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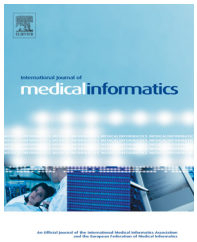

Evaluation methods used on health information systems (HISs) in Iran and the effects of HISs on Iranian healthcare: A systematic review

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ABSTRACT

Objectives: The most important goal of a health information system (HIS) is improvement of quality, effectiveness and efficiency of health services. To achieve this goal, health care systems should be evaluated continuously. The aim of this paper was to study the impacts of HISs in Iran and the methods used for their evaluation.
Methods: We systematically searched all English and Persian papers evaluating health information systems in Iran that were indexed in SID, Magiran, Iran medex, PubMed and Embase databases until June 2013. A data collection form was designed to extract required data such as types of systems evaluated, evaluation methods and tools.
Results: In this study, 53 out of 1103 retrieved articles were selected as relevant and reviewed by the authors. This study indicated that 28 studies used questionnaires to evaluate the system and in 27 studies the study instruments were distributed within a research population. In 26 papers the researchers collected the information by means of interviews, observations, heuristic evaluation and the review of documents and records. The main effects of the evaluated systems in health care settings were improving quality of services, reducing time, increasing accessibility to information, reducing costs and decreasing medical errors.
Conclusion: Evaluation of health information systems is central to their development and enhancement, and to understanding their effect on health and health services. Despite numerous evaluation methods available, the reviewed studies used a limited number of methods to evaluate HIS. Additionally, the studies mainly discussed the positive effects of HIS on health care services.

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1. Introduction

Today, information is considered as power, because it has a great role in timely and appropriate decision making [1]. To this end, introduction of Information Technology (IT) in many fields, including healthcare has resulted in fundamental changes. Some argue we are near the tipping point where one can expect a steady rise in the number of health information system implemented and in their intensity of use in different settings, especially by healthcare providers at the point of care [2].

Healthcare organizations globally invest in information technologies to improve the quality of healthcare services and to reduce their costs [3]. Different studies [4–7] indicated that implementation of health information systems results in increasing the quality of patient care and safety through reducing medication errors, improving providers' performance and effectiveness of service, reducing treatment costs, and saving resources in health and medical organizations. Moreover, these systems can increase the legibility of recorded data, reduce medical errors and finally lead to users' satisfaction [8–11].

The continual evaluation of health information systems is necessary in order to ensure the overall goals of the system, such as conducting epidemiological research, managing health information, avoiding repeated activities, promoting care quality, and reducing costs, are met [12]. The evaluation of information systems helps to determine user's satisfaction level, systems effectiveness and efficiency, systems' usability level, and to identify weaknesses and strengths of these systems for system improvement [13]. Worldwide, many health information systems have been evaluated using different evaluation methods. Reviewing each of these studies solely, does not provide a complete picture of the state of system development and implementation in different geographic areas.

Systematic reviews, by aggregating the findings of these studies, provide researchers a better understanding of health information systems and their impact on health care systems. Current systematic reviews, such as those on information system evaluation methods [14,15] and on the effect of evaluated health information systems on health and health services [4,9,16] mostly have reviewed English language papers. Meanwhile, many healthcare information systems are developed and evaluated in non-English-speaking countries, including developing countries, where the results of those studies are mostly published in their own languages. Likewise, the results of most studies evaluating healthcare information systems in Iran are published in Persian and a few in English. Therefore, information revealed and knowledge gained by most of these studies cannot be shared worldwide. Hence, a systematic review of all studies evaluating health information systems in Iran is essential to share the gained knowledge with international audiences. The objective of this study is to systematically review evaluation studies of healthcare information systems in Iran whether they are published in English or in Persian. This study specifically focuses on different evaluation methods used to evaluate these systems and the effects of evaluated information systems in healthcare domain.

2. Methods

This study is a systematic review on evaluation studies of health information systems in Iran from January 2003 till June 2013. We searched PubMed and EMBASE for relevant papers in English and Magiran, Iranmedex and SID (Scientific Information Database) for relevant papers in Persian. In searching these databases, three groups of key terms were used: (A) key terms denoting evaluation of systems (B) key terms describing different types of health information systems, and (C) key terms indicating that study was done in Iran. Fig. 1 shows the key words of each group.

We used two different strategies to extract relevant articles in these databases and the results of the two strategies were combined. To search PubMed and EMBASE, the advanced search functions were used as follows: first, we used "OR" to combine terms in each group A, B and C separately, then, we combined results from three groups using "AND" operator to accumulate all the Iranian evaluation studies of health information systems. Persian databases (Magiran, SID and Iranmedex) were searched in the following steps: 1) the terms in groups A and B were combined separately using operator "OR" 2) We used "AND" to combine group A with group B.

Once the titles and abstracts of the identified citations were obtained, two evaluators (LA and SSN) independently reviewed and assessed the retrieved publications against the following pre-defined inclusion and exclusion criteria. Any discrepancy to include a paper was resolved through discussion between these two evaluators. Remaining disagreements were discussed with the third evaluator (RK) and final decision was reached through consensus.

The inclusion criteria were:

(1) The paper must report on an original study.
(2) The study should have evaluated any aspect of health information systems.
(3) The evaluated systems must be used in Iranian health care facilities.

Review studies, editorials, commentaries, letters and studies carried out on systems that are not used in Iran were excluded. Studies proposing or validating information system models, not functional systems, were excluded.

For all the evaluation studies the authors' names, year of publication, type of evaluated system, and evaluation methods and tools were extracted (Tables 1 and 2). Besides aforementioned information, the effects of evaluated systems on medical and administrative procedures were also extracted, if they had been evaluated and reported in the papers (Table 2).

3. Results

The online databases search retrieved 1103 papers (Fig. 2). After removing duplications and irrelevant papers, 53 relevant papers (Tables 2 and 3) about the evaluation of health information systems remained (eight English language papers and 45 Persian language papers), of which 20 papers reported on the

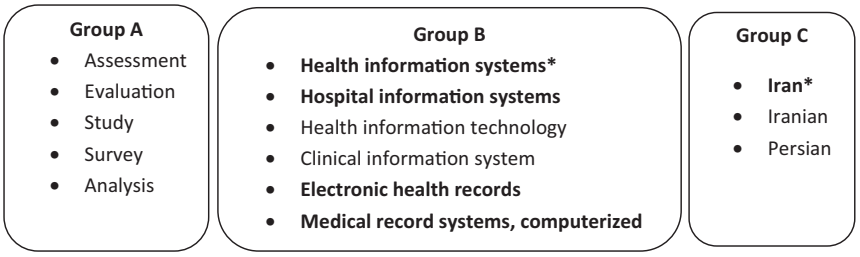

Fig. 1 – Groups of keywords used in the search strategy.*MeSH terms are in bold.

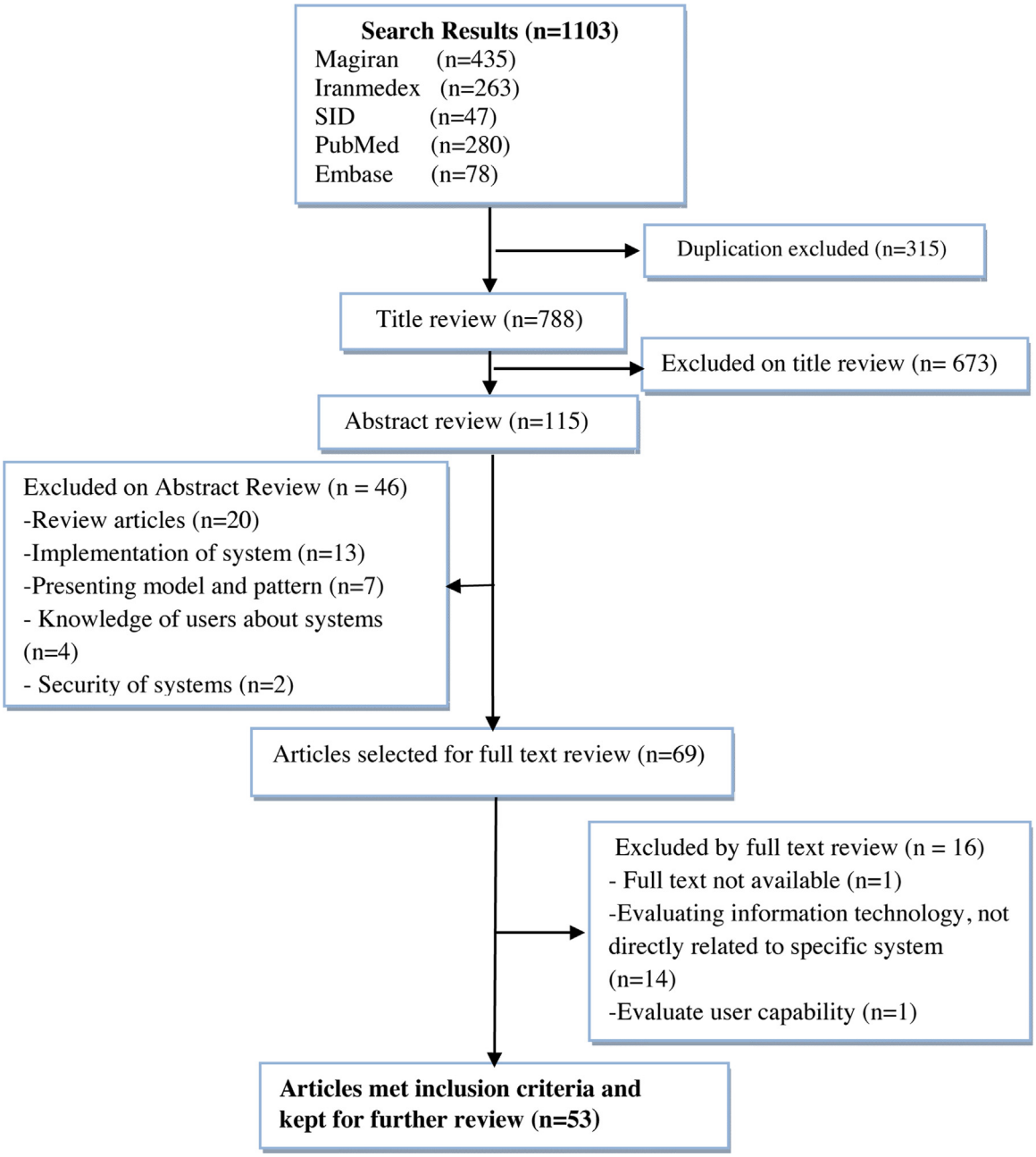

Fig. 2 – Search flow.

Table 1 – Studies' objectives and settings.

Evaluation studies objectives	Number of studies
Effect on data quality and on data management activities	31
Effect on hospitals performance and quality of medical services	13
Usability of systems	5
Systems' advantages and disadvantages	3
Adherence to users' needs	1
Settings	
Academic hospital	35
None academic hospital	15
Other institutions	3

positive and negative impacts of the systems on the medical and administrative procedures (Table 3).

Table 1 presents general information concerning evaluation studies objectives and settings. Based on these results, majority of studies addressed the effects of systems on data quality and on the data collecting, recording and processing activities ($n = 31$). Moreover, most of them were conducted in academic hospitals ($n = 35$).

The results in response to main objectives of this study are presented in two sections: methods and tools used to evaluate health information systems, and the reported effects of evaluated systems on working and treatment procedures.

3.1. *Evaluation studies' methods and tools*

Table 2 summarizes various tools and methods used to evaluate health information systems in Iran. In terms of evaluation methods, the dominant type of studies were surveys and around half of the studies used this method ($n = 27$). Each of the evaluation methods such as heuristic evaluation (a usability evaluation method) and review of the documents were used in two studies. In terms of evaluation tools, more than half of the studies used questionnaires to evaluate health information system ($n = 28$). Checklists were the second most frequently used evaluation tool ($n = 15$). Other types of tools were used seldom ($n < 3$).

Further examination of papers showed that all studies were summative (i.e. carried out after implementation of the systems to provide information about their effectiveness). Forty-six studies used quantitative, five qualitative and two mixed methods.

Table 2 – Evaluation studies' methods and tools.

Evaluation methods	Number of studies
Survey [17–43]	27
Interview [44–50]	7
Observation [51–53]	3
Interview & observation [54–63]	10
Survey & observation [64]	1
Heuristic evaluation [65,66]	2
Review the records [67,68]	2
Interview, observation, reviewing records [69]	1
Evaluation tools	
Questionnaire [17,18,20–25,27–44,46,49]	28
Checklist [26,45,47,50,52–56,59,60,62,63,65,68]	15
Checklist & questionnaire [19,51,57,58,61,64,69]	7
Data collection form [66,67]	2
Audio recorder [48]	1

3.2. *Evaluation studies' effects*

Twenty out of the 53 relevant studies evaluated the positive and/or negative effects of the systems on different aspects of medical and administrative activities in health care sector (Table 3). The results of these studies are presented below.

Six studies evaluated the effects of systems on errors and reported a considerable decrease in administrative and medication errors compared with pre-implementation condition. Thirteen studies investigated the impacts of the systems on costs of which, two studies showed that the implementation of system increased the costs imposed to hospitals. Twelve studies evaluated the impact of the systems on data accessibility. In one of these studies, the respondents believed using these systems had a very low or no effect on accessibility of information. Twenty studies addressed quality of information and services provided to patients of which seven studies indicated a substantial progress in the accuracy of information and 13 studies on the improvement of services. From 13 studies evaluating effect of systems on time one study reported that a health information system prolonged time on tasks. Effects of systems on other factors such as workload, satisfaction, and risk are understudied ($n < 6$). Studies addressing the effect of systems on these factors mainly reported positive effects.

4. Discussion

This study revealed that a limited number of methods used to evaluate health information systems in Iran, on the other hand evaluating the effects of health information systems in Iran confirmed the positive effects of these systems on many medical and administrative activities and procedures.

4.1. *Evaluation methods used in the evaluation studies*

Our results showed that all evaluation studies were summative indicating that no formative evaluation was carried out during development phase of the systems or their results have not been published. In summative studies systems are evaluated after implementation to provide information about their effectiveness while, in formative studies, systems are typically evaluated during their development or early implementation to provide information for the development of systems [70]. This finding is inconsistent with the results of systematic reviews of English literature [15,71] indicating that a high number of health information system evaluations have been formative. Vast usage of commercial systems in Iranian health care organizations and lack of cooperation between system developers and scientific community in universities who evaluate systems could be the main reasons for applying

Table 3 – The effects of health information systems.

Effects of evaluated systems	Effect*	Number of studies
Decreasing administrative and medication errors [33,36,37,40,41,48]	+	6
Reducing working and human resources costs [35,37–40,43,46–48]	+	9
Increasing the costs imposed to hospitals [37,47]	–	2
Raising or no change in the costs imposed to patients or hospitals [67,69]	–	2
Increasing security of information of patients & documents [33,36,37,40,47]	+	5
Increasing data accessibility [33,34,36,37,40–42,47–49,53]	+	11
Lowering or no effect on accessibility of information [39]	–	1
Increasing accuracy of information and activities [33,36–38,40,46,50]	+	7
Improving the quality & efficiency of services and medical care [33,35–41,43,46,50,68,69]	+	13
Reducing task time & increasing working speed [35,37,39–41,43,46–50,69]	+	12
Prolonging task time [37]	–	1
Increasing employee satisfaction [37,46]	+	2
Improving decision making efficiency [34,42]	+	2
Facilitating transmission of lab test orders [33,36]	+	2
Reducing staff movement between wards [35]	+	1
Improving communication between wards & staffs [37,41,43]	+	2
Reducing paper work & use of paper [33,35,36,48]	+	4
Increasing tendency to use system [33,36]	+	2
Reducing work load [35]	+	1
Increasing work load [43,46]	–	2
Preventing repeated tests and activities [37]	+	1
Improving reviewing patients records and planning their care[47]	+	1
Improving exchange of information [35,38,40]	+	3
Improving accreditation and audit [40]	+	1
Increasing hospital revenue [40]	+	1
Improving collection of discharge data [33]	+	1
Reducing length of stay [69]	+	1
Increasing bed occupancy rate [67]	+	1
Improving management performance [46]	+	1
Improving risk-taking, creativity, collaboration & team working [47]	+	1
Improving documentation [37]	+	1
Improving disease-based demographic analysis & comparison between private and public sectors [49]	+	1
Reducing care risks [38,41]	+	2
Facilitating admission process [38,50,69]	+	3
Increasing correct diagnoses [40]	+	1
Reducing delays in care at the time of shift change [41]	+	1

* + Positive effect; – negative effect.

summative studies. Using formative evaluation could have economic advantages due to early identification and prompt elimination of problems during development and implementation phases of system. Pressman [72] has shown that for every Dollar spend fixing a problem during product design, 10$ would be spend fixing it during development, and 100$ would be spend after the products' release.

This study showed that no before–after study was done on evaluated systems. This could also be due to lack of tight cooperation between system developers and evaluators. A before–after design helps to determine how much the new system has alleviated the problem, helping investors to justify the expenditure and judge the likely value of future information technology expenditure [70]. Appropriate evaluation helps people to deliver systems that offer a wide range of clinical and economic benefits [73,74].

The majority of evaluations in both Persian and English publications were carried out in hospital settings especially in academic hospitals. We recommend future studies to expand their evaluation to other health care organizations and to compare health information systems in academic and non academic institutions. The results showed that most studies were carried out quantitatively. Although quantitative methods are used to measure numerical parameters and to gather objective data such as patients waiting time, number of errors, or patient satisfaction quantitatively, but they have some

limitations and do not provide subtle results in many aspects. For instance, quantitative methods may be used for enumerating errors or problems concerning a system, but with these methods the reason or originating causes of these errors, which should be tackled during system promotion, could not be evaluated [75]. Hence, qualitative data collection methods emerged after it has become known that traditional quantitative data collection methods were unable to express human feelings and emotions [76]. For instance, when working with a system suffering from a high number of problems, it might be pleasant for a group of users while other groups feel frustrated using the system with the same problems. In this case, a quantitative method cannot uncover the underlying causes. Usually qualitative methods are multidimensional and need to be used along with quantitative methods to discover the hidden causes of such problems. Most of the time, researchers tend to use quantitative methods because of their consistent, precise, and reliable data that are usually generalizable to large populations. But many methodologists believe that in these methods, data may not be robust enough to explain complex issues [77]. On the other hand, qualitative methods are to provide a deeper understanding of a problem or question being observed [78]. This approach answers many questions in the field of medical and health informatics. Many studies emphasize on the combination of both quantitative and qualitative methods (mixed-methods) to examine professional and organizational factors in system evaluation [73,79,80]. Only two of the reviewed papers in this study used mixed methods. This finding is not consistent with the finding of a systematic review on CPOE evaluations carried out by Khajouei et al. [71] that showed most of the CPOE evaluation studies used qualitative or mixed-methods. A previous study showed the potential of mixed-method studies to understand and improve health systems performance in low- and middle-income countries [79].

In the terms of tools, our study showed that most of the studies evaluating health information systems in Iran, used questionnaires to gather data. The validity and reliability of all these tools were confirmed prior to the study. Questionnaires have many advantages such as generating large amount of data while spending little cost and time, but it has some limitations including different conceptual understanding of questionnaire content by respondents and low response rates. In terms of information system evaluation, this method usually is used to collect respondents' knowledge and attitudes toward systems. Hence, it is recommended to substitute self-completion questionnaires with interviews and/or observations when evaluating health information systems. Interviews have the advantage that an interviewer can explain the questions unclear to a respondent or can ask for further elaboration of the answers. In addition, they can be used to analyze users' tasks and to explore how users understand their works. Observation is one of the most effective methods to identify systems requirement and user's tasks. If applied carefully, it can truly discover users' behavior and reveal how they get their works done using the system in a specific context [78].

In all reviewed articles using observation method, the researchers observed the systems as such using predesigned checklists. In this way, system is only checked against a number of pre-determined criteria. Therefore, many unforeseen important data may remain neglected. For instance, effect of systems on users' behavior, system drawbacks leading to human errors when interacting with the systems and alteration of user's communication patterns may remain unrevealed. Although, some studies may resort to using concurrent interviews to compensate this shortcoming, it is recommended that future observational studies focuses on evaluating system-in-use to collect richer data. Interview relies on narrative data and may not reflect the actual behavior of users. Few recent studies used mixed methods or other methods such as heuristic evaluation of systems which can be a step toward using more comprehensive and rigorous methods.

4.2. *Effects of systems*

Studies evaluating the effects of health information systems in Iran mainly reported on providing quality service and medical care, reducing tasks time, increasing accuracy and access to information, and reducing costs and errors. Few studies reported negative effects of the systems including increasing organizational costs concerning implementation, and requiring more time to perform new activities related to systems.

Medical error is prevalent and a worldwide problem. In the studies that had examined the effect of systems on errors, medical and administrative staff of health care centers believed that these systems could reduce errors by 50–70%. Medical errors in approximately all aspects of health care delivery system can directly or indirectly affect patient's care and result in disability or death. Some of these errors might be due to workload of medical staff, miscommunication of patient's information, fatigue, lack of knowledge, and in some cases, illegibility of handwritings [81]. Such errors can be reduced by the use of information systems and through electronic transmission of information in health care organizations [71,82]. For example, in the study by Vardi et al. [82] systems such as clinical decision support systems (CDSS) and CPOE, reduced errors of medication forms by nearly 100%.

Although none of the studies reported increasing medical errors by health information systems in Iran, some studies around the world have shown that these type of systems may introduce new kind of errors [83,84]. Failure to identify potential errors concerning health information systems in Iranian studies might be due to the fact that these studies have sought staffs' perception towards the effects of these systems rather than studying the real outcome of the activities carried out by the systems. What people expect of a new technology might be expressed as their opinion about that technology [10].

About half of the studies concerning the systems' effect on the costs showed that these systems were not successful in reducing the costs imposed on hospitals and patients. This is in contrast with the results of Lau [85] showing that more than 50% of studies conducted during 1993–2008 indicated that health information system had a positive effect on reduction of the costs. Only in 2% of reviewed studies by Lau [85] these systems increased the costs. Moreover, the results of a study in American hospitals showed a substantial reduction in costs, on average, five years after implementation of clinical information systems [86]. This inconsistency

of the results can be explained by the fact that we reviewed studies carried out on systems in a developing country while the studies reviewed by Lau and the results of other study with contrasting results were mainly carried out in developed countries. Health information systems in Iran may differ in the range of functionalities and their advancement level from the systems developed in other countries.

The implementation of health information systems in Iran has positively affected the speed and accuracy of the working procedures and activities such as ordering and patient information recording and retrieval For instance, these can be achieved by facilitating accessibility to information, increasing accuracy of documentation and accelerating procedures such as patient admission, communication of laboratory results and billing [87–91]. Our results are consistent with the results of Kuperman et al. showing that an automatic alerting system reduced the time until an appropriate treatment was ordered for patients who had critical laboratory results [92].

Overall, all the studies showed that the implementation of health information systems in Iran has had a positive effect on the quality of care and services provided to patients. The quality of care and services could be the result of reported accuracy, time saving, error reduction, and the improvement of administrative and medical staff's activities following implementation of the systems. Many studies have shown the important role of these systems in increasing health care quality and improving patient care processes [4,9,16,93]. Moreover, more than 50% of the studies reviewed by Lau et al. emphasized that these systems improve the quality of care and services provided to patients, and only one percent of the studies rejected this [85].

The results of this study provide a good insight concerning the effects of health information systems for policymakers and researchers. However, there are few limitations. First, there were a limited number of studies evaluating the effect of health information systems. Second, to limit our search results to evaluation studies we used group A keyword (Assessment, Evaluation, Study, Survey, Analysis). Hence, we may have missed few evaluation studies not using one of these keywords. To check for this limitation we searched databases using other groups of keywords (groups B and C) and reviewed the first 150 results for studies not captured using group A keywords. No further relevant study was found. Third, information provided in the abstracts of some included studies was inconsistent with the information in the full texts. In such cases, we based our data collection on the full text. To our knowledge, this is the first study systematically reviewing studies evaluating health information systems in a developing country.

5. Conclusions

The results of this study indicate a positive attitude toward the use of computerized health information systems in Iran. Despite existence of various methods for evaluating information systems, a limited number of methods has been used to evaluate health information systems in Iran. Evaluation is an important part of any system development and implementation activity that reveals the strengths and weaknesses of systems. Selection of evaluation methods depends on the type of system, organization and its priorities and the goal of the evaluation. According to the results, evaluators mostly used quantitative evaluation methods, which may not be sufficient to study different aspects of a health information system. Therefore, we recommend evaluators to practice both quantitative and qualitative methods to be able to make a sound decision concerning the selection of one or a combination of these methods. Qualitative methods relying on observations of real users' behavior and the system in use, interviews with stakeholders and analysis of the records are appropriate for evaluating effectiveness of a system in a specific real environment. In terms of stage of evaluation, most studies use summative evaluation. However, formative evaluation has more economic advantages than summative evaluations, due to the detection of problems in the early phases of system development life cycle. Less time, money and effort are required to resolve problems detected by a formative and these problems can be prevented before leading to patients harm. Hence, continuous evaluation of systems during all stages of development cycle is recommended.

In terms of systems' effects, it was shown that the evaluated health information systems mostly increase satisfaction and efficiency and improve health care processes and the quality of care. However, the results indicate that the effect of health information systems in Iran is poorly studied. Most of the studies focused on the overall status of the system and relied on subjective opinions of users and other stakeholders rather than on rigorous empirical studies. Based on the results it is suggested that further studies to be conducted concerning economic efficacy of these systems as well as empirical studies on the impact of system on users' performance, outcomes of care, and on public health.

Competing interests

There is no conflict of interest.

Author contributions

Leila Ahmadian had main responsibility of the article. She was responsible for the study design and study outline. She also contributed actively in all the other parts of the article.

Reza Khajouei worked on the methodology section of the article. He steered the authoring team in running the systematic review, reporting the results, and preparation and finalizing the paper.

Simin Salehi Nejad had the main responsibility for searching databases, extraction of the data as well as writing the preliminary draft of the article.

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Summary points

What was already known

- Health information systems affect patient care process and outcome.
- There are different evaluation methods at the disposal of researchers that address specific aspect of health information systems.
- Some specific evaluation methods of health information systems have a capacity of revealing potential hidden problems.

What this study added to our knowledge

- Despite availability of many evaluation methods, a few numbers of them are used extensively by researchers to evaluate health information systems.
- To evaluate health information systems researchers tend to use summative methods more.
- Beside assessment of patients' and health care providers' attitudes, a more precise evaluation of health information systems requires assessment of the users behavior when using the systems.
- Health information systems increase satisfaction and efficiency and improve health care processes and the quality of care.

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