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Review

Complications of type 2 diabetes in Iranian population: An updated systematic review and meta-analysis

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ABSTRACT

Complications among patients with type 2 diabetes mellitus (T2DM) have increased dramatically through two past decades. Thus, the aim of this updated systematic review and meta-analysis was to estimate the pooled prevalence of T2DM complications in Iranian patients. Using Medical Subject Headings terms, Emtree, and related equal Persian key words, international databases including PubMed, ISI/WOS, Scopus, Iran Medex, SID, Magiran, Irandoc, Medlib, domestic databases were searched from January 1990 till January 2018 reporting prevalence of any complications of type 2 diabetes in Iran. All the keywords were searched electronically by two Boolean operators through the explained search strategy, separately. Relevant additional articles were identified from the lists of the retrieved articles. Random and fixed effect meta-analysis was used to estimate the pooled prevalence of complications in Iranian patients with T2DM. Through searching steps, among 1238 publications retrieved from literature search, finally 45 studies met the inclusion criteria for meta-analysis, with number of 30679 participants. According to random effect, the estimated pooled prevalence of diabetic foot ulcer, cardiovascular disease, retinopathy, neuropathy and nephropathy in Iranian patients with T2DM were 3%(95% CI: 1–5%), 33%(95% CI: 16–49%), 36%(95% CI: 27–45%), 38% (95% CI: 14–63%), and 43% (95% CI: 27–60%), respectively. This updated meta-analysis shows that prevalence of major microvascular complications of T2DM in Iran is high. Our findings provide practical evidence for better planning and clinical decision making.

1. Introduction

Diabetes is responsible to more than 1,200,000 death in 2010 across the world, and assigned attributed mortality has doubled compared to estimations of 1990(1, 2). Burden of Diabetes is a serious warning for urgent action plan across the world. complications among patients with type 2 diabetes has increased dramatically through two past decades [3].

In Iran different evidences shown a progressive considerable

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prevalence of diabetes in the age range 25–64 years Iranians [4,5]. According to the World Health Organization predict, if current trends continues, there will be 5.2 million people with diabetes mellitus in 2025 in Iran [5].

Diabetes mellitus is the leading cause of adult blindness, non-traumatic lower limb amputations and advanced kidney disease that mostly leads to dialysis and kidney transplantation [6–8]. More over patients with type 2 diabetes are 2–4 times more likely to develop cardiovascular diseases [8,9], and about 2–5 times higher risk of death from these conditions [8,10].

Despite of priority of problem, In Iran, there are very limited study on health problems associated with diabetes [10]. Recent review study in Iran not measured all complications of diabetes [11,12].

For better policy it is necessary to have more evidences in order to provide sufficient guide for preventive programs. However, there have been some scatter studies in different parts of country, we performed this systematic review in addition meta-analysis to have more precise estimate of prevalence of complications of type 2 diabetes.

2. Methods

2.1. Search strategy

In order to identify prevalence of macro- and micro-vascular complications among patients with type 2 diabetes in Iranian population, through systematic search strategy, three international databases including, PubMed, ISI/WOS, Scopus, Iran Medex, SID, Magiran, Irandoc, and Medlib searched. The search terms were developed concentrating on prevalence of type 2 diabetes macro- and/or micro-vascular complications, including nephropathy, retinopathy, neuropathy or cardiovascular and peripheral vascular complications such as hypertension, in Iranian type 2 diabetic patients, Iran. Data was refined for national, provincial, district, community population-based studies, human subject, and without restriction on language and time. There was no limitation on age groups (Table 1).

2.2. Inclusion and exclusion criteria

The selection criteria of the articles were [1]: published in a peer-reviewed journal as an original research article [2]; only the T2DM subjects who developed any complication were captured [3]; English language article; and [4] Subjects who only reside in Iran. The articles were excluded if [1]: study population is a mix of T1DM and type 2 diabetes (T2DM); and [2] if it was not possible to determine the frequency of complication in T2DM [3]; the diabetes subtype, which is included in the study is not clear; and [4] the articles were in a language other than English.

2.3. Data management

The bibliographic information of retrieved studies was transformed on Endnote software for further reference management. Through three steps of data refinement, including titles, abstracts and full texts review, all of processes follow by two independent experts. Possible disagreements were resolved by discussion and consensus.

2.4. Quality assessment and data extraction

The quality assessment and data extraction of eligible remained papers has been conducted independently by two independent research experts and probable discrepancy between them resolved through referencing the third expert opinion. Quality assessment of general information about citation, publication year, study year, place of study, type of study, population characteristics and methodological criteria (sample size, mean age, type of measure, results of measures and other information). that was approved previously. Using Cohen's kappa statistic, agreement between the results of quality assessment of two experts was 0.92.

Data were collected according to a standard protocol including for citation, place of study, type of study, study year, publication year, sample size, age range, measures, mode of reporting, and gender were extracted based on studied groups.

Table 1
Search strategy.

PubMed/Medline

((((Diabet*[tiab] OR "Diabetes Mellitus"[Mesh] OR "Diabetes Mellitus"[tiab]) AND ("Kidney Diseases"[Mesh] OR "Kidney Diseases"[tiab] OR Neuropathy[tiab] OR Nerve Damage[tiab] OR "Ketones"[Mesh] OR Ketones [tiab] OR "Diabetic Ketoacidosis"[Mesh] OR "Diabetic Ketoacidosis"[tiab] OR DKA[tiab] OR "Ketosis"[Mesh] OR Ketosis [tiab] OR "Hypertension"[Mesh] OR "Hypertension"[tiab] OR "High Blood Pressure"[tiab] OR "Eye Insight"[tiab] OR "Retinal Diseases"[Mesh] OR "Retinal Diseases"[tiab] OR retinopathy [tiab] OR "Stroke"[Mesh] OR Stroke[tiab] OR CHD[tiab] OR "Cardiovascular Diseases"[Mesh] OR "Cardiovascular Diseases"[tiab] OR "Hyperglycemic Hyperosmolar Nonketotic Coma"[Mesh] OR HHNS[tiab] OR "Hyperosmolar Hyperglycemic Nonketotic Syndrome"[tiab] OR "Gastroparesis"[Mesh] OR Gastroparesis [tiab] OR "Foot Ulcer"[Mesh] OR "Foot Ulcer"[tiab] OR "Amputation"[Mesh] OR Amputation [tiab] OR "Poor Circulation"[tiab])) AND (Prevalence[tiab] OR Epidemiology [tiab] OR Frequency[tiab])) AND (iran[tiab] OR iran[pl] OR iran[ad])) AND 1990/01/01[DP]:2017/10/20[DP]

ISI Web of Science

TI = ((Diabetes OR "Diabetes Mellitus, Type 1" OR "Diabetes Mellitus, Insulin Dependent" OR "Diabetes Mellitus, Type I" OR "Type 1 Diabetes Mellitus" OR "Type 1 Diabetes" OR "Diabetes, Type 1" OR IDDM OR "Diabetes Mellitus, Type 2" OR "Diabetes Mellitus, Type II" OR NIDDM OR "Diabetes Mellitus, Noninsulin Dependent" OR "Type 2 Diabetes Mellitus" OR "Type 2 Diabetes" OR "Diabetes, Type 2" OR "Diabetes Mellitus, Adult-Onset") AND (Neuropathy OR "Nerve Damage" OR Ketones OR DKA OR Ketoacidosis OR Nephropathy OR "Kidney Disease" OR "High Blood Pressure" OR Hypertension OR "Eye Insight" OR retinopathy OR Stroke OR CHD OR "cardiovascular disease" OR "Heart Disease" OR "Hyperosmolar Hyperglycemic Nonketotic Syndrome" OR HHNS OR Gastroparesis OR "Foot Complications" OR "Foot Ulcers" OR Amputation OR "Poor Circulation" OR Calluses) AND (Prevalence OR Epidemiology OR Frequency) AND (Iran)) AND PY=(1990–2018)

Scopus

(TITLE-ABS-KEY (Diabetes) OR TITLE-ABS-KEY **(**"Diabetes Mellitus, Type 1") OR TITLE-ABS-KEY **(**"Diabetes Mellitus, Insulin Dependent"**)** OR TITLE-ABS-KEY ("Diabetes Mellitus, Type I") OR TITLE-ABS-KEY **(**"Diabetes Mellitus, Type I"**)** OR TITLE-ABS-KEY ("Type 1 Diabetes Mellitus") OR TITLE-ABS-KEY("Type 1 Diabetes") OR TITLE-ABS-KEY("Diabetes, Type 1") OR TITLE-ABS-KEY**(**IDDM**)** OR TITLE-ABS-KEY**(**"Diabetes Mellitus, Type 2"**)** OR TITLE-ABS-KEY**(**"Diabetes Mellitus, Type II"**)** OR TITLE-ABS-KEY**(**NIDDM**)** OR TITLE-ABS-KEY**(**"Diabetes Mellitus, Noninsulin Dependent"**)** OR TITLE-ABS-KEY("Type 2 Diabetes Mellitus") OR TITLE-ABS-KEY("Type 2 Diabetes" OR "Diabetes, Type 2"**)** OR TITLE-ABS-KEY("Diabetes Mellitus, Adult-Onset") AND TITLE-ABS-KEY**(**Neuropathy**)** OR TITLE-ABS-KEY("Nerve Damage"**)** OR TITLE-ABS-KEY**(**Ketones) OR TITLE-ABS-KEY(DKA) OR TITLE-ABS-KEY **(**Ketoacidosis) **OR** TITLE-ABS-KEY (Nephropathy) OR TITLE-ABS-KEY ("Kidney Disease") OR TITLE-ABS-KEY ("High Blood Pressure") OR TITLE-ABS-KEY (Hypertension) OR TITLE-ABS-KEY ("Eye Insight") OR TITLE-ABS-KEY (retinopathy) OR TITLE-ABS-KEY (Stroke) OR TITLE-ABS-KEY (CHD) OR TITLE-ABS-KEY ("cardiovascular disease") OR TITLE-ABS-KEY ("Heart Disease") OR TITLE-ABS-KEY ("Hyperosmolar Hyperglycemic Nonketotic Syndrome") OR TITLE-ABS-KEY (HHNS) OR TITLE-ABS-KEY (Gastroparesis)OR TITLE-ABS-KEY ("Foot Complications") OR TITLE-ABS-KEY ("Foot Ulcers") OR TITLE-ABS-KEY (Amputation) OR TITLE-ABS-KEY ("Poor Circulation") OR TITLE-ABS-KEY (Calluses) AND TITLE-ABS-KEY**(**Prevalence**)** OR TITLE-ABS-KEY(Epidemiology) OR TITLE-ABS-KEY(Frequency) AND TITLE-ABS-KEY (Iran)**)** AND (PUBYEAR > 1990 AND PUBYEAR < 2018)

2.5. Statistical analysis

The results were presented as prevalence and 95% confidence interval. Heterogeneity of reported prevalence between studies was assessed by the chi square-based Q test and the I square statistics. The result of the Q test was regarded to be significant when P value was less than 0.10. Due to severe heterogeneity among studies regarding reported values, pooled prevalence was estimated using a random-effect meta-analysis model (using the DerSimonian and Laird method). We undertook a meta-regression analysis of those studies with appropriate data. Forest plot was used to present results of the meta-analysis schematically. The analyses were conducted using the Stata (version 12.0, Stata Corp LP, College Station, TX, USA).

3. Results

We refined data for Prevalence of macro- and micro-vascular complications among patients with type 2 diabetes in Iranian population. Based on our search strategy we found 1238 records; of them 1238 were from international databases and the remaining 40 were obtained from national databases. After removing duplicates, via the refining steps, only 45 articles were remained to be included in the meta-analysis. The flow diagram of the study selection process is shown in Fig. 1.

Table 2 shows the characteristic of included studies which twenty six studies were reported prevalence of retinopathy [13–38], eight studies were reported nephropathy [21,27,36,37,39–42], neuropathy was reported in nine studies [21,27,36,43–48], two other studies were reported diabetic foot ulcer [49,50], and eight studies were reported cardiovascular disease [37,38,51–56]. As it is shown in Table 2 there was a wide range for reported of prevalence of complications. The prevalence rate of retinopathy varied from 9% to 89% through different provinces. Also the prevalence rate of nephropathy varied from 14.3% to 92% through different provinces. The results of subgroup analysis based on the method of diagnosis shown in Table 3 (quality assessment shown in Table 4).

Results of meta-analysis (random effect) shown that the pooled prevalence of nephropathy, neuropathy, retinopathy, cardiovascular disease, and diabetic foot ulcer in patients with diabetes were 43% (27–60%), 38%(14–63%), 36%(27–45%), 33%(16–49%), and 3%(1–5%), respectively (Figs. 2–6).

3.1. Meta regression

Meta regression was used to explore the sources of between-study heterogeneity, including method of data collection and sample size. According to the results, prevalence of retinopathy, neuropathy, nephropathy, diabetic foot ulcer and cardiovascular were not related to age ($P > 0.10$) and sample size ($P > 0.10$).

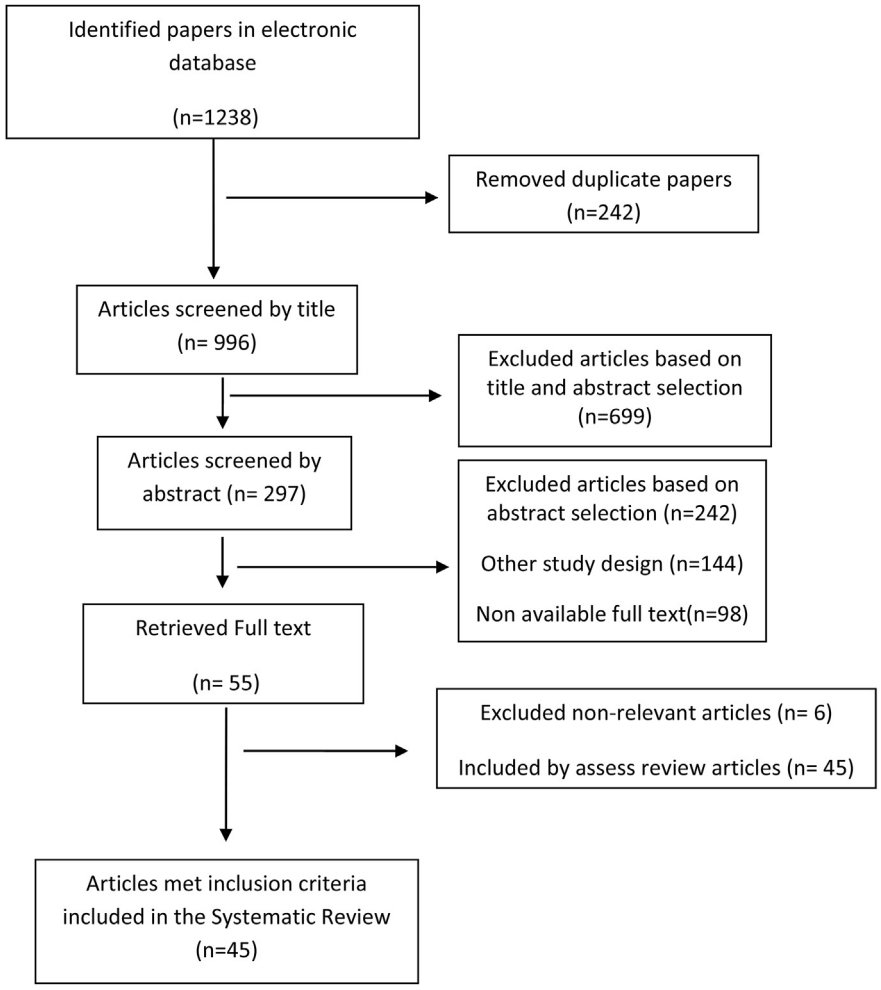

Fig. 1. Papers search and review flowchart for selection of primary study.

Table 2
The characteristic of included studies.

Study	sample Size	Gender	Age mean/Range	clinical finding	other controlled variable	Method of data collection	Prevalence %				
							Nephropathy	Neuropathy	Retinopathy	Diabetic foot	Cardiovascular disease
Abdollahi, A. et al. (2006) [12]	152	M: 60 (39.5%), F: 92 (60.5%)	T: 48.8 ± 11.8	Retinopathy	age, duration of disease, fasting plasma glucose, HbA1c, and systolic blood pressure	Questionnaire	–	–	14% (9–19)	–	–
Abdollahi, A. et al. (2009) [55]	100	M: (49.0%), F: ((51.0%)	T: 58.1 ± 8.5	Retinopathy	duration of diabetes, HbA1c, DPN,	Questionnaire	–	–	73% (64–82)	–	–
Alavi, A. et al. (2009) [56]	247	M: 56 (23%), F: 191 (77%)	T: 52 ± 12	callus formation	Callus, Ulcer, Dermopathy, Heel crack, Stroke, Dry skin, Claw toe, Hammer toe, Nail Discoloration, Heart problem, Thickened nail fasting blood sugar	Physical examination, questionnaire	–	–	–	4% (2–6)	–
Khazai, MH. et al. (2010) [48]	200	M: 66 (33%), F: 134 (67%)	T: 44.8 ± 5.8	Diabetic foot ulcer	abnormal diastolic blood pressure, abnormal systolic blood pressure, TG, HDL-c,LDL-c, BMI	Interview and physical examination	–	–	–	2% (0–4)	–
Amini, M. et al. (2008) [13]	710	M: 286 (40.3%), F: 424 (59.7%)	T: 48.8 ± 9.8	Retinopathy	FPG, 2hpp, HBA1C, cholesterol, TG, HDL-c,LDL-c, BMI, systolic and diastolic blood pressure, median of 24-h urinary albumin	Physical examination	–	–	9% (7–11)	–	–
Amini, M. et al. (2007) [57]	558	M: 111 (22%), F: 394 (78%)	T: 57.5 ± 9.5	Microalbuminuria	Retinopathy, hypertension, HbA1c,SBP	Questionnaire and physical examination	92% (90–94)	–	–	–	–
Askarishahi, M. et al. (2011) [58]	459	–	T: 47.2 ± 4.8	Retinopathy	Retinopathy, hypertension, HbA1c	Questionnaire and physical examination	–	–	41% (31–45)	–	–
Askarishahi, M. et al. (2012) [16, 58]	459	–	T: 55.0 ± 9.9	Retinopathy	age (year), gender, duration of diabetes (year), smoking status (yes, no), history of family diabetes (yes, no) and the mode of treatment (oral, insulin) and Body mass index (BMI)	Questionnaire and physical examination	–	–	41% (37–47)	–	–
Bonakdaran, S. et al. (2011) [85]	752	M: 355 (47.2%), F: 397 (52.8%)	T: 58.2 ± 10.3	Cardiovascular r risk factors	HbA1C, total cholesterol, TG/HDL ratio, Microalbuminuria, Macroalbuminuria, retinopathy, Uric acid, Creatinine	physical examination	–	–	–	–	52% (48–55)
Dehghan, M.H. et al. (2015) [60]	539	–	T: 54.16 ± 10.18	Retinopathy	HbA1C, duration of diabetes, systolic and diastolic blood pressure	Laboratory evaluations	–	–	12.7%(10–14)	–	–
Esteghamati, A. et al.(2007) [19]	66	M: 26 (%), F: 40(%)	T: 57.00 ± 9.50	microvascular complications	urodynamic parameters	Physical examination	32% (21–44)	71% (60–82)	36% (28–44)	–	–
Forouzandeh, F. et al.(2005) [61]	142	M: (58.5%), F: (41.5%)	T: 57.10 ± 11.37	Neuropathy	BMI, duration of diabetes	Questionnaire	–	26% (20–31)	–	–	–
Ghaffari, M.A. et al.(2014) [62]	308	M: 134 (43.5%), F: 174 (56.5%)	T: 53.6 ± 5.3	Coronary artery disease	CRP, glucose and lipid profile, Body mass, smoking, MI in recent 3 months, Hypertention	Questionnaire	–	–	–	–	49% (43–55)

(*continued on next page*)

Table 2 (*continued*)

Study	sample Size	Gender	Age mean/Range	clinical finding	other controlled variable	Method of data collection	Prevalence %				
							Nephropathy	Neuropathy	Retinopathy	Diabetic foot	Cardiovascular disease
Golbahar, J. et al. (2008) [63]	254	M: 102 (40.1%), F: 152 (59.9%)	T: 55.8 ± 8.7	Retinopathy	BMI, duration of diabetes, Hypertention, smoking, HbA1C, total cholesterol, Uric acid, Creatinine	Questionnaire and physical examination	–	–	48.8%(43–55)	–	–
Heydari, B. et al. (2012) [17]	1022	–	–	Retinopathy	blood pressure and blood biochemical parameters, fasting blood sugar, blood urea nitrogen, and level of HbA1c, duration of diabetes	Questionnaire and physical examination	–	–	24%(21–26)		–
Horri, N. et al. (2011) [64]	738	M: 522 (69.8%), F: 226 (30.2%)	T: 60.29 ± 10.3	Retinopathy (blind, low vision, Not impaired)	demographic characteristics, past history, family history, blood pressure, lipid profile, blood urea nitrogen (BUN), creatinin, HbA1c (glycosylated hemoglobin), urine albumin, the results of eye exams and of cardiovascular follow-ups	Questionnaire	–	–	12.0%(10–14)	–	–
Janghorbani, M. et al. (2004) [20]	3888	M: 1348(%), F: 2540 (%)	T: 52.0 ± 10.5	Cataract	age, age at diagnosis of diabetes, duration of diabetes, and smoking, Systolic and diastolic blood pressure, gender, HbA1, proteinuria, body mass index, cholesterol, triglyceride and creatinine	Questionnaire	–	–	33.1%(32–35)	–	–
Janghorbani, M. et al. (2005) [51]	3202	M: 1315 (69.8%), F: 1887 (30.2%)	T: 48.3 ± 10.6	Hypertension	systolic and diastolic blood pressure, duration of diabetes, body mass index (BMI), triglyceride, cholesterol and have lower proportion of proteinuria but have higher insulin-treated diabetes and slightly higher fasting blood glucose, HbA1	Questionnaire	–	–	–	–	61%(59–63)
Janghorbani, M. et al. (2003) [22]	549	M: 161(%), F: 388 (%)	T: 45.7 ± 9.3	Retinopathy	age, poor metabolic control and fasting blood glucose, Systolic and diastolic blood pressure, gender, smoking, proteinuria, body mass index and creatinine	Questionnaire	–	–	89.4% (87–92)	–	–
Janghorbani, M. et al. (2006) [52]	1566	M: 524(%), F: 1042 (%)	T: 50.6 ± 12.3	Coronary heart disease (CHD)	age, BMI, smoking, and insulin treatment, Gender, duration of diabetes, cholesterol and triglycerides	Questionnaire and self-reported medical history.	–	–	–	–	28%(26–30)
Janghorbani, M. et al. (2006) [66]	810	M: 289(%), F: 521(%)	T: 44.1 ± 10.2	Peripheral neuropathy	age, proteinuria, and duration of diabetes, insulin-treatment, and presence of any retinopathy and ischaemic heart disease (IHD)	Questionnaire	–	75% (72–78)	–	–	–

Kalantari, F. et al. (2007) [67]	219	M: 99(%), F: 120(%)	T: 22.5 ± 10.3	Cardiovascular disease (CVD) risk factors	dyslipidemia, smoking and hypertension, Serum cholesterol, LDL, HDL, TG, systolic blood pressure, diastolic blood pressure	Questionnaire and physical examination					8% (4–11)
Karamifar, H. et al. (2007) [68]	80	M: 34 (42.5%), F: 46 (57.5%)	T: 18.16 ± 5.22	Diabetic neuropathy	sex, HbAlc, puberty, parental consanguinity and family history of DM	Questionnaire	–	14% (6–21)	–	–	–
Kiani, J. et al. (2013) [69]	600	–	T: 53.26 ± 14.46	Diabetic peripheral neuropathy (DPN)	history of foot ulcer, age, duration of diabetes, weight, education level, and sex, systolic blood pressure, diastolic blood pressure, BMI	Questionnaire	–	46% (42–50)	–	–	–
Manaviat, M.R. et al. (2008) [86]	590	M: 244 (%), F: 346 (%)	T: 54.9 ± 10.2	Retinopathy	HbA1C, BMI, Fasting Blood sugar	Questionnaire	–	–	47.5% (39–56)	–	–
Manaviat, M.R. et al. (2008) [71]	199	M: 80 (%), F: 119 (%)	T: 54.16 ± 11.02	Diabetic retinopathy (DR)	age, sex, duration of diabetes, cigarette smoking	Questionnaire	–	–	70.3% (64–77)	–	–
Moayeri, H.et al. (2006) [72]	118	M: 58 (%), F: 60 (%)	T: 12.4 ± 4	Microalbuminuria	duration of DM, age, Hb A1c, blood pressure,sex, cholesterol and TG levels	Questionnaire and physical examination	19% (12–27)	–	–	–	–
Najafi, L. et al. (2013) [25]	243	M: 102 (42%), F: 141 (58%)	T: 55.80 ± 10.33	dry eye disease& microvascular complication	Hb A1c, creatinine, cholesterol, triglyceride and for 12 h urinary albumin and creatinine concentration sex, age, duration of diabetes, BMI, blood pressure, and the type of treatment for diabetes, fasting glucose, lipids and glycosylated hemoglobin (HbA1C), smoke, BMI	Questionnaire and physical examination	28% (22–33)	26% (20–31)	23% (18–28)	–	–
Pourmoghaddas, A.et al. (2003) [54]	200	M: 91 (%), F: 109 (%)	N/D	QTc prolongation	blood pressure	Questionnaire and physical examination	–	–	–	–	8% (4–12)
Razavi, Z. et al. (2009) [73]	105	M: 49 (%), F: 56 (%)	T: 13.3 ± 5.5	Microalbuminuria	age, sex, duration of the disease, stage of puberty, dose of insulin/kg/day, and blood pressure, protein, creatinine, and microalbumine	Questionnaire	14.3% (8–21)	–	–	–	–
Rohani, F. et al. (2014) [74]	62	M: 36 (%), F: 26 (%)	T: 13	pre-hypertensive stage in children with T1D	HbA1C, creatinine, microalbumine	Questionnaire and physical examination	–	–	–	–	26% (15–37)
Safaei, H. et al. (2006) [75]	710	M: 161 (37.4%), F: 269 (62.6%)	T: 53.8 ± 10.7	Neuropathy	FBS, HbA1c, lipid profile, urea, Creatinin, and 24 houre urin examniation for albumin	Laboratory evaluations	–	–	9%(7–11)	–	–
Shahbazian, H. et al. (2013) [76]	430	M: 45 (32.1%), F: 95 (67.9%)	T: 53.49 ± 9.72	Retinopathy	age, gender, duration of disease, fasting blood sugar (FBS), hemoglobin A1c (HbA1c), blood pressure (BP), method of diabetic control	Questionnaire	–	35% (30–40)	–	–	–

(*continued on next page*)

Table 2 (*continued*)

Study	sample Size	Gender	Age mean/Range	clinical finding	other controlled variable	Method of data collection	Prevalence %				
							Nephropathy	Neuropathy	Retinopathy	Diabetic foot	Cardiovascular disease
Soleymani, A. et al. (2012) [27]	140	M: (44%), F: (56%)	T: 53 ± 12	Peripheral neuropathy	Blood urea nitrogen,creatinine, total cholesterol, HDL,LDL, triglyceride	Questionnaire	–	–	36.4%(24–48)	–	–
Tabatabaei-Malazy, O. et al. (2011) [77]	124	M: 161 (37.4%), F: 269 (62.6%)	T: 53.8 ± 10.7	Neuropathy	sex, BMI, smoking	Questionnaires	–	54% (45–63)	–	–	–
Zakerkish, M. et al. (2013) [78]	350	–	–	Albuminuria	height, weight, and blood pressure, Blood urea nitrogen,creatinine, total cholesterol, HDL,LDL, triglyceride, and glycosylated hemoglobin	Questionnaire and physical examination	21% (16–25)	–	–	–	–
Vahabi, N. et al. (2015) [79]	623	M: 284 (45.6%), F: 339 (54.4%)	T: 59.9 ± 11.53	Retinopathy	Gender,height, weight, and blood pressure, Blood urea nitrogen, total cholesterol, HDL,LDL, triglyceride	Questionnaire and physical examination	–	–	38%(34–42)	–	–
Rasoulinejad, S.A. et al. (2015) [80]	1562	M: 357 (22.9%), F: 1205 (77.1%)	T: 54.6 ± 10.6	Retinopathy	Gender,height, weight, and blood pressure, Blood urea nitrogen, total cholesterol, HDL,LDL, triglyceride and Family History	questionnaire and physical examination	–	–	63.4%(61–66)	–	–
Ghodsi, R. et al. (2014) [29]	978	M: 357 (42.1%), F: 1205 (57.9%)	T: 47.7 ± 15.7	Retinopathy	Duration of disease, FBS, Hb A1C, Triglycerides, SBP, DBP	Physical examination	–	–	10.4% (8–12)	–	–
Yaghoubi, M.A. et al. (2014) [81]	342	M: 108 F: 234	–	Retinopathy	Duration of disease, FBS, Hb A1C, Triglycerides, SBP, DBP, Family History	Questionnaire and physical examination	–	–	30.4%(26–33)	–	–
Tazhibi, M. et al. (2014) [82]	3535	M: 1261 (35.7%), F: 2271(64.2%)	T: 52.57 ± 10.28	Retinopathy	FBS, Hb A1C, Triglycerides, SBP, DBP, Family History	Questionnaire and physical examination	–	–	53.4% (52–55)	–	–
Kohian, H. et al. (2013) [32]	625	–	T: 47.9 ± 11.7	Retinopathy	FBS, Hb A1C, Triglycerides, SBP, DBP	Physical examination	–	–	29.3% (26–33)	–	–
Mahmoudi, M. et al. (2013) [33]	1563	M: 443 (28.3%), F: 1120(71.7%)	T: 53.64 ± 11.83	Retinopathy	mean health literacy, education level,	Questionnaire and physical examination	–	–	12.1%(10–14)	–	–
Sadat Hosseini, M. et al. [83]	305	M: 144 (47.2%), F: 161(52.8%)	T: 53.90 ± 10	Nephropathy Neuropathy Retinopathy (Microvascular)	Duration of Diabetes BMI hemoglobin	Laboratory evaluations	77%	44.6%	35.7%	–	–
Mansournia, N. et al. (63)	255	M: 137 (53.8%), F: 118(46.2%)	T: 62.5 ± 10.9	Nephropathy cardiovascular disease (CVD)	–	Laboratory evaluations and medical history	41.2%	–	–	–	30%

Table 3
Summary prevalence estimates [95% confidence intervals (CIs)] for cross sectional studies of the prevalence of Microvascular Complication in Iranian patients by Method of data collection.

Variables	Subgroup	Number of studies	Summery prevalence (95% CI)	Between studies		Between subgroups	
				I^2	$P_{heterogeneity}$	Q	$P_{heterogeneity}$
Nephropathy	Questionnaire	6	47% (13–82%)	99.7%	0.0001	3.05	0.0001
	Laboratory evaluation	3	25% (15–36%)	69.7%	0.069		
	Total	9	38% (14–63%)	99.6%	0.0001		
Retinopathy	Questionnaire & Physical examination	10	37% (24–51%)	99.5%	0.0001	7.99	0.0001
	Questionnaire	9	46% (27–65%)	99.7%	0.0001		
	Physical examination	4	20% (11–29%)	97.4%	0.0001		
	Laboratory evaluation	3	19% (7–30%)	97.6%	0.0001		
	Total	26	36% (27–45%)	99.6%	0.0001		
Neuropathy	Questionnaire & Physical examination	1	–	–	–	5.13	0.0001
	Questionnaire	6	42% (23–61%)	98.9%	0.0001		
	Physical examination	1	–	–	–		
	Laboratory evaluation	0	–	–	–		
	Total	8	43% (27–60%)	96.7%	0.0001		
Cardiovascular disease	Questionnaire & Physical examination	3	12% (5–18%)	79.8%	0.007	3.92	0.0001
	Questionnaire	3	46% (22–70%)	99.6%	0.0001		
	Physical examination	1	–	–	–		
	Laboratory evaluation	1	–	–	–		
	Total	8	33% (16–49%)	99.5%	0.0001		

Table 4
Quality assessment of included studies.

Study	Total score	Item $_1$	Item $_2$	Item $_3$	Item $_4$	Item $_5$	Item $_6$	Item $_7$	Item $_8$	Item $_9$	Item $_{10}$
Abdollahi, A. et al. (2006)	6	Y	N	Y	Y	Y	UC	UC	Y	Y	UC
Abdollahi, A. et al. (2009)	8	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA
Alavi, A. et al. (2009)	6	Y	Y	Y	Y	Y	NA	NA	Y	NA	N
Khazai, MH. et al. (2010)	5	Y	N	Y	Y	Y	UC	UC	Y	UC	NA
Amini, M. et al. (2008)	8	NA	Y	Y	Y	Y	Y	Y	Y	Y	N
Amini, M. et al. (2007)	5	NA	UC	Y	Y	Y	NA	UC	Y	Y	NA
Askarishahi, M. et al. (2011)	5	Y	UC	Y	Y	UC	UC	NA	Y	NA	Y
Askarishahi, M. et al. (2012)	6	Y	UC	Y	Y	Y	N	N	Y	Y	N
Bonakdaran, S. et al. (2011)	7	Y	N	Y	Y	Y	NA	Y	Y	Y	NA
Dehghan, M.H. et al. (2015)	6	Y	Y	Y	Y	Y	N	N	Y	NA	UC
Esteghamati, A. et al.(2007)	5	Y	Y	N	Y	Y	NA	NA	Y	N	N
Forouzandeh, F. et al.(2005)	6	Y	Y	Y	Y	Y	NA	UC	Y	N	UC
Ghaffari, M.A. et al.(2014)	7	Y	Y	Y	Y	Y	N	UC	Y	Y	NA
Golbahar, J. et al. (2008)	6	Y	Y	Y	Y	Y	Y	NA	UC	UC	UC
Heydari, B. et al. (2012)	6	Y	Y	Y	Y	Y	Y	N	NA	UC	NA
Horri, N. et al. (2011)	6	Y	Y	Y	Y	Y	Y	N	UC	UC	UC
Janghorbani, M. et al. (2004)	6	Y	Y	Y	Y	Y	Y	UC	UC	UC	N
Janghorbani, M. et al. (2005)	6	Y	NA	Y	Y	Y	Y	NA	Y	N	UC
Janghorbani, M. et al. (2003)	6	Y	N	Y	Y	Y	Y	NA	N	Y	NA
Janghorbani, M. et al. (2006)	8	Y	N	Y	Y	Y	Y	Y	Y	Y	NA
Janghorbani, M. et al. (2006)	5	Y	NA	Y	Y	Y	UC	UC	N	Y	NA
Kalantari, F. et al. (2007)	5	Y	N	Y	Y	Y	Y	NA	UC	UC	NA
Karamifar, H. et al. (2007)	8	Y	Y	Y	Y	Y	Y	Y	Y	N	NA
Kiani, J. et al. (2013)	7	Y	Y	Y	Y	Y	Y	NA	Y	UC	N
Manaviat, M.R. et al. (2008)	8	Y	Y	Y	Y	Y	Y	Y	Y	N	UC
Manaviat, M.R. et al. (2008)	8	Y	Y	Y	Y	Y	Y	Y	Y	N	UC
Moayeri, H.et al. (2006)	7	Y	Y	Y	Y	Y	Y	NA	Y	N	N
Najafi, L. et al. (2013)	5	Y	N	Y	Y	Y	UC	UC	UC	Y	UC
Pourmoghaddas, A.et al. (2003)	6	Y	NA	Y	Y	N	UC	Y	Y	Y	NA
Razavi, Z. et al. (2009)	5	Y	UC	Y	Y	Y	Y	NA	NA	N	NA
Rohani, F. et al. (2014)	3	Y	N	N	Y	Y	NA	NA	NA	N	NA
Safaei, H. et al. (2006)	5	Y	Y	Y	Y	Y	N	NA	N	N	NA
Shahbazian, H. et al. (2013)	5	Y	Y	Y	Y	Y	UC	NA	UC	NA	N
Soleymani, A. et al. (2012)	7	Y	Y	Y	Y	Y	Y	NA	Y	NA	N
Tabatabaei-Malazy, O. et al. (2011)	6	N	Y	Y	Y	Y	Y	NA	Y	NA	N
Zakerkish, M. et al. (2013)	6	UC	Y	Y	Y	Y	Y	NA	Y	UC	N
Vahabi, N. et al. (2015)	5	N	N	Y	Y	Y	Y	NA	Y	N	NA
Rasoulinejad, S.A. et al. (2015)	6	Y	N	Y	Y	Y	Y	UC	Y	UC	NA
Ghodsi, R. et al. (2014)	8	Y	UC	Y	Y	Y	Y	Y	Y	Y	NA
Yaghoubi, M.A. et al. (2014)	6	Y	N	Y	Y	Y	Y	UC	Y	UC	NA
Tazhibi, M. et al. (2014)	5	Y	N	Y	Y	Y	NA	NA	Y	NA	NA
Kohian, H. et al. (2013)	5	Y	N	Y	Y	Y	N	UC	Y	UC	NA
Mahmoudi, M. et al. (2013)	7	Y	N	Y	Y	Y	Y	NA	Y	Y	N

(*continued on next page*)

Table 4 (*continued*)

Study	Total score	Item $_1$	Item $_2$	Item $_3$	Item $_4$	Item $_5$	Item $_6$	Item $_7$	Item $_8$	Item $_9$	Item $_{10}$
Sadat Hosseini, M. et al.(	6	Y	N	Y	Y	Y	Y	N	Y	N	N
Mansournia, N. et al.	6	Y	N	Y	Y	Y	Y	Y	UC	N	NA

Item $_1$: Was the sample representative of the target population?.
Item $_2$: Were study participants recruited an appropriate way?.
Item $_3$: Was the sample size adequate?.
Item $_4$: Where the study subjects and setting described in detail?.
Item $_5$: Was the data analysis conducted with sufficient coverage of the identified sample?.
Item $_6$: Were objective, standard criteria used for measurement of the condition?.
Item $_7$: Was the condition measured reliably?.
Item $_8$: Was there appropriate statistical analysis?.
Item $_9$: Are all important confounding factors/subgroups/different identified and accounted for?.
Item $_{10}$: Were subpopulations identified using objective criteria?.
Y: Yes, N: No, UC: Unclear, NA: Not applicable.

4. Discussion

Results of meta-analysis shown that the pooled prevalence of diabetic foot ulcer, cardiovascular disease, retinopathy, neuropathy and nephropathy in Iranian patients with T2DM were 3%(95% CI: 1–5%), 33%(95% CI: 16–49%), 36%(95% CI: 27–45%), 38% (95% CI: 14–63%), and 43% (95% CI: 27–60%), respectively. This is an updated systematic review on reported prevalence of macro- and microvascular complications among patients with type 2 diabetes in Iranian population, according to sex, age, and levels of reported values. In our study, a total of 45 studies were eligible for inclusion. In this study, the point estimate of diabetes complications, including nephropathy, neuropathy, retinopathy, heart diseases and diabetic foot ulcers, was estimated. Amini et al. [12] found the prevalence rate of diabetes complications by conducting a systematic review, but in their study, no meta-analysis was carried out and the results were reported qualitatively. In the present study, the prevalence of diabetes complications was extracted from other studies and an estimate of the point estimate of these complications in Iran was reported. In this study, the point estimate of nephropathy in Iran was 43% (27–60%).The rate of prevalence of nephropathy ranged between 14% and 92% which is similar with other international reports [57–59]. This variation could be explained due to different measuring of nephropathy and its diagnosis and different sample size of included studies. According to the results of this systematic and meta-analysis review, nine studies reported the prevalence of neuropathy in Iran with the prevalence ranged of 14–71%, which was also a wide range. The reason was not only the differences in methodologies and the demographic factors in the patients, but also the difference in the screening methods. A study conducted by Janghorbani et al. [45] in Isfahan reported the prevalence of neuropathy to be 75%. Furthermore, various studies in Tehran reported the prevalence of about 33% [12,48,60]. Based on the results of this study, the prevalence of retinopathy in diabetic patients in Iran was 36%, with a wide range. The prevalence of diabetic retinopathy in previous studies which conducted in Iran ranged from 26.6% to 96.3%. The could be due to the subjects' characteristics and the diagnostic criteria for

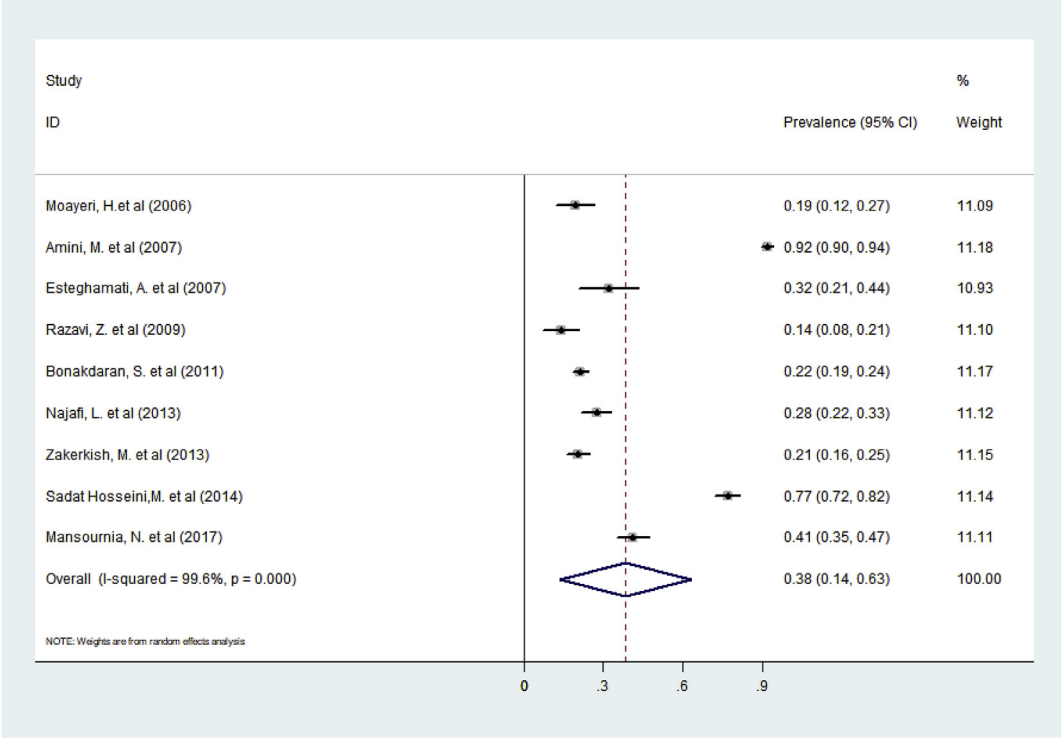

Fig. 2. Forest plot showing prevalence of diabetic Nephropathy among diabetic patients in Iran.

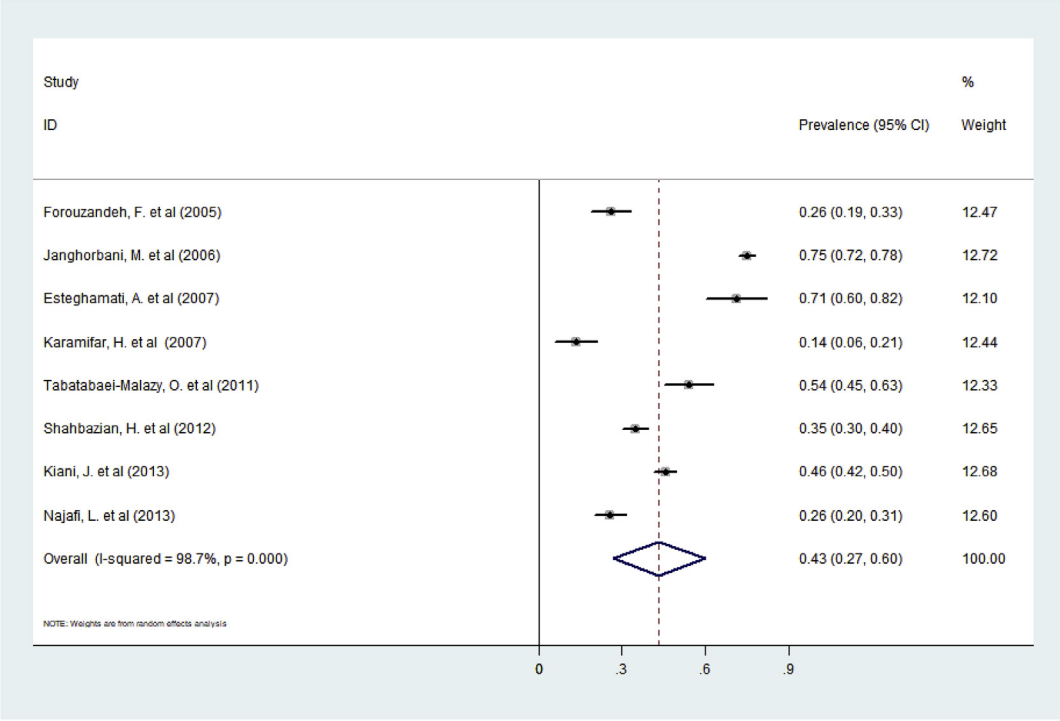

Fig. 3. Forest plot showing prevalence of diabetic Neuropathy among diabetic patients in Iran.

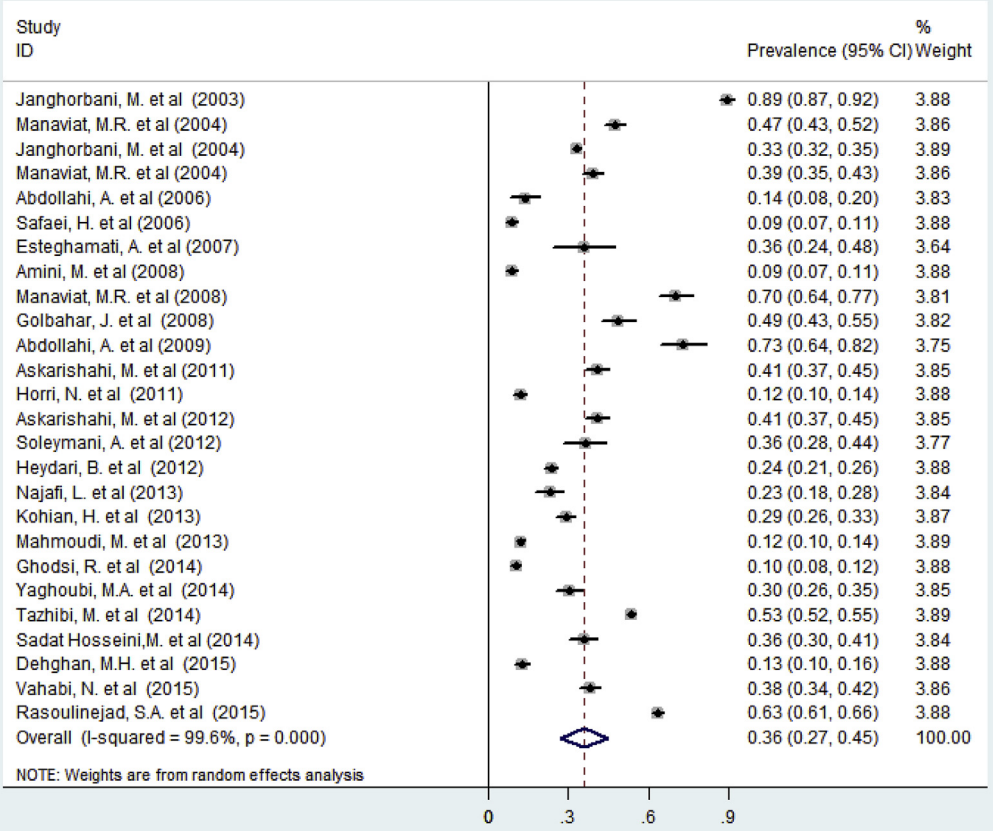

Fig. 4. Forest plot showing prevalence of diabetic Retinopathy among diabetic patients in Iran.

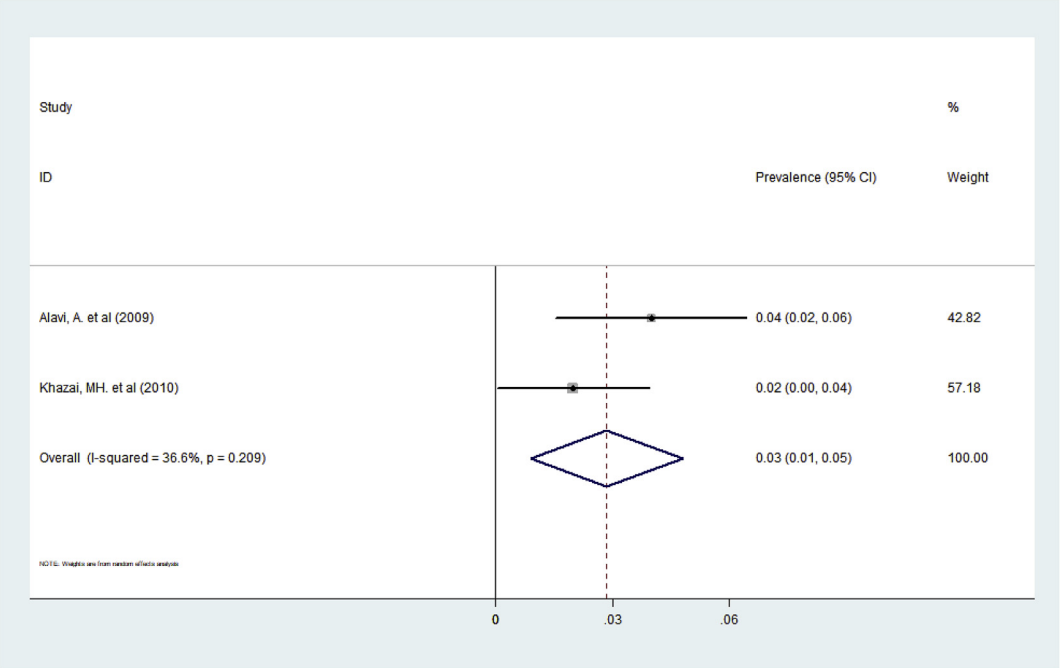

Fig. 5. Forest plot showing prevalence of Diabetic foot ulcer among diabetic patients in Iran.

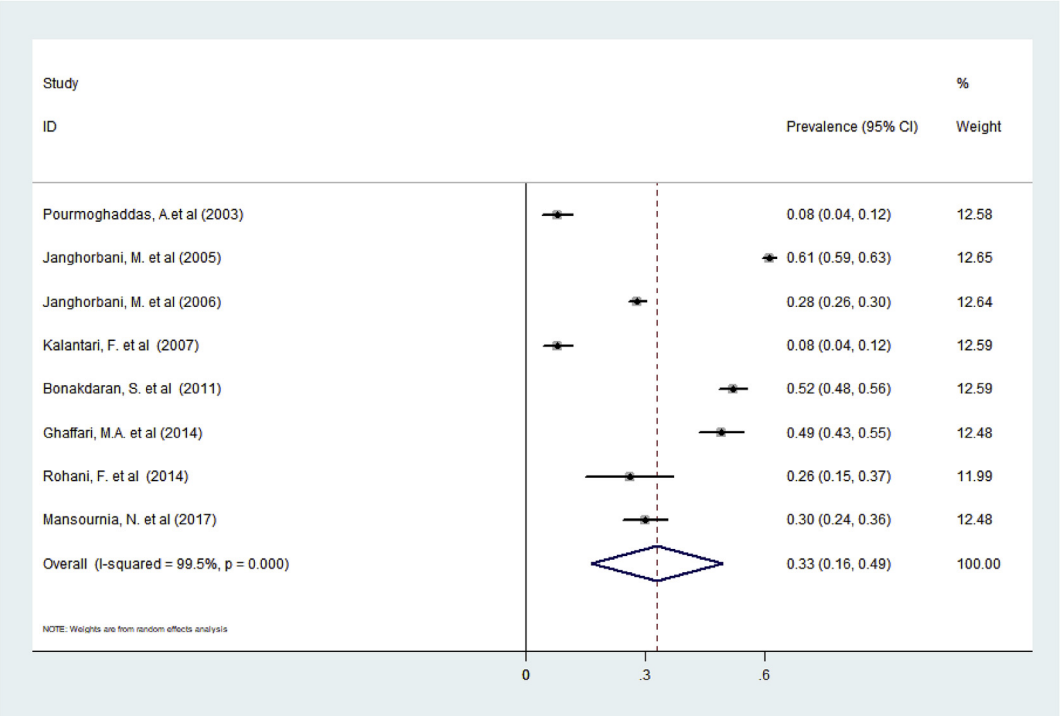

Fig. 6. Forest plot showing prevalence of Cardiovascular disease among diabetic patients in Iran.

retinopathy could be attributed to this wide range.

The incidence of cardiovascular diseases in people with diabetes is more likely than in non-diabetic individuals [61]. According to the results of this study, the prevalence of cardiovascular diseases in diabetic patients was 33% in Iran with a range of 16%–49%. One reason for the high prevalence rate of these diseases in diabetic patients is the lack of controlling confounding factors such as high triglycerides, low mobility, gender, and so on. Based on the results of the study by Lehmann et al. [62], increased Triglyceride levels were one of the most important and effective factors in the incidence of cardiovascular diseases in diabetic patients compared to non-diabetic ones. In Iran, few studies have been conducted on the prevalence of the complications of diabetic foot ulcers. As indicated in this study, the number of articles published from 1990 to 2018 on

the prevalence of diabetic foot ulcers was 2, which is fewer than the studies on the prevalence of other complications. Therefore, it is recommended to do some studies on the prevalence of these complications in Iran. Of course, the reason for the limited number of the studies in this area can be the hard diagnosis of diabetic foot ulcers or high costs of doing diagnostic tests. Considering the previous studies, the present study has several achievements. This study presents scientific evidences to depict prevalence of macro- and micro-vascular complications among patients with type 2 diabetes in Iranian population. All available sources of data and domestic data-bases were searched using English/Persian equivalent search terms. As the main limitation, the validity and applicability of our systematic review depends on the quality of the primary studies that are included. As another point, heterogeneity of searched results limits the generalization of our findings.

5. Conclusion

According to our knowledge, this is the updated systematic review of prevalence of nephropathy, neuropathy, retinopathy, diabetic foot ulcer, and cardiovascular disease among patients with type 2 diabetes in Iranian population that provide practical information for better planning. There was considerable variation in selection of designs and measures and reported values. Results could be useful for better health policy and more planned studies in this field. These also can be used for future complementary researches.

Conflicts of interest

The authors declare that they have no competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.05.018.

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