The prevalence of urinary tract infections in type 2 diabetic patients: a systematic review and meta-analysis

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Research

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Abstract

Background

Urinary tract infection is the most common infection in type 2 diabetic patients. Various studies have reported different outbreaks of urinary tract infections in type 2 diabetic patients, Therefore, the present study aimed to determine the prevalence of urinary tract infections in type 2 diabetic patients during a systematic review and meta-analysis to open windows to more detailed programs to reduce the incidence of urinary tract infections in type 2 diabetic patients.

Methods

In this study, systematic review and Meta-Analysis of study data related to the prevalence of urinary tract infection in type 2 diabetic patients using keywords including: Type 2 diabetes, urinary tract infection, diabetes, prevalence, Meta-Analysis and their English equivalents in SID, MagIran, IranMedex, IranDoc, Google scholar, Cochrane, Embase, Science Direct, Scopus, PubMed and Web of Science (ISI) databases over the years It was mined from 1993 to 2020.In order to perform the analysis of qualified studies, the model of random effects was used and the inconsistency of studies with I^2 index was investigated. Data analysis was performed with Comprehensive Meta-Analysis (version 2).

Results

In a study of 15 studies with a sample size of 827,948 in Meta-Analysis, the overall prevalence of urinary tract infection in patients with type 2 diabetes was 11.5% (95% confidence interval: 7.8–16.7%). Increasing the number of years of research, the prevalence of urinary tract infections in diabetic patients of the Iranian type increased (P = 0.000), and with increasing age of participants (P = 0.000) and also with increasing sample size (P = 0.000), this prevalence decreased.

Conclusion

The results of this study show that urinary tract infections are highly prevalent in patients with type 2 diabetes, so due to the growing prevalence of diabetes and its complications such as urinary tract infections, the need for appropriate screening programs and health care policies is becoming more apparent.

Background

Diabetes is the most common endocrine disorder in the last century. In developing countries, various factors, including lifestyle changes, have increased the incidence of the disease [1]. There are two main types of diabetes, and type 2 diabetes is more common. Type 2 diabetes is a chronic and progressive

metabolic disease involving a heterogeneous group of disorders associated with varying degrees of insulin resistance, insulin secretion disorder, its development and persistence, and increased glucose production [2–6]. The prevalence of type 2 diabetes has increased in recent years [7, 8]. In 2015, about 415 million adults with type 2 diabetes were reported, which is projected to increase to 642 million by 2040 [7]. It increased from 4.3% to 9% in men and from 5% to 7.9% in women [8]. Type 2 diabetes increases the risk of certain diseases, including cardiovascular disease, eye and blindness problems, amputation of the lower limbs, kidney disease and infectious diseases [9, 10]. The most common infectious disease in diabetic patients is type 2 urinary tract infection (UTI) [11]. It is estimated that 150 million people worldwide suffer from urinary tract infections each year [12].

Factors such as: Immune system disorders, weakening of white blood cells, poor blood supply, bladder dysfunction due to nephropathy and glucosuria can cause urinary tract infections in type 2 diabetic patients [13–22]. Dysuria is a complication of urinary tract infection in diabetic patients due to organ damage and even death due to the complexity of pyelonephritis. Also, these patients experience urinary retention, urgency, and incontinence during the night due to increased urination to excrete excess glucose [23]. The prevalence of urinary tract infections in women is higher than in men, which may be due to the specific structure of the short urinary tract, the shortness of the urethra, and its proximity to the anus in women [24]. Urinary tract infections make it difficult to control blood sugar in diabetic patients, which increases the need for blood sugar monitoring, reduces quality of life, and imposes significant treatment costs on the patient [25].

Due to the effect of various factors on the prevalence of urinary tract infection in type 2 diabetic patients and the lack of general statistics, we decided to review the studies conducted in this field and statistically analyse the results of general statistical studies on the prevalence of urinary tract infections in diabetic patients. Let's get to the second type to open a window to more detailed programs to reduce the effects of urinary tract infections and improve people's health.

Methods

The study looked at systematic review and Meta-Analysis to find related studies from the SID, MagIran, IranMedex, IranDoc, Cochrane, Embase, Science Direct, Scopus, PubMed and Web of Science (ISI) databases, and the Google Scholar search engine. To achieve the desired articles using keywords including: prevalence, urinary tract infection, type 2 diabetes and Latin keywords Prevalence, UTI, Type 2 diabetes mellitus and all possible combinations of these words, search strategy for each database was determined.

In the search process, all related studies were identified and the information of these studies was transferred to the information management software (EndNote). Therefore, all possible related articles published from 1993 to 2020 were identified and their information was transferred to EndNote. In order to maximize the comprehensiveness of the search, the list of sources used in all related articles found in the above search was manually reviewed.

Inclusion Criteria

Criteria for entering studies included: studies that examined the prevalence of urinary tract infections in type 2 diabetic patients, descriptive studies, cross-sectional studies, and studies in which the full text was available.

Exclusion Criteria

Criteria for leaving the study include: intervention studies, case studies, grouping, review and irrelevant studies, studies without sufficient data, repeatability of studies, and uncertainty of study methods.

Selection of studies

Initially, studies that were repeated in various databases searched were removed from this study. Then, the researchers of this study prepared a list of the titles of all the remaining articles, so that we can get qualified articles by evaluating the articles in this list.

In the first stage, screening, the title and abstract of the remaining articles were carefully studied and deleted based on the criteria for entering and leaving unrelated articles. In the second stage, ie the evaluation of the competence of the studies, the full text of the possible related articles remaining from the screening stage was examined based on the entry and exit criteria, and in this stage, the unrelated studies were removed.

To prevent bias, all sources were reviewed and extracted by two researchers independently. If the articles are not included, the reason for deleting them was mentioned. In cases where there was a disagreement between the two researchers, the third person reviewed the article. Twenty studies entered the third stage, qualitative assessment.

Qualitative evaluation of studies

In order to validate and evaluate the quality of articles (methodological validity and results), a checklist appropriate to the type of study is used. STROBE checklists are commonly used to critique and evaluate qualitative observational studies such as the present study. The STROBE checklist consists of 6 scales or general sections including: title, abstract, introduction, methods, results, and discussion. Some of these scales have subscales for a total of 32 items. In fact, these 32 items represent different methodological aspects of study, including title, problem statement, study objectives, study type, study statistical population, sampling method, appropriate sample size determination, definition of variables and procedures, study data collection tools and methods, includes statistical analysis and findings. Accordingly, the maximum score obtained from the qualitative evaluation will be in the STROBE 32 checklist, and considering the score of 16 as the cut-off point, the articles with scores of 16 and above will be considered good and medium quality articles and the following scores will be obtained. Also, 16 articles with poor methodological quality were considered weak and therefore excluded from the study [42].

In the present study, based on the evaluation based on the STROBE checklist, 15 papers entered the systematic review and Meta-Analysis process as good and moderate methodological quality studies and 5 papers had poor methodological quality and were excluded from the study [26].

Extracting the data

Information on all final papers entered into the process of systematic review and Meta-Analysis was extracted from a pre-prepared checklist. The checklist included the title of the article, the author's first name, year of publication, place of study, sample size, prevalence of urinary tract infection in type 2 diabetic patients and mean age.

Statistical analysis

The I^2 test was used to assess the heterogeneity of the selected studies. In order to investigate the publication error, due to the high volume of samples entered into the study, Egger test was used at a significance level of 0.05 and also the corresponding Funnel plot was used. Data analysis was performed using Comprehensive Meta-Analysis software (Version 2).

Results

In this study, systematic review and Meta-Analysis of systemic study data on the prevalence of urinary tract infections in type 2 diabetic patients without time constraints and according to PRISMA guidelines were systematically investigated. Based on an initial search of the database, 1904 possible related articles were identified and transferred to the information management software (EndNote). Out of a total of 1904 identified studies, 173 were duplicate and were eliminated.

In the screening stage, out of 1731 remaining studies, 1650 articles were deleted by reading the title and abstract based on entry and exit criteria. In the competency assessment phase, 61 of the remaining 81 studies were eliminated by studying the full text of the article based on entry and exit criteria due to un-relatedness. In the qualitative evaluation stage, through the study of the full text of the article and based on the score obtained from the STROBE checklist, out of the remaining 20 studies, 5 articles that had poor methodological quality were removed. Finally, 15 studies entered the final analysis (Figure 1).

(Figure 1 Here)

Based on the results of the test (I^2: 99.9) and due to the heterogeneity of the selected studies, the random effects model was used to combine the studies and the common estimate of the prevalence. The total sample size was 872948 people in each study and the specifications of the selected articles are given in Table 1. The lowest and highest sample size, respectively, related to the studies of sheep and colleagues (2001) (155 people) and Wilk et al. (2016) (456586 people) and the highest and lowest prevalence of urinary tract infections in type 2 diabetic patients related to Jennifer et al. (2009). (1157 people) and Hirji (2012) (3466 people).

(Table 1 Here)

The probability of bias in the publication of the results was investigated by funnel diagram and Egger Test (Figure 1) which shows that the bias of the publication was not statistically significant (p = 0.857, also the results of Begg and Mazumdar test at the significance level of 0.1 also indicate no Published bias was present in the study (p=0.552).

(Figure 2 Here)

According to the results of the study, the overall prevalence of urinary tract infection in type 2 diabetic patients was 11.5% (95% CI: 7.8-16.7%) (Figure 3).

(Figure 3 Here)

The midpoint of each line indicates the prevalence of urinary tract infections in each study, and the rhombic shape of the prevalence of urinary tract infections in type 2 diabetic patients for the entire study.

Using Meta-Regression, the relationship between year of study (p = 0.000) and sample size (p = 0.000) and age of participants in the study (p = 0.000) with the prevalence of urinary tract infection in type 2 diabetic patients was examined. The prevalence of urinary tract infection was significantly different from all three cases. With increasing year of research, the prevalence of urinary tract infections in diabetic patients increased and with increasing age of participants and also with increasing sample size, this prevalence decreased (Figures 4 and 5).

(Figure 4 Here)

(Figure 5 Here)

Discussion

According to the studies studied, the prevalence of urinary tract infections in patients with type 2 diabetes varies in different countries of the world. On average, 10.16% of patients with type 2 diabetes who participated in the study had a urinary tract infection, compared with 33.29% at Nicholas 2017 (conducted in the United States and Germany) and at Hirji 2012 (in the United States, Germany, and Sweden), with a prevalence rate of 2.55%, has the highest and lowest prevalence rates, respectively [29, 34].

People with type 2 diabetes have a higher chance of developing infections than non-diabetics [40, 41].

A person with UTI is considered to have certain microbial pathogens in his or her urinary tract [42]. In people with type 2 diabetes, the main organism that causes urinary tract infections is the E-Coli bacterium [39, 43, and 44]. Bacterial urinary tract infections are clinically distinct. Septic bacteria cause urinary tract infections with obvious symptoms such as increased frequency of urination, dysuria, haematuria, and painful touch of the hyperaemic area, while aseptic bacteria cause urinary tract infection without obvious

symptoms [42]. It is said that the prevalence of aseptic bacteria in people with diabetes is three times higher than in normal people [45]. Also, asymptomatic bacterial infections are more common in these people, which does not indicate that their upper urinary tract is not involved. These people have been observed [46].

In people with type 2 diabetes, several different mechanisms may increase the risk of urinary tract infections, including diabetic nephropathy, autonomic neuropathy, immune system disorders, and glucosuria [9, 47].

Diabetic nephropathy leads to disorders such as protein excretion and severe glucose. Neurological damage associated with high blood sugar levels can adversely affect the ability of the bladder sensation. Sensory bladder sensory disturbances cause urinary retention. Increases urinary tract infections [48–52].

Diabetes reduces blood circulation, so as diabetes lengthens, it weakens the immune system, which is reduced by treating certain cytokines such as IL_6 and other anti-inflammatory cytokines in a diabetic patient. On the other hand, there are abnormal leukocytes. In diabetics and impaired phagocytic function, leukocytes due to high glucose levels in diabetic patients may contribute to the weakening of the immune system of these patients [53–57].

Apart from BMI, UTI is significantly associated with age, sex, recent UTI history and microalbuminuria [58].

It should be noted that there is a difference of opinion regarding the effect of diabetes duration and blood sugar control on UTI. The study of vismanthan2009 linked the duration of diabetes to UTI, but not to the study of He2018 (28, 36). The relationship between blood sugar control and UTI is also highly controversial. It is effective in UTI, but in Greeling's study, blood sugar control did not affect whether or not UTI was present [58–60].

With increasing age, the risk of developing UTI in both sexes, especially in women, increases. For example, in the Carrondo2020 study, the UTI rate in people aged 18–64 was 9%, compared with 27.5% in people over 85 years old [27]. In all of the articles reviewed, the UTI rate in women was higher than in men, which appears to be related to bladder neurological dysfunction, physiological bladder changes due to aging or shortness of breath and its proximity to the anus among women [24, 27].

Example

A study of Carrondo2020 in Portugal found that 23.6% of women with type 2 diabetes had UTI, compared with only 10.5% of men with type 2 diabetes [27]. A 2011 study in Fu2014 reported a 14% increase in the incidence of UTI in women with type 2 diabetes and 9.1% in non-diabetic women, compared with 5% in men with type 2 diabetes and 2.4% in non-diabetic men.

The association between diabetes, urinary tract infection and gender has been well established [11]. In a 2018 study in China, out of 1,072 women with type 2 diabetes in the study, 341 people were infected and

of the 1,783 men with type 2 diabetes in the study, only 68 people had a urinary tract infection (28). In connection with the study of venmans2009, in which the prevalence rate of UTI in men is higher than in women, it is necessary to provide the necessary explanations. In this study, the prevalence rate of recurrent bacterial cystitis in women was 2%, while in men the prevalence of bacterial cystitis and prostatitis was 3%, so this could be a possible cause of the discrepancy [37].

Therefore, female gender can be considered a risk factor for urinary tract infection. The prevalence of UTI in Stage1 diabetics is higher than in Stage2, because Stage2 diabetics already have blood sugar control [8, 61].

For example: In Carrondo2020 study, the prevalence rate of UTI in diabetic patients was Stage1, 24.4% and in diabetic patients Stage2, was 4.8% [27].Living geography appears to be associated with urinary tract infections in patients with type 2 diabetes. In an epidemiological study, the prevalence rate was highest in developing countries (24%) and 12.9% and 19.6% in the United States and Europe, respectively [62].

One of the limitations of this study, which is mainly due to the review of the study, is the following:

1-Not all articles are available

2-It is not the same as the method of measuring the variables studied in all studies

3- Ignoring nutrition and lifestyle in all studies

4- Due to the inconsistency of the study conditions and the volume of the samples, it is not possible to generalize the results of the present study.

5- It is hoped that the present study provides an organized and complete perspective for the development of screening programs, appropriate planning, and health care policies to prevent the increase in the incidence and complications of UTI in people with type 2 diabetes.

Conclusion

The results of this study show that urinary tract infections are highly prevalent in patients with type 2 diabetes. Therefore, due to the growing prevalence of diabetes and its complications, such as urinary tract infections, the need for appropriate screening programs and health care policies is becoming more apparent.

Abbreviations

UTI
urinary tract infection
SID

Scientific Information Database
ISI
Web of Science
PRISMA
Preferred Reporting Items for Systematic Reviews and Meta-Analysis.
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology for cross- sectional Study

Declarations

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Availability of data and materials

Datasets are available through the corresponding author upon reasonable request.

Authors'contributions

AKV and NS and MMK and MCH contributed to the design, MM and RJ statistical analysis, participated in most of the study steps. SHB and AD and SHSH prepared the manuscript. NS and AD assisted in designing the study, and helped in the, interpretation of the study. All authors have read and approved the content of the manuscript

Ethics approval and consent to participate

Ethics approval was received from the ethics committee of deputy of research and technology, Kermanshah University of Medical Sciences (3009610).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflict of interest.

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Tables

Table 1: Characteristic of included studies prevalence Urinary Tract Infection

Author, year, Reference	Mean age (years)	Country	Sample size	Prevalence %
Carrondo,2020 (27)	71	Portugal	7347	16.2
He,2018 (28)	59.32	China	3264	12.53
Nicolas,2017 (29)	60.2	USA, Germany	39295	33.3
Sewify,2016 (30)	55.5	Kuwait	722	34.9
Wilke,2016 (31)	73.8	USA, Germany	456586	9.28
Yu,2014(33)	62.5	USA	73151	8.22
Fu,2014 (11)	56	USA	89790	9.42
Al-rubeaan,2012 (32)	51.9	Saudi Arabia	1000	25.3
Hiriji,2012 (34)	63	USA, Germany, Sweden	135920	2.55
Hammar,2010 (35)	57.4	Sweden	6016	2.36
Janifer,2009 (36)	-	India	1157	42.8
Venmans,2009 (37)	67	The Netherlands	6343	2.74
Muller,2005 (9)	65.7	The Netherlands	6712	6.9
Goswarni,2001 (38)	33	India	155	9.03
Bonadio,2000 (39)	64.9	Italy	490	18.16

Figures

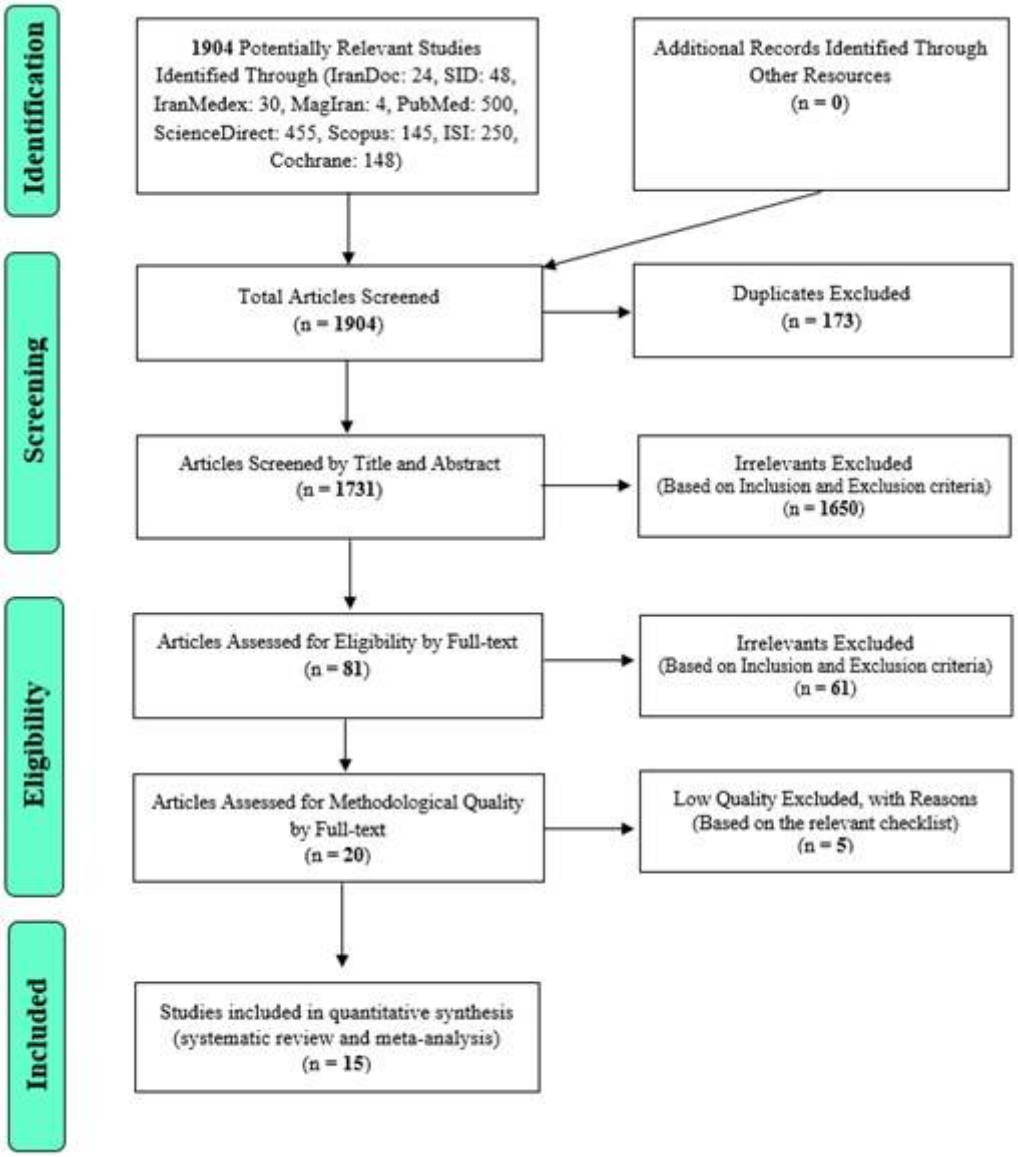
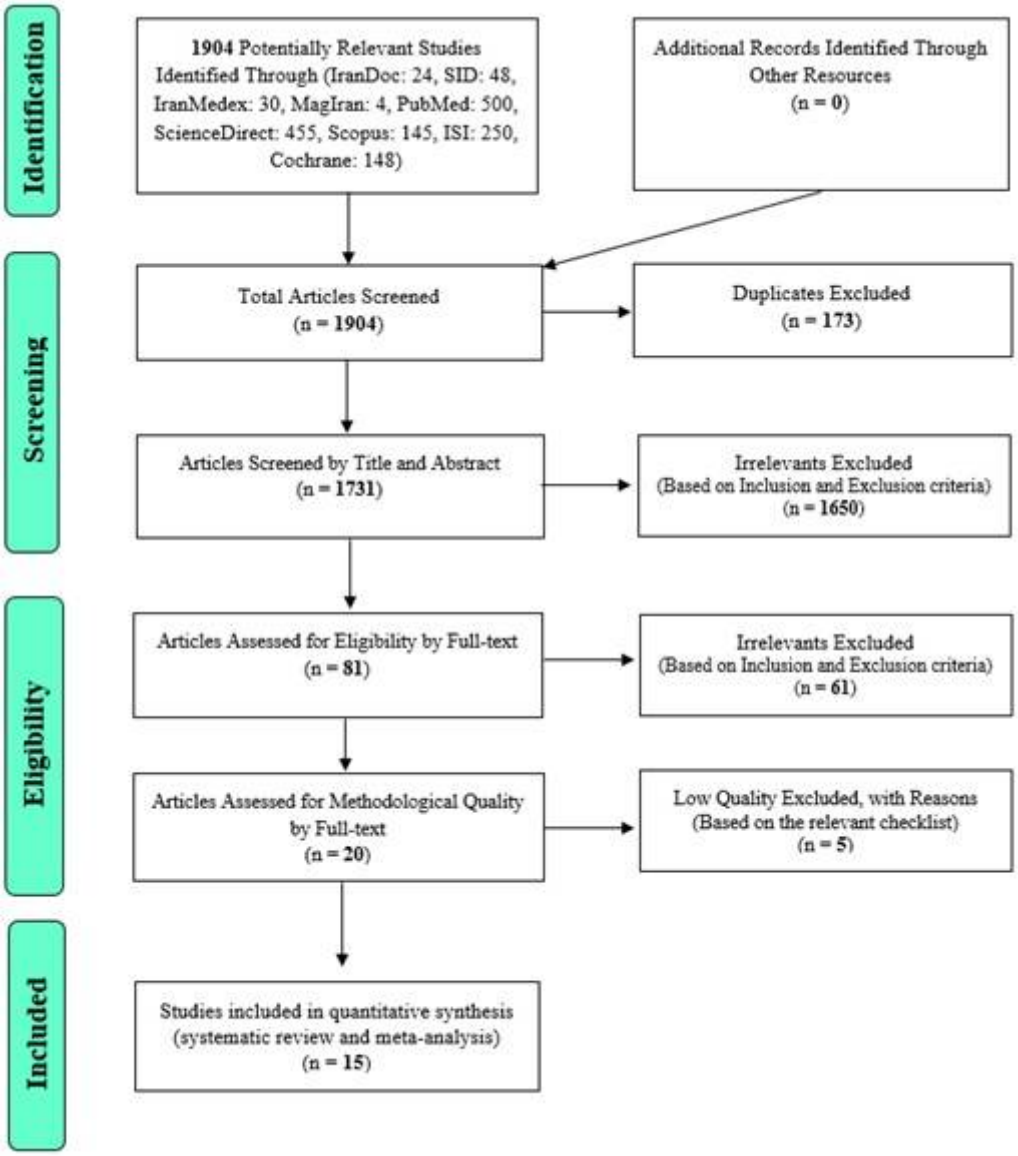


Figure 1

The flowchart on the stages of including the studies in the systematic review and meta-analysis (PRISMA 2009)



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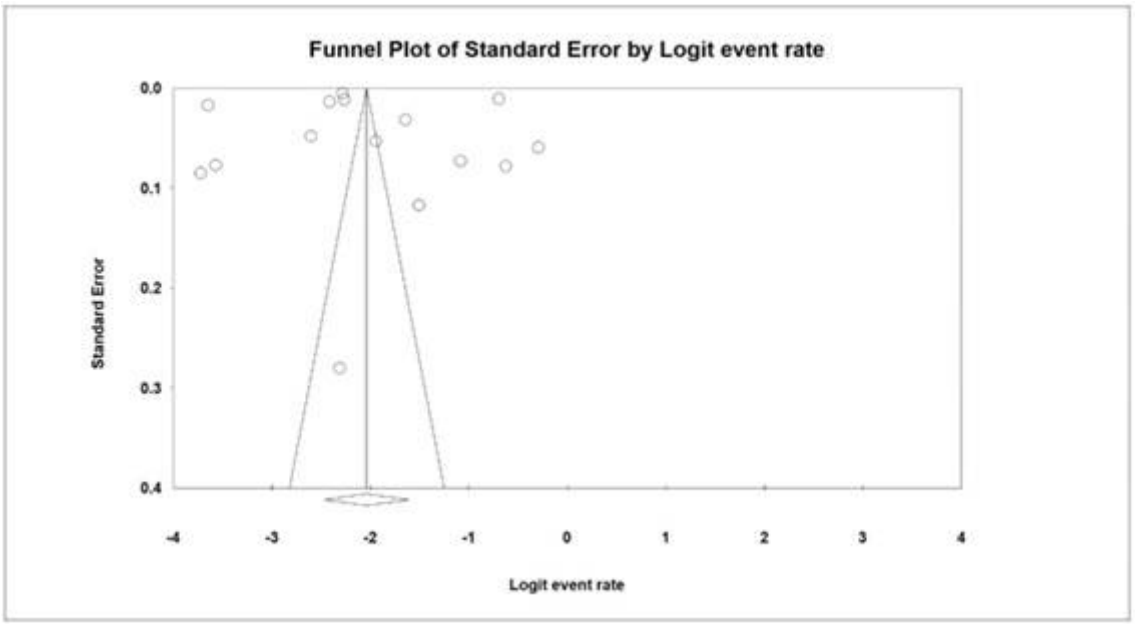
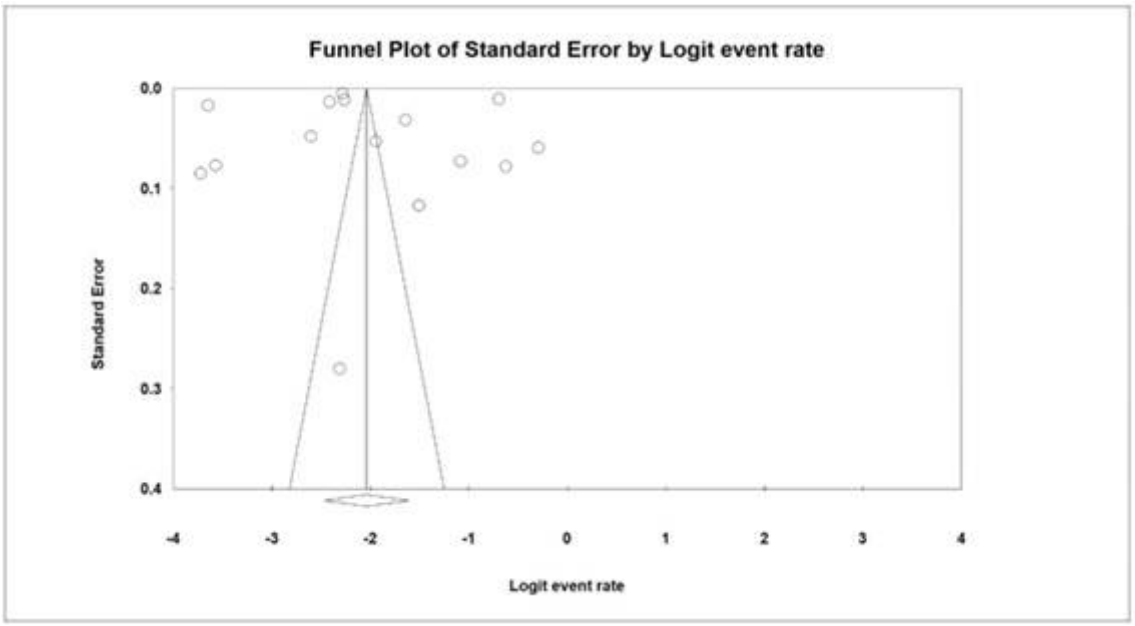


Figure 2

Funnel Plot results from the overall prevalence of urinary tract infection in type 2 diabetic patients



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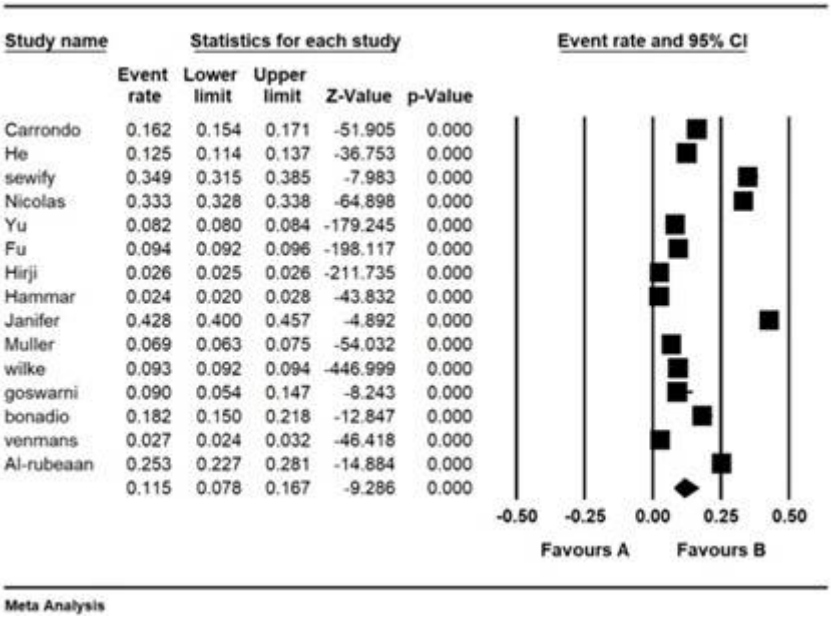
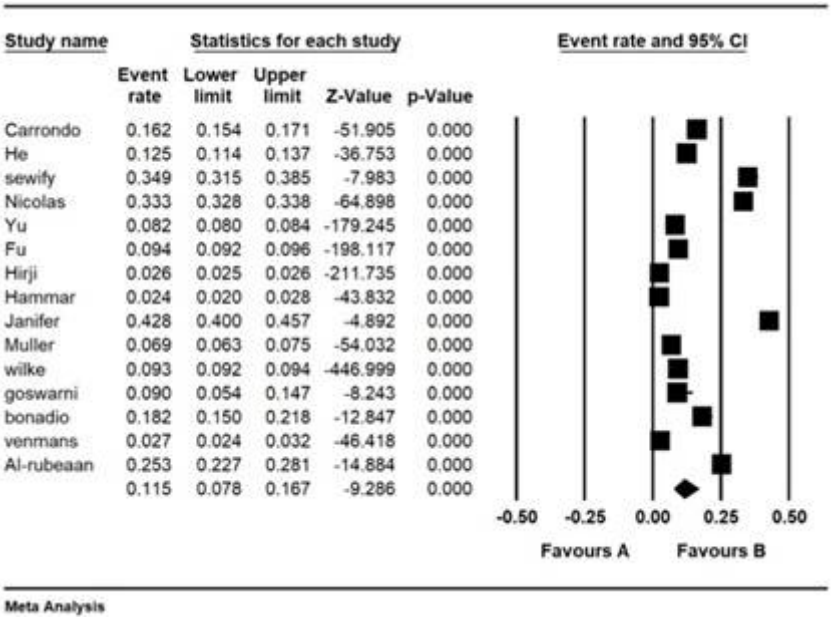


Figure 3

Overall prevalence of urinary tract infection in type 2 diabetic patients and 95% confidence interval.



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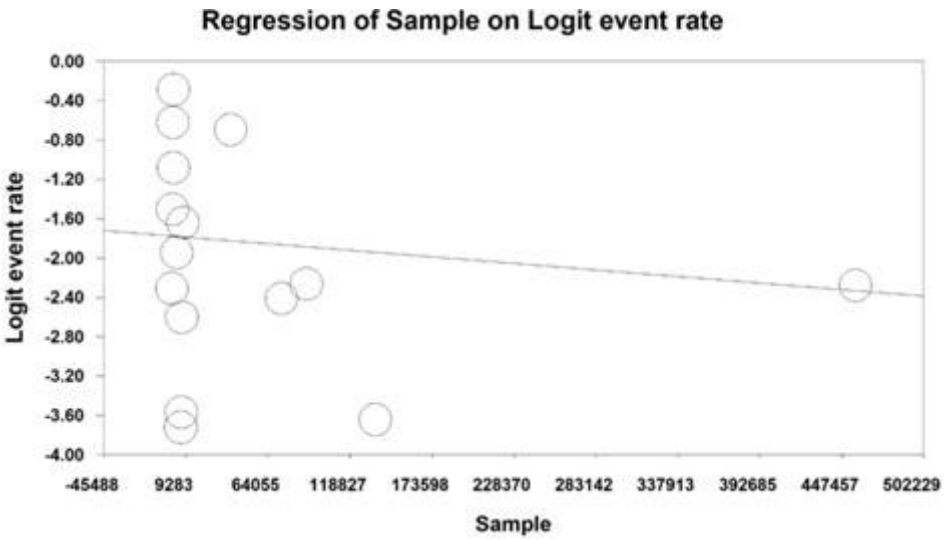
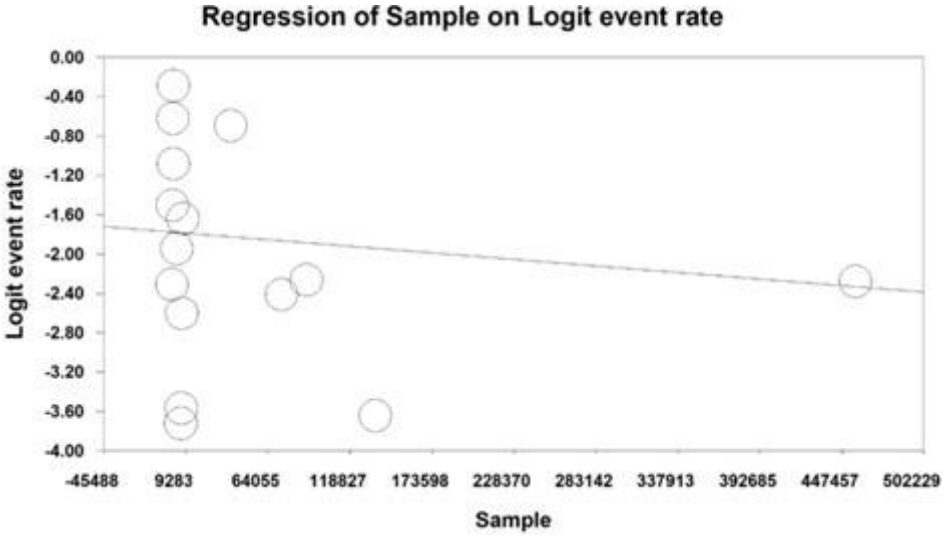


Figure 4

Meta-Regression of the relationship between sample size and prevalence of urinary tract infection in type 2 diabetic patients



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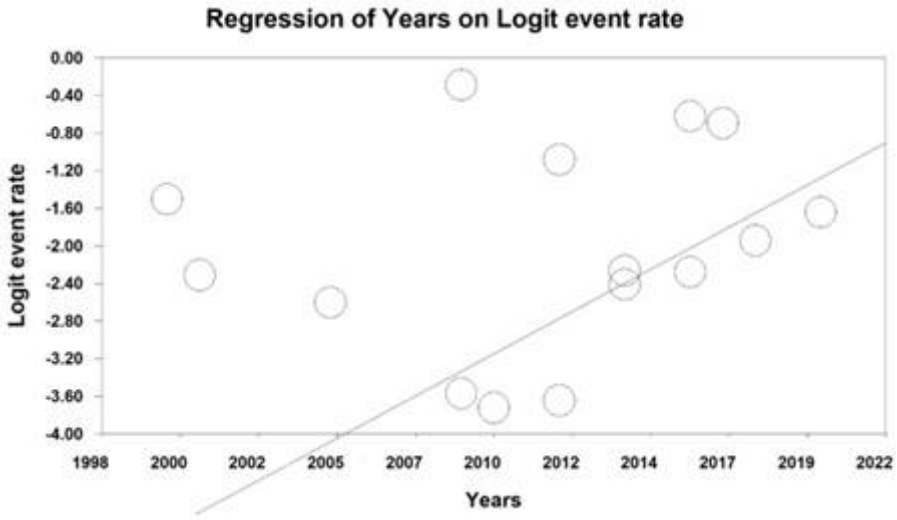
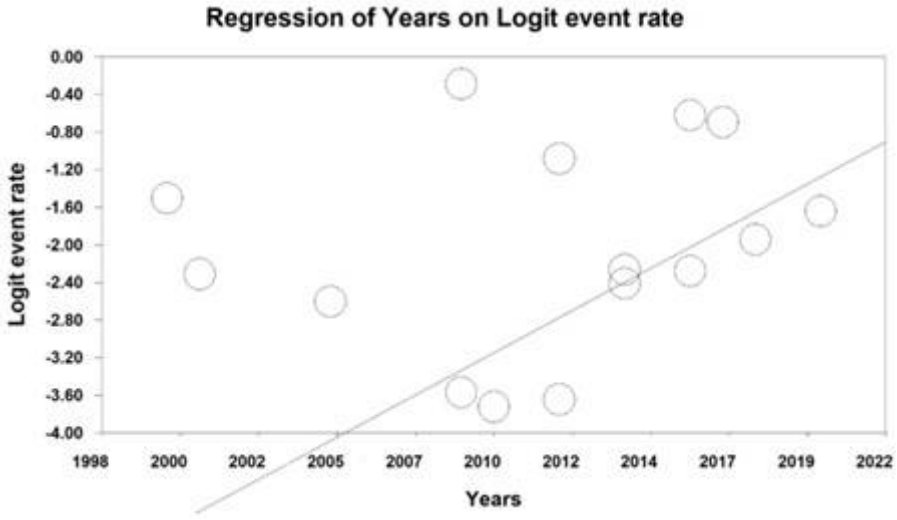


Figure 5

Meta- Regression between the year of study and the prevalence of urinary tract infection in type 2 diabetic patients



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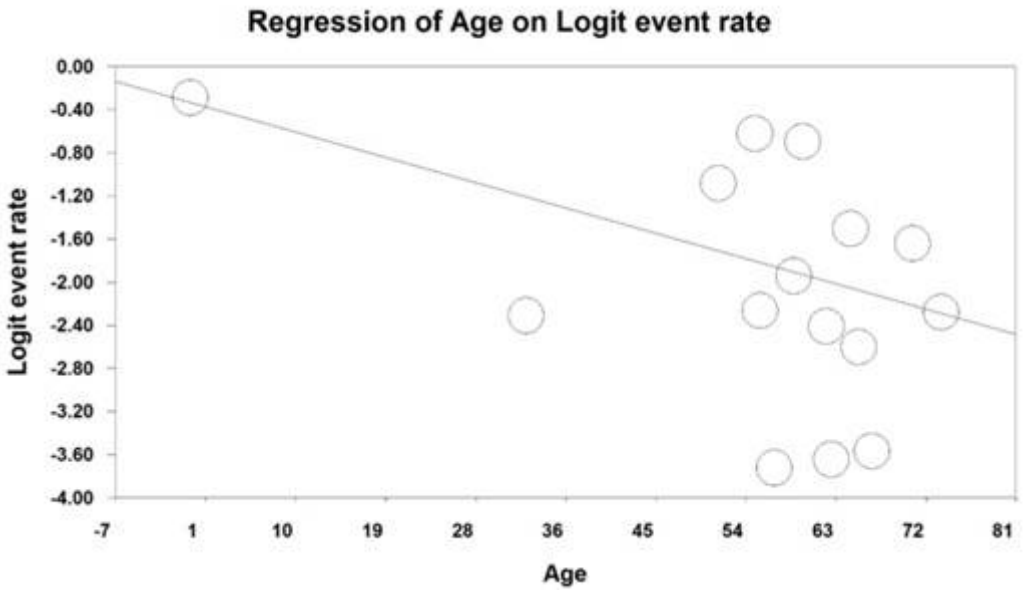
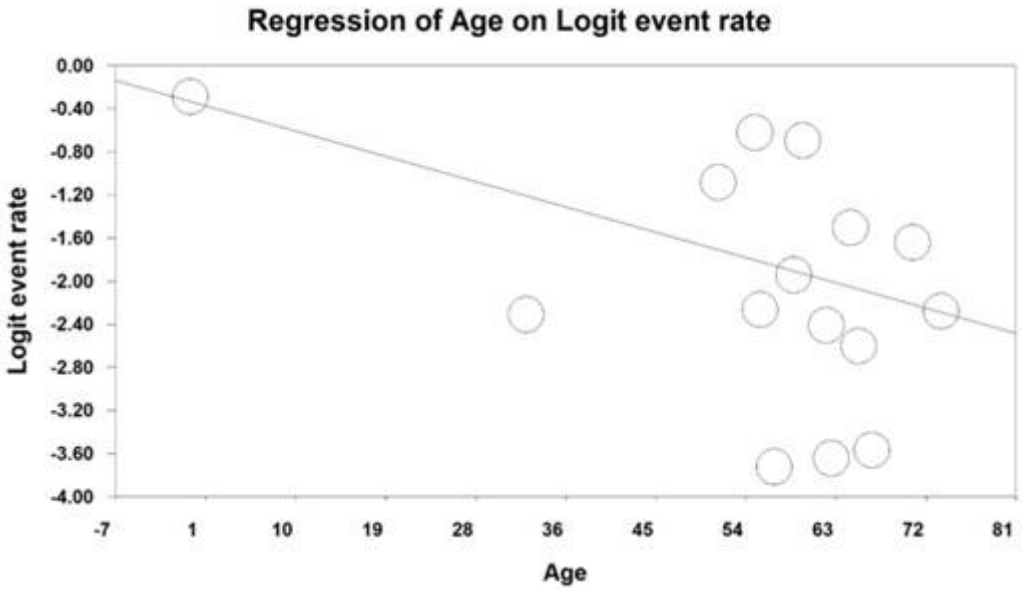


Figure 6

Meta- Regression between participants' age in the study and prevalence of urinary tract infections in type 2 diabetic patients



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