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eHealth and health informatics competences: A systemic analysis of literature production based on bibliometrics

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A systemic analysis of literature production based on bibliometrics

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Abstract

Purpose – The rapid development of eHealth requires the extension of existing health informatics competences sets. These competences are needed not only by health-care professionals but also by health-care consumers. The purpose of this paper is to analyse literature production of health informatics and eHealth competences/skills (EHCS).

Design/methodology/approach – Bibliometric analysis and mapping have been used as a form of distant reading approach in the manner to perform thematic analysis, identify gaps in knowledge and predict future trends.

Findings – This study shows that the literature production of health informatics and EHCS differs in bibliometric indicators, as well as in research content. Thematic analysis showed that medicine is the most productive subject area in both fields. However, health informatics competencies/skills are more oriented toward education, nursing, electronic health record and evidence-based practice, while EHCS cover health information technology, engineering, computer science and patient-centred care. The literature research production exhibits positive trend and is geographically widespread in both fields.

Research limitations/implications – The use of Scopus database might have led to different results if the authors had used Web of Science or Medline, because of the fact that different databases cover different lists of source titles. The authors used various search strings, and the most optimal one for their study; however, a different search string might result in slightly different outcomes. In addition, the thematic analysis has been performed on information source abstracts and titles only, as the analysis of full texts (if available) could lead to different results. Despite the fact that the thematic analysis has been performed by three researchers with different scientific backgrounds, the results of the analysis are subjective. On the other hand, the bibliometric analyses and comparison of health informatics and eHealth competences have never been done before and this study revealed some important gaps in research in both fields.

Practical implications – The World Health Organization defined four distinct but related components of eHealth: mobile health, health information systems, telemedicine and distance learning. While the research in telemedicine and health information systems seems to be well covered, the skills and competencies in mobile health and distant learning should be researched more extensively.

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Social implications – More research in the skills and competencies associated with so-called connected health, a new subfield in eHealth research, is needed. The skills and competencies of how to better implement and use the services related to the management of chronic diseases, health coproduction and how to implement eHealth in developing countries are currently under research areas and with candidates for future research. For both health informatics competencies/skills and EHCS, we noted that more research is needed for personalised medicine, health coproduction, smart health, internet of things, internet of services and intelligent health systems.

Originality/value – The literature production on health informatics and EHCS has been analysed for the first time and been compared in a systemic way, using bibliometrics. The results reveal that current research directions as well as knowledge gaps could thus provide guidelines for further research.

Keywords Bibliometric analysis, Competency-based education, eHealth

Paper type Literature review

1. Introduction

eHealth, in its newest form, is concerned with the development, testing and integration of smart technology into health care. Its aim is to improve how health care is accessed, acted and monitored. It can thus significantly support recent health-care trends, such as patient self-management, health coproduction, engagement and empowerment (Loissele and Ahmed, 2017). Thus it is not surprising that eHealth has gained a lot of attention also on different political and policymaking fronts. For instance, European Commission eHealth Action Plan 2012-2020 title "Innovative healthcare for the 21st century" states that from 2013, the Commission has been promoting policy inclusions on eHealth at a global level. The inclusion should foster interoperability, and the use of international standards, develop information and communication technologies (ICT) skills, compare evidence of the effectiveness of eHealth and promote ecosystems of innovation in eHealth (Commission of the European Communities, 2004).

Workforce capacity and patient health-care literacy are important factors for successful transition of eHealth into real-world practice. Health-care professionals need capacity to use available technologies to support and monitor patient care and to develop health information systems. Grain and Hovenga (2011) stressed the importance to improve workforce capacity in all aspects associated with the skills and knowledge required for successful eHealth and health informatics implementation. Health professional IT skills and competences are important elements of achieving the European Union action plans. Despite all mentioned initiatives and claims, a gap in competencies and skills in information technology (IT) education for the health-care workforce in the European Union and the USA was encountered (Traver *et al.*, 2015).

On the other hand, health literacy is also important for health consumers as it offers them the possibility to effectively use eHealth services, communicate with patient groups or social or supportive networks, search for health information and gain new learning opportunities (Pardue *et al.*, 2014). Indeed, a recent study revealed that lack of health literacy was an important reason that health consumers especially seniors and those from lower socioeconomic groups do not use eHealth services and applications (Peng *et al.*, 2016).

Few quantitative studies on health informatics competences/skills (HICS) (Kokol *et al.*, 2015) or eHeath competencies (Kokol *et al.*, 2015) have been performed, and to the best of our knowledge, none on eHealth competencies/skills (EHCS) has been performed.

The aim of the present study is to use the bibliometrics analysis to fill this gap. Bibliometrics is a recognized approach to analyse research literature production and induce synthetic reviews (Alfonzo *et al.*, 2014; Baumgartner, 2010; Colin *et al.*, 2014; Jiain *et al.*, 2015). It is now also used for the analysis of highly specialized subjects (Rons, 2018). Bibliometrics encompasses different counting and mapping methods (Garfield, 2006). Contrary to ordinary reviews, which result in table of evidence, bibliometric mapping visualises the results of the analyses in the form of bibliometric maps (Colin *et al.*, 2014).

Bibliometric mapping can be regarded as a form of "distant reading" (Moretti, 2013), a method to analyse large amounts of written materials (amount too large to be read manually) to discover patterns (Vošner *et al.*, 2016). With the help of bibliometrics, we will provide answers to following research questions regarding HICS and EHCS:

RQ1. What are the trends regarding the research literature production?

RQ2. How is the research dispersed among countries, institutions and journals?

RQ3. Which are the most productive research themes?

RQ4. Which are the research gaps?

2. Material and methods

2.1 Data extraction

Scopus (Elsevier, The Netherlands) is the largest bibliographic database. All journals covered in the Scopus database are re-reviewed each year using very strict measures to ensure that high-quality standards are maintained. Using Scopus, we first created the health informatics competences/skill corpus (HICSC) (using the search string [**medical OR health OR nursing OR clinical*] *AND informatic* AND* [*competence* or skill**] *AND NOT* [*ehealth or e-health*]) in information source title, abstract and keywords. The second corpus, eHealth competences/skill corpus (EHCSC) was created using the same database and search fields, using the search string (*eHealth or e-health*) *AND* (*competenc* or skill**). eHealth is sometimes considered as a part of medical informatics (Ammenwerth *et al.*, 2010), thus we did not exclude health informatics information sources from the EHCSC. To enable holistic analysis, all English language information sources (e.g. article, review, conference paper, editorial, note, short survey, book chapter, etc.) from 1984 to 2015 were included in the study. No other inclusion or exclusion criteria were used.

2.2 Data analysis

Descriptive bibliometric analysis (literature production dynamics, geographical, document type and journal distribution and subject areas) was performed using built in Scopus analysis services. The thematic analysis was done on the author-clustered keywords network induced by VOSviewer software V1.6.6 (Leiden University, The Netherlands) (Van Eck and Waltman, 2014). VOSviwer was successfully used in many bibliometrics mapping studies (Holman *et al.*, 2017), (Palmblad and Torvik, 2017).The clustering approach used by VOSviewer is based on a normalized term co-occurrence matrix and a similarity measure which calculates the association strength between terms, in our case author networks. Closely associated terms are then merged into clusters.

Author keywords represent an important information about the content of a publication because author keywords represent the message the author would like to convey to the research community (Zhang *et al.*, 2009). We induced an author keywords network for each of the HICSC and EHCSC. To enable comparison, 60 most frequent author keywords were selected from both corpuses and seven clusters generated for each map. The selection of the number of keywords and clusters was based on the smaller cluster, that is EHCSC. First, we selected all the keywords with the occurrence of three or more, and in that manner 60 keywords were selected (Table I). Using these 60 keywords, VOSviewer induced the author keywords network on which seven clusters emerged automatically. The terms belonging to clusters were then analysed using thematic analysis (Boyatzis, 1998) and a theme was assigned to each of those. Related clusters were combined into one theme.

EHCS	IHSC
adolescents	bioinformatics
breast cancer	biomedical informatics
cancer	clinical competence
competencies	clinical informatics
consumer health information	collaboration
curriculum	communication
curriculum development	competencies
developing countries	competency
digital divide	competency-based education
eHealth	computer literacy
education	computer skills
eHealth	computers
eHealth literacy	curriculum
evaluation	curriculum development
health care	decision making
health communication	dental education
health education	eLearning
health informatics	education
health information	electronic health record
health information technology	electronic health records
health literacy	ethics
health professionals	evaluation
health promotion	evidence-based medicine
healthcare	evidence-based practice
informatics	graduate medical education
information	health care
information literacy	health informatics
information management	health informatics education
information technology	health information technology
innovation	health literacy
internet	implementation
knowledge	informatics
literacy	informatics competencies
medical education	information
medical informatics	information literacy
mhealth	information management
mobile health	information retrieval
nurses	information storage and retrieval
nursing education	information systems
nursing informatics	information technology
older adults	internet
online	learning
patient education	medical
patient empowerment	medical education
patient participation	medical informatics
policy	medical informatics applications
primary care	nurses
public health	nursing
qualitative research	nursing education
quality	nursing informatics

(*continued*)

Table I.
Author keywords analysed in the study

EHCS	IHSC
quality of life	nursing informatics competencies
security	nursing students
self-efficacy	patient safety
self-management	primary care
skills	problem-based learning
technology	professional competence
telecommunications	public health
telehealth	public health informatics
telemedicine	qualitative research
telepsychiatry	quality improvement

Table I.

3. Results

The search was performed on 12 May 2017. The HICSC and EHCSC consisted of 1,979 and 373 information sources, respectively. From Table II, it is evident that the structure of information source types between both areas of study is similar. Most of the information sources were published in journals as articles and in conference proceedings. However, more archival publications (various types of journal papers) are produced in health informatics field. The absolute number of book chapters in both fields is almost equal, expressed in percentages; this means that more books chapters are produced in eHealth, contrary to the number of editorials which is much larger in health informatics skills/competences area. The χ^2 test shows the significant difference in the distribution of paper types between HICSC and EHCSC.

3.1 Trends in literature production

Figure 1 shows the dynamics of research literature production on HICS and EHCS. The first information source related to HICS and EHCS was published in 1984 1993, respectively. The trend in both scientific areas is positive, but steeper in health informatics than in EHCS. In HICS, the exponential trend started in 1990, became negative in 2006 and then linearly positive in 2006. The trend in EHCS research is more or less steady with a linear jump in production in 2005.

3.2 The geographical and journal distribution

The information sources from HICSC were written by authors affiliated in 96 different countries and from EHCSC by authors affiliated in 63 countries. Most productive countries

Information sources	HICS (%)	EHCS (%)
Article	1,145 (58)	199 (53)
Review	285 (14)	33 (9)
Conference paper	332 (17)	95 (25)
Editorial	56 (3)	3 (1)
Note	40 (2)	4 (1)
Short survey	50 (2)	3 (1)
Book chapter	20 (1)	19 (5)
Other	51 (3)	17 (5)

Table II.
Number of information sources

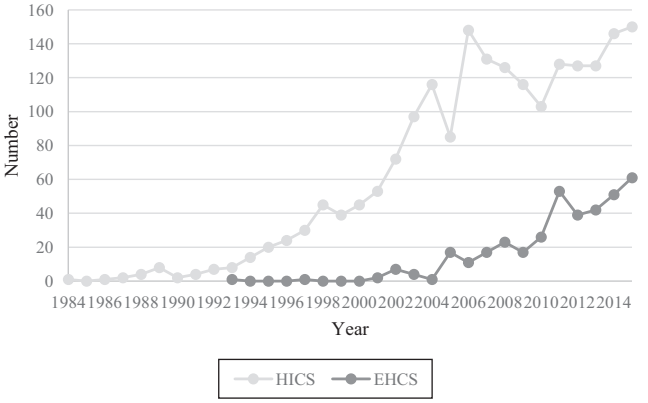

Figure 1.
Number of information sources per year

are shown in Table III. The vast majority of information sources were published in the USA, followed by the UK, Canada and Australia. Most productive countries in both areas are comparable (eight countries are the same). The research in both fields is geographically widespread, but again substantially more spread in HICS field. The top productive countries are leading countries (most belonging to G7), according to economic, research and health-care development indices.

Five most productive institutions in health informatics competences are located in the USA. According to the number of published information sources, these are ordered as follows: VA Medical Center (n = 35), Columbia University in the City of New York (n = 30), University of Utah (n = 24), OR Health and Science University (n = 23) and University of Pittsburgh (n = 22). The first non-USA institution which followed next was the University of Victoria (Canada) (n = 16).

Interestingly, the majority of most productive institutions in the area of eHealth competences are not originating in the USA, despite the fact that the USA is the most productive country, but are from Australia and Europe. On the other hand, the research on EHSC in the USA is dispersed through 181 institutions, which is just a bit less than for all other countries together where research is done on 193 institutions. The most productive institutions are University of Queensland – Australia and

Country	No. of information sources HICS	Country	No. of information sources EHCS
USA	808	USA	87
UK	203	Australia	44
Canada	104	Canada	33
Australia	95	UK	31
Netherlands	49	Netherlands	30
Germany	40	Italy	17
Sweden	34	Spain	17
Italy	24	Germany	15
Spain	23	Sweden	10
Taiwan	24	Denmark	8
Finland	22	Norway	8

Table III.
Most productive countries

University of Toronto (n = 10), University of Wisconsin (n = 8), University of Twente (n = 7) and Maastricht University, University of Sydney and University of Melbourne (n = 6).

Most prolific journals (source titles) in health informatics competences are shown in Table IV and those from the field of eHealth competences in Table V. As expected, the most prolific source titles in both fields are from the health informatics category; however, the source titles are different, and the only exception is *Methods of Information in Medicine*. The HICS journals are from medical and nursing fields, while the ones in EHCS are more internet and telemedicine-oriented. Despite the fact that competences/skills are inherently related to education, few source titles are from that area. However, an interesting difference between health informatics and eHealth is that both educational journals in HICS are from nursing education, whereas in EHCS, only one is from the patient education field. This might indicate that the researcher in eHealth area might recognize that patients must be skilled in health informatics to efficiently use eHealth services (Železnik *et al.*, 2017).

3.3 Thematic analysis

Each publication indexed in Scopus database is assigned to one or more subject areas. The comparison of the six most productive subject areas for HICS and EHCS fields (Figure 2) reveals that medicine is the most productive subject area in both fields. Furthermore, comparison shows that HICS field is more medicine- and nursing-oriented, whereas EHSC is more focused on engineering and computer science.

Table IV.
Most prolific journals in health informatics competences/skills

Source title (Journal name)	Indexed in Scopus since	Number
International Journal of Medical Informatics	1996	70
CIN: Computers Informatics Nursing	2002	59
Methods of Information in Medicine	1962	36
Journal of the Medical Library Association	1999	31
Journal of the American Medical Informatics Association	1994	29
Academic Medicine	1940	29
Journal of Digital Imaging	1980	29
Journal of the American Health Information Management Association	1991	24
Nurse Education Today	1985	23
Journal of Nursing Education	1965	22

Table V.
Most prolific journals in eHealth competences

Source title (Journal name)	Indexed in Scopus since	Number
Journal of Medical Internet Research	1999	27
Telemedicine and e-Health	2004	27
BMC Medical Informatics and Decision Making	2001	8
BMC Public Health	2001	7
Journal of Telemedicine and Telecare	1995	4
Methods of Information in Medicine	1962	4
Patient Education and Counselling	1983	4
Trials	2006	4

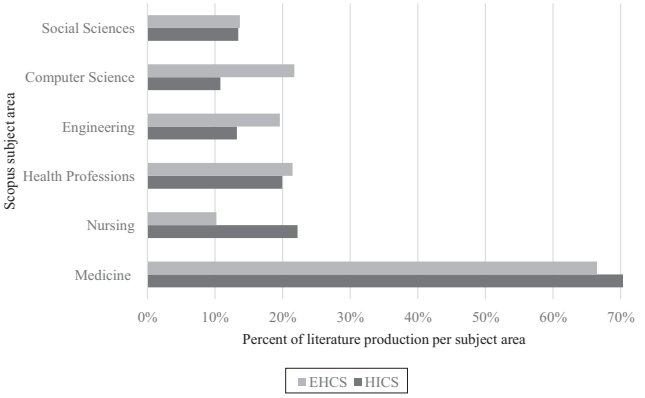

Figure 2.
Most productive subject areas in HICS and EHCS

Figures 3 and 4 present the cluster maps induced by text analysis, performed by VOSviewer software. Seven clusters defining six HICS themes were identified in the HICS author keywords network (Figure 3):

(1) *information systems* (yellow colour), combining information systems with health literacy, implementation, public health informatics and usability;

(2) *education* (blue colour), linking curriculum and curriculum development with graduate medical information, competency-based education and with terms concerning computer literacy and competency;

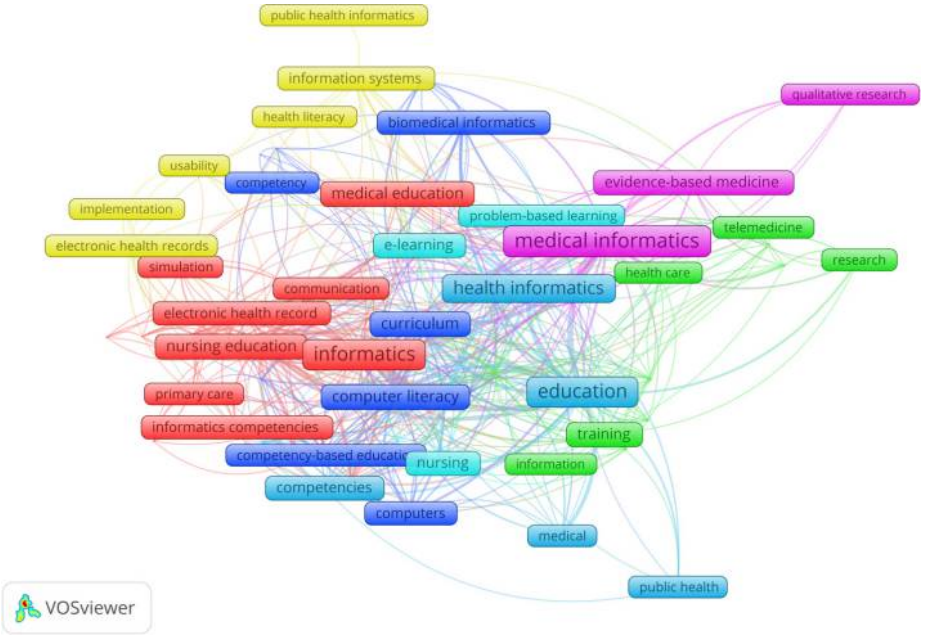

Figure 3.
HICS author keywords network (terms belonging to same clusters are labelled with same colours, more frequent terms are tagged with larger fonts)

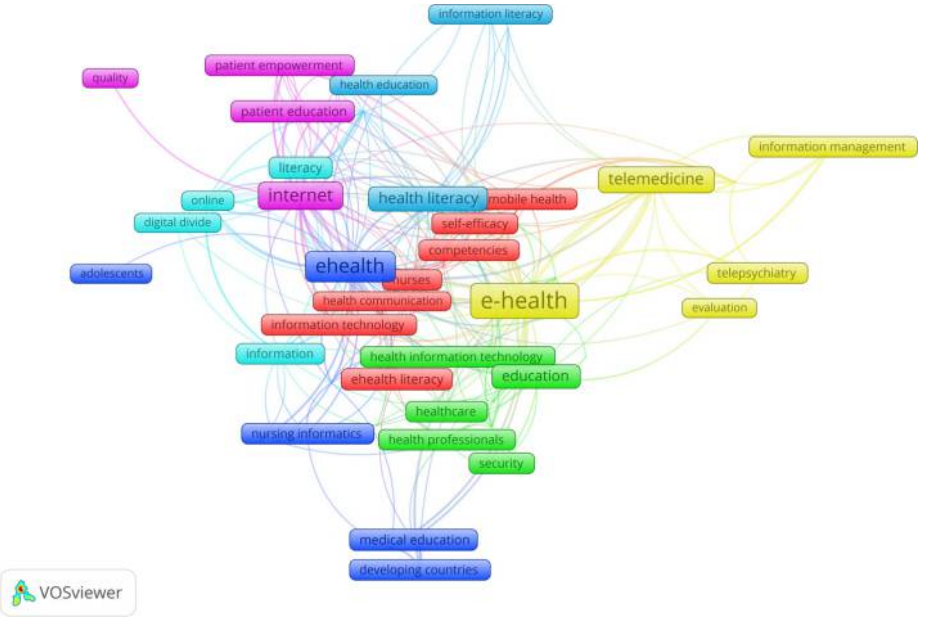

Figure 4.
EHCS author keywords network (terms belonging to same clusters are tagged with same colours, more frequent terms are tagged with larger fonts)

(3) *nursing informatics* (red colour), combining informatics competencies with quality improvement, primary care, evidence-based practice, electronic health record and communication;

(4) *health informatics* (light blue colour), associating health informatics with education, e-learning, problem-based learning, dental education with clinical competence and with terms related to nursing and public health;

(5) *information technology* (green colour), combining IT, information, information storage and retrieval with training and learning and with terms related to ethics, telemedicine, decision-making, research and health care; and

(6) *medical informatics* (violet colour), linking medical informatics with evidence-based medicine, clinical informatics and qualitative research.

Seven clusters defining five EHCS themes were identified in EHCS author keywords network (Figure 4):

(1) *eHealth* (yellow and blue colours), linking eHealth with telemedicine, telehealth and telepsychiatry and with terms related to nursing informatics, medical education and developing countries;

(2) *health literacy* (light blue colour), combining health literacy and information literacy with health education and health care and with terms related to patient participation and digital divide;

(3) *information technology* (red colour), associating IT with eHealth literacy, health communication, knowledge and with terms linked to nurses, competencies and self – management;

(4) *patient empowerment* (violet colour), linking patient empowerment with patient education, internet and quality; and

(5) *health information technology education* (green colour), linking health IT and medical informatics with diseases such as cancer and with innovation, health care, primary care, training, education, health professional and further on with attributes, such as security and quality of life.

Comparison of HICS and EHCS clusters reveals a considerable difference between the research topics in the two fields of our study. The EHCS research is more on health IT, internet- and telehealth/medicine-oriented and less toward curricula, education and competencies and skills. It is also more patient-centred oriented, focusing on patient education, participation and empowerment. Contrary, HICS research is focused more on educational topics (e.g. curriculum development, training, competences and eLearning), electronic health record, information sharing and different forms of evidence-based practices. In both fields, research on information and communication technology and health literacy seems to be a topic of primary concern.

4. Discussion and conclusions

The successful use of advanced IT in healthcare requires the high level of health informatics and eHealth competences in both health-care providers and consumers. However, these competences have been rarely studied thoroughly and holistically. Bibliometric analysis of HICS and EHCS research literature production can identify the bibliometric characteristics about two areas, what is already known, what are the differences between areas and which gaps in the research do exist.

Bibliometric analysis and mapping as well as the thematic analysis found differences between HICS and EHCS. The two areas differ in both descriptive attributes of research literature production and its content. There is a large difference in the volume of research literature production; however, trends in both areas are positive. The difference is quite logical because of the fact that eHealth was "officially born" in 2001, about 35 year after health informatics (Eysenbach, 2001). The delayed start of research literature production in EHCS in regard to HICS might be based on the same fact (Norman and Skinner, 2006). Health informatics and eHealth are strongly associated with the IT; hence the positive trend in research literature production in both areas is most probably the consequence of rapid development of new technologies (Monea *et al.*, 2016).

The research in both areas is geographically widespread. The top productive countries are leading countries (most belonging to G7), according to economic, research and health-care development indices. The USA is the most productive country. However, most productive institutions in EHCS are not from the USA. The likely reason for this is that according to our results, the EHSC research in the USA is distributed through many more institutions than in other countries, where the research is centralised in few bot strong centres.

The HICS is more health-oriented and EHCS is more engineering-oriented, which might result from the definitions of both areas. While health informatics is concerned with data and information in health (Sullivan, 2001), eHealth is more focused on the use of health and IT in health care (Eysenbach, 2001). This fact may also explain why the lists of most prolific journals differ between two areas.

Contrary to IHCS, the EHCS addresses also consumer competences which is consistent with the recent trends in consumer-oriented health care (Xiang and Stanlej, 2017; Jacobs *et al.*, 2014; Ricciardi *et al.*, 2013).

4.1 Research gaps and possible future research direction

The World Health Organization defined four distinct but related components of eHealth: mobile health, health information systems, telemedicine and distance learning (Castelnuovo *et al.*, 2015). While the research in telemedicine and health information systems seems to be well covered, the skills and competencies in mobile health and distant learning should be researched more extensively. Also more research in the skills and competencies associated with the so-called connected health (Loissele and Ahmed, 2017), a new subfield in eHealth research, is needed. The skills and competencies of how to better implement and use services related to the management of chronic diseases (Castelnuovo *et al.*, 2015), health coproduction (Graffigna *et al.*, 2016) and how to implement eHealth in developing countries (Mwendwa, 2018) are currently under research areas and with candidates for future research. For both IHCS and EHCS, we noted that more research is needed for personalised medicine, health coproduction, smart health, internet of things, internet of services and intelligent health systems.

4.2 Study limitations and strength

The use of Scopus database might have led to different results if we had used Web of Science or Medline, because of the fact that different databases cover different lists of source titles. We used various search strings, and the most optimal one for our study; however, a different search string might result in slightly different outcomes. In addition, the thematic analysis was performed on information source abstracts and titles only, as the analysis of full texts (if available) could lead to different results. Despite the fact that the thematic analysis was performed by three researchers with different scientific backgrounds, the results of the analysis are subjective. On the other hand, the bibliometric analyses and comparison of HICS and EHCS have never been done before and this study revealed some important gaps in EHCS and IHCS research.

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