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Development of Information Systems for Sexual and Reproductive Health: A systematic review

Desarrollo de sistemas de información para salud sexual y reproductiva: Una revisión sistemática

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Abstract

In recent years, information systems have improved the quality of life of people, contributing significantly to generating changes that are reflected in their way of life. Perhaps one of the most important contributions is related to health, seeking to produce a standardization of user information. In order to identify problems and research gaps, many researchers use a variety of comprehensive methodologies, such as systematic reviews. The aim of this systematic review (SR) is to identify, analyze and evaluate research published in the context of Sexual and Reproductive Health (SRH), on guidelines, functional requirements and information necessary for the development of health information systems. A total of 36 articles were identified that report primary studies published in congresses and journals in the context of sexual and reproductive health between 2015 and 2019. In selecting the articles, a set of inclusion/exclusion criteria were used. One of the greatest difficulties that became evident in the SR was the lack of unification of terms associated with the SRH domain; to mitigate this situation, searches were made using terms related to SRH. New research is therefore urged that would make it easier to define and standardize the necessary information and requirements for the design of health information systems.

Keywords: Ontology, Framework, Sexual and reproductive health, Health information systems.

Resumen

En los últimos años los sistemas de información han permitido mejorar la calidad de vida de las personas, contribuyendo significativamente a generar cambios que se ven reflejados en su forma vida. Quizá uno de los aportes más importantes está relacionado con la salud, buscando que se produzca una estandarización de la información de los usuarios. Con el fin de identificar problemas y brechas de investigación muchos investigadores utilizan diferentes metodologías exhaustivas, por ejemplo, las revisiones sistemáticas. El objetivo de esta revisión sistemática es identificar, analizar y evaluar investigaciones publicadas en el contexto de Salud Sexual Reproductiva (SSR), sobre directrices, requisitos funcionales e información necesaria para el desarrollo de sistemas de información en salud. Se identificó en total 36 artículos que reportan estudios primarios publicados en congresos y revistas en el contexto de salud sexual y reproductiva entre 2015 y 2019, para la selección de los artículos se utilizaron un conjunto de criterios inclusión/exclusión. Una de las mayores dificultades que se hizo evidente en la RS fue la falta de unificación de términos asociados al dominio de la SSR, para mitigar esta situación se hizo búsquedas con términos relacionados a la SSR. Por tal motivo, se insta a realizar nuevas investigaciones que permitan definir y estandarizar la información necesaria y requerimientos para el diseño de sistemas de información en salud.

Palabras clave: Ontología, Framework, Salud sexual reproductiva, Sistemas de información en salud.

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1. Introduction

Improving access to health services for most population groups has allowed significant changes that are reflected in the way in which people's health information is gathered, processed and stored. Despite this, in developing countries there are challenges to be met to make their health systems sustainable and ensure coverage and quality of access to health services for the entire population. Problems related to public finance, unequal distribution of living conditions, poor management of resources, among others, generate great difficulties in ensuring the sustainability of public health and the quality of health services [1].

Achieving standardization of information collected from users, ensuring it is complete and correct, represents one of the most important challenges to be faced to better understand the needs of the population and establish plans for promotion, prevention and action by the corresponding entities [2]. Involving information technologies in health issues is a task that has been carried out in recent years through the development of applications in different environments.

These applications are widely used, since they improve the quality of health care and reduce the costs of care [3]. Although there are many applications related to health issues, not all are of high quality, a consequence usually of failing to employ established standards for developing and evaluating applications in this area [4].

A number of standards, methodologies, models, frameworks, etc. are found in the literature that can be used for the development of applications in different environments. These standards provide useful guidelines for generating good quality applications, but in order to develop applications for the health sector it is necessary to take into account that these standards involve the most relevant aspects of the context, to carry out an adequate capture, processing and storage of the information [5]. Hence the International Organization for Standardization (ISO) created standard ISO/IEC 62304: 2006 'Medical device software — Software life cycle processes', which is a complement to the standard for medical devices ISO/IEC 13485: 2016 'Medical devices — Quality management systems — Requirements for regulatory purposes'; Organization HL7 (Organization HL7, 2000) [6] has further presented a set of standards adopted by different countries and organizations in order to standardize the development of systems and the standardization of information. Even so, countries such as Colombia lack their own models for standardizing information in this sector and because of local conditions, implementation of international models is difficult. Initiatives such as (Decree 780 of 2016) [7] propose the definition of a common standard to achieve data interoperability. However, these solutions leave out aspects of system design and to a greater extent in a number of domains, such as Sexual and Reproductive Health (SRH). The review aims to identify whether or not recommendations described in frameworks, methodologies, guides and standards for the design of Health Information Systems (HIS) can be used in the SRH domain and recommend both functional aspects and information that a HIS must support in this domain. It also seeks to identify whether or not these allow for collaborative work in HIS design.

The rest of the article is organized as follows. Section 2 describes the process followed in carrying out the systematic review, research questions and the articles selection process. The results are summarized in Section 3. In Section 4 an analysis and discussion of the primary studies selected is carried out. Finally, conclusions drawn from the systematic review are presented in Section 5.

2. Systematic review process

This systematic review was carried out based on the guide proposed by Kitchenham in [8]. A systematic review (SR) follows a well-defined method and is a means to identify, analyze, evaluate and compare relevant research to answer a research question on a specific topic and allows to identify new research papers [9]. The main objective of this SR is to identify, analyze and compare the existence of proposed solutions for the development of HIS, especially in the SRH domain.

The SR was carried out in three phases, as shown in Figure 1. In the first phase the protocol to guide the search was defined, which includes the research questions, keywords and inclusion and exclusion criteria. In the second phase, articles were searched for each of the research questions and the most relevant selected according to the established criteria. Finally, in the third phase, categorization and processing of the studies that would be used as the primary source of information in the systematic review was done.

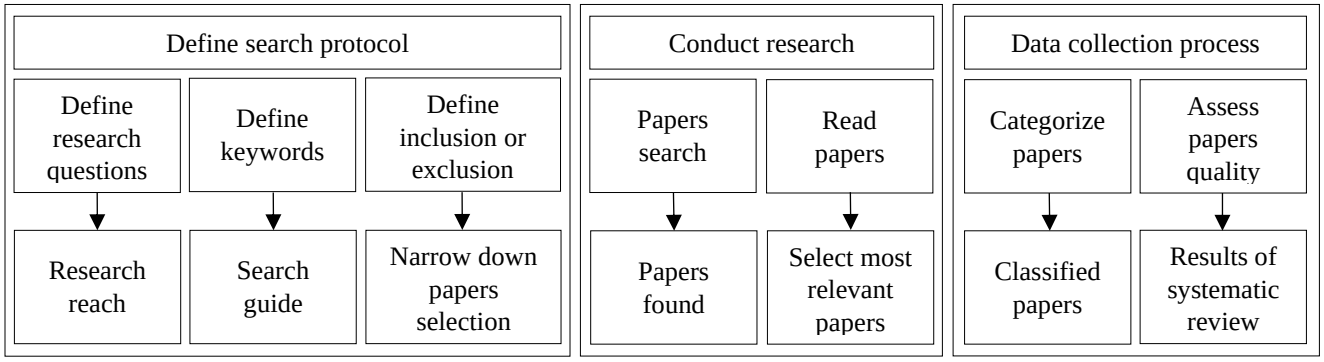

Figure 1. Systematic review process

2.1. Define search protocol

This protocol is used to define the elements necessary to carry out the SR, establishing the criteria for the search, selection and analysis of the information. Each element of the process carried out in the SR is presented below:

2.1.1 Research questions

The research questions established that are expected to be resolved in carrying out the SR are

- **RQ 1.** What are the main guidelines being used in developing Health Information Systems?
- **RQ 2.** What is the required and current information used in Sexual and Reproductive Health?
- **RQ 3.** What computer programs exist to support Sexual and Reproductive Health?

RQ1 seeks to identify the guidelines that have been used up till now in HIS development. Among these guidelines are methodologies, methods, frameworks, architectures, etc. that establish a set of steps or rules to follow in HIS development; RQ2 looks to define information necessary for operating SRH programs supported by HIS in processes of information capture and visualization; while RQ3 is focused on determining those computer programs or applications that have been designed to support the different lines of SRH.

2.1.2 Define keywords

Once the research questions were clearly defined, a set of keywords (Table 1) in English and Spanish associated with each of research question were identified. Similarly, bibliographic databases on which the articles were searched were identified. For each database the search string was established using the keywords

Table 1. Keywords

RQ	English	Spanish
RQ1	Methodology, framework, guideline, model, architecture, method, ontology, standard, paradigm, pattern, structure, politic, health, healthcare, system information, software, application, app, information technology, development	Metodología, Marco de trabajo, lineamiento, modelo, arquitectura, método, ontología, estándar, paradigma, patrón, estructura, política, salud, cuidado, sistemas de información, software, aplicación, app, tecnologías de la información
RQ2	Data, Information, Record, registry, Sexually transmitted infections, HIV, unintended pregnancy, safe abortion, violence related to gender and sexuality, sexual health, sexual orientation and gender identity; family planning, sexual health programs, sexual health programs	Datos, información, registro, enfermedades de transmisión sexual, VIH, embarazo no deseado, aborto seguro (legrado), violencia relacionada con género y sexualidad, salud sexual, "orientación sexual e identidad de género", planificación familiar, programas de educación sexual, Cáncer de cuello uterino, cáncer de próstata
RQ3	application, app web, app mobile, software, Information System, web site, Sexually transmitted infections, HIV, unintended pregnancy, safe abortion, violence related to gender and sexuality, sexual health, sexual orientation and gender identity; family planning, sexual health programs, sexual health programs	aplicación, aplicación web, aplicación móvil, software, sistema de información, sitio web, infecciones de transmisión sexual, VIH, embarazo no deseado, aborto seguro, violencia relacionada con el género y la sexualidad, salud sexual, orientación sexual e identidad de género, planificación familiar, programas de salud sexual

2.1.3 Define inclusion or exclusion criteria

In order to select only those research papers related to the objective of this SR and that answer the research questions, a set of inclusion and exclusion criteria were defined as follows:

- The article is unrelated to the research aim: despite containing keywords in the title and abstract, the article reveals no information relevant to the research questions.
- For RQ2, only those articles that explicitly contained the keywords in the title were included, due to the ambiguity of the searched terms.
- Duplicate articles describing identical or similar results were excluded, but published elsewhere. Only the most recent or that with the most detailed explanation of the work carried out was included.
- Articles with insufficient information, that do not allow full access, that do not provide detailed information on the research carried out or that are considered incomplete were excluded.
- Published research older than 5 years was excluded, because topics related to ICT and health must be constantly updated.
- Those articles not written in English, Spanish or Portuguese were discarded.
- Articles not belonging to the ICT and Health sectors were excluded.
- A review was carried out in Google Scholar and due to the number of articles obtained, research papers lacking citations were excluded.

2.2 Conduct information search

Having established the search protocol, the literature search of the scientific research was begun.

2.2.1 Article search

Using the keywords, articles were searched in Scopus, IEEE Xplore, ACM Digital Library, SpringerLink, PubMed and Google Scholar. For each electronic database the search string was modified according to the required format. The articles were classified taking into account the year of publication and the research question with which they were related, the distinctions by year and research question are shown in Table 2.

Table 2. List of articles published between 2015 and 2019

RQ	2015	2016	2017	2018	2019	Total
RQ 1	792	1396	693	743	70	3694
RQ 2	321	481	257	351	109	1519
RQ 3	332	654	643	648	203	2480
					Total studies	**7693**

A total of 7,693 articles were found in all electronic databases: 3694 articles related to RQ1; 1519 related to RQ2; and 2480 to RQ3. As an exclusion criterion, a period of 5 years was established. Thus, articles from 2015 to those published in 2019 were selected.

2.2.2 Reading of articles found

The reading and selection of primary articles was carried out by applying the inclusion/exclusion criteria in three steps, as seen in Figure 2. In the first step, 7434 articles were discarded in which no relation to the objective of the investigation was revealed. Despite containing some keywords in the title and the abstract, the article does not show relevant information regarding the research questions. In the second step, 259 articles passed. Of these, the introduction, results and conclusions were read to determine if they offered significant contributions related to the SR objective. In this phase, 40 articles were selected and 219 discarded. Finally, in the third step, these 40 articles were read thoroughly and 36 selected as the primary information source. Each article was allocated to the research question to which it was linked.

3 Processing of collected data

3.1 Assessing the quality of the studies

The quality of the selected articles was established taking into account the type of article (case study, empirical studies, surveys, primary study, secondary study, etc.). Based on the reading of each article, analysis of the data allows identification of research gaps and offers suggestions for future research. All this information obtained was recorded in an Excel document containing the following fields:

- Title of article
- Authors
- University/institute,
- Abstract/important contributions
- Year of publication
- Language
- Keywords
- Bibliographic database in which it was published
- Research question with which it is associated

To assess the quality of the article, the tool developed by [10], was used, in which a set of 11 questions were considered to determine the quality of the studies. The questions seek that the studies meet three quality criteria necessary to be selected as relevant for this SR. These criteria are: rigor (completeness of the research method used in the study), credibility (the findings are well presented and significant) and relevance (the findings are useful for the industry and the research community). Data extraction and quality assessment of each study was carried out in parallel for each of the articles, by three reviewers.

4 Results

Overall, 36 research studies were identified as a source of primary information in the bibliographic databases, as shown in Table 3. The first 23 studies were classified as relevant to identify guidelines, frameworks, methodologies, methods, ontologies, and architectures, among others, used for the development of HIS (RQ1); 3 studies mentioned necessary and existing information for the context of SSR (RQ2); and 9 primary studies related to computer programs developed to support SRH such as HIV, safe motherhood, family planning, etc. (RQ3).

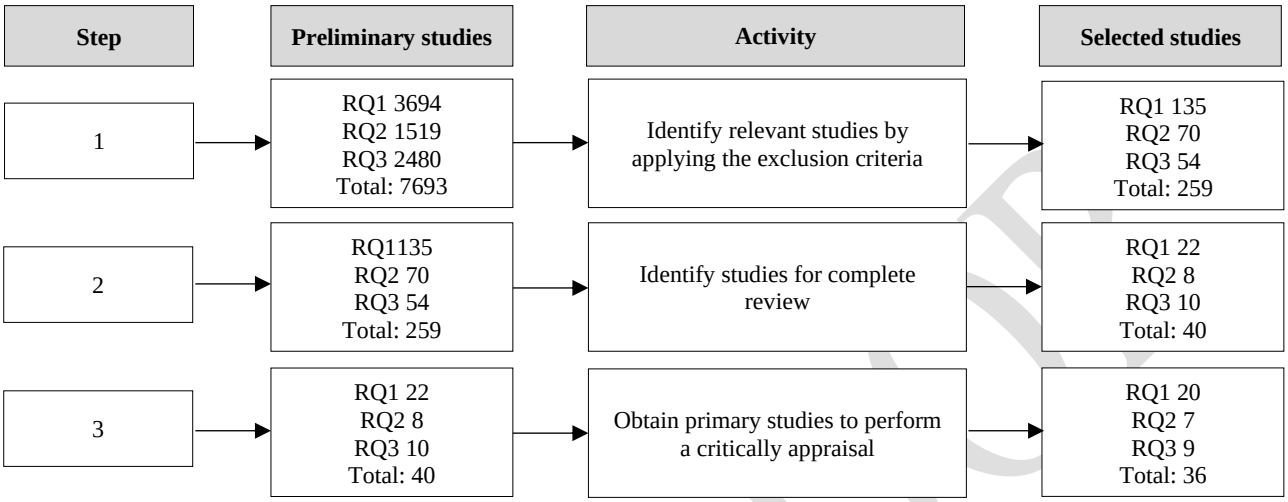

Figure 2. Phases of the process of reading and selecting articles

Table 3. Primary studies selected

ID	Autor	Title	Reference	Type solution	Health domain
RQ 1					
1	Yi-Fan Zhang et al.	Design and Development of a Sharable Clinical Decision Support System Based on a Semantic Web Service Framework	[11]	Framework	Other
2	Lozano-Rubí et al.	OntoCR A CEN ISO-13606 clinical repository based on ontologies	[12]	Ontology	Other
3	Ighe and Asma	Towards improving information quality requirements for online health information systems: A review on the recent frameworks	[13]	Framework	Other
4	Moreira et al.	Semantic interoperability and pattern classification for a service-oriented architecture in pregnancy care	[14]	Ontology	Safe motherhood
5	Kamalrudin et al.	Trust Requirements in E-Health System: A Conceptual Framework	[15]	Framework	Other
6	Gibbs et al.	The eClinical Care Pathway Framework: a novel structure for creation of online complex clinical care pathways and its application in the management of sexually transmitted infections	[16]	Framework	Other
7	Naydanov et al.	Development of automated methods for the critical condition risk prevention, based on the analysis of the knowledge obtained from patient medical records.	[17]	Ontology	Other
8	Tahmasbi et al	Behavioral Reference Model for Pervasive Healthcare Systems	[18]	Architecture	Other
9	Hightow-Weidman et al	Youth Technology and HIV: Recent advances and future directions.	[19]	Guide	HIV
10	Besoain, et al	Prevention of sexually transmitted infections using mobile devices and ubiquitous computing.	[20]	Methodology	STIs
11	Bellgard et al	Design of a framework for the deployment of collaborative independent rare disease-centric registries: Gaucher disease registry model	[21]	Model	Other
12	Bashi et al	Self-Management Education Through mHealth Review of Strategies and Structures	[22]	Guide	Other
13	Hatef et al	A Population Health Measurement Framework: Evidence-Based Metrics for Assessing Community-Level Population Health in the Global Budget Context.	[23]	Framework	Other
14	Subramaniam et al	A Framework for Developing Prediabetes Self-care Application	[24]	Framework	Other

15	Azarm and Peyton	An Ontology for a Patient-Centric Healthcare Interoperability Framework	[25]	Ontology - Framework	Other
16	Hussain et al	Conceptual framework for the security of mobile health applications on Android platform	[26]	Framework	Other
17	Hussain et al	A Security Framework for MHealth Apps on Android Platform	[27]	Framework	Other
18	Macedo et al	The Evolution of a Healthcare Software Framework: Reuse, Evaluation and Lessons Learned	[28]	Framework	Other
19	Sherr et al	Measuring health systems strength and its impact: Experiences from the African Health Initiative	[29]	Framework	Other
20	Boonchieng et al	Integrative system of virtual electronic health record with online community-based health determinant data for home care service: MHealth development and usability test	[30]	Guide	Other
21	Barcellos and Farinelli	Ontologies for the Representation of Electronic Medical Records: The Obstetric and Neonatal Ontology	[31]	Ontology	Safe motherhood
22	Sockolow et al	Assessment of evaluation frameworks for design of a sexual risk prevention game for black adolescent girls	[32]	Framework	Other
23	Ismail et al	A Granular Ontology Model for Maternal and Child Health Information System	[33]	Ontology	Other
24	García-Magariño et al	FAMAP: A Framework for Developing m-Health Apps	[34]	Framework	Other
		RQ 2			
1	Alege et al	Knowledge, sources and use of family planning methods among women aged 15-49 years in Uganda: a cross-sectional study.	[35]	Guide	Family planning
2	Venter et al	Improving Linkage to HIV Care Through Mobile Phone Apps: Randomized Controlled Trial.	[36]	Guide	ITS y VIH
3	Eleuteri et al	Sexual health in your hands How the smartphone apps can improve your sexua lwellbeing	[37]	Guide	Sexual and Reproductive Health
		RQ 3			
1	Akinola et al	Development of a Mobile App on Contraceptive Options for Young African American and Latina Women.	[38]	Model	Sexual and Reproductive Health
2	Sonalkar and Gaffield	Introducing the World Health Organization Postpartum Family Planning Compendium	[39]	Guide	Family planning
3	Bertozzi et al	Collecting family planning intentions and providing reproductive health information using a tablet-based video game in India.	[40]	System of information	Family planning
4	Milberg, John	Development, use, and integration of a nationally-distributed HIV/AIDS electronic health information system.	[41]	System of information	ITS y VIH
5	Whiteley et al	A Mobile Gaming Intervention to Increase Adherence to Antiretroviral Treatment for Youth Living With HIV: Development Guided by the Information, Motivation, and Behavioral Skills Model	[42]	System of information	ITS y VIH
6	Brayboy et al	Girl Talk: A Smartphone Application to Teach Sexual Health Education to Adolescent Girls	[43]	Application mobile	Sexual and Reproductive Health
7	Flickinger et al	Social Support in a Virtual Community: Analysis of a Clinic-Affiliated Online Support Group for Persons Living with HIV/AIDS	[44]	Application web	ITS y VIH
8	Marent et al	Development of an mHealth platform for HIV care: Gathering user perspectives through co-design workshops and interviews	[45]	Application web	ITS y VIH
9	Benjumea et al	Desarrollo de software educativo que contribuya a la promoción de la salud sexual y reproductiva en la institución técnica Jorge Eliécer Gaitán de González	[46]	System of information	Sexual and Reproductive Health

The main objective of the SR was to identify studies related to the design and development of HIS in the SRH domain. Specifically, for question RQ1 it was to identify the guidelines used for the design of information systems in SRH. With this in mind, after performing a rigorous classification of the research studies identified, 24 solutions were obtained among architectures, frameworks, guides, methodologies, models, ontologies and other solutions, as shown in Figure 3. It was seen that 52% of the solutions classified correspond to framework and that 100% do not support the SRH domain. The remaining 48% corresponds to other solutions that were not developed for HIS design, but

are used in this domain. Therefore, these studies are an important basis for proposing a suitable solution for the design of HIS in this domain.

Regarding RQ2, it was proposed to identify the variables that a HIS in SRH should support, but no sets of variables defined for this domain were identified. However, in Table 4 some identified works that propose certain variables for some special cases are described.

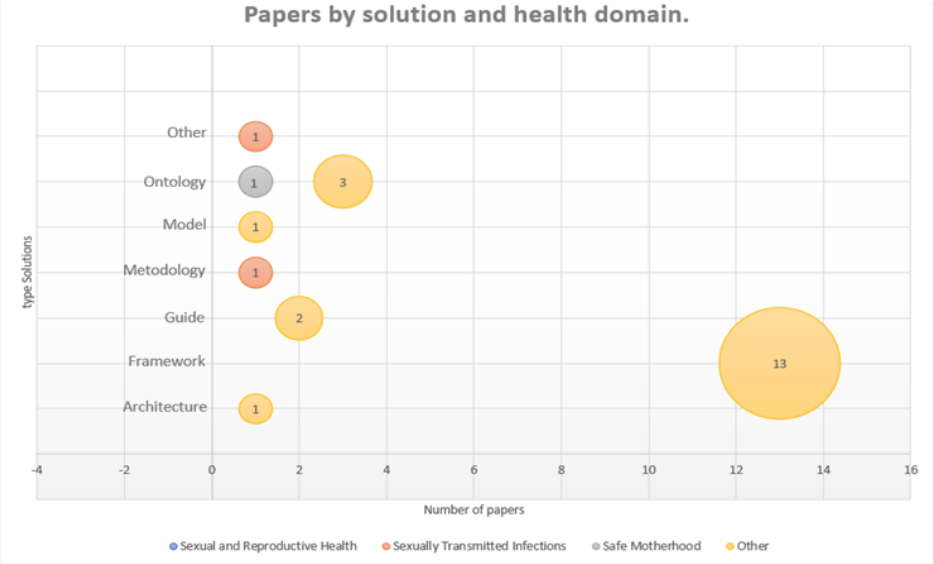

Figure 3. List of articles according to the type of solution and health domain

Table 4. Studies that propose variables for specific topics

Paper	**Contribution**
[34]	Database to analyze family planning methods in women between 5 and 49 years of age. The variables included are ● Information source of family planning record ● Reliability of information source ● Current, preferred and intended use of family planning methods ● Level of knowledge about family planning methods ● Perception of what the method involves ● Which family planning method is safer
[35]	Solution for the integration of laboratory systems for HIV-associated tests • ID data of the person • Attention center • Access credentials Clinical laboratory document (does not specify model or standard)
[36]	Describes the information that the teenagers prefer to have in a SRH mobile app. ● Reminder of fertile days in women ● Ensure timely use of contraceptives ● Identify STDs ● Check pregnancy and symptoms ● Information about SRH in a creative and fun context

With question RQ3, it was proposed to identify applications used in the SRH domain, mainly those that are based on guidelines for the development of systems. Initially, 68 applications were identified. Only 9, however, met the conditions established in the SR. To make an adequate analysis of the results, classification was carried out on four aspects: the associated domain or subdomain, the type of intervention carried out from the solution, the platform on which the solution operates and the type of solution developed.

According to the results, only 22% comprehensively address SRH, the rest focus on family planning and sexually transmitted diseases. Those relating to intervention type can be divided in two: educational interventions, with 67%, and support in health aspects, with 33%. Of solutions developed for mobile devices, 78 % could be grouped into five types: expert systems, interactive web, video games, social networks and integration of information, with the most common being the development of video games, with 22%. Table 5 shows the labeling of the studies selected in the SR according to the four above-mentioned aspects. Furthermore, Figure 4 comprises a summary of the results, in percentages.

Table 5. Studies that answer and contribute to RQ3

Title	Domains/SubDomain	Type of intervention	Platform	Type of Solution
[38]	Family planning	Education	Mobile	Expert system
[39]	Family planning	Education	Web	Interactive web
[40]	Family planning	Education	Mobile	Videogame
[41]	Sexually Transmitted Infections	Health Support	Mobile	Information integration
[42]	Sexually Transmitted Infections	Education	Mobile	Videogame
[43]	Sexual and Reproductive Health	Education	Mobile	Videogame
[44]	Sexually Transmitted Infections	Health Support	Mobile	Social network
[45]*	Sexually Transmitted Infections	Health Support	Mobile	Expert system
[46]	Sexual and Reproductive Health	Education	Web	Social network

(*) Development carried out collaboratively

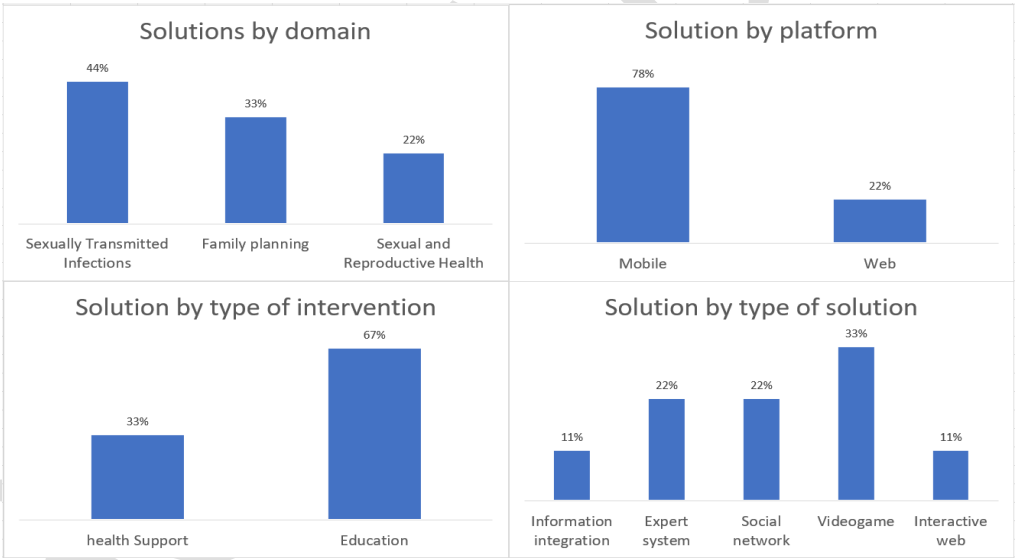

Figure 4. List of studies according to the type of solution

In general, it can be observed that important studies that have been carried out in this domain. Nevertheless, there are no clear criteria on how to design and develop solutions. Neither are the functional and non-functional requirements that must be taken into account defined.

5 Discussion

One of the greatest difficulties that became evident in carrying out the SR was the lack of unification of terms associated with the SRH domain. To mitigate this situation, searches were made with related terms. However, the queries on the bibliographic databases yielded many results unrelated to the aim of the SR. It can be seen that guidelines exist for the design and development of HIS according to RQ1, but that there is a sizeable gap regarding the adaptation of these guidelines (models, framework, guide, etc.) to the SRH domain.

Meanwhile, taking RQ2 into account, there is no evidence of variable sets of information required in this domain. While some have been defined in the studies reviewed, carrying out a solution based on these findings can cause problems of integration, interoperability and insufficiency of the solutions. Practically, the research works reviewed were developed for a specific problem.

However, it is worth highlighting [38] that it was the study carried out collaboratively that made it possible to define a solution that meets the needs of all the participants in the design and the compatibility with other solutions, mitigating some of the problems previously described.

Finally, the solutions identified with RQ3 show a wide variety of applications that support different domains in different ways. The nine solutions prioritized describe a formal process in its development. Some features in the design and development of a system can be considered static as its quality, reliability etc. Some depend on the organizations or on the client of the solution, but there are other characteristics that are specific to the domain and cannot be easily specified. Characteristics such as the sufficiency of information and the adaptation of functionality are specific to the domain and cannot be taken from other domains.

6 Conclusions

This study was carried out to obtain an overview of the existing research for the development of HIS in the area of sexual and reproductive health; 36 articles published between 2015 and 2019 were identified. The panorama of work carried out, contributions and challenges were described and reveal needs on which to focus research efforts. The greatest amount of work carried out is related to the treatment, education and clinical support for HIV cases. However, this problem does not represent the entire domain of SRH.

According to the interpretation of RQ1 there is no adequate guideline for the design and development of information systems in this domain; in RQ2 there is no formal set of variables required for systems in this same domain; and according to RQ3 there are important solutions to support specific problems that are in the SRH domain, but they are not based on standard models that ensure an adequate level of support for this domain.

In conclusion, the solutions identified are not sufficient for the development of information systems in the SRH domain. However, they do form the basis for supporting an appropriate solution. The main contributions of this document relate to identification of research studies conducted in the SRH context; application or adaptation of relevant information, to be applied in research work in Colombia; and research in which information systems were developed to support issues related to SRH.

Among the challenges identified, it was found that: (i) the standardization of information on health-related issues is important; (ii) cover of other components of SRH, including such as gender violence, family planning, and voluntary termination of pregnancy; and (iii) definition of functional and non-functional requirements necessary for the development of HIS. This work was used as the basis for the creation of a domain ontology and a framework for the development of Information Systems as a support tool for SRH programs.

References

[1] C. Gutiérrez, “El sistema de salud colombiano en las próximas décadas: cómo avanzar hacia la sostenibilidad y la calidad en la atención,” 2018.

[2] E. Mukasa, H. Kimaro, A. Kiwanuka, and F. Igira, “Challenges and strategies for standardizing information systems for integrated tb/hiv services in Tanzania: A case study of Kinondoni municipality,” *Electron. J. Inf. Syst. Dev. Ctries.*, vol. 79, no. 1, pp. 1–11, 2017.

[3] C. Lee Ventola, “Social media and health care professionals: Benefits, risks, and best practices,” *P T*, vol. 39, no. 7, pp. 491–500, 2014.

[4] M. H. Van Velthoven, J. Smith, G. Wells, and D. Brindley, “Digital health app development standards: A systematic review protocol,” *BMJ Open*, vol. 8, no. 8, pp. 1–5, 2018.

[5] H. Yesid, C. Cobo, N. Giovanni, and A. Ippolito, “Characterization of information systems for primary health care.,” vol. 18, no. 34, pp. 141–164, 2019.

[6] HL7 International, “Introduction to HL7 Standards,” *HL7.org*, 2013. [Online]. Available: http://www.hl7.org/implement/standards/index.cfm?ref=nav. [Accessed: 13-Dec-2019].

[7] Ministerio de Salud y Protección Social, “Decreto número 1990 de 2016,” p. 5, 2016.

[8] B. Kitchenham, “Procedures for Performing Systematic Review,” *Ann. Saudi Med.*, vol. 37, no. 1, pp. 79–83, 2017.

[9] B. Kitchenham and S. Charters, “Guidelines for performing Systematic Literature Reviews in SE,” pp. 1–44, 2007.

[10] T. Dybå and T. Dingsøyr, “Empirical studies of agile software development: A systematic review,” *Inf. Softw. Technol.*, vol. 50, no. 9–10, pp. 833–859, 2008.

[11] Y. F. Zhang, L. Gou, Y. Tian, T. C. Li, M. Zhang, and J. S. Li, “Design and Development of a Sharable Clinical Decision Support System Based on a Semantic Web Service Framework,” *J. Med. Syst.*, vol. 40, no. 5, 2016.

[12] R. Lozano-Rubí, A. Muñoz Carrero, P. Serrano Balazote, and X. Pastor, “OntoCR: A CEN/ISO-13606 clinical repository based on ontologies,”

J. Biomed. Inform., vol. 60, pp. 224–233, 2016.

[13] M. A. Ighe and S. A. B. Mohammed, "Towards improving information quality requirements for online health information systems: A review on the recent frameworks," *Proc. - Int. Conf. Inf. Commun. Technol. Muslim World 2018, ICT4M 2018*, pp. 138–143, 2018.

[14] M. W. L. Moreira, J. J. P. C. Rodrigues, A. K. Sangaiah, J. Al-Muhtadi, and V. Korotaev, "Semantic interoperability and pattern classification for a service-oriented architecture in pregnancy care," *Futur. Gener. Comput. Syst.*, vol. 89, pp. 137–147, 2018.

[15] M. Kamalrudin, N. A. S. Winarsih, and S. Sidek, "Trust requirements in e-health system: A conceptual framework," *J. Telecommun. Electron. Comput. Eng.*, vol. 10, no. 2–2, pp. 29–33, 2018.

[16] J. Gibbs *et al.*, "The eClinical Care Pathway Framework: A novel structure for creation of online complex clinical care pathways and its application in the management of sexually transmitted infections," *BMC Med. Inform. Decis. Mak.*, vol. 16, no. 1, pp. 1–9, 2016.

[17] C. Naydanov, D. Palchunov, and P. Sazonova, "Development of automated methods for the critical condition risk prevention, based on the analysis of the knowledge obtained from patient medical records," *Proc. - 2015 Int. Conf. Biomed. Eng. Comput. Technol. Sib. 2015*, pp. 33–38, 2015.

[18] A. Tahmasbi, S. Adabi, and A. Rezaee, "Behavioral Reference Model for Pervasive Healthcare Systems," *J. Med. Syst.*, vol. 40, no. 12, pp. 1–23, 2016.

[19] L. B. Hightow-weidman *et al.*, "Youth, Technology and HIV: Recent Advances and Future Directions," vol. 12, no. 4, pp. 500–515, 2016.

[20] F. Besoain, A. Perez-Navarro, J. A. Caylà, C. J. Aviñó, and P. G. de Olalla, "Prevention of sexually transmitted infections using mobile devices and ubiquitous computing," *Int. J. Health Geogr.*, vol. 14, no. 1, 2015.

[21] M. I. Bellgard *et al.*, "Design of a framework for the deployment of collaborative independent rare disease-centric registries: Gaucher disease registry model," *Blood Cells, Mol. Dis.*, vol. 68, pp. 232–238, 2018.

[22] N. Bashi, F. Fatehi, M. Fallah, D. Walters, and M. Karunanithi, "Self-management education through mhealth: Review of strategies and structures," *JMIR mHealth uHealth*, vol. 6, no. 10, 2018.

[23] E. Hatef, E. C. Lasser, H. H. K. Kharrazi, C. Perman, R. Montgomery, and J. P. Weiner, "A population health measurement framework: Evidence-based metrics for assessing community-level population health in the global budget context," *Popul. Health Manag.*, vol. 21, no. 4, pp. 261–270, 2018.

[24] S. Subramaniam, J. S. Dhillon, M. S. Ahmad, C. Teoh, and J. W. S. Leong, "A framework for developing prediabetes self-care application," *Int. Conf. Res. Innov. Inf. Syst. ICRIIS*, 2017.

[25] M. Azarm, K. E. Ave, L. Peyton, and K. E. Ave, "An Ontology for a Patient-Centric Healthcare Interoperability Framework," *2018 IEEE/ACM Int. Work. Softw. Eng. Healthc. Syst.*, pp. 34–41, 2018.

[26] M. Hussain *et al.*, "Conceptual framework for the security of mobile health applications on Android platform," *Telemat. Informatics*, vol. 35, no. 5, pp. 1335–1354, 2018.

[27] M. Hussain *et al.*, "A security framework for mHealth apps on Android platform," *Comput. Secur.*, vol. 75, pp. 191–217, 2018.

[28] A. A. Macedo, J. A. Baranauskas, and R. F. Bulcão-Neto, "The evolution of a healthcare software framework: Reuse, evaluation and lessons learned," *Proc. 2018 Fed. Conf. Comput. Sci. Inf. Syst. FedCSIS 2018*, vol. 15, pp. 1043–1051, 2018.

[29] K. Sherr *et al.*, "Measuring health systems strength and its impact: Experiences from the African Health Initiative," *BMC Health Serv. Res.*, vol. 17, no. Suppl 3, 2017.

[30] W. Boonchieng, E. Boonchieng, W. Tuanrat, C. Khuntichot, and K. Duangchaemkarn, "Integrative system of virtual electronic health record with online community-based health determinant data for home care service: MHealth development and usability test," *2017 IEEE Healthc. Innov. Point Care Technol. HI-POCT 2017*, vol. 2017-Decem, pp. 5–8, 2017.

[31] F. F. Mauricio Barcellos Almeida, "Ontologies for Representation of Electronic Medical Records: the Obstetric and Neonatal Ontology," *J. Am. Ceram. Soc.*, 2008.

[32] P. Sockolow, M. Joppa, and J. Zhu, "Assessment of evaluation frameworks for design of a sexual risk prevention game for black adolescent girls," *Stud. Health Technol. Inform.*, vol. 250, pp. 101–105, 2018.

[33] S. Ismail, M. Alshmari, K. Latif, and H. F. Ahmad, "A Granular Ontology Model for Maternal and Child Health Information System," *J. Healthc. Eng.*, vol. 2017, 2017.

[34] G. P. Iván Gracia, Manuel Gozalez, "FAMAP: A Framework for Developing m-Health Apps.," *10th Eur. Conf. Inf. Syst. Manag. Acad. Conf. Publ. Ltd.*, vol. 1, no. March, pp. 20–28, 2016.

[35] S. G. Alege, J. K. B. Matovu, S. Ssensalire, and E. Nabiwemba, "Knowledge, sources and use of family planning methods among women aged 15-49 years in Uganda: A cross-sectional study," *Pan Afr. Med. J.*, vol. 24, pp. 1–12, 2016.

[36] W. Venter *et al.*, "Improving linkage to HIV care through mobile phone apps: Randomized controlled trial," *JMIR mHealth uHealth*, vol. 6, no. 7, 2018.

[37] S. Eleuteri, R. Rossi, F. Tripodi, A. Fabrizi, and C. Simonelli, "Sexual health in your hands: How the smartphone apps can improve your sexual wellbeing?," *Sexologies*, vol. 27, no. 3, pp. e57–e60, 2018.

[38] M. Akinola *et al.*, "Development of a Mobile App on Contraceptive Options for Young African American and Latina Women," *Heal. Educ. Behav.*, vol. 46, no. 1, pp. 89–96, 2019.

[39] S. Sonalkar and M. E. Gaffield, "Introducing the world health organization postpartum family planning compendium," *Int. J. Gynecol. Obstet.*, vol. 136, no. 1, pp. 2–5, 2016.

[40] E. Bertozzi, A. Bertozzi-Villa, P. Kulkarni, and A. Sridhar, "Collecting family planning intentions and providing reproductive health information using a tablet-based video game in India," *Gates Open Res.*, vol. 2, no. 0, p. 20, 2018.

[41] J. A. Milberg, "Development, use, and integration of a nationally-distributed HIV/AIDS electronic health information system," *J. Am. Med. Informatics Assoc.*, vol. 23, no. 6, pp. 1190–1194, 2016.

[42] L. Whiteley, L. Brown, M. Lally, N. Heck, and J. J. van den Berg, "A mobile gaming intervention to increase adherence to antiretroviral treatment for youth living with hiv: Development guided by the information, motivation, and behavioral skills model," *JMIR mHealth uHealth*, vol. 6, no. 4, 2018.

[43] L. M. Brayboy *et al.*, "Girl Talk: A Smartphone Application to Teach Sexual Health Education to Adolescent Girls," vol. 30, no. 1, pp. 23–28, 2017.

[44] T. E. Flickinger *et al.*, "Social Support in a Virtual Community: Analysis of a Clinic-Affiliated Online Support Group for Persons Living with HIV/AIDS," *AIDS Behav.*, vol. 21, no. 11, pp. 3087–3099, 2017.

[45] B. Marent *et al.*, "Development of an mHealth platform for HIV care: Gathering user perspectives through co-design workshops and interviews," *JMIR mHealth uHealth*, vol. 6, no. 10, 2018.

[46] U. F. de P. S.- Ocaña, "Desarrollo de un Software Educativo que Contribuya a la Promoción de la Salud Sexual y Reproductiva," *Tesis*, pp. 1–49, 2017.