experience did not show an association with physicians' willingness to implement OMS. But we found that it was related to physicians' actual OMS uptake, which physicians with more years of work experience were more likely to actually employ OMS. Several reasons might explain this finding. One is that the more years physicians have worked, the more access they have to OMS. Another possibility is that in China, physicians must have more than 3 years of independent consultation experience to be allowed to perform OMS.[45]

Meso system factors

Incentive mechanisms, such as financial rewards,[46] can increase physicians' OMS uptake willingness. Their OMS uptake willingness was positively associated with whether the hospital had an incentive mechanism, similar to the study by Ruiz Morilla *et al*.[47] These findings also underscore that advocacy from hospitals is a facilitating factor for physicians performing OMS, which can be attributed that physicians may have easy access to (and offer) OMS if hospitals advocate for (or even organise) OMS.

Under peer influence and endorsement,[48] a physician would be prompted to perform OMS if he/she learnt that his/her colleagues had experience in OMS uptake. Notably, the impact from patients cannot be ignored. More than half of the physicians in this study reported that they have been asked by offline patients about their experience in conducting OMS. Those who had been consulted were more likely to offer OMS. This outcome is similar to findings on primary care physicians based on the improved technology acceptance model by Francesc Saigi-Rubió *et al*,[49] who implied that patients' attitudes toward OMS can influence physicians' use of telemedicine.

Macro system factors

Medical disputes between physicians and patients have always attracted much attention; inevitably, they can occur in both online and offline medical activities. A qualitative study noted that the dearth of interpretation and application of the law and policy caused a lack of willingness among medical personnel to participate in telecare due to fear of disputes.[50] In addition, many quantitative studies have pointed out that physicians have strong concerns about OMS-related laws and policies.[51] In China, although, a series of policies and laws have been issued to promote OMS, they were still imperfections and not been implemented very well,[52] which exacerbated physicians' worries and hesitations about OMS. In the study of Cai *et al* in Gansu Province of China, one of the reasons why physicians were reluctant to participate in telemedicine in the future was the imperfect laws and regulations.[53] The findings revealed that 69.3% of the physicians believe that existing laws and policies cannot solve the problem of medical disputes in online medical activities. The multivariate analysis demonstrated that physicians who believe that existing laws and policies can solve physician–patient disputes well were more willing to offer OMS. As such, laws and policies related to online healthcare should also be considered.

To the best of our knowledge, limited research has depicted the relationship between media and OMS uptake of physicians, but other studies in the health behaviour field have already revealed that media coverage and communication can affect individuals' cognition and behaviour.[54] Similar to these conclusions, this study found a positive relationship between media orientation and physicians' OMS uptake willingness.

Implications

This study offers practical insight for future interventions in advancing physicians' OMS uptake. At the micro level, health administration departments should pay more attention to improving physicians' correct awareness of OMS-related information and knowledge, carry out skills training to improve physicians' OMS operating skills, and take measures to increase the opportunities for qualified young physicians to carry out OMS. At the meso level, hospitals should establish appropriate incentive mechanisms to encourage OMS uptake willingness among physicians. Meanwhile, hospitals (especially comprehensive ones) should optimise internal resource allocation

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

and create their own online medical platforms to provide physicians with a helpful online medical environment. Hospitals or departments can advocate for or organise internal activities with OMS as the theme, so as to facilitate the exchange of experiences between colleagues. At the macro level, the government should improve laws and policies related to medical disputes, especially those that may occur in OMS. Meanwhile, mass media should be guided to actively report on and publicise relevant policies of OMS. Due to the extensive existence of factors based on SET, these recommendations may inspire research into other areas besides the study sites.

Limitations

Some limitations should be acknowledged. First, this was a cross-sectional study. Consequently, the relationships between these factors and conclusions were exploratory. Hence, longitudinal studies are necessary to further investigate factors that affect OMS uptake among physicians, since cross-sectional design results may lead to difficulty in establishing cause-and-effect relationships among the study variables.[55] Second, quantitative outcomes can be combined with qualitative findings to provide more comprehensive insight.[56] In this study, only quantitative investigation was carried out. The results revealed correlative factors. However, the reasons explaining the correlations still need to be clarified through qualitative research. Therefore, a combination of qualitative and quantitative studies should be performed to better understand the causes that affect OMS uptake. Third, the data were collected by self-reported, and thus, the current results were at risk of subjectivity and response bias. Fourth, limited by the small number of medical staff, participants from community hospitals accounted for only a small proportion. This may bias study results when applied to community physicians. Finally, this study was implemented during the COVID-19 pandemic; due to its effects, the execution of OMS has increased.[57] Therefore, the correlations between obtained determinants and OMS uptake among physicians may be overestimated.

CONCLUSIONS

Based on SET, this study explored the determinants of physicians' OMS uptake. Accordingly, multidimensional interventions from the micro, meso, and macro systems should be carried out to encourage physicians to offer OMS. Certain measures should be taken, including enhancing physicians' awareness and skills, creating access opportunities for qualified young physicians, attaching importance to peer roles, strengthening the construction of OMS in hospitals, improving relevant policies and laws, and guiding positive media orientation.

Author affiliations
[1]School of Public Health, Nanjing Medical University, Nanjing, Jiangsu, China
[2]Center for Health Policy and Management Studies, Nanjing University, Nanjing, Jiangsu, China
[3]The First Affiliated Hospital with Nanjing Medical University, Nanjing, Jiangsu, China
[4]School of Nursing, Nanjing Medical University, Nanjing, Jiangsu, China
[5]School of Health Policy & Management, Nanjing Medical University, Nanjing, Jiangsu, China

Contributors HY designed the study and critically reviewed, commented and revised the manuscript. XP, ZL and CZ participated in the data analysis, performed the final statistical analyses and prepared the first version of manuscript. YJ, RL, JC, and ZQ collected the data. MZ, SZ and JG collected literature materials.

Funding National Natural Science Foundation of China (No. 72074122), Jiangsu college students' innovation and entrepreneurship training programme (No. 202010312066Z).

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study was approved by the Ethics Review Committee of Nanjing Medical University ((2020)592), and all the methods were performed in accordance with the relevant guidelines and regulations.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data are available upon reasonable request from the corresponding author. E-mail: youhua98@163.com.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iDs
Jinjin Ge http://orcid.org/0000-0002-6140-1057
Hua You http://orcid.org/0000-0002-0004-0470

REFERENCES

1 WHO. Universal health coverage. Available: https://www.who.int/health-topics/universal-health-coverage#tab=tab_1 [Accessed 28 Dec 2020].
2 Shaw T, McGregor D, Brunner M, *et al*. What is eHealth (6)? development of a conceptual model for eHealth: qualitative study with key informants. *J Med Internet Res* 2017;19:e324.
3 CNNIC. The 44th statistical report on Internet development in China. Available: http://www.cac.gov.cn/2019-08/30/c_1124939590.htm [Accessed 28 Dec 2020].
4 Tuot DS, Boulware LE. Telehealth applications to enhance CKD knowledge and awareness among patients and providers. *Adv Chronic Kidney Dis* 2017;24:39–45.
5 Cao X, Wang D. The role of online communities in reducing urban-rural health disparities in China. *J Assoc Inf Sci Technol* 2018;69:890–9.
6 Huang S, Xiao Y, Yan L, *et al*. Implications for online management: two cases with COVID-19. *Telemed J E Health* 2020;26:487–94.
7 Weiss D, Crooks M, Goorland L, *et al*. Limiting potential exposure during a pandemic: the importance of diagnostic testing options for COVID-19. *Telemed J E Health* 2021;27:1074–7.
8 Sun S, Yu K, Xie Z, *et al*. China empowers Internet hospital to fight against COVID-19. *J Infect* 2020;81:e67–8.
9 Hoogenbosch B, Postma J, de Man-van Ginkel JM, *et al*. Use and the users of a patient portal: cross-sectional study. *J Med Internet Res* 2018;20:e262.

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.

10 Cajita MI, Hodgson NA, Lam KW, *et al*. Facilitators of and barriers to mHealth adoption in older adults with heart failure. *Comput Inform Nurs* 2018;36:376–82.
11 Hoque MR. An empirical study of mHealth adoption in a developing country: the Moderating effect of gender concern. *BMC Med Inform Decis Mak* 2016;16:51.
12 Mayer G, Gronewold N, Alvarez S, *et al*. Acceptance and expectations of medical experts, students, and patients toward electronic mental health Apps: cross-sectional quantitative and qualitative survey study. *JMIR Ment Health* 2019;6:e14018.
13 Nguyen AD, Frensham LJ, Baysari MT, *et al*. Patients' use of mobile health applications: what general practitioners think. *Fam Pract* 2019;36:214–8.
14 Levine M, Richardson JE, Granieri E, *et al*. Novel telemedicine technologies in geriatric chronic non-cancer pain: primary care providers' perspectives. *Pain Med* 2014;15:206–13.
15 Kirchberg J, Fritzmann J, Weitz J, *et al*. eHealth literacy of German physicians in the Pre-COVID-19 era: questionnaire study. *JMIR Mhealth Uhealth* 2020;8:e20099.
16 Byambasuren O, Beller E, Glasziou P. Current knowledge and adoption of mobile health Apps among Australian general practitioners: survey study. *JMIR Mhealth Uhealth* 2019;7:e13199.
17 Villalba-Mora E, Casas I, Lupiañez-Villanueva F, *et al*. Adoption of health information technologies by physicians for clinical practice: the Andalusian case. *Int J Med Inform* 2015;84:477–85.
18 Ariens LF, Schussler-Raymakers FM, Frima C, *et al*. Barriers and facilitators to eHealth use in daily practice: perspectives of patients and professionals in dermatology. *J Med Internet Res* 2017;19:e300.
19 Kissi J, Dai B, Dogbe CS, *et al*. Predictive factors of physicians' satisfaction with telemedicine services acceptance. *Health Informatics J* 2020;26:1866–80.
20 Bronfenbrenner U. *The ecology of human development*. Cambridge, MA: Harvard University Press, 1979.
21 Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obes Rev* 2001;2:159–71.
22 Schölmerich VLN, Kawachi I. Translating the socio-ecological perspective into multilevel interventions: gaps between theory and practice. *Health Educ Behav* 2016;43:17–20.
23 Gillen EM, Hassmiller Lich K, Yeatts KB, *et al*. Social ecology of asthma: engaging stakeholders in integrating health behavior theories and practice-based evidence through systems mapping. *Health Educ Behav* 2014;41:63–77.
24 Ly BA, Labonté R, Bourgeault IL, *et al*. The individual and contextual determinants of the use of telemedicine: a descriptive study of the perceptions of Senegal's physicians and telemedicine projects managers. *PLoS One* 2017;12:e0181070.
25 de Vries ST, Wong L, Sutcliffe A, *et al*. Factors influencing the use of a mobile APP for reporting adverse drug reactions and receiving safety information: a qualitative study. *Drug Saf* 2017;40:443–55.
26 Adenuga KI, Iahad NA, Miskon S. Towards reinforcing telemedicine adoption amongst clinicians in Nigeria. *Int J Med Inform* 2017;104:84–96.
27 National Health Commission of the People's Republic of China and National Administration of Traditional Chinese Medicine. Notice on printing and distributing three documents including the measures for the administration of Internet diagnosis and treatment (Interim). Available: http://www.gov.cn/gongbao/content/2019/content_5358684.htm [Accessed 28 Dec 2020].
28 Dünnebeil S, Sunyaev A, Blohm I, *et al*. Determinants of physicians' technology acceptance for e-health in ambulatory care. *Int J Med Inform* 2012;81:746–60.
29 de Souza CHA, Morbeck RA, Steinman M, *et al*. Barriers and benefits in telemedicine arising between a high-technology hospital service provider and remote public healthcare units: a qualitative study in Brazil. *Telemed J E Health* 2017;23:527–32.
30 Bhatta R, Aryal K, Ellingsen G. Opportunities and challenges of a Rural-telemedicine program in Nepal. *J Nepal Health Res Counc* 2015;13:149-53.
31 Giraldo L, Schachner B, Luna D, *et al*. Exploring nurses' perceptions and expectations toward a BCMA implementation using a mobile APP and Workstations as a change management strategy. *Stud Health Technol Inform* 2018;250:134–8.
32 Morrow S, Daines L, Wiener-Ogilvie S, *et al*. Exploring the perspectives of clinical professionals and support staff on implementing supported self-management for asthma in UK general practice: an IMP^{2}ART qualitative study. *NPJ Prim Care Respir Med* 2017;27:45.
33 Lapão LV, da Silva MM, Gregório J. Implementing an online pharmaceutical service using design science research. *BMC Med Inform Decis Mak* 2017;17:31.
34 CY M, Wang QZ. An empirical study on physicians' willingness to adopt online medical service platform and its influencing factors. *Chin J Health Policy* 2018;11:58–73.
35 HB L. Risks and countermeasures of Internet medical third-party platform. *J Hohai Univ* 2021;23:89–96.
36 You H, Lau JTF, Gu J, *et al*. Awareness and acceptability of female condoms among monogamous Hong Kong Chinese female sexually transmitted infection patients. *AIDS Behav* 2013;17:1195–204.
37 Hofer F, Haluza D. Are Austrian practitioners ready to use medical apps? results of a validation study. *BMC Med Inform Decis Mak* 2019;19:88.
38 Alzghoul BI, Abdullah NAC. Pain management practices by nurses: an application of the knowledge, attitude and practices (KAP) model. *Glob J Health Sci* 2015;8:154–60.
39 Fisher JD, Fisher WA, Misovich SJ, *et al*. Changing AIDS risk behavior: effects of an intervention emphasizing AIDS risk reduction information, motivation, and behavioral skills in a college student population. *Health Psychol* 1996;15:114–23.
40 Dünnebeil S, Sunyaev A, Blohm I, *et al*. Determinants of physicians' technology acceptance for e-health in ambulatory care. *Int J Med Inform* 2012;81:746–60.
41 Armstrong AW, Kwong MW, Ledo L, *et al*. Practice models and challenges in teledermatology: a study of collective experiences from teledermatologists. *PLoS One* 2011;6:e28687.
42 Kayyali R, Hesso I, Mahdi A, *et al*. Telehealth: misconceptions and experiences of healthcare professionals in England. *Int J Pharm Pract* 2017;25:203–9.
43 Jacob C, Sanchez-Vazquez A, Ivory C, Social IC. Social, organizational, and technological factors impacting clinicians' adoption of mobile health tools: systematic literature review. *JMIR Mhealth Uhealth* 2020;8:e15935.
44 Ly BA, Kristjansson E, Labonté R, *et al*. Determinants of the intention of Senegal's physicians to use telemedicine in their professional activities. *Telemed J E Health* 2018;24:897–8.
45 National Health Commission of the People's Republic of China. Administrative measures for Internet diagnosis and treatment (trial), 2018. Available: http://www.nhc.gov.cn/ewebeditor/uploadfile/2018/09/20180913135522695.docx
46 Jing D, Jin Y, Liu J. The impact of monetary incentives on physician prosocial behavior in online medical consulting platforms: evidence from China. *J Med Internet Res* 2019;21:e14685.
47 Ruiz Morilla MD, Sans M, Casasa A, *et al*. Implementing technology in healthcare: insights from physicians. *BMC Med Inform Decis Mak* 2017;17:92.
48 Gagnon M-P, Ngangue P, Payne-Gagnon J, *et al*. m-Health adoption by healthcare professionals: a systematic review. *J Am Med Inform Assoc* 2016;23:212–20.
49 Saigi-Rubió F, Jiménez-Zarco A, Torrent-Sellens J. Determinants of the intention to use telemedicine: evidence from primary care physicians. *Int J Technol Assess Health Care* 2016;32:29–36.
50 Chiang K-F, Wang H-H, Chien I-K, *et al*. Healthcare providers' perceptions of barriers in implementing of home telecare in Taiwan: a qualitative study. *Int J Med Inform* 2015;84:277–87.
51 Rogove HJ, McArthur D, Demaerschalk BM, *et al*. Barriers to telemedicine: survey of current users in acute care units. *Telemed J E Health* 2012;18:48–53.
52 PN G, Zhao Y, Han CX. Problems and countermeasures on the implementation of Internet medical Policy——An analysis based on Smith model. *Health Econ Res* 2021;38:17–21.
53 Cai H, Wang H, Guo T, *et al*. Application of telemedicine in Gansu Province of China. *PLoS One* 2016;11:e0158026.
54 Wackowski OA, Sontag JM, Hammond D. Youth and young adult exposure to and perceptions of news media coverage about e-cigarettes in the United States, Canada and England. *Prev Med* 2019;121:7–10.
55 Sedgwick P. Cross sectional studies: advantages and disadvantages. *BMJ* 2014;348:g2276.
56 Story DA, Tait AR. Survey research. *Anesthesiology* 2019;130:192–202.
57 Helou S, El Helou E, Abou-Khalil V, *et al*. The effect of the COVID-19 pandemic on physicians' use and perception of telehealth: the case of Lebanon. *Int J Environ Res Public Health* 2020;17. doi:10.3390/ijerph17134866. [Epub ahead of print: 06 Jul 2020].

BMJ Open: first published as 10.1136/bmjopen-2021-048851 on 16 September 2021. Downloaded from http://bmjopen.bmj.com/ on March 29, 2024 by guest. Protected by copyright.