Social network analysis on consumers’ seeking behavior of health information via the Internet and mobile phones

Ji-Young An*, Haeran Jang**, Jinkyung Paik***

ABSTRACT

In consideration of the rapid changes in the so-called information society of the 21st century, about 80% of a total population in Korea has used the Internet. However, the social effect of the Internet and related devices has not been yet systematically studied in the literature. In healthcare as well, consumers’ efficient use of the Internet for their positive health outcomes is becoming an issue. The purpose of this study was to analyze the medical subject headings keywords of the selected studies on consumers’ use of Internet and mobile health information. For the analysis, social network analysis was used to provide basic information to present directions for future research on the field of interest.

Key words: e-Health, Internet, Mobile Phone, Health Information, Social Network Analysis

1. INTRODUCTION

Statistics Canada conducts the Canada Internet Use Survey (CIUS) every other year under the advice of the Organisation for Economic Co-operation and Development (OECD). Since 2000, the United States (US) has been conducting a survey called “Pew Internet & American Life Project” through the private research laboratory Pew Research Center to study the American citizens’ Internet use and its effects. In addition, Pew Research Center has been carrying out “tracking survey” numerous times a year to obtain general information regarding their use of the Internet. In Korea, the Korea Internet & Security Agency (KISA) also conducted home interview surveys through a stratified multi-stage cluster sampling method and used the ordinary household enumeration districts in the 2005 Population and Housing Census by the National Statistical Office (NSO) as the sample frame, extracting 30,000 households throughout Korea and 72,559 family members thereof. From 2004 onwards, KISA has expanded the scope of research subjects from 3 years to older individuals by including wireless mobile phones in their survey on the Internet use.

With the launching of the high-speed Internet in 1998 following the opening of Internet commercial services in 1994, the national Internet usage rate reached 70.2% with 3,158 Internet users as of 2004. Since then, the Internet usage rates were 72.8% in 2005, 76.5% in 2008, and 77.8% in 2010, revealing an increase rate to less than 1% [1]. According to KISA [1], as of July 2011, 78% of a

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population of more than 3 years of age used the Internet. Approximately 98.7% of the Internet users were online at least once a week, and 85.2% at least once a day. By household, 81.9% had computers, and 81.8% of the total households had Internet access at home. About 42.9% of the total households had smart devices with Internet connection.

In order to fully understand the social effect of the use of the Internet, which has a significant impact on our daily lives, a systematic analysis on the use of Internet should be conducted. Additionally, with the advent of various types of Internet communities and media materials, the influence of the Internet has been expanding exponentially throughout our society. Nevertheless, research providing the general characteristics of Internet use or forecasting its future direction is lacking [2]. Even in the field of healthcare, the efficient use of the Internet has become an issue, especially now that a social paradigm shift between patients and their healthcare service providers has transpired [3,4].

Research aiming to analyze the status of using online health information has been conducted in the literature [5-8]. Healthcare consumers no longer regard online information or related services as a simple act of using an application, but recognize it as a medium that affects their daily life. They are advancing from passive healthcare consumers to active users of online health information, particularly using such information for autonomous decision-making. Therefore, it is the responsibility of healthcare professionals to set a very solid foundation regarding consumers’ use of online health information. In order to obtain a positive outcome from the use of health information via the Internet and mobile phones, the starting point should be scientifically analyzing previous research on the field of interest.

Due to exponentially increasing the number of journal articles, it is not simple to grasp the associations and or relationships among research themes of the articles [9-11]. Therefore, researchers in the fields of sociology and psychology have developed an interdisciplinary method of social network analysis (SNA). This method has been widely used in academia [5], which is an excellent way of visualizing links between research themes by converting human relation networks into mathematical models [12-14].

Analysis on co-occurring keywords is one of the methods to visualize the cognitive structures through SNA: it is an appropriate method to express actual contents of the outcomes of research by linking extracted keywords from the research papers [10,14]. Co-occurring keywords in research as well as research purposes and strategies presented by the authors in their papers reflect semantic relations, which can be considered as a contents analysis technique [15].

Recently, SNA using keywords extracted from published papers has been applied to the field of healthcare to understand the whole picture of the relationships constituting the cognitive structures of the research themes. For instance, results of network analyses using extracted keywords from the field of preventive medicine [16], epidemiology [17], medical informatics [18], and nursing [19] have been reported in the literature. In addition, there are a few studies employing SNA by the use of extracted medical subject headings (MeSH), a hierarchically structured medical terminology and uniformly designated by professionals to index papers [13,20-23], which are controlled and maintained by the U.S. National Library of Medicine (NLM) at the National Institutes of Health (NIH).

The purpose of this study, therefore, were to (1) analyze MeSH keywords of academically accumulated empirical studies on the use of health information via the Internet and mobile phones by employing SNA of co-occurring keywords, and (2) provide basic data to present directions for future research on the field of interest. For the analysis, the concepts of weighted degree centrality and
standardized degree centrality were considered. From this study, it was also expected that the potential of applying a social network analysis to the field of healthcare would be presented [22].

2. METHOD

2.1 Data Collection

The MeSH keywords from the PubMed database, which is a free database accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics, were extracted from the papers necessary for analyzing the use of online health information via the Internet and mobile phones. In order to select the targeted papers for the analysis, search terms with search conditions were applied. After excluding overlapping papers, keywords of the pre-selected papers were reviewed.

2.1.1 Paper Extraction

A total of 1,229 initially extracted papers regarding the use of Internet health information were extracted with the MeSH search terms "Internet" AND "Consumer Health Information," "Internet/utilization" AND "Consumer Health Information," and "Internet/utilization" AND "Health Education," which yielded 544, 105, and 582 search results, respectively. Finally, 1,001 papers were selected after excluding the overlapping ones. For mobile health information, the MeSH search terms were "Cellular Phone" AND "Consumer Health Information" and "Cellular Phone" AND "Health Education." A total of 98 papers were finally selected after excluding the overlapping ones. Since a large number of studies regarding consumers' use of Internet and mobile health information were conducted along with health education; therefore, "Health Education" was also included in the search terms as conditions.

2.1.2 Keyword Extraction and Selection of Keywords

The extracted keywords from the 1,001 papers regarding Internet health information were 1,213 in total (accumulated keywords: 8,021). After excluding the overlapping keywords from the five categories of the three-year brackets (before 2000, 2000 - 2002, 2003 - 2005, 2006 - 2008, and 2009 - 2011), finally 155 (weighted frequencies: 3,780) keywords were included for the analysis.

For mobile health information, a total of 926 keywords were extracted from the 98 papers regarding the use of mobile health information. After excluding the overlapping keywords, 328 were finally included in this study. To observe the changes in the categories containing these words, the keywords occurring before 2005 that showed very low frequency were grouped as one category. Therefore, a total of three categories were set including the 2006 - 2008 and 2009 - 2011 brackets. After excluding the overlapping keywords, 98 keywords (weighted frequencies: 636) were finally included in this study.

When previous studies in the field of interest are taken into consideration, any change significantly noticed within a certain time frame may be observed in the literature. Therefore, it is helpful for researchers to examine the period of "turning point" by analyzing the time sequential appearance of keywords for future studies [23,24].

2.2 Data Analysis

To conduct SNA using the selected keywords, NetMiner v.3 (CYRAM, Korea) was used. Keywords were referred to as nodes in SNA; in case of a same keyword appearing in different papers, a link was considered to exist between these keywords as building a keyword matrix.

If a network is established using all the selected keywords, it is difficult to identify the links between these keywords. Thus, the degree and the density of the links were applied to SNA. The more links between nodes, the more resources are yielded [25]. Density is defined as the ratio of actual links to the total possible links; however, it is in-
versely proportional to the size of a group. Therefore, SNA should be conducted after standardizing the size of the group because even if a node has the same number of links, the density decreases as the group size increases [25,26].

Moreover, the impact coming from the network degree of the nodes can be measured by looking at the center of the network, which is referred to as a degree centrality. It means that a node with several direct links is considered to have a high degree centrality [25,27]. More importantly, a weighted degree centrality index is the connection strength of a central role within the network [28,29]. When weighted inter-node connection strength is strong, it can be placed in the center of a network due to an increased centrality. However, even if nodes have the same number of links, densities are different depending on the size of the group.

To observe the changes in the core keywords, which was the purpose of this study, the weighted degree centrality index should be used to establish networks [30]. Therefore, in this study, a pruning method was applied to determine the boundary of the networks, which restructures core keywords with a high degree centrality value [13,31] and with a cut off value as a standard [10,24]. In this case, some information loss may occur, but the degree centrality among core keywords showing strong connections can be observed [13]. The cut off value of the pruning method was set at the value of 0.6% as the maximum degree centrality of a keyword.

Finally, two total degree centrality networks, five category-based networks, and three category-based networks were presented in this study. By observing the change of the keywords in each category, this study was able to track the time-dependent changes in the core keywords analyzed in this study.

3. RESULTS

3.1 Analysis of Using Health Information via the Internet

3.1.1 Network Analysis of the Total Keywords

In the literature, keywords regarding health information via the Internet started appearing in 1998. The frequency of occurrence has steadily increased every year with a rapidly increase observed since 2007 (Fig. 1).

According to the degrees among the keywords shown in the networks of 155 keywords (Fig. 2), “Patient Education as Topic” had the highest degree centrality and showed a strong degree of connection with “Health Education,” “Information Services,” “Health Knowledge, Attitudes, Practice,” “Self Care,” and “Patient Participation.”

According to the 2012 MeSH Browser maintained by NLM, “Patient Education as Topic” means “the teaching or training of patients concerning their own health needs.” “Health Education” related keywords were linked with “Health Behavior,” “Consumer Satisfaction,” “Health Promotion,” “Information Dissemination,” and “Attitude towards Health” which can be regarded as positives outcomes of health education. “Information Services” was linked to keywords such as “Attitude towards Computers” and “Information Storage and Retrieval.”

Studies using the computer as a parameter, such

![Graph showing keywords](image-url)
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999

Fig. 2. Total keyword network of health information via the internet (pruning=35, n=31),

as "User–Computer Interface," "Computer-Assisted Instruction," and "Computer Literacy," as well as studies dealing with communication with healthcare professionals, such as "Communication" and "Physician–Patient Relations," were connected in the case of providing health information for patients or health consumers.

For patient education, according to the hierarchical structure of MeSH, carcinoma appeared to be the core keyword in the network of neoplasms. Keywords regarding age, sex, socio-economic factors, and educational status also appeared which are known to affect consumer behavior towards health information.

3.1.2 Category-based Network Analysis

When examining the core keywords regarding health information via the Internet, "Patient Education as Topic" and "Health Education" appeared to be the core research topics in every category (Table 1). It was also reflected in this study that as consumers started to engage in decision-making regarding the management of their own health. Consumers wanted to be involved in, for example, "Self Care," "Self-Help Groups," and "Patient Participation." Therefore, keywords regarding online "Social Support" function appeared to be one of the important core keywords of the related studies. One of the keywords most frequently searched by consumers regarding actual diseases were "Women's Health" and "Neoplasms." In case of "Neoplasms," its degree centrality increased over time, which indicates a constant and active search by consumers.

In examining the keywords by the category, 28 keywords out of 155 appeared in the category of 'before 2000' (Fig. 3). "Information Services" seemed to be the keyword with the strongest centrality, reflecting the social change in the online society. Furthermore, the keywords such as "Marketing of Health Services," "Commerce," and "Remote Consultation" were indicative of the fact...
that health information via the Internet was perceived as one of the commercial means actively used by healthcare service providers rather than consumers. Research conducted during this period showed that "Delivery of Health Care" was related to "Consumer Participation" and "Consumer Satisfaction." Additionally, "Quality Control" of health information was seen as an example of a conscious effort to verify the credibility of health information via the Internet.

During 2000-2002, newly emerging research topics such as "Attitude to Health" and "Health
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Fig. 3. Keyword network of before 2000 (pruning=0, n=28).

Services Accessibility,” “Decision-Making” for self-care of consumers as well as “Self-Care” and “Self-Help Groups” were appeared (Fig. 4). “Consumer Participation” and “Patient Participation” were noted as well. Studies on online “Social Support” function, which was related to “Adapta-

Fig. 4. Keyword network of 2000-2002 (pruning=5, n=33)
tion, Psychological,” were initiated in this period. “Self-Care” and “Social Support” are high-ranking keywords in the network even to this date. The health-education-related keywords “Adolescent Behavior” and quality-related keywords “Quality Assurance, Health Care” also appeared in the network.

In the period of 2003–2005, a network regarding “Patient Education as Topic” related to socio-demographic characteristics were expanded along with the increase of centrality of “Health Knowledge, Attitudes, Practice” (Fig. 5). “Information Storage and Retrieval” and “Information Dissemination” also appeared likewise. Keywords regarding diseases or illnesses were “Neoplasms” and “Women’s Health.” In case of “Neoplasms,” the degree centrality increased over time, showing actively studied on the topic.

During 2006–2008, the centrality of “Health Knowledge, Attitudes, Practice” and “Information Dissemination” increased (Fig. 6). The keyword of “Computer Literacy” newly appeared; it was because understanding computers was importantly considered to search, locate, and utilize online health information. An independently identified network of the keywords was related to “Smoking” and “Smoking Cessation.”

In the period of 2009–2011, the centrality of “Health Education” relatively decreased, while that of “Social Support” increased (Fig. 7). Newly appeared keywords in the network were “Information Seeking Behavior” and “Health Literacy,” which were related to high-ranking core keywords such as “Patient Education as Topic.” Moreover, keywords related to a specific illness included “Chronic Disease.” The genetic-related keywords of “Genetic Testing” and “Genome, Human” also newly appeared and thus expanded the scope of the network.

3.2 Analysis of Using Health Information via Mobile Phones

3.2.1 Network Analysis of Total Keywords

In the literature, keywords regarding health information via mobile phones started appearing in

![Fig. 5, Keyword network of 2003-2005 (pruning=9, n=23).]
While a constant increase in keywords was observed from 2005 to 2010, the drastic and rapid increase occurred thereafter (Fig. 8).

As examining the network including the 98 keywords, which structured the 43 networks with the high centrality, the degree centrality of "Cellular Phone" ranked the highest, followed by "Patient Education as Topic," "Internet," "Health Education," then "Self Care" (Fig. 9). From this network, it was found that using health information via mobile phones brought along the simultaneous use of health information via the Internet. In addition, the
purpose of searching and locating health information via mobile phones was to provide information regarding "Self Care." It seemed to have originated from the "Social Support" aspect. Mainly provided health information via mobile phones was about disease-related information services and specific disorders such as "Diabetes Mellitus, Type 2," "Obesity," "HIV Infection," "Asthma," "Depression," and "Anxiety." Ongoing studies were regarding risk factor management to improve the overall health status, including studies on "Smoking Cessation," "Exercise," and "Medication Adherence."

3.2.2 Category-based Network Analysis

For the high-ranking keywords listed in the top 20, a mobile phone was used to obtain health information related to "Diabetes Mellitus, Type 2" and "Blood Glucose Self-Monitoring." Keywords related to "HIV Infections" appeared recently although they were not high-ranking keywords. It was also noticed that research on "Telemedicine" was more extensively conducted (Table 2).

Specific keywords in nursing, such as "Nursing Evaluation Research" and "Nurse's Role," were studied along with the use of health information...
Table 2 List of top 20 degree centrality keywords by category

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<td>1</td>
<td>Cellular Phone</td>
<td>Cellular Phone</td>
<td>Cellular Phone</td>
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<tr>
<td>2</td>
<td>Patient Education as Topic</td>
<td>Patient Education as Topic</td>
<td>Patient Education as Topic</td>
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<tr>
<td>3</td>
<td>Diabetes Mellitus, Type 2</td>
<td>Internet</td>
<td>Internet</td>
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<tr>
<td>4</td>
<td>Internet</td>
<td>Diabetes Mellitus, Type 2</td>
<td>Self Care</td>
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<tr>
<td>5</td>
<td>Blood Glucose</td>
<td>Blood Glucose</td>
<td>Health Education</td>
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<tr>
<td>6</td>
<td>Computer-Assisted Instruction</td>
<td>Hemoglobin A, Glycosylated</td>
<td>Diabetes Mellitus, Type 2</td>
</tr>
<tr>
<td>7</td>
<td>Fasting</td>
<td>Nursing Evaluation Research</td>
<td>Health Promotion</td>
</tr>
<tr>
<td>8</td>
<td>Hemoglobin A, Glycosylated</td>
<td>Nurse’s Role</td>
<td>Health Knowledge, Attitudes, Practice</td>
</tr>
<tr>
<td>9</td>
<td>Follow-Up Studies</td>
<td>Computer-Assisted Instruction</td>
<td>Diabetes Mellitus</td>
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<tr>
<td>10</td>
<td>Patient Satisfaction</td>
<td>Blood Glucose Self-Monitoring</td>
<td>Patient Compliance</td>
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<tr>
<td>11</td>
<td>Self Care</td>
<td>Program Evaluation</td>
<td>Blood Glucose Self-Monitoring</td>
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<tr>
<td>12</td>
<td>Program Evaluation</td>
<td>Fasting</td>
<td>Electronic Mail</td>
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<tr>
<td>13</td>
<td>Health Education</td>
<td>Postprandial Period</td>
<td>Telemedicine</td>
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<tr>
<td>14</td>
<td>Treatment Outcome</td>
<td>Telemedicine</td>
<td>Patient Satisfaction</td>
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<tr>
<td>15</td>
<td>Risk Factors</td>
<td>Self Care</td>
<td>Reminder Systems</td>
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<tr>
<td>16</td>
<td>Patient Satisfaction</td>
<td>Information Dissemination</td>
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<tr>
<td>17</td>
<td>Pilot Projects</td>
<td>Pilot Projects</td>
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<tr>
<td>18</td>
<td>Communication</td>
<td>Hemoglobin A, Glycosylated</td>
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<tr>
<td>19</td>
<td>Feasibility Studies</td>
<td>HIV Infections</td>
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<tr>
<td>20</td>
<td>Social Support</td>
<td>Exercise</td>
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via mobile phones. Information on the role of nurses as a mediator as well as an advocate of health used to be provided in clinical settings in the past; however, with the use of the Internet and mobile phones, this result showed that consumers turned to be very active in the management of their health and empirically demonstrated the need for a role shift among nurses with regard to providing health information. It was also noted that studies regarding the outcomes of such phenomenon were intensively conducted.

Although not listed in the high rank, there was an increase in the provision of information through “Text Message.” Compared with the previous years, many keywords newly appeared during the period of 2009 - 2011, which reflected a rapid increase of keywords on the use of health information via mobile phones.

For the keyword networks by each category, 15 keywords appeared during the period of 2002 - 2005 (Fig. 10). Studies on mobile-based education including “Computer-Assisted Instruction” as well as information on “Diabetes Mellitus, Type 2” and “Self Care,” “Patient Satisfaction,” and “Program Evaluation” for such diseases, were conducted.

During the period of 2006 - 2008, 52 keywords were studied, including “Blood Glucose,” “Hemoglobin A, Glycosylated,” “Logistic Regression,” “Health Education,” “Patient Education,” and “Patient Satisfaction.” A large proportion of keywords related to “Blood Glucose,” “Hemoglobin A, Glycosylated,” and “Logistic Regression” are connected to “Health Education,” which indicates that the information on health education is the central role in the keywords network. Furthermore, during the period of 2009 - 2011, 73 keywords were studied, with a high proportion of keywords related to “Blood Glucose,” “Hemoglobin A, Glycosylated,” and “Logistic Regression.” The keywords network is similar to that of the previous period, indicating that the information on health education continues to be the central role in the keywords network.
appeared in the network (Fig. 11). The core keywords of “Diabetes Mellitus, Type 2,” “Obesity” and “HIV Infections” were noticed. Consequently, a gradual expansion of the scope and the topics regarding health information via mobile phones was noticed. Studies on “Patient Compliance” and providing health information via “Electronic Mail” also started to appear in the literature.

During 2009 - 2011, 76 keywords appeared in the network (Fig. 12). The degree centrality of “Health Education” and “Self Care” increased. It was noticed that information on “Obesity” and “HIV Infection” was disseminated via mobile phones. For the information used to be provided via “Electronic Mail” alternative communication channels such as “Telemedicine” or “Text Message” started being adopted. Although not being presented in the network, the use of health information regarding “Asthma,” “Depression,” “Anxiety,” and “Smoking Cessation” were actively studied. “Patient Compliance” regarding “Health Knowledge, Attitudes, Practice” also appeared as important keywords.

4. DISCUSSION

This study attempted to grasp the systematic picture of research topics by extracting core keywords in the field of interest. The centrality measure for SNA has a downside of not reflecting the weighted degree of connection between nodes [30]. Therefore, in order to grasp the centrality of research topics, this study applied weight not only
to the number of linked keywords but also to the frequency of the links. In this manner, the degree centrality increases with increased weight \([29,32]\). However, as such weighting does not completely reflect the quality of a research topic; thus, it should be considered to apply relative weight for future research. Additionally, because it is not possible to display all of the keywords extracted from the literature, only rather frequently appearing keywords above a certain level of values were included by the pruning method. Considering these limitations of SNA in this study, attention should be paid to the presence of the keywords having a high degree of centrality in the networks.

In the keyword networks related to health information via the Internet, the research topic of “Patient Education as Topic” had the strongest centrality. As it was noticeable in the network, “Patient Education as Topic” was linked to “Age” and “Sex” as well as other core keywords. Researchers in the past actually attempted to identify influential factors affecting a Technology Acceptance Model (TAM). Based on their findings, an Internet–related Information and Communication Technology Acceptance Model (ICTAM) was devised and proposed \([3,4]\). In the study demonstrating the validity of ICTAM, An and her colleagues \([3,4]\) reported that gender differences had a significant impact on the acceptance of Internet–related information and communication technologies. To date, there are still insufficient amount of theoretical and empirical studies regarding ICTAM by age. Therefore, socio-demographic factors and the inherent information gap should be further studied in interpreting the results of research on the use of online health information.

In the studies on the ensuing use of health information via mobile phones, consumer behaviors were extensively studied with Internet–related research. However, the keywords shown in the networks were very different. In addition, the absolute number of the papers on mobile related
health information was certainly not comparable with that on Internet related health information. In case of health information via mobile phones, the keywords extracted from environmental diseases or socio-psychological perspective such as "Asthma," "Depression," and "Anxiety" as well as "Smoking Cessation," "Diabetes Mellitus, Type 2," and "Chronic Disease" appeared in the networks, indicating consumers used essential health information for the management of their health without delay, whenever necessary. These keywords recently and rapidly appeared in the literature. It was also noticed that the age groups using mobile phones to access health information were expanded from teenagers and young adults to 40 years and older. This trend accelerated steadily in the literature. In addition, cutting-edge medical information, such as genetic related information mobile, could be accessible via mobile phones.

The keywords regarding health information via the Internet started to appear in 1998 and increased rapidly after 2007. In case of keywords regarding health information via mobile phones, it started to appear in 2002 and increased rapidly after 2010. Diffusion of "so-called" innovation of both cases took about 10 years in the academia. Rogers [33] defined innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" when discussing diffusion of innovations. With the wide use of smart phones, its convergence contents were dramatically diffused. The early adopters always are using an upgraded level of "innovation" and spreading it at the same time [34]. Therefore, studies regarding consumers' use of health information can be predicted on smart phone-based digital convergence contents.

Healthcare consumers no longer regard online information or related services as a simple act of using an application. Instead, they recognize it as a medium or channel for communication. In consideration of the rapid changes in the information society of the 21st century, healthcare consumers are turning to very active users using online health information for their autonomous decision-making. Therefore, it is the responsibility of healthcare professionals to set an evidence-based solid foundation regarding online health information. In order to obtain a positive outcome from the use of online health information, the starting point should be based on scientifically studied empirical research on consumers’ use of online health information. The results of this study, therefore, can be provided basic information to present directions for future research on this area.

Recommendations were proposed based on the results of this study. First, methods for future research should be designed in consideration of information gap and speed of information diffusion, which are dependent on socio-demographic factors of health consumers. In interpreting the results, inherent information gap should be also considered.

Second, analyzing the time sequential trend of the increasing number of Internet users in Korea, it seems that the increase will slow down. However, along with the expanding social communications such as emails, messengers, blogs, and social networking services and in tune with the current trend of digital media convergence contents, studies on the use of smart phone-based health information by consumers seem to be necessary. Furthermore, consumers also should be educated on how to appropriately use the obtained health information for the improvement of their health. A balanced viewpoint on information technology, culture, and the society is also required. Third, when conducting SNA, it is suggested that applying weight to the MeSH keywords should be considered [35]. In addition, to utilize the results of SNA as a basis for policy making or designing future research, it is recommended that an in-depth expert review regarding its results should be conducted. Lastly, a previously proposed framework for the visualization of networks could be helpful for readers to
understand the results of the networks. In addition, this approach may be an emerging research theme in information design [36].

5. Conclusion

This study attempted to grasp the time sequential appearance of research topics in the field of interest by extracting core keywords. Based on the analysis, access to health information via the Internet was made prior to information access via mobile phones. Studies on health information via the Internet seemed to be in a settled stage when it comes to investigating the influence of various socio-demographic factors and the characteristics of users (i.e., consumer behaviors) on finding information for the maintenance and improvement of self-care. In the studies on the ensuing use of health information via mobile phones, consumer behaviors have been extensively studied via Internet-related research. Many keywords not appeared in the Internet-related studies appeared in the mobile-related studies even in the initial stage of research. The results of this study using SNA provided basic information to guide research directions for future studies in the field of interest. In this regard, an in-depth review (i.e., an expert review) of these results should be performed to establish the objectivity and the validity of this study.

REFERENCE


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