

# Social Network Analysis of Elders' Health Literacy and their Use of Online Health Information

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**Objectives:** Utilizing social network analysis, this study aimed to analyze the main keywords in the literature regarding the health literacy of and the use of online health information by aged persons over 65. **Methods:** Medical Subject Heading keywords were extracted from articles on the PubMed database of the National Library of Medicine. For health literacy, 110 articles out of 361 were initially extracted. Seventy-one keywords out of 1,021 were finally selected after removing repeated keywords and applying pruning. Regarding the use of online health information, 19 articles out of 26 were selected. One hundred forty-four keywords were initially extracted. After removing the repeated keywords, 74 keywords were finally selected. **Results:** Health literacy was found to be strongly connected with 'Health knowledge, attitudes, practices' and 'Patient education as topic.' 'Computer literacy' had strong connections with 'Internet' and 'Attitude towards computers.' 'Computer literacy' was connected to 'Health literacy,' and was studied according to the parameters 'Attitude towards health' and 'Patient education as topic.' The use of online health information was strongly connected with 'Health knowledge, attitudes, practices,' 'Consumer health information,' 'Patient education as topic,' etc. In the network, 'Computer literacy' was connected with 'Health education,' 'Patient satisfaction,' 'Self-efficacy,' 'Attitude to computer,' etc. **Conclusions:** Research on older citizens' health literacy and their use of online health information was conducted together with study of computer literacy, patient education, attitude towards health, health education, patient satisfaction, etc. In particular, self-efficacy was noted as an important keyword. Further research should be conducted to identify the effective outcomes of self-efficacy in the area of interest.

**Keywords:** Consumer Health Information, Health Literacy, Internet, Medical Subject Headings, Aged

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## I. Introduction

According to Statistics Korea, people over 65 years of age constitute 11.0% of the total population of Korea [1]. It is predicted that the proportion of the aged will reach 24.3% by 2030 and 38.2% by 2050, which will mean a transfer to an extremely aged society. One of the methods to increase the quality of life of the aged, their ultimate health goal, is to promote a healthy lifestyle for them as well as the effective management and prevention of disease.

There exists digital divide with socio-demographic factors when it comes to the application of information and communication technologies (ICT), including the Internet [2,3].

The concept of the digital divide can be explained in terms of social differences between individuals, groups, and countries at different socio-economic status levels. The digital divide appears in an unequal form in terms of the opportunity to access, physically possess, and practically apply ICT [4].

Korea has carried out two-phase comprehensive program to reduce the digital divide. Phase I (2001–2005) emphasized the preparation of a basis for the access and use of information. Phase II (2006–2010) focused on the practical use of ICT. The Ministry of Health and Welfare of Korea recently launched a community-based pilot project for a ubiquitous healthcare service which manages metabolic syndromes at community health centers. The Korean government has also initiated increased awareness of using ICT in healthcare areas [5-7].

Previous studies investigated the factors that influence individuals' acceptance of ICT, which were the basis for the development and validation of the Information and Communication Technology Acceptance Model [4,8-10]. However, few studies on testing this model employing an aged population exist. The Internet, which allows quick searches and easy handling of all types of information, even including information related to emergency situations, can be of use to the aged, who typically have psychological, physiological, and physical limitations [11].

According to a 2007 Korean fact-finding survey on the digital divide, there was a gap between ages: 37.4 among middle-aged people and 13.7 among aged people per every 100 used the Internet [5]. In a 2009 survey, compared with Internet use by 77.0% of the general population, Internet use among middle-aged people in their 50s stood at 55.9%. Among the aged more than 60 years old the percentage was 21.8% [6,7]. According to a recent survey by the Korea Internet Security Agency [12], Internet use by the aged in their 60s increased from 33.8% in 2010 to 35.9% in 2011 (Figure 1). However, there is insufficient semantic research on whether or not this Internet use is productive.

The aged who use the Internet mostly want to search for

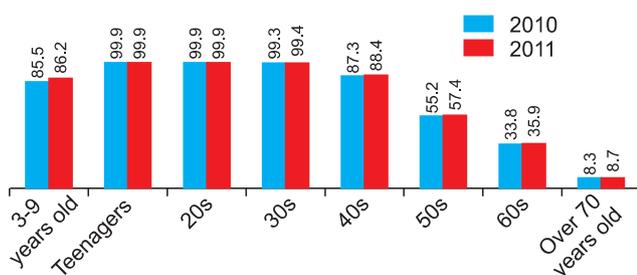


Figure 1. Internet use by age group in Korea [12].

and locate information regarding activities related to their leisure and hobbies. They also search for and use online content related to aging [13]. Accordingly, the number of Internet portal sites exclusively for the aged has been increasing. Some websites for the aged allow the sharing of information with people having similar interests. Despite the fact that the aged have gradually started to use the Internet, they still account for only a part of the aged population [12]. Moreover, a study examining the health information literacy of Finns aged 65–79 years also reported that the aged lack health information literacy and that there are significant relationships between education level, interest in health information, seeking activity, self-rated current health, and the dimensions of health information literacy [14]. Previous studies have consistently reported the necessity to develop a curriculum on how to use the Internet and how to locate information targeting aged populations [2,14,15]. In addition, the literature states that there is a need for a systematic research on aspects of their Internet use.

Considering the rapid social changes in the 21st century, it is predicted that the aged will not always remain passive consumers seeking health information and services on the Internet. To expect positive outcomes regarding the active use of health information by the aged, scientific studies of their health literacy and the use of online health information are needed. Therefore, this study aims to review and analyze previous studies on health literacy and the use of online health information by those aged 65 years and over. The studies were obtained from the PubMed database of the National Library of Medicine (NLM). Medical Subject Heading (MeSH) keywords of the studies were analyzed using a social network analysis (SNA) method.

## II. Methods

### 1. Subject

#### 1) Paper extraction

To extract published articles on health literacy and the use of health information by the aged over 65, predefined and selected MeSH terms from the PubMed database of the NLM were used. Search was initially conducted, with repeated articles excluded afterwards. The keywords in all of the extracted articles were reviewed to make a final selection of the articles for the analysis.

The search requested articles related to health literacy of the aged over 65. A total of 361 articles were extracted. Among them, 127 articles concerning the aged over 65 were selected. After the repeated articles were removed, 110 articles were finally included in the analysis, which include the following

MeSH terms with the corresponding number of selected articles: health communication AND aged (9 out of 23); health literacy AND aged (61 out of 191); computer literacy AND aged (39 out of 104); computer literacy AND health education AND aged (18 out of 48).

Subsequently, articles related to the use of online health information by the aged over 65 were selected. Using the same extraction process used for 'health literacy,' 26 articles were selected. After the repeated articles were removed, the final 19 articles were included in the analysis. These include the following MeSH terms with the corresponding number of selected articles: Internet/utilization AND consumer health information AND aged (7 out of 34); Internet AND consumer health information AND aged (6 out of 87); Internet/utilization AND health education AND aged (13 out of 161).

## 2) Keyword extraction

From the 110 articles related to health literacy, a total of 1,021 MeSH keywords were extracted. After removing repeated keywords, a final 401 keywords were selected. It was difficult to construct a network of and distinguish the relations between the 401 keywords; therefore, a pruning method was used. Pruning is applied to reconstruct a network based on keywords with a degree higher than a certain cut-off level that establishes the boundaries of a network [16-18]. After applying the pruning method (pruning = 5), the network was reconstructed based on a final number of 71 keywords. Regarding the use of online health information, a total of 144 MeSH keywords were obtained from the 19 articles. After removing repeated keywords, 74 keywords were finally selected.

## 2. Statistical Analysis

SNA is a statistical method that can be widely used in interdisciplinary fields [18,19]. SNA converts the relationships between studies and their results into easily understood visual models [18,20,21]. In Korea, research using SNA has recently been published in healthcare [22-26]. Of these studies, only a few extracted MeSH terms from the NLM database [22,27,28].

The core of SNA is the degree and the density of nodes. The degree plays an important role in the SNA process [29]. If a group size increases, the density decreases accordingly, and if networks are of different sizes, standardization is required [29,30]. If a node moves to the center and has many connections to other nodes, its degree centrality increases in the network [29,31]. A higher degree centrality indicates a more central keyword; therefore, it can be interpreted as a keyword that has been actively studied in the literature [18,32].

NetMiner v.3 (Cyrax Inc., Seoul, Korea) was used to construct keyword networks. For the construction of a network, the keywords of each article were used as the nodes in the network. A method used in SNA, an analysis of co-appearing keywords, was also applied in this study. Co-appearing keywords reflect a semantic connection between articles [17,21,33] and visually present the content of the articles, including the intention and the philosophy of the authors, in the form of pictures [34].

This study applied the notion of weighted degree centrality to investigate the changes in the main keywords in each section of the networks [35]. Normally, degree centrality standardization is performed for networks of different sizes. However, it was not necessary to consider the differences in the densities of the keyword networks in this study because the networks were constructed from separate searches in two different areas. Thus, it was established that there was no need for standardization.

## III. Results

### 1. Keyword Network of Health Literacy

Keywords which appeared in selected articles related to 'health literacy' emerged in 1997, and the number of related keywords has increased rapidly since 2010 (Figure 2).

After applying pruning to the 401 keywords, the network was constructed based on the remaining 72 keywords. Among them, keywords with the highest degree centrality in the network were 'health literacy' and 'computer literacy.' With the exception of these two keywords, the keywords with the highest degree centrality were 'Patient education as topic,' 'Internet,' 'Health knowledge, attitudes, practice,' and 'Attitude towards computers.' Table 1 shows the keywords with the highest degree centrality.

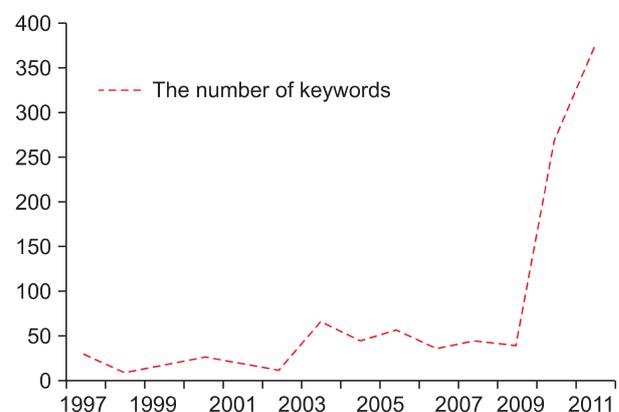


Figure 2. Change in the number of keywords for health literacy by year.

Table 1. Top 30 keywords with degree centrality for health literacy

Rank	Keyword	Frequency	Degree centrality value
1	Health literacy	61	2.167464
2	Computer literacy	44	1.966507
3	Patient education as topic	30	1.425837
4	Internet	28	1.306220
5	Health knowledge, attitudes, practice	23	1.081340
6	Attitude to computers	21	1.043062
7	Age factors	15	0.727273
8	Attitude to health	12	0.679426
9	Educational status	12	0.564593
10	Self-care	12	0.502392
11	Health education	11	0.564593
12	Health promotion	10	0.416268
13	Computer user training	9	0.483254
14	Health communication	9	0.401914
15	Patient satisfaction	9	0.449761
16	Computer-assisted instruction	8	0.444976
17	Patient participation	8	0.449761
18	Physician-patient relations	8	0.440191
19	Pilot projects	8	0.382775
20	User-computer interface	8	0.354067
21	Activities of daily living	7	0.344498
22	Chronic disease	7	0.339713
23	Focus groups	7	0.344498
24	Information services	7	0.315789
25	Patient compliance	7	0.287081
26	Comprehension	6	0.287081
27	Geriatric assessment	6	0.301435
28	Heart failure	6	0.287081
29	Neoplasms	6	0.267943
30	Quality of life	6	0.291866

Of the top 30 which were most frequently appearing keywords, five were related to computers (Computer literacy; Attitude towards computers; Computer user training; Computer-assisted instruction; User-computer interface), four were related to the role of the patient (Patient satisfaction; Patient participation; Physician-patient relations; Patient compliance), three were related to attitudes (Health knowledge, attitudes, practice; Attitude towards computers; Attitude towards health), two were related to education (Patient education as topic; Health education), and the remaining two were 'Internet' and 'Information services.'

When the relationships between the keywords were inter-

preted in the keyword network, 'Health literacy' had a strong degree of connection with 'Health knowledge, attitudes, practice' and 'Patient education as topic.' 'Computer literacy' had a strong degree of connection with 'Internet' and 'Attitude towards Computer.' 'Computer literacy' was connected to 'Health literacy' and researched as a parameter of 'Attitude towards health' and 'Patient education as topic.' The majority concerned the acquisition of information related to chronic diseases such as diabetes and high blood pressure (Figure 3).

Table 2 presents the changes in the top 20 keywords by year. This table shows that the degree centrality of 'Computer literacy' was highest before 2010. The degree centrality of

Table 2. Change in the top 20 keywords by year

Rank	2006	2007	2008	2009	2010	2011
1	Computer literacy	Computer literacy	Computer literacy	Computer literacy	Health literacy	Health literacy
2	Patient education as topic	Attitude to computers	Internet	Internet	Patient education as topic	Health knowledge, attitudes, practice
3	Attitude to computers	Internet	Health education	Attitude to computers	Internet	Patient education as topic
4	Computer-assisted instruction	Aging	Health knowledge, attitudes, practice	Forecasting	Age factors	Physician-patient relations
5	Attitude to health	Great Britain	Age factors	Software	Socioeconomic factors	Health communication
6	Program evaluation	Self-concept	Patient satisfaction	Patient satisfaction	Health knowledge, attitudes, practice	Comprehension
7	Nursing evaluation research	Antipsychotic agents	Aging	Health services for the aged	Computer literacy	Self-care
8	Online systems	Awareness	Quality of life	Delivery of health care	Patient participation	Communication barriers
9	Scotland	Culture	Diabetes mellitus	Therapy, computer-assisted	Attitude to health	Age factors
10	Computer user training	Delusions	Self-care	Patient acceptance of health care	Attitude to computers	Rural population
11	Pilot projects	Electronic mail	Access to information	Telemetry	Self-care	Emigrants and immigrants
12	Nursing assessment	Parapsychology	Educational status	Computer-assisted instruction	Self-efficacy	Language
13	Risk assessment	Psychotic disorders	Chronic disease	Patient education as topic	Health status	Early detection of cancer
14	Attitude of health personnel	Risperidone	Self-help devices	Neoplasms	Educational status	Health promotion
15	Choice behavior	Cognition disorders	Attitude to computers	Learning	Medication adherence	Educational status
16	Decision trees	Day care	Attitude to health	Health promotion	Health communication	Patient participation
17	Diagnosis, computer-assisted	Mental recall	Information services	Focus groups	Computer user training	Communication
18	Health behavior	Mental status schedule	Medical informatics	Health knowledge, attitudes, practice	Qualitative research	Patient compliance
19	Hypertension	Pensions	Consumer satisfaction	Analysis of variance	Health education	Patient satisfaction
20	Life style	Prejudice	Intention	Mental recall	Dental care	Focus groups

'Health literacy' was ranked first in 2010. Moreover, there was a notable increase in both 'Age factor' and 'Socioeconomic factor' related to 'Health literacy.' In 2008, 'Self-care' entered to the top 20 keywords. Both 'Self-care' and 'Self-efficacy' appeared on the list in 2010. More behaviors related

to independence and active dealings with health were also observed. 'Health communication' entered the list in 2010, and the scope was extended to 'Physician-patient relations,' 'Communication barriers,' and 'Communication' in 2011. 'Emigrants and immigrants' first appeared on the list in



Table 3. Top 30 keywords with weighted degree centrality for the use of online health information

Rank	Keyword	Frequency	Weighted degree centrality value
1	Internet	19	0.598086
2	Consumer health information	11	0.306220
3	Health knowledge, attitudes, practice	5	0.234450
4	Patient education as topic	5	0.215311
4	Age factors	5	0.215311
6	Health education	6	0.177033
7	Computer literacy	4	0.167464
8	Attitude to computers	3	0.133971
9	Medical informatics	3	0.119617
10	Educational status	2	0.114833
11	Physician-patient relations	2	0.105263
11	Survivors	2	0.105263
13	Patient satisfaction	2	0.100478
13	Risk factors	2	0.100478
13	Self-efficacy	2	0.100478
16	Attitude to health	2	0.095694
16	Computer-assisted instruction	2	0.095694
16	Risk assessment	2	0.095694
19	Health services for the aged	2	0.086124
20	Breast neoplasms	2	0.081340
20	Information dissemination	2	0.081340
20	Mass screening	2	0.081340
23	Access to information	2	0.076555
24	Mass media	2	0.062201
24	Exercise	2	0.062201
26	Income	1	0.057416
26	Sex factors	1	0.057416
26	Information services	1	0.057416
26	Models, psychological	1	0.057416
26	Neoplasms	1	0.057416

in the study of the use of online health information on the Internet. In particular, 'Self-efficacy' emerged as the top keyword starting in 2010. In terms of access to online health information, the aged are still in the minority when it comes to communication, and they lack the ability to search for, locate, and use online health information [12,14]. Accordingly, 'Self-efficacy' is considered to be the keyword which best reflects this phenomenon. In other words, this keyword emerged from the necessity for study on the characteristics of the use of online health information by the aged over 65, who generally accept online information in a slightly passive way [6,15].

Considering the tendency toward the gradual increase in the percentage of ICT use and its practical use by the aged each year [12], social awareness about its usefulness should also be increased. With the increase in the number of the aged who are vulnerable when attempting to obtain and use health information, it is estimated that according to their

online health information seeking behavior, personalized health management services should be developed [14]. In addition, by the time middle-aged people, who are currently accustomed to the Internet and who already have self-efficacy, advance in age, they will look for inexpensive and cost-effective, personalized online health information [9,14,15].

In a more comprehensive interpretation of the results, studies of health literacy and the use of online health information by the aged over 65 were conducted together with the keywords of 'Computer literacy,' which allows access to the medium to simplify the locating of health information [13,15], as well as 'Information dissemination' and 'Access to information,' which are related to the digital divide [14,15]. Therefore, there is a need to educate the aged regarding how to use ICT and how to enhance the practical use of online health information. With the help of such education, the aged can efficiently search, locate, and use online health information. Accordingly, based on the results of this study,



connections between nodes [35]. To investigate the centrality of a research subject in this study, the number of connected keywords and the weights depending on the number of connections were reflected. It was demonstrated in the literature that a greater weight increases degree centrality [42,43]. However, granting such a weight cannot entirely reflect the quality level of a research subject. Therefore, there is a need to reflect such relative weights through various methods.

Moreover, not all of the keywords extracted from the articles could be visualized in the networks as pruning was performed. Only the keywords with a certain level of degree centrality were included. Accordingly, the interpretation of the results has limitations because certain keywords not appearing in the networks were excluded. The excluded keywords may be important keywords; therefore, it is suggested that researchers who use SNS request an in-depth review from content experts in their field(s) of interest when interpreting results obtained from SNA.

Assuming that research in the area of interest shows certain internal changes, turning points or changes of progressive knowledge can be tracked through a time series analysis of the research area [16,44]. Keyword networks can confirm changes in the interest area. This can help researchers explore the directions of their research. In other words, SNA results can serve as a scientific predictor of future research.

Finally, there are a number of considerations for future research. First, 'Self-efficacy' and 'Specific health-related self-efficacy' as well as 'Internet self-efficacy' in aged populations require further study. Second, a user-centered and detailed curriculum reflecting the needs of the aged should be developed. In particular, an educational program and detailed guidelines to increase health literacy in elderly Koreans, similar to 'Helping older adults search for health information online' (<http://nihseniorhealth.gov/toolkit/toolkit.html>), established by the National Institute on Aging in the United States, is needed. Third, a comprehensive review of guidelines from the viewpoint of user-friendliness is needed to provide easy to use online health information [4,8-10,13]. Fourth, to use SNA results as a basis of evidence-based research, a committee for in-depth professional reviews is necessary.

## Conflict of Interest

No potential conflicts of interest relevant to this article are reported.

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