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How multimorbid health information consumers interact in an online community Q&A platform

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ABSTRACT

Background: There is an increasing population of health information consumers (HIC) with multiple conditions (multimorbid). Previous studies explored the online behavior of HIC in general or HIC with a specific disease; however, the behavior of multimorbid HIC remains poorly researched.
Objectives: This research aims to investigate the behaviors of the multimorbid HIC on community Q&A platforms.
Methods: Using kidney disease, a prevalent disease with high likelihood of multimorbidity as a case, we analyzed the online interaction behaviors of HIC with multimorbidity in Quora, a community Q&A platform, and compared them to those of single-disease HIC.
Results: The findings of this study reveal significant differences in the online interaction behavior between HIC of single vs. multimorbid diseases. Compared with single-disease HIC, multimorbid HIC are more active in multiple aspects, such as asking questions, following different topics or users, and providing suggestions for improvement of questions and answers. Additionally, multimorbid HIC are more likely to add topics to their questions, and their questions tend to attract more answers than those of single-disease HIC. On the other hand, questions and answers provided from single disease HIC had more views, followers, and upvotes than those from multimorbid HIC.
Conclusion: The high level of activity among multimorbid HIC can be explained by their complex needs for information, driving an increased number of questions and drawing more attention from the whole community in answering them. Multimorbid HIC appear to be valuable contributors to the online community and reasons for the reduced visibility and upvoting of their answers should be investigated.

1. Introduction

An increasing number of people today are living not just with one disease but multiple chronic conditions [1,2]. This co-existence of two or more chronic diseases, referred to as multimorbidity [3], includes both physical and mental health conditions [4]. The prevalence of chronic conditions varies and accordingly there are highly common and less common multimorbid diseases [3], where highly prevalent diseases are known to occur frequently together. Chronic Kidney Disease (CKD) is one such condition that usually occurs in individuals with other chronic medical problems [3]. CKD has emerged as a significant global public health issue due to a rising rate of incidence and prevalence, the high cost of treatment, and poor outcomes [6].

Compared to single-disease Health Information Consumers (HIC), their multimorbid counterparts have more complex requirements, a higher risk of adverse medication events, and can receive potentially conflicting clinical advice from multiple providers responsible for single chronic diseases [7]. Due to the complex nature of multimorbidity, such patients experience unique difficulties when seeking information, including making sense of and using the information obtained from different resources and distinguishing between the symptoms of different diseases [8]. Despite studies exploring the priorities and preferences with respect to HIC's information needs, much of the work has examined only single diseases such as cancer [9–11] and diabetes [12] in isolation, and little is known about the online interaction behavior of multimorbid HIC. With the ever-growing volume of health information online, the information search and navigation

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in online health platforms becomes more challenging for multimorbid HIC.

Community Q&A platforms provide a venue for asking explicit questions and posting answers [13], which represent the most natural way for a person to seek information online especially after failing to find information via search engines [14]. In community Q&A research, health has been identified as a major domain for observing user interactions [15]. The aim of this study is to investigate the interaction behaviors of multimorbid HIC in a community Q&A platform as compared to those with a single disease. The primary findings of this investigation can form the basis for further focused research and have the potential to facilitate the development of a personalized solution to the information needs of a growing population with multimorbidity as well as inform the design of online health information search platforms to better support multimorbid HIC.

2. Methods

2.1. Selection of Q&A platform

We collected data from Quora (www.quora.com), an innovative and popular online community Q&A platform where users, including HIC, can post, follow, tag, and share questions, follow topics and other users, answer, comment, and upvote/downvote questions or topics. One of the unique characteristics of Quora is that it builds social networks within the platform. Each Quora user has a profile which contains their demographic information and social connections (e.g., followers and followees), as well as a history of questions and answers provided by the user and the topics they follow.

2.2. Topic Collection

We focused on users with kidney diseases because such patients, particularly those with CKD, are highly susceptible to multimorbid conditions [5]. Accordingly, we chose popular kidney topics in Quora to seek a broad coverage of important and relevant topics. These topics included but were not limited to, kidney disease, chronic kidney disease, kidney failure, dialysis, kidney-stones, polycystic kidney disease, CKD, dialysis patients, kidney infection, and pyelonephritis. The list of topics was finalized after several iterations using the snowball pooling strategy. Specifically, we started with an initial list of kidney-related topics, and these topics in turn led to additional topics based on the most popular and relevant topics, as suggested by Quora, and so on.

There are four conditions that are more common in patients with CKD compared to patients without CKD: anemia, blood pressure, diabetes, and heart disease [16]. Additionally, the prevalence of these multimorbidities increases as CKD progresses. Using the above common multimorbidities of CKD as seeds, we extracted additional keywords and synonyms based on the definitions of seed diseases according to two authoritative online medical sources: MedlinePlus (https://medlineplus.gov/encyclopedia.html) and Mayo Clinic (https://www.mayoclinic.org/diseases-conditions). We combined all the keywords and synonyms to build a list of topics that represented comorbidity of kidney related diseases.

2.3. Data collection

Quora does not offer publicly available datasets or official application programming interfaces (APIs), so we collected data using a customized web crawler between October and November of 2018. The crawler utilized several python libraries: Scrapy, Selenium and Pandas. Scrapy is a fast and powerful scraping and web crawling framework in python. Selenium is a web driver capable of controlling the navigation of web pages. Pandas is one of preferred and widely used tools in data munging.

Our crawling strategy was to first scrape the profiles of users who posted questions on the list of Quora topics. Then, we filtered those users who posted anonymous questions in order to gain insights into the overall interaction behavior of HIC. Then, we identified and removed duplicated profiles across different topics. Finally, we collected detailed data about the interaction behaviors of each user profile, including questions, answers and topics posted, follower-followee relationships existing among the users and posts.

2.4. Variables

We determined the type of HIC (single vs. multimorbid) based on an analysis of their posted questions. The analysis matched user questions to the list of topics of kidney multi-morbidities using the string-matching method. If there was a match, the HIC who posted the question would be labelled as multimorbid type; otherwise, the HIC would be labelled as single-disease. We measured the HIC interaction behavior at two different levels: overall and questioning/ answering behaviors. In addition, participation in online communities can take place in a variety of forms, which can be classified into two main categories: sharing information with others in the community, and joining social structures within the community. Examples of the first type include contribution of information (i.e. posting questions and answers) [17,18] and contribution of metainformation (i.e. adding topics to questions or making suggestions) [19,20]. The second type of community participation refers to activity in social structures, such as following users, questions, or topics. The selected variables for measuring each type of the behaviors are described in Table 1. The variables of the overall user activities were measured as the total frequency count. The variables of interaction behaviors (i.e., questioning and answering behavior) were measured as the average counts of specific interaction behaviors per question or per answer.

2.5. Data analysis

Non-parametric statistical analysis was conducted because the data did not satisfy the assumptions for parametric analysis (highly skewed data). Specifically, the Mann-Whitney test was used in comparing the interaction characteristics between the two groups, multimorbid HIC and single-disease HIC. The level of significance was set to be an alpha value of 0.05.

3. Results

We report the results of comparing user interaction behaviors between the two groups of users: single- disease and multimorbid HIC. We collected 1904 user profiles that posted questions on one or more of the selected topics. After removing duplicate users and those who posted anonymously, 1312 unique users where identified. Among them, 1110 (53%) posted questions on kidney disease related topics only, and 202 (11%) posted questions on one or more of the common comorbidities as well as kidney disease. The results of the Mann-Whitney test are reported in Table 2.

3.1. Overall Interaction Behaviors

Questions and answers posted or followed: Multimorbid HIC tend to be more active in asking questions and following other questions than single-disease HIC ($p < .001$). In particular, the multimorbid HIC posted on average 39 questions compared to 3 questions among the single disease HIC. Although there is no significant difference in terms of answering questions among the two types of HIC ($p > .05$),

Table 1
A List of Variables and Their Descriptions.

Interaction Type	Variable	Description
Overall user activities	questions	Number of questions that a target HIC has posted
	questions followed	Number of questions that a target HIC is following
	answers	Number of answers a target HIC has provided to other HICs' questions
	topics followed	Number of topics a target HIC is following
	Familiar topics	Number of topics that a target HIC has expertise in. It is derived based on the self-selected topics listed under the Topic Credential section in the user profile.
	topics interested	Number of topics pertaining to questions, answers or followed questions that a target HIC is has posted in or followed
	Edits	Number of edits that a target HIC has made to his/her own questions and answers or providing suggestions to other users' questions and answers
	followers	Number of other users who have followed the target HIC
	followees	Number of other users whom a target HIC is following
Questioning Behavior	Topics	Average number of topics under which a HIC has posted a question
	views	Average number of other users who have viewed a target HIC's questions
	followers	Average number of users who have followed the questions posted by a target HIC
	answers	Average number of answers to a target HIC's questions, including invited answers
	invited answers	Average number of community-invited answers posted by a target HIC
	question edits	Average number of edits made to posted questions including their text, description and topics, by any user
Answering behavior	upvotes	Average number of votes per answer that the target HIC has provided
	views	Average number of viewing of a target HIC's answers

multimorbid HIC posted 12 answers on average as compared 1 answer contributed by almost 60% of single disease HIC.

Topics followed, interested in or familiar with: Multimorbid HIC were interested in more topics, followed more topics and qualified in more topics than single HIC ($p < .001$). For example, multimorbid HIC were interested in about 428 topics on average, which is much more than 16 topics of single-disease HIC.

Edits: The result shows that multimorbid HIC (mean = 196) made a greater number of edits than single disease HIC (mean = 10, $p < .001$).

Followers and followees: The number of followees of multimorbid HIC (mean = 132.46) is greater than that of single-disease HIC (mean = 40.07, $p < .001$), whereas there is not a significant difference in terms of the number of followers ($p = .89$).

3.2. Questioning Behaviors

Topics: The results show that the questions from multimorbid HIC tend to cover more topics (mean = 4.38) than those of single-disease HIC (mean = 4.23, $p < .001$).

Views and followers: Our results show that questions from multimorbid HIC (mean = 11,578.07) have more views ($p < .001$) than those from single-disease HIC (mean = 9301.27). Similarly, questions from multimorbid HIC (mean = 12.01) have more followers ($p < .001$) than those from single-disease HIC (mean = 10.9, $p < .001$).

Answers and invited answers: Our results show that multimorbid HIC received more answers to their questions (mean = 4.25) compared to single disease HIC (mean = 3.63, $p < .001$). On the other hand, there were more invited answers for single disease HIC (mean = 27.03) than multimorbid disease HIC questions (mean = 12.35, $p = .029$).

Edits: Our results show that questions from single-disease HIC (mean = 9) were more likely to be edited than those from multimorbid HIC (mean = 0.75, $p < .001$).

3.3. Answering Behaviors

Upvotes and views: Answers provided by single-disease HIC (mean = 0.67, $p < .001$) received more upvotes than those from multimorbid HIC (mean = 0.24). In addition, there was a higher number of views per answer provided by single-disease HIC (mean = 24.85, $p < .001$) than from multimorbid HIC (mean = 8.91).

Table 2
Mann-Whitney Test Results between Single and Multimorbid HIC.

Interaction Type	Variable	Single		Multi		p-value
		mean	std.dev	mean	std.dev	
High level user activities	questions	28.59	240.94	207.50	502.59	<.001***
	questions followed	4.78	17.31	14.34	36.85	<.001***
	answers	48.95	732.28	114.50	348.83	0.21
	topics followed	78.99	196.57	137.31	402.71	<.001***
	topics familiar with	8.61	13.71	13.26	22.11	<.001***
	topics interested	610.02	2315.71	2068.98	4135.79	<.001***
	Edits	354.35	4288.49	1109.25	2915.66	<.001***
	followers	151.89	2324.17	175.53	1004.57	0.89
	followees	40.07	175.54	132.46	557.44	<.001***
Questioning behavior	topics	4.23	1.40	4.38	1.59	<.001***
	views	11,578.07	100440.54	9301.27	21165.86	<.001***
	followers	12.01	1.96	10.16	1.27	<.001***
	answers	3.63	4.25	4.25	3.73	<.001***
	invited answers	27.03	81.57	12.35	23.23	0.0295*
	question edits	0.75	1.05	0.38	1.05	<.001***
Answering behavior	upvotes	0.67	3.17	0.24	0.68	<.001***
	views	24.85	94.97	8.91	17.61	<.001***

* significant at .05 level.
*** significant at .001 level.

4. Discussion

In view of the prevalence of multimorbidity, particularly for chronic diseases, we examined the interaction behavior of HIC with multimorbidity in a community Q&A platform. We chose kidney disease, a prevalent disease with high likelihood of multimorbidity, as the case of study. The findings of this study reveal significant differences in the online interaction behavior between HIC who were interested in information about a single disease vs. multimorbid diseases. In general, multimorbid HIC are more active in multiple aspects such as asking questions and following different topics and users. The high level of activity of multimorbid HIC may be driven by their complex information needs, which can only be satisfied with a diverse set of information sources.

Patients with multimorbidity are asking or following more questions and tagging them with more topics than patients with single diseases, and this may represent a simple correlation with the number of different health problems that they experience. However, other factors should also be considered. Patients with complex health needs are at an increasing risk of receiving conflicting information from medical professionals [21] and this could be a motivating factor in their participation in Q&A sites to resolve such conflicts. It is also possible that the answers they receive in the online platform are unsatisfactory, further driving them to try alternative questions in order to get satisfactory answers. The increased participation may also indicate that these patients are more involved and pro-active in their care in general. Although patients with complex needs may experience lack of motivation and poor self-efficacy [21], our study design and sampling strategy filter out such patients and only those with increased self-reliance and motivation are most likely represented.

The increased participation and value to the community is also seen in the higher number of edits by multimorbid HIC compared to single-disease HIC. People who have more than one chronic condition have gained knowledge from personal experience overt time [22,23], and this likely makes it easier for them to continuously improve and make suggestions to questions or answers, of either their own or that of others. The increased knowledge also explains why more questions from single-disease HICs are edited compared to questions posted by multimorbid HICs; the latter HICs are possibly able to better articulate their questions that contain more relevant information and thus require fewer edits.

Questions from multimorbid HIC received more answers than those from single-disease HIC, suggestive that the complex health information needs of HIC tend to attract attention from the online community. Although it could be argued that this is due to the increased visibility of the questions due to multiple tagging, questions from single-disease HIC actually had more views. One possible explanation is that the health needs of multimorbid HIC are not easily satisfied but require inputs from multiple answers.

The answers generated by single-disease HIC also have higher view and upvote counts, and subsequently receive more recognition or generate more impact in the community, highlighting the quality of the answers [24]. The focus on a single disease may allow the person who posts the answer to offer in-depth information about the target disease, which potentially includes new and useful information that meets the needs of other HICs and is more specific and easier to be understood by other HICs, including HICs with multimorbidity. Answers from people with multimorbidity may be more complex and personalized, reducing their generalizability and their view and upvoting count.

The present study marks the first attempt at investigating the online interaction behavior of HIC with multimorbidity by applying behavior analysis to online community Q&A data and by conducting analyses at different levels of granularity: overall activities, and questioning and answering behavior. The findings have widespread practical implications as our comparison analysis of multimorbid and single-disease HIC reveal significant differences between the two groups. The large number of questions posted online by HIC with multimorbidity and the large number of answers they receive may indicate a lack of supportive systems that allow them to express and clarify their complex information needs and address these information needs, either off-line or online. Therefore, community Q&A platforms, and in health systems in general, should be adapted to improve the health information seeking experience of such patients.

Patients with multiple chronic diseases improve their knowledge as they gain experience from managing their own conditions, becoming more responsible for their illnesses [25]. Therefore, the design of Q&A systems that support patients with multimorbidity and that continuously adapt to users' evolving level of experience are important areas for future research, especially since improving the support for multimorbid HIC, who are active contributors to online health communities, will benefit not only the HIC themselves but also the community at large.

By addressing multi-morbid HIC, the findings of this study will lend themselves to the development of a conceptual framework of information seeking behavior for multimorbid HIC and it is hoped that this research will be the beginning of an ongoing body of research into the issue of health information seeking for HIC with multimorbidity.

Similar to other studies on online search behavior, this study has some limitations. First, we collected data from a single online platform. For future direction, we could extend the study to different types of diseases and other online platforms to test the generalizability of our findings about HIC with multimorbidity. Second, in addition to the interaction between user and content (e.g., questions and answer) in an online community Q&A platform, social interaction can also take place among different users. Combining data from different sources will provide a deeper understanding of HIC's online interaction behavior. Also, it will be interesting to examine the possible effects of anonymity on online interaction behaviors in view of the personal and sensitive nature of health-related topics, as HIC tend to ask or answer questions anonymously on the Quora platform [26]. Finally, some of the difficulties that multimorbid HIC may face are making sense and use of the information obtained from different online health resources and distinguishing between the symptoms of different diseases [8]. Thus, how to support the critical requirements of users with multimorbid conditions is an important question for future research.

5. Conclusion

We examined the interaction behavior of HIC with multiple chronic diseases on an online community Q&A platform by comparing them with single disease HIC. Our findings show that multimorbid HIC tend to be more active in online interaction in multiple aspects and their questions tend to attract more answers than those from single-disease HIC, suggesting that they are significant contributors to the online community. However, their questions and answers received less recognition in terms of the number of views, followers, and upvotes than those from single-disease HIC. As such, online health communities should engage more with multimorbid patients by facilitating their interactions with other members of the community.

Summary Points

What was already known on the topic

- There is a growing population with multimorbidity.

- Users turn to community Q&A platform after failing to find information via the search engine.
- Online interaction behavior has been examined for HIC with single diseases but not multimorbidity.
- Chronic Kidney Disease usually occurs in individuals with other chronic medical problems.

What this study added to our knowledge

- Online interaction behaviors of HIC.
- Differences in the online interaction behaviors between multimorbid and single-disease HIC.
- Role of multimorbid HIC in online community Q&A
- Design implications for Q&A platforms to better meet the information needs of multimorbid HIC.

Author Statement

To understand online interaction behavior of HIC with multimorbidity, we collected public data from Quora.

Declaration of Competing Interest

The authors confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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