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The Effect of Media Richness on the Stability of Physician-Patient Relationships on E-Consultation Platforms

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ABSTRACT

Incorporating media richness theory, social presence theory, and apparatgeist theory, the authors used multiple linear regression to explore the effect of media richness on the stability of physician-patient relationships and the moderating effect of disease complexity and response timeliness on the relationship between media richness and relationship stability. The results showed that media richness had a positive effect on the stability of physician-patient relationships. Additionally, both disease complexity and response timeliness positively affect the relationship between media richness and the stability of physician-patient relationships. This research contributes to the literature concerning media selection, e-consultation platforms, and physician-patient relationships; and it provides practical guidance for online doctor teams on how to select appropriate media communication forms for patient consultations in different situations.

KEYWORDS

Media Richness, Preference Score Matching, Social Presence Theory, Stability of Physician-Patient Relationships

INTRODUCTION

In recent years, physician–patient conflicts have occurred frequently, and the tension between physicians and patients has become a major problem in social governance (Wang et al., 2017). A crucial reason for this tension is that the two parties lack trust in each other, and the interaction between the two parties affects the establishment of such trust (Wei et al., 2020). In the offline medical scene, it is difficult for physicians and patients to communicate deeply. Physicians need to treat many patients per day, and they usually only say a few words to most patients. In these situations, patients tend to get the impression that the physicians are irresponsible, reducing their trust in their doctors.

The emergence of an online health consultation platform provides an opportunity to rebuild trust between physicians and patients. Patients can easily contact physicians through the platform, and physicians can make full use of their free time to provide consultation services for patients. However, online health consultation platforms create additional problems for physician–patient communication. First, online physician–patient communication presents trust issues (Li et al., 2018; Li et al., 2020).

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Offline physician–patient communication is face to face. Patients can enhance their understanding of their condition through doctors' facial expressions, vocal inflections, or actions, making the physician–patient communication more efficient. However, on online platforms, patients can only receive clues through text and voice messages with doctors. Compared with offline communication, the sense of social presence is reduced by varying degrees, and patients' trust in their doctors is affected. Second, in offline scenarios, doctors can check a patient's condition by observing, listening, asking, or feeling a patient's pulse. However, in online scenarios, doctors can only make judgments based on the patient's descriptions, complicating communication between them. Additionally, doctors conduct consultations with patients with diseases whose complexity varies. Complex diseases require multiple inquiries to arrive at a better diagnosis, which increases the cost of communication with patients. Third, online platforms are asynchronous, so patients usually wait a long time to receive a reply after consulting (Zhang et al., 2019). All these situations make the physician–patient relationship tenser on online platforms. Therefore, how to improve the stability of physician–patient relationships on online health consultation platforms has become an urgent problem.

Different from offline face-to-face communication, online health consultation platforms provide doctors with different media communication forms: in text, voice, and text with voice, the media richness increases successively. Doctors can also independently choose which media communication format to use. According to media richness theory, media with high richness can provide timely and effective feedback for communication between two sides, making communication more efficient and faster (Kahai & Cooper, 2003; Logsdon & Patterson, 2009). The theory of social presence holds that the higher the richness of the media, the stronger the sense of reality that users feel and the higher the corresponding sense of social presence, which can improve the quality of the relationship between two parties (Lu et al., 2016). The different media communication forms online doctors choose bring different senses of social presence to patients, leading to different communication effects between doctors and patients that determine whether patients are willing to establish a stable relationship with their doctors. Therefore, how to choose the appropriate media richness is a problem online physicians need to consider. Based on media richness and social presence theories, the first research question of this study is as follows:

RQ1: Does the richness of the media online physicians select for patient consultation affect the stability of online physician–patient relationships?

According to media richness theory, media with high richness are convenient for understanding and transmitting information with high fuzziness. However, not all scenarios are suitable for media with high richness. Instead, different media formats should be selected for communication in different task scenarios (Daft & Lengel, 1983). Online doctors will face consultations with patients with different levels of disease complexity, and the choice of media should depend on the disease. Additionally, according to social presence theory, the higher the richness of media, the more patients can feel a connection with doctors. Especially when the disease is complex, a feeling of connection with doctors can help patients trust doctors more. Based on media richness and social presence theories, the second research question of this study is as follows:

RQ2: How does patients' disease complexity moderate the relationship between the media richness online physicians choose and the stability of online physician–patient relationships?

Apparatgeist theory proposes that task matching and user cognition affect media selection. Users think different media have different degrees of asynchrony (Tan et al., 2014). Unlike direct offline communication, online physician–patient communication is often asynchronous, with patients waiting for doctors to respond. The degree of asynchrony patients require for doctors' replies varies with

the media communication methods doctors adopt. The asynchrony of the media needs to match the asynchrony the communication requires to improve its effect. Therefore, based on media richness theory and apparatgeist theory, the third research question of this study is as follows:

RQ3: How does the doctor's response timeliness moderate the relationship between the media richness online physicians choose and the stability of online physician–patient relationships?

Doctor teams are an emerging model of online health consultation platforms. They can integrate resources across regions, hospitals, and departments to provide patients with more timely and comprehensive consulting services. If a doctor is too busy to respond to a patient's consultation, other doctors on the team can respond instead, thus reducing the patient's wait time. In short, the doctor team model makes it easier to establish long-term, stable relationships with patients. Therefore, this paper assumes the online doctor team as the research object.

This paper will expand the existing research on the stability of physician–patient relationships using media selection theories, namely, media richness theory, social presence theory, and apparatgeist theory. The research also provides practical guidance for online doctor teams on how to select appropriate media communication formats for patient consultation in different situations.

LITERATURE REVIEW

Media Selection Theory

Media Richness Theory

Daft and Lengel (1983) first formally proposed *media richness theory*. It focuses primarily on how organizations select appropriate media to reduce uncertainty and ambiguity in information processing. Uncertainty refers to the gap between the data needed to solve a problem and the data available. Ambiguity is defined as the absence of reliable, credible, or adequate information (Kalke et al., 2021). Daft and Lengel (1983) believed that media determine the richness of the information being processed. Media of high richness can deliver more complex and ambiguous information, which can better support organizations in solving problems through communication. Trevino et al. (1990) believed that there are differences in the richness of information transmitted by different media and that media richness can be determined based on four criteria: availability of timely feedback, multi-clue transmission, use of natural language, and personal attention. According to the above criteria, face-to-face communication is the most media-rich form because it allows for rapid feedback, multiple cues, natural language, and communication of emotion. Telephone communication is second in media richness. Telephone communication can also provide timely feedback and use natural language, but the clues provided cannot be as good as those of face-to-face communication, and the body language of the other party cannot be observed. Other media, such as mail, documents, and statistical reports, are lower in richness than the above two forms.

Communication modes with high media richness can make communication faster and more efficient and facilitate the understanding of tasks with high levels of ambiguity. For simple, low-ambiguity tasks, media of high richness may create information overload and prolong the amount of time needed to reach an agreement. Therefore, media of low richness is more appropriate for this type of task (Sun & Cheng, 2007). The matching of media with task complexity is an important prerequisite for improving the internal and external communication effects of organizations (Daft & Lengel, 1986). In terms of online word of mouth, some studies have found that for experiential products, higher levels of media richness are preferable. Verbal media with digital media are indeed better than digital media alone, but adding video to media with both verbal and digital formats does not lead to better user perception (Li et al., 2014).

Since media richness theory was first proposed, many studies have been conducted to verify its core ideas. Kahai and Cooper (2003) designed an experiment to test face-to-face and electronic meetings, email, and other media in managing the execution of two different tasks. The authors found that media of high richness help improve social awareness, identify fraud, and complete complex tasks. When faced with a task that we know little about, media of low richness can improve communication more efficiently. Lee (2022) investigated which media communication forms (e.g., face-to-face, email, and print media) in the organization are effective at communicating with peers, managers, and CEO of a company, respectively. Results showed that media with high richness (e.g., face-to-face) are more suitable for symmetric communication with managers and peers, while media with low richness (e.g., print media, email) are better for symmetric communication with CEO. In addition to verifying the theory, many scholars have studied differences in the effects different media produce. Maity et al. (2018) studied the influence of media richness on consumer information collection strategies. An improvement in media richness reduces the cost of information searches and increases the number of factors that consumers can consider. Vickery et al. (2004) found that in the third-party logistics industry, which is characterized by high degrees of uncertainty and ambiguity, media richness has a direct role in promoting relationships between upstream and downstream actors and indirectly affects loyalty and satisfaction by influencing the relationships between the two parties.

Social Presence Theory

Social presence, which Short et al. (1976) first introduced, refers to the medium of communication through which people experience reality and a degree of contact with others. At first, the term was mainly used in the field of communication. Then, with the development of computer-aided technology, the term's use was extended to the field of distance education. Next, it was applied to the field of robot interaction. With the rise of e-commerce, research in the e-commerce industry also began to appear (Yue et al., 2017). With the development of information technology, scenarios for applying social presence also increased. Social presence was originally described as a feature of media. Different media have different forms of social presence, which will affect the impact of communication (Nguyen et al., 2022). Cyr et al. (2007) believed that media can enable users to experience the reality of others' psychological existence in a virtual environment. According to social presence theory, the social presence of face-to-face media is greater than that of video conferences, which in turn has a greater social presence than that of audio conferences, and audio has more social presence than text.

With the continuous development of work on social presence, many researchers have begun to explore its role in the electronic market. In online shopping environments, social presence refers to the degree of intimacy between buyers and sellers (Choi, 2016), which can reduce the psychological distance between the two parties and improve the quality of their relationship (Lu et al., 2016). Gao et al. (2018) demonstrated that consumers who perceive a high level of social presence in an online retail store are likely to have more information about the product, so they believe that their purchase choices are based on their true interests and values, thus increasing their sense of autonomy, social identity, and enjoyment. Li (2019) investigated the influences of social commerce websites on customer intentions to purchase products and found that social presence would affect their trust intention to product recommendations.

Social presence and media richness theory are inextricably linked. Although they apply different definitions of media attributes, their basic positions are similar. The characteristics of media determine the selection of media. Different media have different abilities to transmit information, so we must choose appropriate media for the given situation. Considering media richness and social presence theory, Tseng et al. (2019) found that immediate feedback and personal focus are the main aspects of media richness that are positively related to social presence, relatedness need satisfaction, and user loyalty. As the level of media richness increases, the sense of reality in the user experience becomes stronger, and the corresponding level of social telepresence becomes higher.

Apparatgeist Theory

Katz and Aakhus (2002) proposed *apparatgeist theory* in 2002, which holds that technologies cannot determine how they are used and offer only limited uses, just as a menu cannot provide unlimited choices and only offers certain options. Users' use of technology can be understood from the *design orientation* (or *soul*) of technology. Apparatgeist theory differs from technology determinism. Determinism holds that the given technology itself determines how users use technology, but apparatgeist theory holds that users' personal views of technology determine how users use technology (Tan et al., 2014). According to Tan et al., although email and short messages have similar functions, they are used for different purposes because of the different views of users. Short messages are generally used to send short, informal messages in anticipation of prompt replies, whereas email is often used to send longer formal messages that do not require prompt replies (Heinonen & Strandvik, 2007). Although complex information systems have a variety of functions and diversified use patterns, user behavior is simpler (Kim et al., 2007). This view fits with apparatgeist theory, according to which users use technology as they understand it rather than based on what it can do.

Users give technology a specific meaning (soul), which then limits the scope of their interaction with it. Over time, this meaning is strengthened, and eventually, most users develop similar technology usage habits (Lahiri, 2010). There is no significant difference between instant messaging software and email, but they are used as synchronous and asynchronous communication tools, respectively, because of their different design positioning (Li et al., 2016). Users are accustomed to using instant messaging software to send synchronous messages. This habit will develop into a consensus when it is consistently strengthened. Email has also developed as an asynchronous communication tool, and it has become a common view that people do not need to reply to an email immediately. However, in essence, the functions of the two tools are almost the same.

Physician–Patient Relationships and Stability Research

Physician–patient relationships refer to the relationships among patients, doctors, and hospitals (Chen & Zheng, 2014). They reflect the relationships between patients and the entire medical system and society (Hoff & Collinson, 2017). Physician–patient relationships affect everyone's vital interests and social stability. In recent years, physician–patient conflicts have occurred more frequently, and increasingly tense relationships between doctors and patients have become a major problem in the process of social governance (Wang et al., 2017).

Tension in physician–patient relationships is most often related to a lack of trust. First, doctors and patients are often strangers to one another and mainly follow utilitarian rules in their interactions, which leads to the establishment of a positive interaction based on trust (Yang & Wu, 2018). Second, there is a problem of information asymmetry between doctors and patients. Patients are on the side with unfavorable information, whereas doctors are on the side with favorable information. This unequal relationship can easily lead to patient distrust and conflict (Liu et al., 2020). Furthermore, the main reasons for patient complaints include improper practices by medical staff and a lack of strong communication with physicians (Pichert et al., 1998).

Tension between doctors and patients can easily lead to negative consequences. Several studies have confirmed that physician–patient relationships affect doctors' job satisfaction (Deng et al., 2018). When doctors are not satisfied with physician–patient relationships, the outcomes of their diagnosis will be affected. Tense doctor–patient relationships tend to lead to doctors ignoring their medical experience when making a diagnosis and relying more on drugs or devices. This leads to the deterioration of such relationships (Xie et al., 2009). The physician–patient relationship also affects the turnover rate of doctors. Patient distrust leads to doctors' physical and mental fatigue, encouraging them to leave the medical profession (Zhang et al., 2020). Improving the medical system, providing good services, and implementing reasonable medical costs are ways to resolve the tensions between doctors and patients (Chen & Zheng, 2014).

Therefore, it is important to restore trust between doctors and patients to reconstruct harmonious and stable physician–patient relationships. Establishing trust is a long–term process. When patients and doctors can maintain long–term, stable relationships under demanding conditions, it is conducive to establishing relationships of mutual trust between the two sides.

In recent years, online health consulting services have developed rapidly and received widespread attention (Li et al., 2018). The online health consultation platform provides an efficient and convenient communication platform for doctors and patients, offering pre-illness consultation, remote diagnosis, post-illness follow-up, and other services, which is conducive to narrowing the distance between patients and doctors and improving their relationships. From a macroscopic perspective, e-consultation platforms can meet the growing demand for health services to a certain extent and allocate existing health care resources more effectively (Zhang et al., 2019).

Scholars have examined factors that affect patients' choice of doctors on e-consultation platforms. It is actually a two-way choice between doctors and patients. Patients choose doctors by referring to the attributes of physicians (such as professional titles and ages; Wu et al., 2019), the demographic factors of patients (such as gender and age; Liu et al., 2018), the online behavior of patients (such as comments; Liu et al., 2018) and so on. Besides, online doctors also have the right to choose patients when facing the consultations of many patients. Lu and Wang (2022) explored physician preferences for selecting online patients from physician's perspective, which helps them to participate more actively in online services and improve physician–patient relations.

However, online health platforms also contribute to trust problems between doctors and patients. Li et al. (2018) pointed out that patients may have an initial distrust of online health platforms because of their unfamiliarity with the online operating environment, leading to their distrust of the services doctors provide. Uncertainty about the quality of doctors' services because of patients' unfamiliarity with doctors is another challenge. Few studies have explored how online platforms can improve the quality of physician–patient communication by enhancing patient trust in doctors. Peng et al. (2020) confirmed that improvement of physician–patient interaction and trust should be combined with patients' efficient use of online health information, such as improvement of the practicability and credibility of online health information, doctors' guidance, and the correction of information from other sources.

Research Gap

Previous literature examined physician–patient relationships and their stability, suggesting that the most important reason for tension in a physician–patient relationship is lack of trust. These scholars mainly discussed offline doctor–patient problems and believed that improving the medical system, providing good services, and implementing reasonable medical costs are the best solutions (Chen & Zheng, 2014). However, few studies have explored the online physician–patient relationships existing on online health consultation platforms. The current paper fills this research gap.

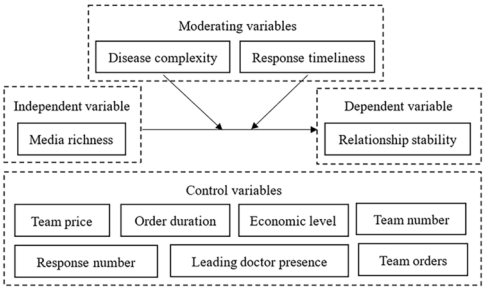
Because physicians and patients usually communicate face to face offline, few studies have explored whether media richness affects the stability of physician–patient relationships in the online scenario from the perspective of media selection. The current paper fills the research gap of media selection theory in the field of online physician–patient relationships. When combined with media selection theory, high-richness media are suitable for complex and fuzzy tasks, and different media forms should be selected for communication according to both different task scenarios and user cognition. This paper further innovatively explores how the complexity of diseases and the timeliness of physician responses affect the influence of media richness on the stability of the physician–patient relationships and expand the application scenarios of media selection theory.

RESEARCH DESIGN AND HYPOTHESES

Research Model

To address the proposed three research questions, the authors designed the research model as shown in Figure 1. The primary focus of this paper is the influence of media richness on the stability of physician–patient relationships. The authors also consider the moderating effect of disease complexity and the timeliness of the physician's response on the relationship between media richness and the stability of physician–patient relationships. Specific hypotheses are addressed in the next section.

Figure 1. Research model for the influence of media richness on the stability of physician–patient relationships



The Influence of Media Richness

To establish stable physician–patient relationships, improving patient trust in doctors is essential. Previous studies have shown that improving media richness helps enhance the quality of bilateral relations and strengthen feelings of trust (Vickery et al., 2004). Rich media can promote social perception and improve the ability to identify fraud and reduce deceptive behavior on both sides (Kahai & Cooper, 2003; Logsdon & Patterson, 2009). On an online medical platform, if doctors use their voices to communicate with patients, they can provide more clues to patients, which is conducive to positive patient impressions of doctors' professionalism, improving patient trust in doctors, helping patients establish stable and harmonious relationships with doctors, and improving willingness to consult doctor teams again when patients have further needs. Therefore, this study proposes the following hypothesis:

H1: Media richness has a significant positive impact on the stability of physician–patient relationships.

The Moderating Effect of Disease Complexity

Higher levels of media richness lead to more complex and fuzzy information that can be transmitted, better supporting organizations in solving problems through communication (Daft & Lengel, 1986). Tang et al. (2015) found that adjusting the type of communication media to the type of task involved can improve team performance, which is consistent with the core premise of media richness theory. Based on media richness theory, Maity and Dass (2014) explored the effect of media richness on consumer decision-making and channel choice. They found that consumers prefer channels with media and high levels of media richness for carrying out complex decision-making tasks and are likely to undertake simple decision-making tasks on channels that incorporate a low level of media richness.

The more complex a disease is, the more complex is the corresponding consultation task. Compared with text media, voice-based media can transmit more information in a unit of time, helping

doctors spend less time describing disease diagnoses to patients and improving their time-utilization efficiency. According to social presence theory, higher levels of media richness lead to patients experiencing deeper contact with doctors. Especially when disease diagnoses are more complex, patients are more likely to feel fear. Experiencing intense contact with their doctors will increase patient trust. Thus, this study proposes the following hypothesis:

H2: The degree of disease complexity positively moderates the effect of media richness on the stability of physician–patient relationships.

The Moderating Effect of Response Timeliness

Task-matching factors and user cognition influence media selection. According to apparatgeist theory, users' views of media determine the ways they adopt media rather than the characteristics of the media source itself dictating use (Tan et al., 2014). When doctors use their voices to communicate, patients are more likely to regard the communication as synchronous and expect a timelier response. When doctors use text to communicate, patients are more likely to regard the communication as asynchronous and do not expect a timely response. The synchronization of media must be matched with the synchronization of communication so that the corresponding media can improve communication performance (Li et al., 2016).

For user cognition, voice communication is more synchronous than text communication. In daily life, for a non-urgent matter, a text message will be sent on instant messaging software. When an emergency requires others to reply immediately, a telephone or voice call will be used. Although the synchronization of a single voice is not as good as a telephone or voice call, it has a stronger visual impact than text and encourages others to reply in a timely manner. When doctors use their voices as a medium for communication, patients prefer to identify this as a synchronous communication mode and place greater demands on the timeliness of doctor responses. Timely responses from doctors can moderate the influence of media richness on the stability of physician–patient relationships. Therefore, this suggests the following hypothesis:

H3: The timeliness of the physician's response positively moderates the effect of media richness on the stability of physician–patient relationships.

METHODOLOGY

Research Data

The research data used in this study was obtained from Good Doctor Online, one of the best online health consultation platforms in China. The authors chose this platform as a data sample because it has comprehensive medical remote services, the largest number of authoritative doctors with the highest quality of medical services in China, and is highly trusted by patients. As of September 2020, the platform included more than 10,000 regular hospitals and more than 700,000 doctors. Among these active doctors, 78% of doctors are from Grade III A hospitals and have high medical service authority. In addition, Good Doctor Online is a typical website for serious illness treatment and physician–patient matching (Li et al., 2018), which is more helpful for the researchers to explore physician –patient relationships online.

The authors collected order consultation data for 19,216 patients from more than 1,000 doctor teams in place in November 2019. After excluding patients who did not reply to their doctors, the remaining 17,355 data points were used as the sample for this study. Order consultation data used included the region a patient came from, the timing and content of physician –patient communication, and the number of orders a patient placed. The data were freely available on the internet and thus did

not violate any privacy regulations. The authors also declared no potential conflicts of interest with respect to the research results.

Variable Definitions

Dependent Variable: Relationship Stability

The authors used physician–patient relationship stability as the dependent variable. *Stability* refers to a patient's willingness to establish contact with a doctor more frequently, reflecting the patient's trust in and recognition of the doctor and the stability of the patient's relationship with the doctor. More stable physician–patient relationships on online medical platforms correlate with the platform's offering more value to patients and patients being more willing to seek medical services numerous times through the platform. In this paper, the authors used the number of times a patient purchased the services of a doctor's team to measure relationship stability. The more times services were sought, the more stable the relationship between a patient and a doctor team was and the more positively the doctor team was evaluated.

Independent Variable: Media Richness

According to the theory of social presence and the principle of media richness, social presence increases from text to voice media and then again to visual media. Through Good Doctor Online, patients can ask questions, and doctors can reply by text or voice message. Compared with text messages, voice messages provide more information and offer higher levels of media richness and social presence. The independent variable of this paper was media richness. When patients and doctors communicated only by text, the level of media richness was the lowest at 1; when patients communicated only with voice messaging, the level of media richness was higher at 2; when patients communicated with both text and voice messaging, the level of media richness was the highest at 3.

Moderating Variables

Disease Complexity

When a task is more complex, it is necessary to adopt a communication mode of high media richness, which can be more convenient. Disease complexity corresponds to disease severity. More serious diseases are more complex. Very serious diseases (e.g., cancer, leukemia, uremia, AIDS, heart disease, kidney transplantation) were assigned a value of 1, and other diseases were assigned a value of 0.

Response Timeliness (Reverse Index)

According to apparatgeist theory, what users think the given technology is used for, rather than what it can actually do, determines how users use the technology. High media richness is associated with synchronous communication, whereas low media richness is associated with asynchronous communication. Therefore, a timely response can enhance the effect of media richness. The timeliness of a response was measured as the length of time a doctor took to reply to a patient. The researchers calculated this time interval and then averaged all time intervals. Time interval is the reverse index of response timeliness. Longer time intervals indicated a less timely doctor's reply; shorter intervals indicated a more timely reply.

Control Variables

Team Price

Team price is the price a doctor team charges for online consultations. According to the principle of supply and demand, higher prices reduce demand, so team prices may negatively affect the number of orders that patients place with doctor teams. Team prices were measured by the natural logarithm of the consulting service price the team provided.

Order Duration

Order duration records how long the consultation between doctors and patients lasts. Longer team order duration is positively associated with more communication between doctors and patients, which helps doctors understand their patients' situations in more detail and improves patients' degrees of satisfaction. Order duration was measured as the average duration of all orders of patients, and the natural logarithm was adopted.

Response Number

The *response number* is the number of times a doctor replies to a patient, which represents the doctor's level of effort. The more replies a doctor gives, the more energy the doctor is dedicating to the patient. The response number was measured as the number of conversations a doctor had with a patient, and the natural logarithm was used.

Economic Level

Economic levels in different regions of China vary considerably, and online health care is a new tool. In regions with higher levels of economic development, the penetration rate is higher, and the user base is larger. Therefore, economic development has a positive impact on the establishment of stable relationships between doctors and patients. Economic development was measured from per capita GDP. Specifically, this study used the average per capita GDP of a patient's province of residence in the last three years and then calculated the average value of all provinces. If this value was higher than the average value, a value of 1 was assigned; if the value was lower than the average value, a value of 0 was assigned.

Team Number

The *team number* is the number of doctors participating in a service. This will affect service quality and then the number of orders.

Leading Doctor Presence

Each doctor team has a *leading doctor*, who usually is the most senior expert in the team. Whether leading doctors participate in a service will also affect service quality and, ultimately, the number of orders.

Team Orders

Teams that receive more orders are stronger and more attractive to patients. Patients are more likely to place orders with such teams again. *Team orders* were measured as the sum of the orders of all patients for the sample team, and the natural logarithm was used. Table 1 shows the variables the researchers used, and Equation 1 illustrates the econometric model this research constructed:

$$Y_i = \beta_0 + \beta_1 Media\ richness_i + \beta_2 Disease\ complexity_i + \beta_3 Response\ timeliness_i + \beta_4 Media\ richness_i \times Disease\ complexity_i + \beta_5 Media\ richness_i \times Response\ timeliness_i + \beta_6 Team\ price_i + \beta_7 Order\ duration_i + \beta_8 Response\ number_i + \beta_9 Economic\ level_i + \beta_{10} Team\ number_i + \beta_{11} Leading\ doctor\ presence_i + \beta_{12} Team\ order_i + \varepsilon_i \quad (1)$$

Table 1. Variable table

Variable Type	Variable
Dependent variable	Relationship stability
Independent variable	Media richness
Moderating variables	Disease complexity Response timeliness
Control variables	Team price Order duration Response number Economic level Team number Leading doctor presence Team orders

RESULTS AND ROBUSTNESS TEST

Main Results

Table 2 shows the descriptive statistical analysis of all variables, including sample sizes, mean values, standard deviations, and minimum and maximum values. The average value of the stability of physician–patient relationships is 1.084, indicating that patients place 1.084 orders on average, and most patients place only one order. The maximum value is 14, which indicates that some patients have stable relationships with their doctors and place orders many times. The average value of media richness is 1.247, which indicates that most patients communicate with their doctors via text messages.

Table 2. Descriptive statistical analysis of variables

Variable Name	Sample Number	Mean Value	Standard Deviation	Minimum Value	Maximum Value
Relationship stability	17,355	1.084	0.410	1	14
Media richness	17,355	1.247	0.642	1	3
Disease complexity	17,355	0.140	0.347	0	1
Response timeliness (reverse index)	17,355	0.695	3.310	0	29.20
Team price	17,355	3.969	0.950	1.792	6.868
Order duration	17,355	1.477	1.038	0.693	6.774
Response number	17,355	1.664	0.677	0.693	5.541
Economic level	17,355	0.550	0.498	0	1
Team number	17,355	1.330	0.562	1	5
Leading doctor presence	17,355	0.646	0.478	0	1
Team orders	17,355	3.662	1.056	0.693	8.025

Table 3 shows the correlations among the variables. The correlation coefficients for the variables are at an appropriate level but are not high, indicating an absence of multicollinearity. Table 3. Correlation coefficient matrix

Table 3. Correlation coefficient matrix

	1	2	3	4	5	6	7	8	9	10	11
1. Relationship stability	1.000										
2. Media richness	0.049*	1.000									
3. Disease complexity	0.040*	0.000	1.000								
4. Response timeliness	–0.015	–0.010	0.003	1.000							
5. Team price	–0.022*	0.152*	0.077*	–0.014	1.000						
6. Order duration	0.132*	0.066*	0.028*	0.468*	0.089*	1.000					
7. Response number	0.330*	0.057*	0.016	–0.072*	0.154*	0.244*	1.000				
8. Economic level	0.019	–0.006	–0.022*	–0.012	0.045*	0.010	–0.001	1.000			
9. Team number	0.166*	0.066*	0.020*	0.004	0.117*	0.170*	0.373*	0.014	1.000		
10. Leading doctor presence	0.056*	0.130*	–0.005	0.051*	0.085*	0.104*	0.086*	0.012	0.240*	1.000	
11. Team orders	0.093*	0.105*	–0.002	–0.033*	0.221*	0.137*	0.066*	0.016	0.060*	–0.026*	1.000

Table 4. Regression analysis results

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability
Team price	–0.043***	–0.047***	–0.047***	–0.045***	–0.047***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Order duration	0.017***	0.019***	0.016***	0.020***	0.019***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Response number	0.188***	0.186***	0.188***	0.186***	0.187***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Economic level	0.018**	0.019**	0.019**	0.018**	0.019**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Team number	0.031***	0.031***	0.031***	0.031***	0.030***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)

Table 4 continued on next page

Table 4 continued

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability
Leading doctor presence	0.021***	0.019**	0.019**	0.018**	0.019**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Team orders	0.034***	0.033***	0.033***	0.032***	0.033***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Media richness		0.020***	0.017***	0.021***	0.018***
			(0.005)	(0.005)	(0.005)
Disease complexity		0.049***	0.021		0.020
		(0.008)	(0.018)		(0.018)
Media richness * Disease complexity			0.023+		0.024+
			(0.013)		(0.013)
Response timeliness (reverse index)		–0.002+		0.002	0.002
		(0.001)		(0.002)	(0.002)
Media richness * Response timeliness				–0.003+	–0.003*
				(0.002)	(0.002)
Constant	0.729***	0.717***	0.719***	0.717***	0.719***
	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)
Observations	17,355	17,355	17,355	17,355	17,355
R^2	0.127	0.130	0.130	0.129	0.130

Note: Standard deviations are shown in brackets, *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$, + $P < 0.1$.

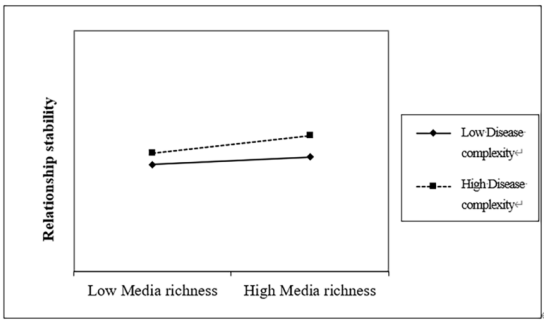
Table 4 shows the regression results. Only control variables were added to Model 1, and the results showed that except for team price, all other control variables have significant positive effects on the stability of physician–patient relationships. This is consistent with the previous analysis. The higher the team price is, the less demand there is for services from price–sensitive users. The longer the order duration is, the lengthier the communication between a doctor and a patient will be, and the easier it will be for the patient to develop a favorable impression of the doctor. The more communication there is, the more fully doctors communicate with their patients, which is conducive to doctors fully understanding their patients' conditions and improving the quality of consultations. The higher the economic level is, the better the network infrastructure is and the more acceptable online health counseling services are. The larger the participating teams are, the more favorable patient views of physicians become and the higher the level of patient satisfaction. A leading doctor forms an online doctor team, and whether the leading doctor participates in consultations affects the evaluation of consultation quality by patients. The team orders represent the overall strength of the team. A stronger team is more likely to attract patients and improve the stability of physician–patient relationships.

Model 2 added independent variable media richness, moderating variables disease complexity and response timeliness based on Model 1. The independent variable of media richness positively affected the stability of physician–patient relationships ($\beta = 0.020$, $P < 0.001$), and the results support H1. According to the theory of media richness and the concept of social presence, higher levels of media richness cause users to feel more social presence, and communication will mimic face-to-face

communication more closely. Doctors choosing voice communication to communicate with patients can reduce the distance between patients and doctors. Compared with text communication, voice communication can provide more information in a unit of time and improve communication efficiency. At the significance level, disease complexity has a positive effect on the stability of physician–patient relationships ($\beta = 0.049$, $P < 0.001$), indicating that when a disease is more complex, patients are more likely to continue to place orders and maintain long-term stable relationships with doctor teams. When a disease is complex, it is difficult to completely solve related problems with a single consultation. In this study, the length of time it takes for doctors to respond is used to measure doctor response timeliness. The reverse index of response timeliness negatively affects the stability of physician–patient relationships ($\beta = –0.002$, $P < 0.1$), indicating that the degree of response timeliness positively affects the stability of physician–patient relationships. Timely responses by physicians lead to more satisfied patients, making it easier to establish a stable relationship with the doctor.

Model 3 added the product terms of media richness and disease complexity based on Model 2. The results showed that disease complexity positively affects the relationship between media richness and the stability of physician–patient relationships ($\beta = 0.023$, $P < 0.1$). The results supported H2. For complex diseases, media richness and social presence are more important. When patients attend consultations for serious diseases, they are typically experiencing fear. In such settings, patients appreciate doctors' services more easily, which can increase patient trust in doctors and promote stable relationships between patients and doctors. Further, when a disease diagnosis is more serious, the tasks doctors face are more complex. The use of voice communication can help doctors clearly

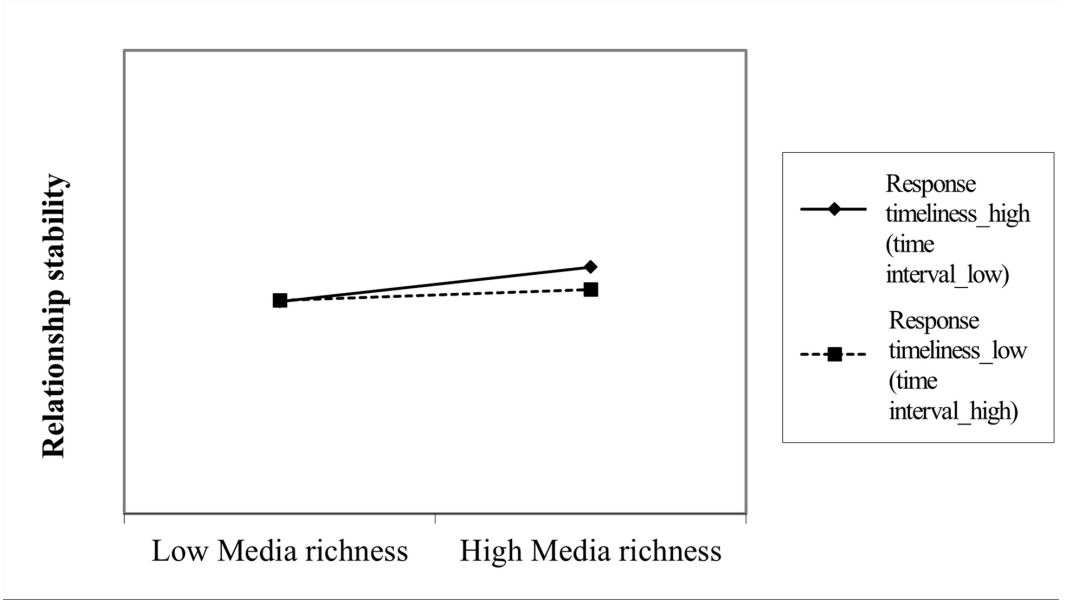
Figure 2. Interaction between disease complexity and media richness



describe complex problems to their patients and increase patient satisfaction. Figure 2 shows that disease complexity enhances the role of media richness.

For Model 4, the product terms of media richness and response timeliness were added to Model 2. The results showed that the time interval, or the reverse index of response timeliness, negatively affects the relationship between media richness and the stability of physician–patient relationships ($\beta = –0.003$, $P < 0.1$). Therefore, response timeliness has a significant positive regulatory effect. These results supported H3. According to apparatgeist theory, what a user thinks technology is used for and not what the technology can actually do determines how the user uses the technology. In the eyes of users, voice and video communication methods are highly synchronized and require timely replies. Text media are suitable for asynchronous communication and do not require timely feedback. Therefore, in an environment with a high degree of response timeliness, communication with a high degree of media richness is more in line with user expectations. Figure 3 shows that the time interval,

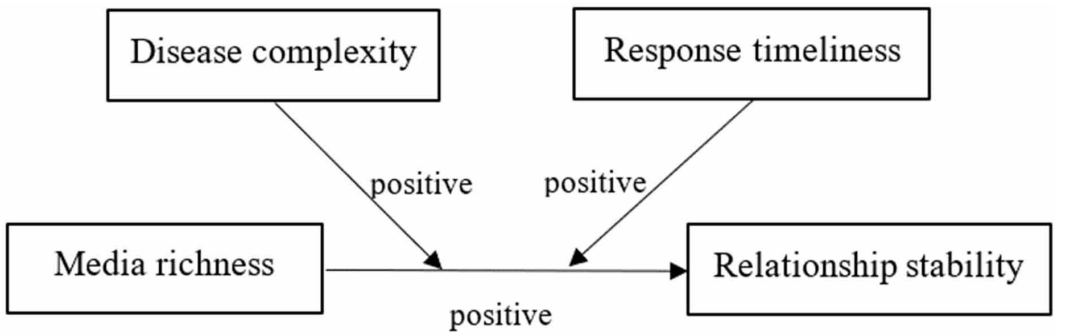
Figure 3. Interaction between response timeliness and media richness



an inverse indicator of timeliness, weakens the effect of media richness, indicating that timeliness strengthens the effect of media richness.

Model 5 was the full model and included all control variables, independent variables, moderating variables, and product terms. The results were consistent with the previous results. Media richness has a positive impact on the stability of physician–patient relationships. Disease complexity has a positive impact on the relationship between media richness and the stability of physician–patient relationships; and the time interval, a reverse indicator of response timeliness, negatively affects the relationship between media richness and the stability of physician–patient relationships. Figure 4 shows the research results.

Figure 4. Research results



Robustness Test

Propensity Score Matching

Sample selection bias affected this study. Users may prefer more media richness because of their doctor preferences or because their disease diagnoses are more complex. To eliminate selection bias problems, propensity score matching (PSM) was used for further analysis. The experimental group included the sample with higher media richness, including voice and text with voice communication, forming a total sample of 2,318. The control group included only text communication, resulting in a total sample of 15,037. The control and experimental group samples were measured from 2:1 to 10:1.

PSM was used to find one or more similar samples in the control group for each sample of the experimental group. The probability of paired samples entering the experimental group was high, which helped balance the samples of the experimental and control groups and eliminate sample selection bias. Previous studies have shown that the research must consider all factors that affect the resulting variables as much as possible. Based on the availability of data, the authors included all the control variables in the PSM model. Because there were usually only two groups of PSM models, they divided the three levels of media richness into two groups: the sample using voice communication and the sample using text communication only. Specifically, the grouping variable (*Treat*) was used to set voice communication to a value of 1, whereas text communication was set as a value of 0. The resulting variable denoted the level of relationship stability.

Model Building

First, as the dependent variable, including all previous control variables, the authors considered team price, order duration, response number, economic level, team number, leading doctor presence, and team orders to build a logit model. As Equation 2 shows, P_i is the probability of each sample entering the experimental group, and x_{i1}–x_{i7} are the control variables. After the estimated parameters of the model were obtained, the probability of each sample using voice communication was calculated from the model, that is, the propensity score. To determine the propensity score, the most commonly used matching methods included nearest neighbor matching, hierarchical matching, radius matching, and kernel matching. In this paper, the authors used the commonly used nearest neighbor matching method (1:3) with a 0.05 caliper value constraint:

$$P_i = \alpha_{i1}x_{i1} + \alpha_{i2}x_{i2} + \alpha_{i3}x_{i3} + \alpha_{i4}x_{i4} + \alpha_{i5}x_{i5} + \alpha_{i6}x_{i6} + \alpha_{i7}x_{i7} + \varepsilon_i \quad (2)$$

Model Results

The regression results in Table 5 show that team price, order duration, leading doctor presence, and team orders significantly encourage patients to choose doctor teams with higher media richness. Response number and economic level restrain patients from choosing doctor teams with higher media richness, whereas team number has no effect. As Figure 5 shows, the distribution of the kernel density function between the experimental group and the control group is significantly different before matching, whereas, as Figure 6 shows, the distribution of the kernel density function between the two groups is basically the same after matching. The common value range of the experimental and control groups reaches equilibrium in Figure 7, satisfying the common supporting hypothesis.

Table 5. Logit model regression results

Variable	Treatment
Team price	0.428***
	(0.026)
Order duration	0.052*
	(0.021)
Response number	–0.140***
	(0.038)
Economic level	–0.107*
	(0.046)
Team number	0.019
	(0.042)
Leading doctor presence	0.930***
	(0.057)
Team orders	0.224***
	(0.022)
Constant	–4.963***
	(0.145)
Observations	16,990

Note. Standard deviations are shown in brackets. ***P < 0.001, **P < 0.01, *P < 0.05, + P < 0.1

Figure 5. Kernel density function of the experimental and control groups before matching

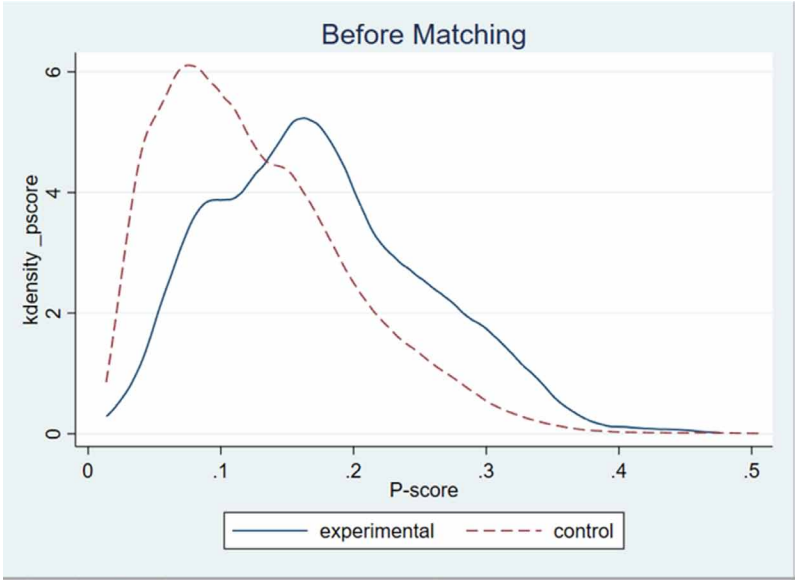


Figure 6. Kernel density function of the experimental and control groups after matching

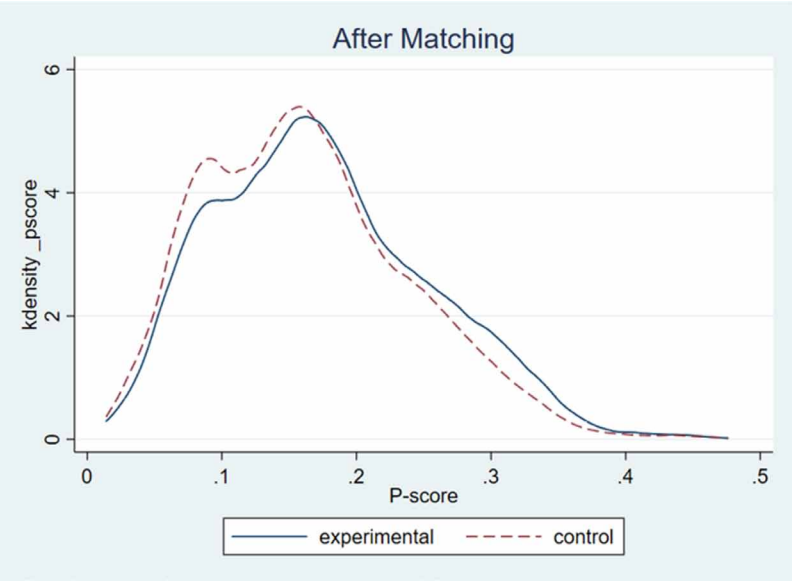
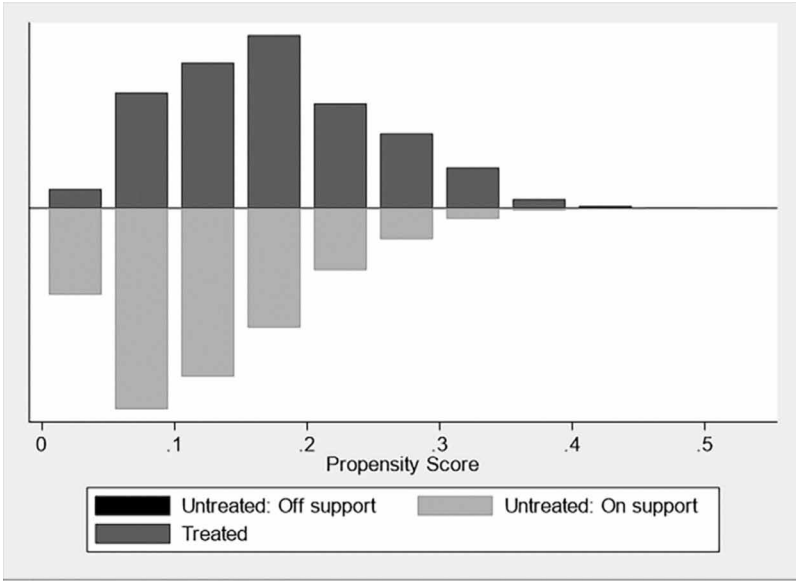


Figure 7. Common value range



As Table 6 shows, before matching, each variable of the experimental and control groups shows significant differences; but after matching, each variable does not present significant differences. This indicates that the balance hypothesis is satisfied.

Table 6. Balance hypothesis test results

Variable	Sample	Mean Value		Deviation %	Reduce Deviation %	*t*-Test	
		Experimental	Control			*t*	$p > \|t\|$
Team price	Before	4.3287	3.9137	45.1		19.80	0.000
	After	4.3287	4.3235	0.6	98.7	0.20	0.843
Order duration	Before	1.6108	1.4565	14.6		6.67	0.000
	After	1.6108	1.6111	0	99.8	–0.01	0.992
Response number	Before	1.6819	1.6617	2.9		1.34	0.180
	After	1.6819	1.7002	–2.7	9.6	–0.91	0.365
Economic level	Before	0.53883	0.55151	–2.5		–1.14	0.253
	After	0.53883	0.54228	–0.7	72.8	–0.24	0.814
Team number	Before	1.396	1.3197	13		6.09	0.000
	After	1.396	1.3905	0.9	92.8	0.30	0.762
Leading doctor presence	Before	0.80889	0.6208	42.6		17.78	0.000
	After	0.80889	0.81252	–0.8	98.1	–0.32	0.752
Team order	Before	3.9339	3.6196	28.4		13.41	0.000
	After	3.9339	3.9424	–0.8	97.3	–0.25	0.801

After matching, the average treatment effect (ATT) of the experimental and control groups was calculated as shown in Table 7. The average number of orders per patient in the experimental group was measured as 1.1264, whereas the average number of orders per patient in the control group was measured as 1.0799. The difference between these values is 0.0465, and the *t* value is 3.75, which is greater than the critical value of 1.96. Media richness can indeed increase the number of orders patients place to the same team, increasing the stability of physician–patient relationships.

Table 7. Influence of media richness on the stability of physician–patient relationships

Variable	Sample	Experimental	Control	Deviation	Standard Deviation	*t* Value
Relationship stability	Before	1.1264	1.0771	0.0493	0.0091	5.39
	ATT	1.1264	1.0799	0.0465	0.0124	3.75

Regression Results of Matching Samples

Table 8 shows the results of the multiple linear regression of the matched samples. The regression results are basically consistent with the previous results. Media richness significantly promotes the stability of physician–patient relationships, and disease complexity and response timeliness positively moderate it, indicating that the results are robust.

Table 8. Regression results of the matched samples

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	Relationship stability	Relationship stability	Relationship stability	Relationship stability	Relationship stability
Team price	–0.043***	–0.045***	–0.046***	–0.044***	–0.046***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Order duration	0.012**	0.014**	0.011*	0.015**	0.014**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Response number	0.212***	0.210***	0.212***	0.210***	0.211***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Economic level	0.023*	0.024*	0.025*	0.023*	0.024*
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Team number	0.027**	0.026**	0.026**	0.027**	0.026**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Leading doctor presence	0.023+	0.023+	0.022+	0.022+	0.022+
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Team orders	0.034***	0.033***	0.034***	0.033***	0.034***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Media richness		0.017**	0.013*	0.019***	0.015*
		(0.006)	(0.006)	(0.006)	(0.006)
Disease complexity		0.047***	–0.004		–0.005
		(0.014)	(0.028)		(0.028)
Media richness * Disease complexity			0.032*		0.033*
			(0.016)		(0.016)
Response timeliness (reverse index)		–0.002		0.002	0.003
		(0.002)		(0.003)	(0.003)
Media richness *Response timeliness				–0.003+	–0.003+
				(0.002)	(0.002)
Constant	0.700***	0.683***	0.690***	0.680***	0.688***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.032)
Observations	7,116	7,116	7,116	7,116	7,116
R^2	0.134	0.137	0.137	0.136	0.138

Note: Standard deviations are shown in brackets. ***P < 0.001, **P < 0.01, *P < 0.05, + P < 0.1.

Sample Replacement

The stability of physician–patient relationships is more meaningful for chronic diseases than for acute diseases because most patients with acute diseases do not need to be treated numerous times. The treatment of chronic diseases is a long-term process. Patients with chronic diseases maintain a stable relationship with their doctors, which shows that these patients are more satisfied with the medical services their doctors provide. Therefore, the authors selected some of the original chronic disease

samples for further analysis, including those involving coronary heart disease, diabetes, tumors, and rheumatoid arthritis, resulting in a total sample of 6,346.

Table 9 shows the regression results. For Models 2 and 4, media richness significantly positively affects the stability of physician–patient relationships, and response timeliness positively regulates the relationship between media richness and the stability of physician–patient relationships. Model 3 shows that disease complexity no longer regulates the relationship between media richness and the stability of physician–patient relationships. This is because serious chronic diseases such as tumor development, cancer, and cerebral infarction are more complex, resulting in the inconspicuous moderating effect of disease complexity found in the chronic disease samples.

Table 9. Regression results of chronic disease samples

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability
Team price	–0.050***	–0.054***	–0.054***	–0.051***	–0.054***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Order duration	0.018***	0.020***	0.016**	0.021***	0.019***
	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)
Response number	0.179***	0.177***	0.179***	0.177***	0.178***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Economic level	0.019*	0.022*	0.022*	0.020*	0.022*
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Team number	0.044***	0.043***	0.043***	0.044***	0.043***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Leading doctor presence	0.014	0.013	0.013	0.011	0.013
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Team orders	0.035***	0.035***	0.035***	0.034***	0.035***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Media richness		0.020**	0.019*	0.022**	0.021*
		(0.007)	(0.009)	(0.008)	(0.009)
Disease complexity		0.051***	0.045*		0.044*
		(0.010)	(0.021)		(0.021)
Media richness * Disease complexity			0.005		0.005
			(0.015)		(0.015)
Response timeliness (reverse index)		–0.002		0.002	0.003
		(0.002)		(0.003)	(0.003)

Table 9 continued on next page

Table 9 continued

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability	Relationship Stability
Media richness *Response timeliness				–0.003+	–0.004+
				(0.002)	(0.002)
Constant	0.752***	0.728***	0.728***	0.736***	0.726***
	(0.026)	(0.027)	(0.028)	(0.027)	(0.028)
Observations	6,346	6,346	6,346	6,346	6,346
R^2	0.128	0.133	0.132	0.129	0.133

Note: Standard deviations are shown in brackets, ***P < 0.001, **P < 0.01, *P < 0.05, + P < 0.1

DISCUSSION AND CONCLUSION

This research contributes to the literature concerning media selection, e-consultation platforms, and physician–patient relationships. The authors addressed three research questions in total. They firstly examined whether media richness could affect the stability of physician–patient relationships on online health consultation platforms from the perspective of media selection theory (RQ1). Additionally, they explored the moderating effects of disease complexity and response timeliness using the multiple linear regression model (RQ2 and RQ3).

For RQ1, the results showed that media richness significantly and positively affects the stability of physician–patient relationships, and the degree of media richness increases successively from text to voice communication and then to text with voice communication. Text with voice communication can encourage patients to place multiple orders, improve patient trust in doctors, and help maintain stable relationships between patients and doctor teams.

For RQ2, the results showed that when a disease is more complex, the role of media richness is stronger. In more complex diseases, more content must be explained to the patient, and more in-depth professional knowledge is involved, requiring the use of communication methods of high media richness.

For RQ3, the results showed that when the physician respond in a more timely manner, the role of media richness is stronger. According to apparatgeist theory, the use of technology should conform to the user's understanding of technology, and the use of media of high richness for communication is more suitable for a synchronous communication environment. Therefore, when conditions permit, doctors on online health consultation platforms can choose a more diversified medium to communicate with patients. This is especially true when complex disease diagnoses are involved. When using a medium of high richness, attention should focus on the timeliness of responses. Therefore, in busy settings in which synchronous communication is not suitable, less rich media should be adopted.

This study provides several theoretical contributions. First, previous research on physician–patient relationships was mostly conducted offline; research on online physician–patient relationships was lacking. The current study is innovative because it measures the stability of physician–patient relationships through the lens of the order times of patients to doctor teams. Second, few studies have explored the influence of media richness on physician–patient relationships from the perspective of media selection. The current article fills this research gap in the field of online physician–patient

relationships using media selection theory and further expands the application scope of three media selection theories.

The research findings also have practical implications. This study provides feasible suggestions for alleviating physician–patient communication problems on e-consultation platforms. The suggestions of this study note which types of media communication forms should be selected in different circumstances, not only improving physician work efficiency and patient satisfaction but also fully utilizing platform resources. Physicians should choose appropriate media communication methods according to patients' medical conditions, especially when a patient suffers from a very serious disease. If the physician only uses texting, a simple communication method, in this scenario, on the one hand, the physician will fail to explain the condition clearly and answer patient questions effectively. On the other hand, when the patient sees the text message, they will feel the physician is not concerned about them and may think the doctor is being perfunctory. The physician–patient relationship may become even tenser, with both sides doing more harm than good. In addition, the suggestions can help e-consultation platforms adopt appropriate ways of improving their websites. The rich media communication forms provided by Good Doctors Online can also offer more effective operation strategies for other e-consultation platforms with a single form of media communication. Furthermore, e-consultation platforms could take video into consideration, a form of communication with higher media richness, to help patients with more complicated and urgent diseases.

This study has several limitations that should be addressed in future research. First, since Good Doctors Online is one of the largest e-consultation platforms in China, the research only focused on this single platform which provides comprehensive data. At present, more and more e-consultation platforms have gradually added voice and other consultation functions, which enriches the form of media communication. Future research will continue to deepen the comparison exploration of the impact of media richness on various platforms. Specifically, in addition to collecting secondary data, the authors could also conduct an in-depth investigation through questionnaires to further explore the differences between different platforms and try to expand the scope of application of this research. Second, because of the limitation of the sample data, only two media selection methods, text and voice, were considered in this research. In the future, more media forms should be explored in other scenarios.

COMPETING INTERESTS

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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