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Systematic review and meta-analysis of hospital acquired infections rate in a middle east country (1995-2020)

Mohammad Khammarnia[1], Alireza Ansari-Moghaddam[1], Eshagh Barfar[1], Hossein Ansari[1], Azar Abolpour[2], Fatemeh Setoodehzadeh[1]*, Javad Shahmohammadi[3]

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Abstract

Background: Hospital-acquired infections (HAIs) are a global problem in hospitals and significant causes of mortality and morbidity regardless of advances in supportive care, antimicrobial therapy and prevention. The study aimed to determine a comprehensive estimate of the HAIs prevalence, influential factors, and types of these infections in Iran.

Methods: A systematic literature review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines using the online databases; Medline, EMBASE, Scopus, Cochrane, SID, Magiran, and Medlib from January 1995 to September 2020 using a combination of medical subject heading terms (‘Nosocomial infection [Mesh] OR ‘’ Hospital infection [Mesh] OR Hospital Acquired Infection[Mesh] OR Healthcare-associated infection ‘’AND (‘Iran’ [Mesh]) among observational and interventional studies. SPSS version 25 and STATA version 11 were used for data analysis.

Results: A total of 66 (cross-sectional, cohort, and case-control) observational studies were identified. More of the studies had been done before 2014(43 papers or 65%). Based on the random-effects model, the overall prevalence of HAIs in Iran was 0.111 [95% CI: 0.105 - 0.116] with a high, statistically significant heterogeneity (I2= 99.9%). The infection rate was 0.157 and 0.089 before and after the Iranian Health Transformation Plan (HTP), respectively. HAIs rates reported more in the South and West of Iran rather than other regions (0.231 and 0.164) (p= 0.001). Escherichia coli and klebsiella infections were reported in 53 and 52 papers (0.239 and 0.180, respectively). In addition, respiratory and urinary infections were reported 0.296 and 0.286 in 51 and 38 papers, respectively.

Conclusion: The prevalence of HAIs in Iran is relatively high. Preventing and decreasing hospital nosocomial infections can considerably affect reducing mortality and health-related costs. This should be taken into consideration by health policymakers for pathology and revision of some previous programs and standards as well as the development of appropriate and evidence-based control and education programs to reduce this health problem.

Keywords: Hospital infection, Nosocomial infection, Meta-analysis, Hospital, Iran

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Introduction

Hospitals are the most important and costly components of health care systems. They account for more than two-

Corresponding author: *Dr Fatemeh Setoodehzadeh, f.setoodehzadeh@zaums.ac.ir*

1. Health Promotion Research Center, Zahedan University of Medical Sciences, Zahedan, Iran
2. School of Health, Student Research Committee, Zahedan University of Medical Sciences, Zahedan, Iran
3. School of Management and Medical Informatics, Shiraz University of Medical Sciences, Shiraz, Iran

↑What is “already known” in this topic:
Hospital-acquired infections (HAIs) represent a serious public health concern worldwide. Increased prevalence of HAIs in some cases leads to patient’s arbitrary use of drugs, causing severe health hazards as well as significant problems such as drug resistance and death in patients.

→What this article adds:
This study aimed to update and measure the prevalence of HAIs in Iran using a meta-analytic approach. The overall prevalence of HAIs in Iran was 11.1%. The prevalence of HAIs in the South and West of Iran is high. HAIs decreased after Health Transformation Plan in Iran.

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thirds of health care spending. Therefore, they significantly affect the overall health care quality (1). Prevention of infections is part of efforts to improv e the quality of health care services that are vital to patient safety. Hospital-acquired infections (HAIs), also known as nosocomial infections (NI), remain significant causes of mortality and morbidity regardless of advances in supportive care, antimicrobial therapy and prevention (2).

HAIs are a global problem in hospitals (3). The popular definition of hospital infection is an infection that happens within 48 hours after hospitalization, or three days after discharge, or 30 days after surgery. Therefore, symptoms of HAIs may occur at the time of patient's hospitalization or after discharge (4). According to the World Health Organization (WHO) report, hundreds of millions of people are affected by HAIs every year throughout the world (5). Studies showed that the HAIs rates vary worldwide. In high-income countries, HAIs prevalence in hospitalized patients was 7.6%. This figure was 10.1% (varied from 5.7% to 19.1%) in low-and middle-income countries (6). Annually, roughly 2 and 4.5 million HAIs are reported in the United States (US) and the European Union, respectively (7). The infections result in 100,000 deaths and impose additional medical care costs of about $ 6.5 billion annually in the US (6, 7). According to the WHO's report on 2001, hospital infection has the highest percentage in South-East Asia and the Eastern Mediterranean. Based on this report, one of the main reasons for HAIs is inadvertent misuse of antibiotics leading to widespread resistance. Unfortunately, hospitals in developing countries are hotbeds of infection transmission. These infections lead to increased mortality, longer periods of hospitalization cause emotional and mental stress, failure of surgeries, rejection of organ transplantation and a significant financial burden for healthcare systems and patients. Moreover, they are linked to the spread of multi-drug resistance (MDR) in pathogenic bacteria (8, 9).

The most important bacteria causing HAIs are Escherichia coli (E. coli), Klebsiella, methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas aeruginosa, and Enterococci (9, 10). The most common nosocomial infections are urinary tract infections, surgical wound infections, pneumonia, and septicemia (11). Risk factors of the infections for hospitalized patients are divided into two categories: unavoidable risk factors (including old age and serious underlying causes of one's hospitalization) and risk factors that can be mitigated by appropriate treatment (including a longer period of hospitalization, use of inappropriate catheters, excessive use of broad-spectrum, prolonged use of fixed catheters, and improper hand hygiene by healthcare workers) (12).

Prevention of hospital infections is a key way to improve the quality of healthcare. Detailed information on the extent of these infections is essential for evaluating current infection prevention activities and planning for further intervention in the hospitals nationally. An overall review of the documents shows that the reported incidence of all types of HAIs in Iran is very different; so a systematic review of all the documents and their combinations can provide a complete picture of the dimensions of this problem in Iranian society, as well as increase the use of the best and the highest quality documents available. In fact, the purpose of this study was to determine a comprehensive estimate of the prevalence of HAIs, affective factors, and types of these infections in Iran. Our study updates a systematic review that was published in 2018 (13).

Methods

A systematic and meta-analysis study was done in 2020. Relevant studies were found in PUBMED, EMBASE, SCOPUS and WEB OF SCIENCES as international databases and Magiran, SID and Medlib as Persian databases from 1995 to September 2020. The following search terms were used: (‘Nosocomial infection [Mesh] OR ‘’ hospital infection [Mesh] OR Hospital acquired infection [Mesh] OR health care associated infection ‘’AND (‘Iran’ [Mesh]). Also, the references of identifies papers were studied and if their title were in line with the topic, they were investigated by the authors.

The searches were done from July to September 2020. The observational studies (cohorts, case-control, and cross-sectional) both in English and Persian Language were investigated.

Inclusion criteria were: 1) population-based observational studies reporting the prevalence of HAIs, 2) cross-sectional, retrospective and case-control studies, and 3) relevant studies with clear and detailed data. Also, case reports, case series, editorials, letters to the editor, commentaries, reviews and clinical trials as well as studies that were not calculating the prevalence of HAIs, were excluded.

Abstract of all papers were imported into Endnote software version 16 then the duplicates were removed. After that, the authors read the full text, and if they had the inclusion criteria, they were kept for more investigation.

Also, the review and editorial articles were excluded. The checklist was prepared by examining the content of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)(14). The PRISMA Statement comprises a 27-item checklist and a four-phase flow diagram. The checklist includes items considered essential for the transparent reporting of a systematic review. In this Explanation and Elaboration document, the meaning and rationale for each checklist item were explained. For each item, an example of good reporting was included and, anywhere possible, references to pertinent empirical studies and methodological literature.

In the next stage, we checked the results of the papers. If they had reported the rate of nosocomial infection, they were kept as the final suitable papers for analysis.

Data extraction

A data sheet was created in the Excel software and imported the data of suitable variables. The extracted data were as follows: title, year of the study, HAIs rate, gender of patients, type of infection and bacteria, setting, type of hospital, and sample size.

The search generated a total of 1320 records, of which 602 papers were duplicated, and 718 titles and abstracts

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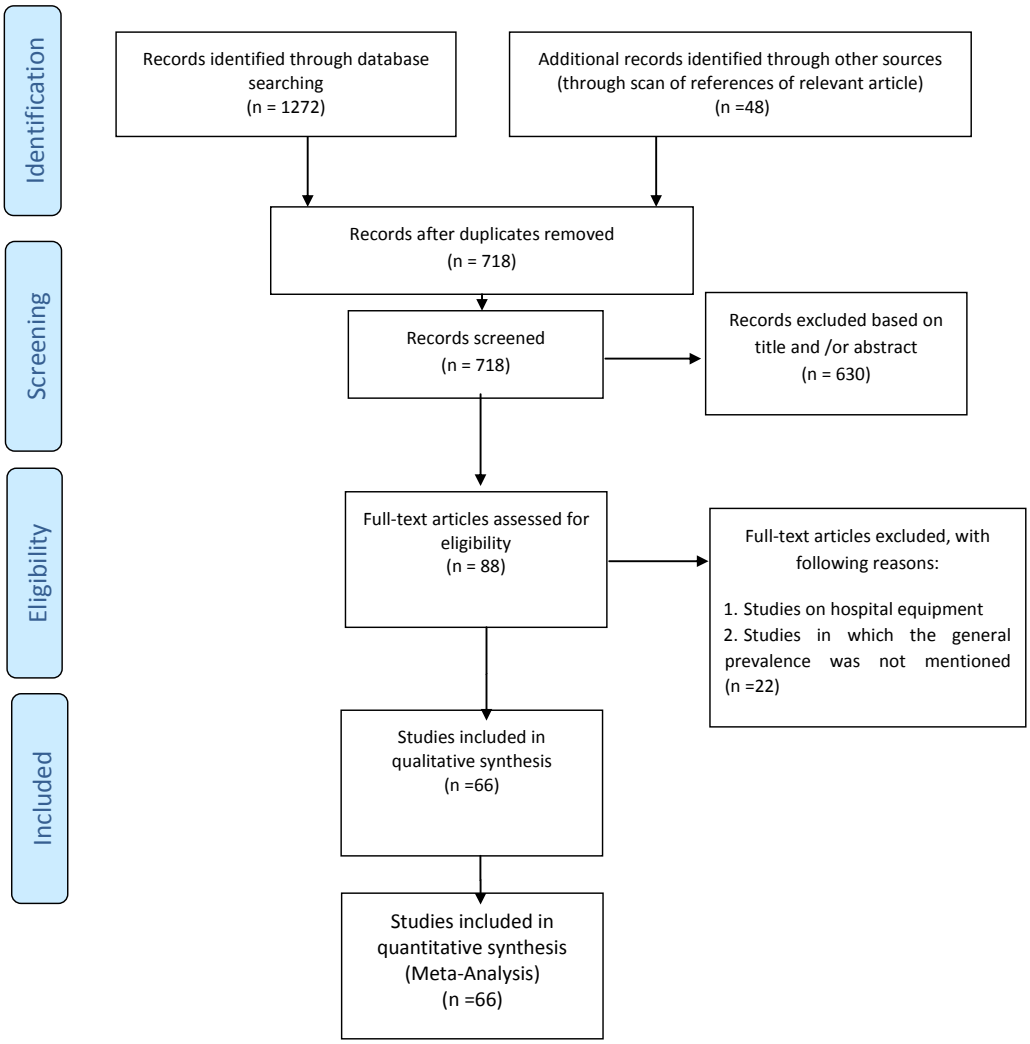

Fig. 1. Flowchart of the present systematic review and meta-analysis

were reviewed. The most fundamental reasons for omission were: studies conducted outside Iran, publication type, and studies not reporting HAIs' rate. A total of 66 articles were included in the meta-analysis and data were extracted. Supplementary information can be accessed in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2009 flow diagram (Fig. 1). Also, for assessing the risk of bias, we used ROBVIS as a web app designed for visualizing risk-of-bias.

Data analysis

Data imported into the STATA software version 11 for analysis. To identify the pooled prevalence, the stochastic DerSimonian-Laird model was applied, computing the effect size with its 95% confidence interval (CI) and pictorially representing it through a Forest plot. Combined estimates were obtained for the HAIs' overall and in detail by means of random effect models. RR Pooled data were used for the data analysis and mean instruction was used in STATA software. To further examine the source of heterogeneity, meta-regression analyses stratified by publication year and sample size in the hospital. Subgroup analyses were conducted based on study quality, geographic areas, sample size, year of publication, type of infection and hospital. Additionally, the possible sources of heterogeneity were examined using I^2 statistics and Cochran's Q test (15). Also, Begg's Rank correlation test and Egger's regression method were used to measure the propagation bias.

Results

Quality assessment of studies

The quality assessment of the studies was appraised by the PRISMA checklist. As shown in Figure 1. 66 studies entered to meta-analysis phase. The studies are shown in Table 1.

As shown in Table 2, the odds ratio of hospital infections was reported 0.111 in the studies hospitals in Iran. Although Ecoli was investigated in 53 papers, it found 0.239 in the hospitals. Respiratory infections were reported 0.296 in the studies. In addition, more of the nosocomial infection was described in the South and West of Iran (0.231 and 0.164, respectively). As a result, male patients had acquired infection more than female (about 0.239 vs. 0.216).

Pooled estimate of HAIs in Iran is shown in Figure 2.

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Table 1. Characteristics of primary studies related to the prevalence of hospital infection in Iranian hospitals in the meta-analysis

Author	Year	Setting	Type of hospital	Sample size	HAIs rate	HAIs in men	HAIs in females	Quality Study
Rastegegar lari et al.(16)	1998	Tehran	Public	6329	0.532	N/A	N/A	Low
Talebi Taher et al.(17)	2001	Qazvin	Public	546	0.041	N/A	N/A	Low
Shojaee et al.(18)	2002	Shahrekord	Public	845	0.049	N/A	N/A	Low
Samadzadeh et al.(19)	2002	Oromea	Public	942	0.049	N/A	N/A	Low
Askarian et al.(20)	2003	Shiraz	Public	106	0.451	N/A	N/A	Medium
Ekrami et al.(21)	2005	Ahwaz	Public	182	0.769	N/A	N/A	Medium
Sadegh Zadeh et al.(22)	2005	Zanjan	Public	150	0.025	N/A	N/A	High
Mousavian et al.(23)	2006	Ahwaz	Public	1604	0.044	N/A	N/A	High
Qurbanalizadegan et al.(24)	2006	Tehran	Public	6817	0.013	N/A	N/A	Medium
Gorbanalizadegan et al.(25)	2006	Tehran	Public	155	0.039	N/A	N/A	Medium
Naderi Nasab et al.(26)	2006	Mashhad	Public	1341	0.039	N/A	N/A	Medium
Nik Bakht et al (27)	2007	Tabriz	Public	460	0.348	0.333	0.358	Low
Ajal Loeyan et al.(28)	2007	Tehran	Private	234	0.183	N/A	N/A	Medium
Esmaili et al.(29)	2007	Tehran	Public	116	0.017	N/A	N/A	Medium
Mohmmadi Mehr et al.(30)	2008	Tehran	Public	165	0.393	N/A	N/A	Medium
Sharifi et al.(31)	2008	Qazvin	Public	1083	0.052	N/A	N/A	Medium
Ghazvini et al.(32)	2008	Mashhad	Public	971	0.033	N/A	N/A	Medium
Oskouee et al.(33)	2009	Tabriz	Public	103	0.331	N/A	N/A	Medium
Asgare Moghadam et al.(34)	2009	Tehran	Public	181	0.741	N/A	N/A	Medium
Amini et al.(35)	2009	Tehran	Private	691	0.109	N/A	N/A	Medium
Talaie et al.(36)	2010	Tehran	Public	582	0.08	N/A	N/A	Medium
Darvishpor et al.(37)	2010	Rasht	Public	270	0.163	N/A	N/A	High
Khani et al.(38)	2011	Tehran	Public	256	0.341	0.323	0.359	Medium
Afkhamzadeh et al.(39)	2011	Sanandaj	Public	149	0.322	0.237	0.351	Medium
Larypoor et al.(40)	2011	Qom	Public	29631	0.001	N/A	N/A	Low
Barak et al.(41)	2011	Tehran	Public	1795	0.039	N/A	N/A	Medium
Ghorbani Birgani et al.(42)	2011	Ahwaz	Public	772	0.101	0.129	0.075	Medium
Mobin et al.(43)	2012	Hamedan	Public	353	0.171	N/A	N/A	High
Saedi et al.(44)	2012	Mashhad	Public	647	0.172	N/A	N/A	Medium
Pourakbari et al.(45)	2012	Tehran	Public	1497	0.034	N/A	N/A	Low
Ghazvini et al.(32)	2012	Mashhad	Public	971	0.033	N/A	N/A	Low
Soltani et al.(46)	2012	Tehran	Public	464	0.373	N/A	N/A	Medium
Hashemi et al.(47)	2013	Hamedan	Public	574	0.528	N/A	N/A	Low
Heydari Sour Shojaee et al.(48)	2013	Charmahale bakhtyare	Public	848	0.087	N/A	N/A	Medium
Shojaei et al.(49)	2013	Qom	Public	12668	0.076	N/A	N/A	Low
Saadat et al.(50)	2013	Shiraz	Public	591	0.149	N/A	N/A	Medium
Abedini et al.(51)	2014	Kurdistan	Public	369	0.027	N/A	N/A	Medium
Akhavan Tafti et al.(52)	2014	Yazd	Public	180	0.003	N/A	N/A	Medium
Shakib et al.(53)	2014	Sanandaj	Public	750	0.103	N/A	N/A	Low
Davodi et al.(54)	2014	Mazandaran	Public	5712	0.010	N/A	N/A	Low
Makhloghi et al.(55)	2014	Qazvin	Public	188	0.196	N/A	N/A	Low
Bijari et al.(56)	2014	South Khorasan	Public	39777	0.001	N/A	N/A	Low
Behzadnia et al.(57)	2014	Mazandaran	Public	34556	0.102	N/A	N/A	Medium
Saeidimehr et al.(58)	2015	Ahwaz	Private	16936	0.020	N/A	N/A	Medium
Hashemizadeh et al.(59)	2015	Shiraz	Public	2229	0.114	N/A	N/A	Medium
Haje bageri et al.(60)	2015	Sanandaj	Public	160	0.152	0.174	0.132	High
Hosini et al.(61)	2016	Jahrom	Public	189	0.254	N/A	N/A	High
Servatyare et al.(62)	2017	Sanandaj	Public	198	0.167	0.162	0.172	Medium
Rahmanian et al.(63)	2017	Jahrom	Public	55295	0.002	N/A	N/A	High
Shali et al.(64)	2017	Tehran	Public	300	0.035	N/A	N/A	High
Farzanpour et al.(65)	2017	Sabzevar	Public	89429	0.012	N/A	N/A	Medium
Dadmanesh et al.(66)	2017	Tehran	Public	900	0.472	N/A	N/A	High
Heydarpour et al.(67)	2017	Kermanshah	Public	6000	0.023	N/A	N/A	High
Eshrati et al.(68)	2018	Iran	Public	7018393	0.012	N/A	N/A	High
Ghanbari et al.(69)	2018	Isfahan	Public	5500	0.045	N/A	N/A	Medium
Nasiri et al.(70)	2018	Tehran	Public	11164	0.033	N/A	N/A	Medium
Rahimi-Bashar et al.(71)	2018	Hamedan	Public	10332	0.026	N/A	N/A	Medium
Kohestani et al.(72)	2019	Tehran	Public	600003	0.046	N/A	N/A	Low
Alkhudhairy et al.(73)	2019	Ahvaz	Public	380	0.316	N/A	N/A	High
Azimi et al.(74)	2019	Tehran	Public	14690	0.077	N/A	N/A	Medium
Piruozi et al.(75)	2019	Grash	Public	300	0.068	N/A	N/A	Medium
Yaqubi et al.(76)	2019	Rasht	Public	738	0.057	N/A	N/A	High
Sepandi et al.(77)	2019	Tehran	Public	14517	0.017	N/A	N/A	High
Mansori et al.(78)	2020	Mashhad	Public	2800	0.411	N/A	N/A	High
Ahmadinejad et al.(79)	2020	Kerman	Public	197	0.401	N/A	N/A	High
Emami et al.(80)	2020	Shiraz	Public	3420	0.281	N/A	N/A	High

According to Table 3. HAIs in the south of Iran are vaired between 0.002 to 0.451.

Table 4 shows the results of the meta-regression analysis.

Egger's test was done to evaluate publication bias (Fig. 3 & Table 5). Evidences of publication bias was found

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Table 2. The results of sub-groups analysis of hospital infection in Iranian hospitals from 1995-2020

Variable	No. reports	Pooled (95% CI)	I2 (%)	p
Quality of studies				
High	16	0.193 (0.143-0.242)	99.9%	0.001
Medium	35	0.097 (0.089-0.106)		
Low	15	0.120 (0.104-0.137)		
Time				
<2014	43	0.157 (0.142-0.172)	99.9%	0.001
>2014	23	0.089 (0.082-0.097)		
Patients' gender				
Male	6	0.239 (0.160-0.318)	99.7%	>0.5
Female	6	0.216 (0.124-0.307)		
Age				
≤50	44	0.117 (0.111-0.124)	99.6%	>0.5
>50	22	0.111 (0.098- 0.123)		
Sample Size				
≤ 1500	42	0.191 (0.162-221)	99.9%	0.001
> 1500	24	0.087 (0.080-0.095		
Region				
Center	30	0.124 (0.112-0.136)	99.5%	0.001
East	7	0.083 (0.071-0.096)		
North	4	0.081 (0.017-0.142)		
South	7	0.231 (0.121-0.341)		
West	19	0.164 (0.143-0.185)		
Type of Hospital				
Public	63	0.112 (0.107-0.118)	97.9%	>0.5
Private	3	0.100 (0.015-0.186)		
Type of bacteria				
Staphylococcus aureus	49	0.166 (0.151-0.182)	99.9%	0.001
klebsiella	52	0.180 (0.163-0.196)		
Escherichia coli	53	0.239 (0.212-0.266)		
Type of infection				
Respiratory	38	0.286 (0.261-0.310)	99.9%	>0.5
Urinary	51	0.296 (0.255-0.337)		
Overall	66	0.111 (0.105-0.116)	99.9%	

(p=0.001).

Discussion

HAIs have always been a major health problem as hospitals expand that, despite multiple attempts, no country or organization has managed to fully resolve (81). In this systematic review and meta-analysis, we have shown that the overall prevalence of HAIs in Iran was 0.111 (95% CI: 0.0.105 – 0.116). The previously systematic review by Ghashghaee et al. (13). revealed the HAIs rate in Iran was 4.5%. HAIs rates are also 10.1% (varied from 5.7% to 19.1%) in developing countries and 7.6% (varied from 3.5% to 12%) in developed countries (5). According to WHO reports, the HAIs rate is between 5% – 22% in the world (82). The high prevalence of HAIs in Iran highlights the need for urgent attention and implementation of a comprehensive plan to control these infections. Variations in HAI rates can, however, be due to differences in diagnostic criteria and tests for infection diagnosis, as well as differences in reporting systems and their consistency.

According to the findings, the HAIs had decreased from 0.157 to 0.089 after HTP in Iran, which was statistically significant (p=0.001). This indicates that the measures taken in HTP have affected the quality of health services and reduced nosocomial infections. In this regard, Ghashghaee in his study, found that HAIs had decreased from 7.6% to 2.4% after HTP (13). Moreover, Braithwaite et al. in their Book in 2018 (83) reported that In Iran, a government policy initiative called HTP was implemented to decrease inequality and improve public health coverage and reached more objectives especially patient safety.

Based on our measurement, the most common bacteria causing HAIs were Escherichia coli and Klebsiella. The findings also demonstrated that respiratory infections and urinary infections were the most common HAIs. These findings are supported by studies carried out in EMRO (the Eastern Mediterranean Regional Office of the World Health Organization) (82). Moreover, a meta-analysis study in Iran reported Klebsiella as common bacteria in HAIs (13). These infections are directly related to contamination of equipment, especially urinary catheters, environment and operating room personnel, and air conditioning systems, which in many developing countries is due to lack of proper equipment.

Our findings showed that the male is more likely to have HAIs than the female. A similar result was reported in the systematic review study conducted in EMRO (82). Clinicians should be mindful of these differences and take them under consideration when managing patients with HAIs. However, one of the probable reasons could also be the lower number of women surveyed in the total papers reviewed in the present study.

According to the results, the prevalence of HAIs in the south and west was more than in other regions of the country. The high rate of HAIs in some parts of the country is the characteristics of studied patients, their underlying diseases and the hospitalized ward. Most of the patients in south Iran were hospitalized in intensive care

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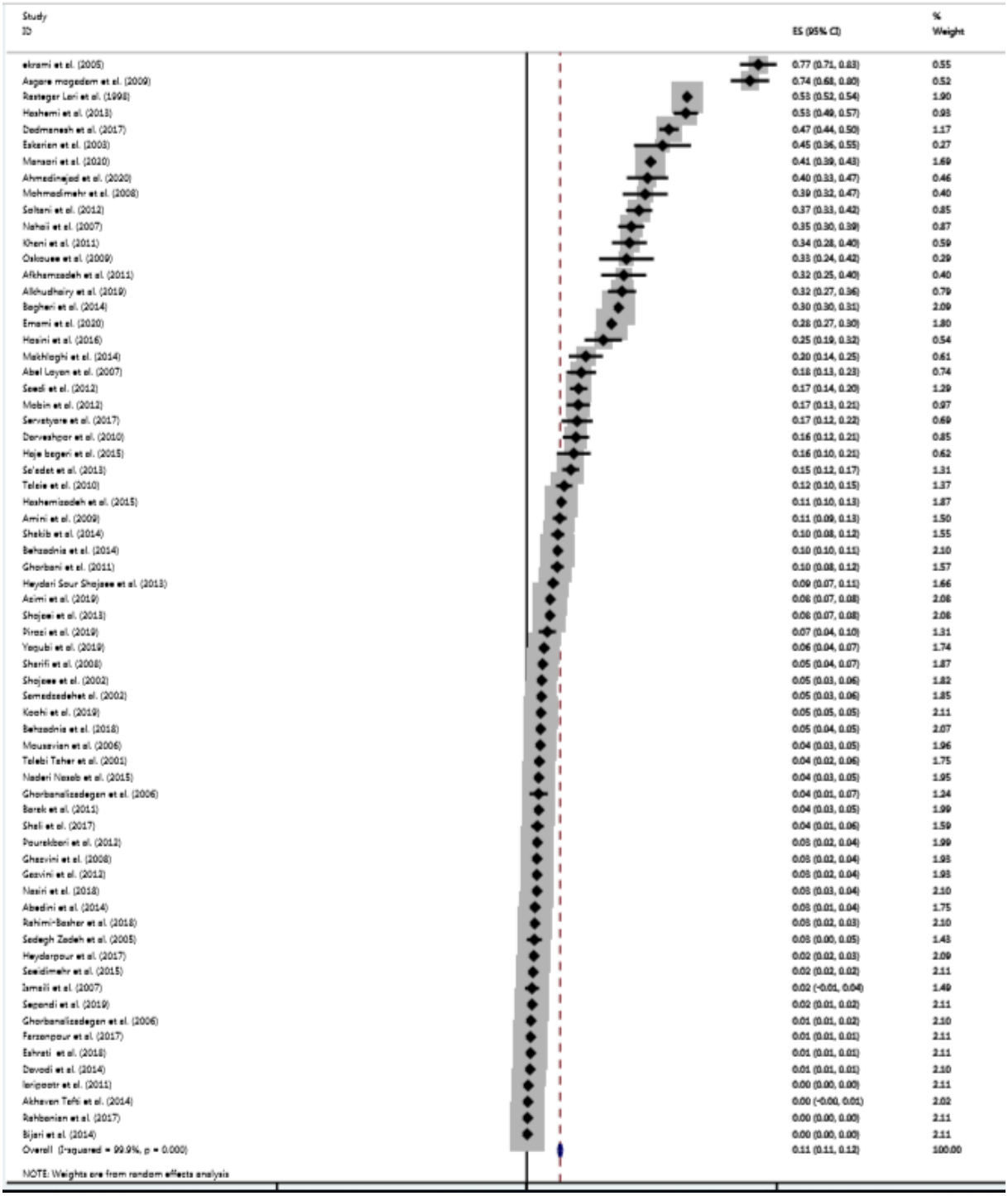

Fig. 2. The forest plot of the overall prevalence of nosocomial infections in Iran

units (20, 79). Moreover, Ahmadinejad declared that about 50% of the studied patients were addicts and they are prone to nosocomial infections (79).

Monitoring and controlling HAIs is difficult, costly, and time-consuming; however, it is necessary and cost-effective. Adherence to hygiene principles and methods of microbiological diagnosis can prevent and control HAIs with lower costs. Using minimally invasive devices and methods, paying close attention to non-intravenous nutrition, preventing misuse and overuse of antibiotics, monitoring the pattern of infection, improving hospital environmental health, training personnel, and effective hand hygiene strategies are methods that can significantly reduce HAIs (84, 85).

Conclusion

According to the reviewed studies, the prevalence of HAIs in Iran is relatively high. Despite the increasing development of health standards and quality development of hospitals in recent years, the prevalence findings indicate

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Table 3. The overall prevalence of nosocomial infections in the south of Iran

Study	ES	95 % Conf. Interval	Weight
Askarian et al.	0.451	0.356- 0.546	13.28
Ahmadinejad et al.	0.401	0.333-0.469	13.94
Emami et al.	0.281	0.266-0.296	14.69
Hosini et al.	0.254	0.192-0.316	14.07
Saadat et al.	0.146	0.118-0.174	14.59
Hashemizadeh et al.	0.114	0.101-0.127	14.70
Rahmanian et al.	0.002	0.002-0.002	14.72
Pooled ES	0.231	0.121-0.341	100.00

Table 4. Results of the meta-regression

Overall prevalence	Coef.	Std. Error	t	p
Year of publication	- 0.006	0.004	- 1.49	0.141
Region	0.008	0.018	0.43	0.670
Type of hospital	- 0.070	0.107	- 0.65	0.516

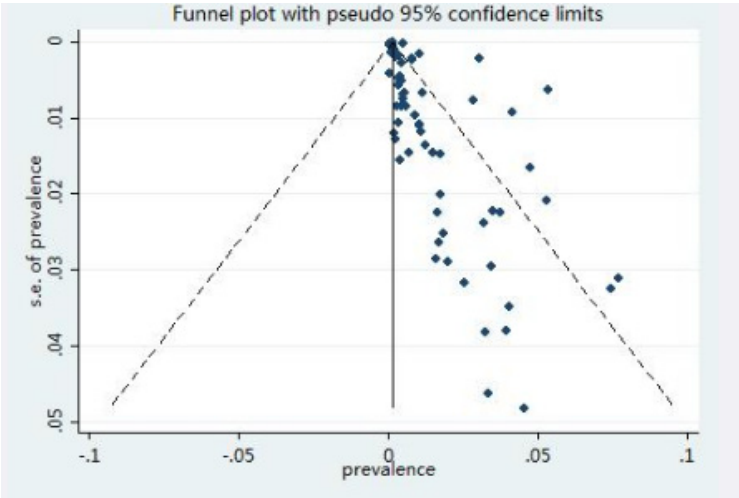

Fig. 3. The Egger test for publication bias

Table 5. The Egger test for publication bias

Std_Eff	beta coefficient.	Std. Err	t	p	95% Conf. Interval
Slope	.0107469	.001112	9.66	0.001	.0085242 .0129696
bias	13.41402	3.581168	3.75	0.001	6.261939 20.56611

a relatively uneven trend in this development and an increase in the prevalence of HAIs in different parts of the country. This should be taken into consideration by health policymakers for pathology and revision of some previous programs and standards as well as the development of appropriate and evidence-based control and education programs to reduce this health problem in Iran. Efforts to improve the quality of nursing care, applied staff training, continuous monitoring HAIs, provision of facilities, implementation of infection control programs, prioritization of hospital wards for more stringent health measures, emphasis on preventive cares such as hand washing and appropriate training through mass media are the most important actions suggested in this regard.

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Conflict of Interests

The authors declare that they have no competing interests.

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