Smartphone and medical application use among dentists in China

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Research article

Keywords: smartphone, medical applications, dentistry, China, dentists

Posted Date: August 20th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-36893/v2

Version of Record: A version of this preprint was published on September 7th, 2020. See the published version at https://doi.org/10.1186/s12911-020-01238-3.

Abstract

Background: With the development of information technology, more and more healthcare professionals are using smartphones and mobile medical applications (apps) in their clinical practice. The objective of this study was to survey the use of smartphone based medical apps among dentists in China and their perceptions on such apps.

Methods: All data were collected using anonymous questionnaires. The questionnaires for this cross-sectional study were randomly sent to dentists by email, and 379 dentists completed the questionnaires. Dentists' demographics and their perceptions on Wechat, QQ (the most popular social media apps in China) and other medical apps were assessed, including questions on the purpose, frequency, daily use, and opinion of these apps they used. Questions were answered using a Likert scale (1 = strongly agree, 2 = agree, 3 = not sure, 4 = disagree, and 5 = strongly disagree).

Results:A total of 379 valid responses were received with a median age of 33.6 years old (63.3% female). All subjects (100%) owned a smartphone, and all of them installed and used WeChat or QQ in their clinical practice. Only 76% subjects installed medical apps (except Wechat and QQ) on their smartphones. Male dentists would like to install medical apps than female dentists ($p < 0.05$). With the increasing of age, the percentage of dentists to install medical apps was decreasing ($p < 0.001$). The frequency and daily use of WeChat or QQ were more often than medical apps. Medical apps were positively perceived, with dentists reporting to recommend these medical apps to other peers (Likert score: 1.67 ± 0.68).

Conclusion: Medical apps were perceived to provide positive impact on clinical practice, education and patient care in dentistry by providing relevant medical information. But there will be still much room for improvement in the future.

Introduction

With the development of information technology and its cheaper charge, more and more people are becoming internet users in the word. Data show that the number of internet users in the world is nearly 4,536,248,808 by June 30, 2019[1]. There are 2,300,469,859 internet users in Asia with 54.2% proportion of the world. As so far, mobile devices (such as mobile smartphones and tablets) are the main tools for internet. Smartphone also has become handheld-computer rather than mobile communication device, because of its powerful computing function, capacious memories, large screen and open operating system. With tremendous flourishment of smartphone, it encourages the development of various third-party applications (apps) which could run in smartphone[2-5]. An app is a small specialized and customizable program which could provide various functions and services for user. In people's smartphones, there are tens of apps, including medical apps. Except general public, more and more healthcare professionals are using medical apps in their clinical practice[2]. In such information society, medicine has undergone remarkable advancements. There have been many studies to survey the use of

smart devices or medical applications among physicians[6-8]. In dental fields, we only could find some similar researches on the use of medical applications or mobile learning technology among dental students around the world[9-12]. But such research in dentists is few, especially in China.

From the above data about the number of internet users around the world, it's easy to find Asia (especial China) will be a big market for smartphone and application. So the aim of our study was to examine the current use of smartphone based medical apps among dentists in China and their attitudes on them. We want to provide readers better understanding of: (1) the popularity of smartphone and medical application among dentists in China, (2) the factors of influencing dentists' use of medical apps, and (3) dentists' purposes of using such medical apps, and attitudes on them. Through the study, we hope computer scientists or dental healthcare professionals could design, improve and develop more convenient and useful smartphone-based applications according to current dentists' opinions. We also hope to help these dentists who haven't used medical application to select proper application to assist their clinical work.

Related work

There have been many studies to survey the use of smart devices or medical applications among physicians or medical students (Table 1). The aim of this study was to survey the use of smartphone based medical apps among dentists in China and their perceptions on such apps.

In 2012, Orrin et al performd a prospective, nation-wide email survey evaluating the use of smartphones and smartphone apps among providers at medical centers recognized by the Accreditation Council for Graduate Medical Education (ACGME) in USA[8]. A total of 3,306 unique responses from 1,397 residents, 524 fellows, and 1,385 attending physicians attended the Study. Greater than 85% of respondents used a smartphone. Over half of the respondents reported using apps in their clinical practice. The most commonly used app types were drug guides , medical calculators,coding and billing apps and pregnancy wheels.

Karl et al conducted an online survey on smartphone and medical related App use among medical students and junior doctors in the United Kingdom in 2012[11]. 79.0% of medical students and 74.8% of junior doctors owned a smartphone. Over 24hours apps were used for between 1–30 minutes for students and 1–20 minutes for doctors.

In 2018, Rikesh et al assessed smartphone use amongst UK surgical doctors[7]. A total of 341 participants were surveyed. 93.5% of participants owned a smartphone, with 54.2% of those owning medical apps and 86.2% using their device to access online medical resources. 79.3% stated that they would be willing to use their smartphone for clinical use.

Payal et al performed an assessment of digital literacy and use of smart phones among Central Indian dental students[13]. Out of 260 students, 250 were internet users. 94.23% students owned a smartphone,

and 46.53% students had some app related to the dentistry in their smartphone device. 89.23% students were keen for implementation of e-learning in their curriculum.

Sameer et al conducted a cross-sectional study on popularity and impact of using smart devices in medicine in Saudi Arabia[14]. A total of 300 physicians attended the study. 88.3% physicians had smart devices, and 86.3% had at least one medical app installed. 53.0% used an app at least once a day. Medical apps were positively perceived, with physicians reporting increased dependency on the apps.

Methods

Questionnaire and procedures

Considering Wechat and QQ are the most popular social media apps in China, we investigated the use of them in dental clinical practice separately. And the definition of medical apps in our study is a series of apps which are associated with clinical practice except Wechat and QQ.

The study questionnaire consisted of several parts. Part 1 collected dentists' demographic data, including age, gender, workplace, medical rank, whether or not a smartphone was used, brand of smartphone. Part 2 investigated the use of Wechat and QQ in dentists' clinical work, including whether or not using Wechat and QQ for work related activities, the purpose, frequency and daily use time of them. Part 3 surveyed the use of medical apps in dentists' clinical work, including whether or not medical apps were installed, how many apps were installed, the purpose, frequency and daily use time of them. Part 4 assessed the dentists' perceptions of smartphone based medical apps. Part 5 assessed the impact of medical apps on clinical practice. Responses to questions in parts 4–5 were based on a 5-point Likert scale: 1 = strongly agree, 2 = agree, 3 = not sure, 4 = disagree, and 5 = strongly disagree.

The questionnaire was sent to 1500 dentists by email. And we received 390 dentists' replies, with response rate of 26%. The questionnaire was reviewed by an expert panel for content validity and reliability. 11 dentists only responded the questions in part 1, so we didn't adopt their questionnaires. Of the remaining 379 subjects, 91 dentists expressed they didn't install any medical apps except Wechat or QQ, and they didn't answer the questions in part 4 and part 5. So we only analyzed the remaining 288 dentists' perceptions of these medical apps. The flow diagram of collecting eligible questionnaires for this study is shown in Figure 1.

Statistical analysis

Data were analyzed using SPSS statistical software (version 17, SPSS, Inc., Chicago, IL, USA). Subject characteristics were presented as frequencies (percentage). Quantitative Likert scale data were presented as mean ± standard deviation. A chi-square test was used to examine the difference of whether or not owning a medical app among different groups. A p value of < 0.05 was considered significant.

Results

Demographic characteristics of surveyed dentists in China

A total of 379 valid responses were received. Study subjects had a median age of 33.6 years old (range: 19– 59 years old), and 240 (63.3%) subjects were female. 168 (44.3%) subjects worked in public hospital, and 211 (55.7) subjects worked in private hospital or clinic. Additionally, 47.2% subjects were resident dentists, 40.4% were dentists in charge, and 12.4% were senior or associate senior dentists. All subjects (100%) owned a smartphone. The most popular brands of smartphone were Apple (46.2%) and Huawei (34%, Table 2).

The use of Wechat or QQ in dentists' clinical work

All participants installed Wechat or QQ on their smartphones, and they all used WeChat or QQ in their clinical practices. Participants reported their main purposes of using WeChat or QQ in clinical practice were acquiring medical information (84.2%), communicating with peers (83.6%) and communicating with patients (77.6%). Frequency of using WeChat or QQ in clinical practice was reported to be at least once a day (73.6%), at least once a week (20.8%), or less than once a month (5.5%, Table 3). The time of daily usage was shown in Table 3. 25.9% subjects used WeChat or QQ in clinical practice more than 60 minutes per day, 19% subjects reported their daily use time was 21-30 minutes, 17.4% subjects was 11-20 minutes.

The use of medical apps in dentists' clinical work

288 (76%) subjects installed medical app (except Wechat and QQ) on their smartphones, and 91 (24%) subjects didn't installed any medical app, as shown in Table 4. Male dentists would like to install medical apps than female dentists (chi-square = 6.702, $p < 0.05$). With the increasing of age, the percentage of dentists to install medical apps was decreasing (chi-square = 45.3.3, $p < 0.001$). However, dentists' workplace and medical rank were not associated with the installment of medical apps significantly (chi-square = 1.670, $p = 0.196$; chi-square = 5.466, $p = 0.065$, respectively, Table 5). Among the 288 subjects, the average number of medical apps was 2.62±1.73 (range: 1-12). Most subjects (71.5%) reported they installed 1-5 medical apps on their smartphones, only 0.5% subjects installed more than 10 medical apps on their smartphones (Table 4). The frequency and daily use (in minutes) of these medical apps among dentists was shown in Table 6. 46.5% subjects used medical apps at least once a day, 42.4% subjects used them at least once a week, and 11.1% used less than once a month. About the daily use, the largest number was 11-20 minutes (31.6%) per day, followed by 11-10 minutes (29.2%) and 21-30 minutes (15.6%). Only 5.2% subjects reported they used medical apps more than 60 minutes per day (Table 6). The top three purposes of using medical apps were reviewing medical knowledge (63.6%), reading medical news (36.4%), and reading medical journals (27.9%, Table 7).

Perceptions of smartphone based medical apps and their impacts on clinical practice

The majority of subjects strongly agreed or agreed that they are looking to obtain more medical apps in the future (1.52 ± 0.69), they would recommend these medical apps to other peers (1.67 ± 0.68), medical

apps are essential tools for undergraduate medical studies (1.91 ± 0.78), and medical apps supplement medical textbooks (1.83 ± 0.64). As for whether medical apps are superior to medical textbooks (3.16 ± 0.81) or medical apps can replace medical textbooks (3.31 ± 0.94), the majority subjects reported disagreement or not sure. 46.2% subjects agreed that there are dangers in using medical apps for patient care, and 39.6% subjects were not sure about this question (2.61 ± 0.73, Table 8).

The majority of subjects agreed that medical apps could improve clinical decision making (2.30 ± 0.77), save time (2.11 ± 0.68), help in making differential diagnoses (2.56 ± 0.74), and perform useful medical-related calculations (2.52 ± 0.77). Additionally, medical apps were thought to be beneficial for allowing faster access to evidence-based medical practice/case (2.34 ± 0.80), reliable sources of clinical skills (2.25 ±0.67), reliable sources of medical knowledge (2.19 ± 0.68), common laboratory reference values (2.30 ± 0.65), and medical information (1.90 ± 0.54, Table 9).

Discussion

In the past decades, the technologies of mobile communication, mobile wireless internet and mobile devices have been widely used in many fields of human's life. Under such background, customized and multi-functional applications (including medical applications) have flourished tremendously. Study showed more and more medical staffs installed medical apps on their smart devices (including smartphone and tablet) and used them frequently [2]. But there are few studies to assess the use of such medical applications among dentists. So in this study, we firstly did such research in China. By using anonymous questionnaires, we collected data on the use of smartphone based medical applications among dentists in China.

We found all participants (100%) in our study owned a smartphone, and the rate was a little higher than many other similar studies (ranged from 82% - 99.3%)[14-18]. The most popular brands of smartphone were Apple and Huawei (a Chinese Android smartphone), and the result was consistent with another study[18]. All subjects installed Wechat or QQ (the most popular social media applications in China) on their smartphones and used them in clinical practice. In 2016, Li et al investigated the effect of WeChat on the compliance and duration of treatment in orthodontic patients in China. The authors found it could reduce the treatment duration and bracket bond failure, and improve the attendance in orthodontic patients[19]. Additionally, in our study, we found 73.6% subjects used them at least once a day, and only 5.5% subjects used them less than once a month. 25.9% subjects reported they would use them in clinical practice more than 60 minutes per day. As we can see, it's very prevalent to use such social media apps (including acquiring medical information, communicating with peers and communicating with patients) among dentists in China.

Only 76% participants (n = 288) installed medical app (except Wechat and QQ) on their smartphones. Though the rate was lower compared with the installment of Wechat and QQ, the number was still in agreement with many other studies in other areas of the world[14, 15, 20]. Our study found that there were significant differences between gender, age and whether or not installing medical apps. The finding was

supported by many studies, in which young physicians were more likely to use medical apps as compared with old ones[7, 14]. In our study, male dentists were more likely to use medical apps than female. Because male is more interested in internet technology or software in China, which could interpret the phenomenon we found.

The average number of installed medical apps was 2.62, we could find it's relatively small. According to the data of frequency and daily use of these medical apps, only 46.5% subjects used medical apps at least once a day, and only 5.2% subjects reported they used medical apps more than 60 minutes per day. Compared with the use of Wechat or QQ in China, we could found the use of medical apps among dentists in China was not very prevalent. And compared with US and British healthcare professionals with the use rate of over 90%, our sample of dentists still showed a relatively lower medical app use[21, 22].

Most of our subjects agreed or strongly agreed that they are looking to obtain more medical apps in the future and recommend these medical apps to other peers, which could reflect their affirmation and expectation towards medical apps. Most subjects agreed or strongly agreed that medical apps are essential tools for undergraduate medical studies and supplement medical textbooks. These were in agreement with several other studies that assessed the use of medical apps among dental students or junior doctors in many other regions around the world[9-12, 23-27]. Though dentists thought medical apps could improve education among students, they reported disagreement or not sure with medical apps are superior to medical textbooks or medical apps can replace medical textbooks. And most of them agreed that there are dangers in using medical apps for patient care. As we know, the accuracy of the information in one medical app is very important. If users make their clinical decision based on the inaccurate or outdated information in medical apps, it will lead to serious consequences. Many studies have been conducted to assess the quality and accuracy (including expert involvement and medical evidence adherence) of these medical applications in the past few years[28-34]. The expert involvement rate of these applications was ranged from 9% to 67% and the adherence rate was ranged from 0 to 87% [28]. So establishing appropriate regulatory procedures is extremely urgent. We believe government health authorities (such as Food and Drug Administration in America[35], Medicines and Healthcare Products Regulatory Agency in England[36], Health Canada in Canada[37] and corresponding authorizes in other countries) could play a key role. In order to regulate these medical apps well, the government health authorities could draft relevant guidelines which should be followed by the application developers.

About the effect of medical apps on clinical practice, from the dentists' opinions in China, they strongly agreed or agreed that these medical apps could allow faster access to medical information with the best score (1.90 ± 0.54). But as for the other aspects of the effect, Chinese dentists' attitudes were less positive than similar study[14]. From the results above, we could find out current medical apps in dentistry in China did well in providing relevant medical information and received positive reviews. But on the other hands (improve clinical decision making; save time; help in making differential diagnoses; perform useful medical-related calculations; faster access to evidence-based medical practice/case, reliable sources of clinical skills, reliable sources of medical knowledge, and common laboratory

reference values), medical apps did not meet the needs of dentists well. So in the future, there will be much room for improvement.

Conclusion

In conclusion, the use of smartphone and some social media apps (Wechat or QQ) is very common among dentists in China. And the use of medical apps is also prevalent. These medical apps received positive reviews, because most dentists reported they would want to obtain more medical apps in the future and recommend these medical apps to other peers. These medical apps could allow faster access to medical information for dentists in their clinical practices. But there is still much room for improvement in patient care in the future (such as assisting diagnoses and determining treatment options).

According to the study, we could find there are many advantages of medical apps, including reviewing medical knowledge, reading medical or journals, acquiring clinical skills, communicating with patients / colleages, preparing presentations or examinations, et al. In general, medical apps could be a good assisstant for dentists in clinical practice. We believe there will be more and more dentists using medical apps in the future. Of course patients would also get the benefits from them. But there are still some disadvantages or risks of medical apps we should pay attention to. Such as data security, virus attack, inaccurate content, lack expert involvment, et al. So establishing appropriate regulatory procedures is extremely important. We think the following tips could help[38]{Lewis, 2014 #214}. Firstly, the app stores should carefully examine the medical app which would like to be published online. Secondly, the content and information in the medical applications should be peer reviewed by relevant medical professionals. Thirdly, a reliable assessment system or method for these medical applications should be established. According to such assessment or score of the applications, it could help users to select more proper application for themselves. Finally, we think the most important one is government health authorities. We believe the risks of using medical apps could be declined by following these methods.

Limitation

There were some limitations in our study. First, our sample size was relatively small. We need a larger sample size to confirm our findings on medical app use among dentists in China in the future. Still, our results are in agreement with many similar studies conducted in other regions around the world and provide preliminary information. Second, our study only examined dentists' perceptions of medical apps. Further studies should be conducted to examine dental patients' use and perceptions of medical apps in order to examine how medical apps affect their oral healthcare. Third, our study did not investigate potentially negative impacts of medical app use. Because the issue of patient safety and privacy has been proposed in these years, we should focus on it in further investigation.

Declarations

Ethics approval and consent to participate

The study was performed according to the World Medical Association's Declaration of Helsinki, and the procedures were approved by the ethics committees of the Stomatological Hospital of the Chongqing Medical University (2019-79). The study did not involve any medical examination, surgical procedure, or collection of personal health information. Therefore, completing and returning the questionnaire was considered as provision of informed consent to participate in the study.

Consent to publish

Not applicable.

Availability of data and materials

You could find the date in additional supporting files.

Competing interests

None of the authors have any relevant financial relationship(s) with a commercial interest.

Funding

This study was supported by the Program for Innovation Team Building at Institutions of Higher Education in Chongqing in 2016 (NO CXTDG201602006), Natural Science Foundation of Chongqing, China in 2018 (Grant No: cstc2018jscx-mszdX0017), Oral Disease Prevention and New Materials, Shanxi Provincial Key Laboratory Open Project (No: KF2020-01).

Author's contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Chao Zhang, Lin Fan, Cong Yu and Zhaowu Chai. The first draft of the manuscript was written by Chao Zhang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors thank colleagues in Stomatological Hospital of the Chongqing Medical University for their work in sending emails of questionnaire to our subjects.

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Tables

Table 1 Previous works

Name	Research object	Country	Objective	Result
Orrin et al (2012)	Medical providers	USA	The use of smartphones and smartphone apps among providers at medical centers recognized by the Accreditation Council for Graduate Medical Education (ACGME)	1. A total of 3,306 unique responses from 1,397 residents, 524 fellows, and 1,385 attending physicians among 27 different specialties attended the Study. 2. Greater than 85% of respondents used a smartphone. 3. Over half of the respondents reported using apps in their clinical practice. 4. the most commonly used app types were drug guides , medical calculators,coding and billing apps and pregnancy wheels.
Karl et al (2012)	Medical students, junior doctors	United Kingdom	Smartphone and medical related App use among medical students and junior doctors	1. 257 medical students and 131 junior doctors attended the study. 2. 79.0% of medical students and 74.8% of junior doctors owned a smartphone. 3. The majority of students and doctors owned 1–5 medical related applications, with very few owning more than 10. 4. Over 24hours apps were used for between 1–30 minutes for students and 1–20 minutes for doctors. 5. Students used disease diagnosis/management and drug reference apps, with doctors favouring clinical score/calculator apps.
Rikesh et al (2015)	Surgical doctors	United Kingdom	Smartphone use amongst doctors within the surgical profession	1. A total of 341 participants were surveyed. 2. 93.5% of which owned a smartphone, with 54.2% of those owning medical apps and 86.2% using their device to access online medical resources. 3. 79.3% stated that they would be willing to use their smartphone for clinical use.
Payal et al (2018)	Dental students	Central Indian	Digital literacy and use of smart phones among Central Indian dental students	1. Out of 260 students, 250 were internet users. 2. 94.23% students owned a smartphone. 3. 46.53% students had some app related to the dentistry in their smartphone device.

				4. Nearly 80% dental students believed that social media helps them in their professional course studies. 5. 89.23% students were keen for implementation of e-learning in their curriculum.
Sameer et al (2018)	Physicians	Saudi Arabia	Popularity and impact of using smart devices in medicine in Saudi Arabia	1. 300 physicians attended the study. 2. 88.3% physicians had smart devices, and 86.3% had at least one medical app installed. 3. 53.0% used an app at least once a day. 4. Medical apps were positively perceived, with physicians reporting increased dependency on the apps

Table 2 Demographic characteristics of surveyed dentists in China (n = 379 subjects)

		Number	Percent (%)
Age	≤ 30	152	40.1
	31-40	181	47.8
	41-50	24	6.3
	> 50	22	5.8
Gender	Male	139	36.7
	Female	240	63.3
Workplace	Public hospital	168	44.3
	Private hospital or clinic	211	55.7
Medical rank	Resident dentist	179	47.2
	Dentist in charge	153	40.4
	Senior/associate senior dentist	47	12.4
Do you own a smartphone?	Yes	379	100
What's the brand of your smarphone?	Apple	175	46.2
	Huawei	129	34
	OPPO	33	8.7
	Xiaomi	28	7.4
	Sumsung	6	1.6
	Others	8	2.1

Table 3 The use of Wechat or QQ in dentists' clinical work (n = 379 subjects)

		Number	Percent (%)
Have you installed Wechat or QQ on your smartphone?	Yes	379	100
Do you use WeChat or QQ in clinical practice?	Yes	379	100
The purpose for using WeChat or QQ in clinical practice	Communicating with patients	294	77.6
	Communicating with peers	317	83.6
	Acquiring medical information	319	84.2
	Others	76	20
Frequency of using WeChat or QQ in clinical practice	At least once a day	279	73.6
	At least once a week	79	20.8
	Less than once a month	21	5.5
Daily use of WeChat or QQ in clinical practice within dentists (in minutes)	None	0	0
	1-10 minutes	51	13.5
	11-20 minutes	66	17.4
	21-30 minutes	72	19
	31-40 minutes	49	12.9
	41-50 minutes	24	6.3
	51-60 minutes	19	5.0
	>60 minutes	98	25.9

Table 4 The use of medical apps in dentists' clinical work (n = 379 subjects)

		Number	Percent (%)
Have you installed medical apps on your smartphone? (except Wechat and QQ)	Yes	288	76
	No	91	24
How many medical apps do you have on your smartphone?	No	91	24
	1-5 apps	271	71.5
	6-10 apps	15	4
	>10 apps	2	0.5

Table 5 The factors of affecting whether or not dentists installed medical apps

		Whether or not dentist installed medical apps		Total	Chi-square test	df	p-value
		Yes	No				
Gender	Male	116	23	139	6.702	1	0.010
	Female	172	68	240			
Age	≤ 30	124	28	152	45.303	3	0.000
	31-40	144	37	181			
	41-50	16	8	24			
	> 50	4	18	22			
Workplace	Public hospital	133	35	168	1.670	1	0.196
	Private hospital or clinic	155	56	211			
Medical rank	Resident dentist	135	44	179	5.466	2	0.065
	Dentist in charge	123	30	153			
	Senior/associate senior dentist	30	17	47			
Total		288	91	379			

Table 6 The frequency and daily use (in minutes) of medical apps within dentists in China (n = 288 subjects)

		Number	Percent (%)
Frequency	At least once a day	134	46.5
	At least once a week	122	42.4
	Less than once a month	32	11.1
Daily use	None	2	0.7
	1-10 minutes	84	29.2
	11-20 minutes	91	31.6
	21-30 minutes	45	15.6
	31-40 minutes	30	10.4
	41-50 minutes	16	5.6
	51-60 minutes	5	1.7
	> 60 minutes	15	5.2

Table 7 Purpose for using smartphone based medical apps (n = 288 subjects)

	Number	Percent (%)
Reviewing medical knowledge	241	63.6
Reading medical news	138	36.4
Reading medical journals	106	27.9
Clinical skills guide	105	27.7
Communicating with patients	98	25.9
Communicating with colleages	97	25.6
Preparing presentations	87	22.9
Assisting diagnosis	80	21.1
Exam preparation	67	17.7
During ward rounds	64	16.9
Medication or drug guide	64	16.9
Scheduling patients’ appointment	47	12.4
Mobile learning	30	7.9

Table 8 Dentists’ perceptions on smartphone based medical apps (n = 288 subjects)

		Number	Percent (%)	Mean	SD
Medical apps are easy to obtain	Strongly agree	56	19.4	2.36	0.99
	Agree	127	44.1		
	Not sure	51	17.7		
	Disagree	54	18.8		
	Stongly disagree	0	0		
I am looking to obtain more medical apps in the future	Strongly agree	160	55.6	1.52	0.69
	Agree	114	39.6		
	Not sure	5	1.7		
	Disagree	9	3.1		
	Stongly disagree	0	0		
I would recommend these medical apps to other peers	Strongly agree	122	42.4	1.67	0.68
	Agree	148	51.4		
	Not sure	10	3.5		
	Disagree	8	2.8		
	Stongly disagree	0	0		
I do most of my medical learning using medical apps	Strongly agree	62	21.5	2.43	1.17
	Agree	131	45.5		
	Not sure	9	3.1		
	Disagree	80	27.8		
	Stongly disagree	6	2.1		
Medical apps are essential tools for undergraduate medical studies	Strongly agree	91	31.6	1.91	0.78
	Agree	140	48.6		
	Not sure	48	16.7		
	Disagree	9	3.1		
	Stongly disagree	0	0		
Medical apps are superior to medical textbooks	Strongly agree	13	4.5	3.16	0.81
	Agree	56	19.4		
	Not sure	98	34		
	Disagree	115	39.9		
	Stongly disagree	6	2.1		
Medical apps can replace medical textbooks	Strongly agree	7	2.4	3.31	0.94
	Agree	68	23.6		
	Not sure	48	16.7		
	Disagree	159	55.2		
	Stongly disagree	6	2.1		

Medical apps supplement medical textbooks	Strongly agree	77	26.7	1.83	0.64
	Agree	193	67		
	Not sure	9	3.1		
	Disagree	8	2.8		
	Stongly disagree	1	0.3		
Medical apps provide useful point-of-care medical information	Strongly agree	54	18.8	2.28	0.97
	Agree	149	51.7		
	Not sure	34	11.8		
	Disagree	51	17.7		
	Stongly disagree	0	0		
There are dangers in using medical apps for patient care	Strongly agree	7	2.4	2.61	0.73
	Agree	133	46.2		
	Not sure	114	39.6		
	Disagree	34	11.8		
	Stongly disagree	0	0		

Table 9 Perceived impact of smartphone based medical apps on clinical practice

		Number	Percent (%)	Mean	SD
Improve clinical decision-making	Strongly agree	30	10.4	2.30	0.77
	Agree	166	57.6		
	Not sure	67	23.3		
	Disagree	25	8.7		
	Stongly disagree	0	0		
Save time	Strongly agree	41	14.2	2.11	0.68
	Agree	185	64.2		
	Not sure	51	17.7		
	Disagree	11	3.8		
	Stongly disagree	0	0		
Allow faster access to medical information	Strongly agree	53	18.4	1.90	0.54
	Agree	214	74.3		
	Not sure	17	5.9		
	Disagree	4	1.4		
	Stongly disagree	0	0		
Allow faster access to common laboratory reference values	Strongly agree	16	5.6	2.30	0.65
	Agree	185	64.2		
	Not sure	72	25		
	Disagree	15	5.2		
	Stongly disagree	0	0		
Help in developing differential diagnoses	Strongly agree	7	2.4	2.56	0.74
	Agree	176	61.1		
	Not sure	70	24.3		
	Disagree	35	12.2		
	Stongly disagree	0	0		
Perform useful medical related calculations	Strongly agree	8	2.8	2.52	0.77
	Agree	163	56.6		
	Not sure	78	27.1		
	Disagree	38	13.2		
	Stongly disagree	1	0.3		
Allow faster access to reliable sources of medical knowledge	Strongly agree	28	9.7	2.19	0.68
	Agree	194	67.4		
	Not sure	50	17.4		
	Disagree	16	5.6		
	Stongly disagree	0	0		

Allow faster access to reliable sources of clinical skills	Strongly agree	24	8.3	2.25	0.67
	Agree	180	62.5		
	Not sure	71	24.7		
	Disagree	13	4.5		
	Stongly disagree	0	0		
Allow faster access to evidence-based medical practice/case	Strongly agree	39	13.5	2.34	0.80
	Agree	132	45.8		
	Not sure	96	33.3		
	Disagree	21	7.3		
	Stongly disagree	0	0		

Figures

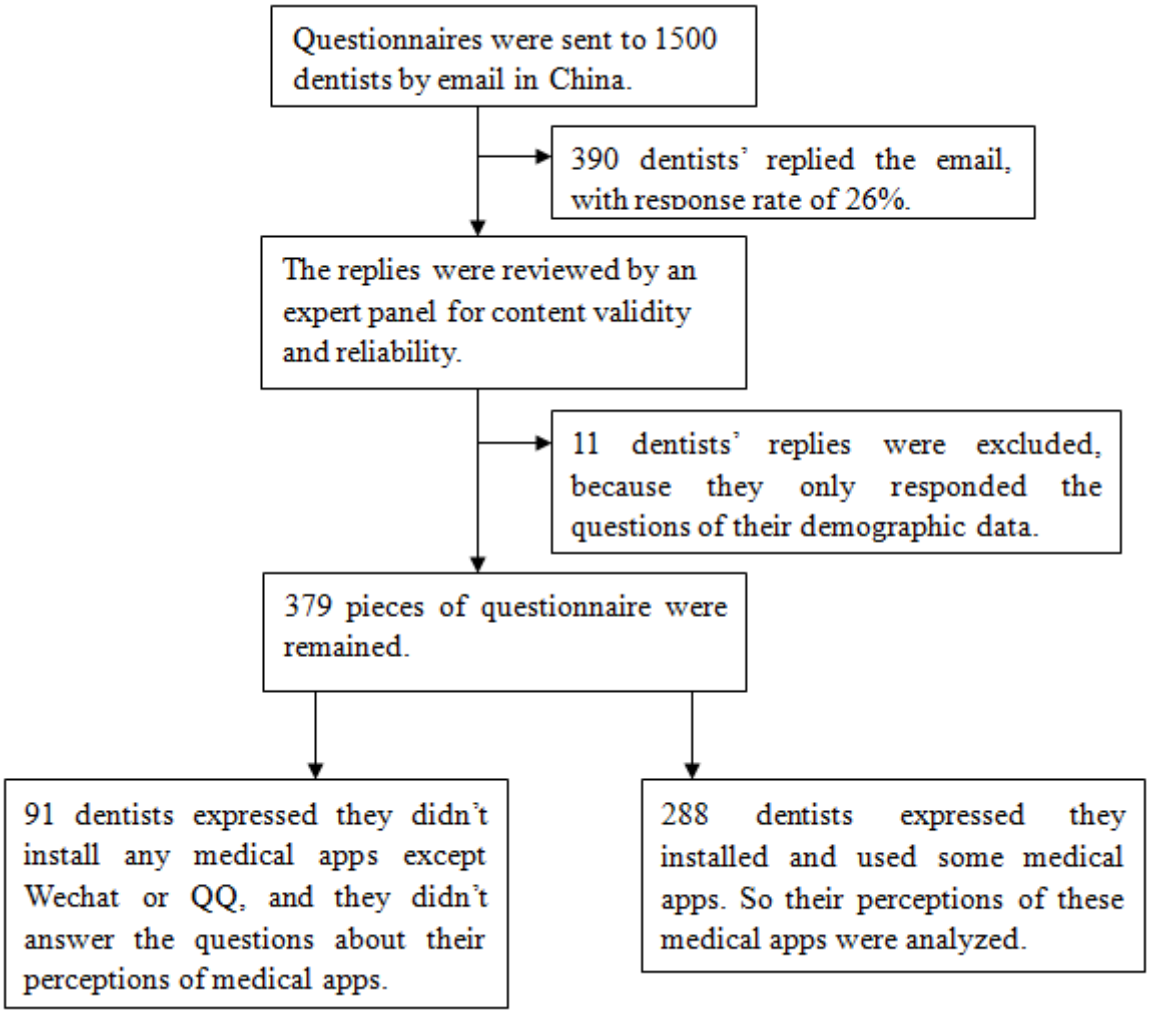

Figure 1

The flow diagram of collecting eligible questionnaires for this study

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- additionalsupportingfile1.xlsx
- additionalsupportingfile2.xlsx