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Prevalence of anti-diabetic medication adherence and determinant factors in Ethiopia: A systemic review and meta-analysis, 2019

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A B S T R A C T

Background: Adherence to antidiabetic medication is the challenge in diabetes treatment. However, from Ethiopia, there are some studies with variability and inconsistency findings. Therefore, the aim of this study was to estimate the pooled prevalence of anti-diabetic medication adherence among diabetic patients in Ethiopia.

Methods: In this systematic review and meta-analysis, we intensely searched PubMed, Google Scholar, Science Direct and Google. To assess the pooled prevalence, studies describing the prevalence of anti-diabetic medication adherence and its determinants were included. Data were extracted by a standardized data extraction format prepared in Microsoft Excel and transferred to STATA 11 statistical software for analysis. Cochrane Q test statistics and I2 test were used to check heterogeneity. Studies were exhibited considerable heterogeneity, so a random effect model was used to the Poole prevalence of anti-diabetic medication adherence. Finally, the link between the factors and anti-diabetic medication adherence was assessed.

Results: The pooled prevalence of adherence of the anti-diabetic medication in Ethiopia, was 69.5% (95% CI (61.1, 78.0)). The subgroup analysis of this study showed that the highest prevalence was from SNNP region, 88.2% (95% CI: 80.5, 95.9%), followed by studies in Addis Ababa 78.7% (95% CI: 68.8, 88.5). Older age (OR: 1.8, 95% CI: (1.3, 2.6)) and rural residence (OR: 4.9: 95% CI: (1.7, 14.0)) were found to be determinants of anti-diabetic adherence.

Conclusion: The overall pooled prevalence of anti-diabetic adherence in Ethiopia, was somewhat low. Age and rural residency were the main determinants of anti-diabetic adherence in Ethiopia.

1. Introduction

Diabetes mellitus (DM) is a group of metabolic disorder characterized by increased blood glucose level resulting from the absence or impaired insulin secretion and variable degrees of peripheral insulin resistance. It is the leading endocrine disorder worldwide (Joslin et al., 2005; Alberti and Zimmet, 1998; Organization, 1999). Globally, there are 382 million people with diabetes in 2013 and this is expected to rise to 592 million by 2035 (Guariguata et al., 2014). Most people with diabetes live in low and middle-income countries (Whiting et al., 2011). In developing countries, the magnitude of the DM was 3.3% (Animaw and Seyoum, 2017). Anti-diabetic drug therapy plays a pivotal role in the glycemic control of patients with diabetes, which depends on patient's adherence to anti-diabetics that realized by controlling the raised glycemic and early inhibiting its consequences (Farsaei et al., 2011). Adherence to ordered anti-diabetic is one of the main dimensions of health service excellence, which is described as the proportion of the ordered doses of the drug actually taken by a patient over a specified period of occasions or the extent to which an individual is taking their medication as instructed by a health care professional (Osterberg and Blaschke, 2005; Organization, 2003).

The World Health Organization emphasized that "rising the effectiveness of anti-diabetic adherence intervention may have a huge impact on the health of the population than any improvement with definite medical treatment" (Organization, 2003). People with diabetes have a high risk of developing a lot of serious health problems; in fact of that poor glycemic control level can affect multiple organs. Uncontrolled blood glucose is the leading causes of cardiovascular diseases, blindness, kidney failure, and lower limb amputation (Joslin et al., 2005; Gregg et al., 2014). Poor glycemic control is due to lack of health insurance, using two or more hypoglycemic agents, and having normal body mass index (Kamuhabwa and Charles, 2014). Intensive anti-diabetic therapy, early screening, and diagnosis, encouraging a healthy diet, performing a regular checkup and diabetic health education are vital in reducing diabetic complications (Astrup, 2001; Association, 2010; Control and Group, 1993).

Adherence to anti-diabetic medication is a major challenge in diabetic treatment. It is affected by the nature of the treatment or the complexity of the treatment, out of pocket costs, perceived medication side effect, and hypoglycemia (Wabe et al., 2011; Polonsky and Henry,

Abbreviations: DM, Diabetes mellitus; AA, Addis Ababa; SNNP, Southern Nation and Nationality of people

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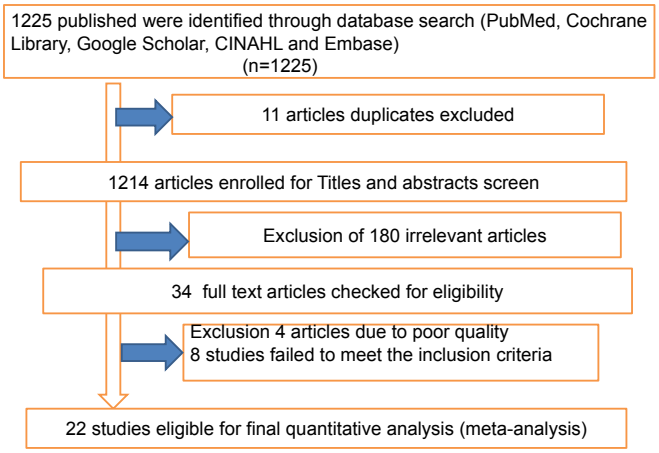

Fig. 1. Flow chart of study selection for meta-analysis on prevalence of adherence to anti-diabetic medication in Ethiopia, 2019

2016). Anti-diabetic medications are integral for glycemic control in diabetes. Non-adherence to the drug can alter blood glucose levels, resulting in the short term and long term complications (Arifulla et al., 2014).

Potential barriers for anti-diabetic medication adherence are diseases related knowledge, health literacy, patient-provider relationship and drug-related factors such as a drug side effect, polypharmacy and various logistical barriers to obtain medications (Gellad et al., 2011). Good diabetic medication adherence improved glycemic control and leads to less hospitalization (Lin et al., 2017).

Medication adherence to anti-diabetic therapy was not yet been studied in Ethiopia. Therefore purpose of this study is to assess the pooled prevalence of anti-diabetic medication adherence among diabetic patients in Ethiopia.

2. Main text

2.1. Materials and methods

2.1.1. Study design and searching strategy

This systematic review study was carried out from published and unpublished literature to determine the pooled prevalence and determinant factors of anti-diabetic medication adherence among diabetic patients in Ethiopia. Studies were found through electronic and manual searches using databases PubMed, Google Scholar, Science Direct and Google for gray literature.

2.1.2. Inclusion criteria

Those studies that had ethical approval and reported anti-diabetic medication adherence or compliance among diabetic patients in Ethiopia were included in the study. Peer-reviewed studies with cross-sectional study design and the primary outcome of interest was included in the study.

2.1.3. Exclusion criteria

Those studies which showed an unclear prevalence of anti-diabetic medication adherence among diabetic patients were excluded from this study.

2.1.4. Data extraction

Two reviewers (KG & AW) screened the titles and abstracts of identified studies and assessed the full text of potentially eligible studies. Any controversy was resolved by consensus. We made some efforts to communicate the authors whenever further information was needed. Data from included studies were extracted independently by these reviewers. Data on the author(s), study year, a region of study, study design, type of diabetes mellitus, the prevalence of anti-diabetic medication adherence and determinant factors, and sample size were extracted using Microsoft Excel. The prevalence of anti-diabetic medication adherence among diabetic patients was extracted from each included study. TA has critically reviewed the whole manuscript.

2.1.5. Quality assurance

Articles were assessed for quality score using the New Castle Ottawa Scale adapted for cross-sectional studies quality assessment tool, a score of ≥5 out of 10 considered as high quality score (Modesti et al., 2016). Two authors (KG &AW) assessed the quality of each paper. The reviewers compared the quality of appraisal scores and resolved any inconvenience before calculating the final appraisal score. All included studies had a high quality of the score.

Table 1
Characteristics of studies included in a meta-analysis of the prevalence of adherence to anti-diabetic medication in Ethiopia, 2019

S. no	Author/s (reference)	Pub. Year	Region	Type	Study design	Sample Size	Prevalence% (95% CI)
1	Nasir T et al. (13)	2011	Oromia	II	Cross-sectional	384	41.80 (36.87, 46.73)
2	Ali et al. (24)	2017	AA	I&II	Cross-sectional	146	54.80 (46.73, 62.87)
3	Belayneh KG et al. (19)	2014	Oromia	I&II	Cross-sectional	270	72.20 (66.86, 77.54)
4	Kalayou KB et al. (25)	2017	AA	II	Cross-sectional	320	97.00 (95.13, 98.87)
5	Gebrehiwot T et al. (20)	2013	Oromia	II	Cross-sectional	267	75.70 (70.56, 80.84)
6	Ashebir K et al. (21)	2016	Oromia	II	Cross-sectional	285	68.80 (63.42, 74.18)
7	Mastewal A et al. (30)	2016	Amhara	II	Cross-sectional	288	85.10 (80.99, 89.21)
8	Ayele K et al. (34)	2012	Harare	I&II	Cross-sectional	222	78.40 (72.99, 83.81)
9	Jemal et al. (35)	2017	Harari	II	cross-sectional	196	70.40 (64.01, 76.79)
10	Bonger et al. (26)	2018	AA	II	Cross-sectional	619	95.70 (94.10, 97.30)
11	Asres T et al. (22)	2014	Oromia	II	Cross-sectional	113	72.00 (63.72, 80.28)
12	Tessema T et al. (27)	2016	AA	II	Cross-sectional	322	66.80 (61.66, 71.94)
13	Kassahun et al. (23)	2016	Oromia	II	Cross-sectional	309	37.20 (31.81, 42.59)
14	Abate (31)	2019	Amhara	I&II	Cross-sectional	416	31.20 (26.75, 35.65)
15	Abebe et al. (32)	2014	Amhara	I&II	Cross-sectional	391	45.90 (40.96, 50.84)
16	Gerada et al. (28)	2017	AA	I&II	Cross-sectional	378	66.90 (62.16, 71.64)
17	Tilahun T et al. (33)	2017	Amhara	I	Cross-sectional	182	59.90 (52.78, 67.02)
18	Sorato et al. (36)	2016	SNNP	II	Cross-sectional	194	84.00 (78.84, 89.16)
19	YohannesTekalegn (29)	2018	AA	II	Cross-sectional	412	87.60 (84.42, 90.78)
20	Kalayou KB et al. (38)	2017	Tigray	II	Cross-sectional	300	83.70 (79.52, 87.88)
21	Fseha B et al. (39)	2017	Tigray	II	Cross-sectional	200	61.00(54.24,67.76),
22	D. J. Tesfaye et al. (37)	2015	SNNP	I&II	Cross-sectional	247	91.90 (88.50 95.30)

Note: - AA- Addis Ababa, SNNP-Southern Nation and Nationality of People.

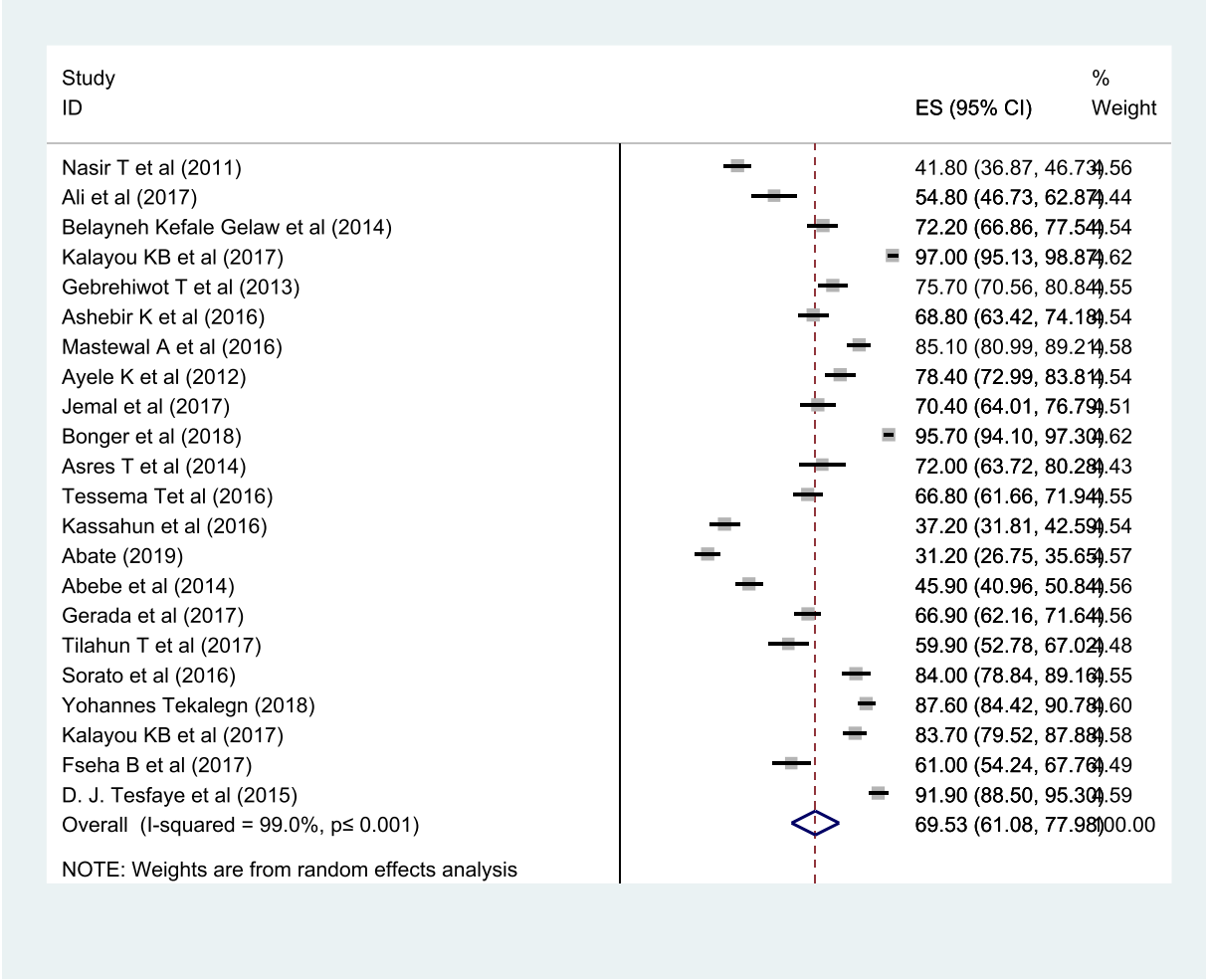

Fig. 2. Forest plot showing the pooled prevalence of adherence to anti-diabetic medication among DM adult patients in Ethiopia, 2019

2.1.6. Data analysis

A systematic review of the pooled prevalence of anti-diabetic medication adherence was carried out using a random effect model, generating a pooled prevalence with 95% CIs using STATA software version 11. Subgroup analyses by region and type of diabetes mellitus were carried out because of significant heterogeneity between studies.

An indicators used to determine the potential publication bias were Bag's test for subjective assessment (Tura et al., 2013) and Egger's test (a p-value less than 0.05) for objective evaluation (Egger et al., 1997). Lastly, sensitivity analysis was done to estimate whether the pooled effect size was affected by single studies.

3. Results

3.1. Selection and identification of studies

A total of 1225 studies were identified from the literature search. Of these studies, 11 articles of duplicate records were identified and removed. Reviewing of titles and abstracts resulted in the exclusion of 1180 irrelevant articles. After assessing the full texts of the remaining articles, additional 4 articles were excluded due to poor quality. Moreover, based on the inclusion and exclusion criteria for entry into the study a total of 8 studies were excluded as they did not meet the inclusion criteria. Then, a total of twenty-two unique studies were eligible and enrolled for final analysis (Fig. 1).

3.2. Characteristics of included studies

A total of 22 studies with 6461 participants included in this meta-analysis is summarized in Table1. The studies were conducted from 2011 to 2019 in different regions of the country. Among the 22 studies, 6 of them (Wabe et al., 2011; Gelaw et al., 2014; Teklay, 2013; Kassahun et al., 2016; Asres Teshome et al., 2014; Kassahun et al., 2016) were conducted in the Oromia region, 6 studies (Ali et al., 2017; Berhe et al., 2012; Bonger et al., 2018; Tsehay et al., 2016; Gerada et al., 2017; Tekalegn et al., 2018) were in Addis Ababa (AA), 4 studies (Abebaw et al., 2016; Abate, 2019; Abebe et al., 2014; Tewabe and Kindie, 2018) were in Amhara, 2 studies (Ayele et al., 2012; Jemal et al., 2017) were in Harari, 2 studies (Sorato et al., 2016; Tesfaye et al., 2015) were in SNNP and 2 studies (Berhe et al., 2017; Fseha, 2017) were in the Tigray region. All studies were institution based cross-sectional study conducted among adult type I and II diabetes mellitus in Ethiopia. The study with minimum and the maximum sample size was conducted in AA and SNNP region, respectively (Asres Teshome et al., 2014; Bonger et al., 2018). In addition, out of all studies enrolled in this meta-analysis 22 studies (Wabe et al., 2011; Fseha, 2017; Gelaw et al., 2014; Teklay, 2013; Kassahun et al., 2016; Asres Teshome et al., 2014; Kassahun et al., 2016; Ali et al., 2017; Berhe et al., 2012; Bonger et al., 2018; Tsehay et al., 2016; Gerada et al., 2017; Tekalegn et al., 2018; Abebaw et al., 2016; Abate, 2019; Abebe et al., 2014; Tewabe and Kindie, 2018; Ayele et al., 2012; Jemal et al., 2017; Sorato et al., 2016; Tesfaye et al., 2015) were conducted by cross-sectional study design (Table1).

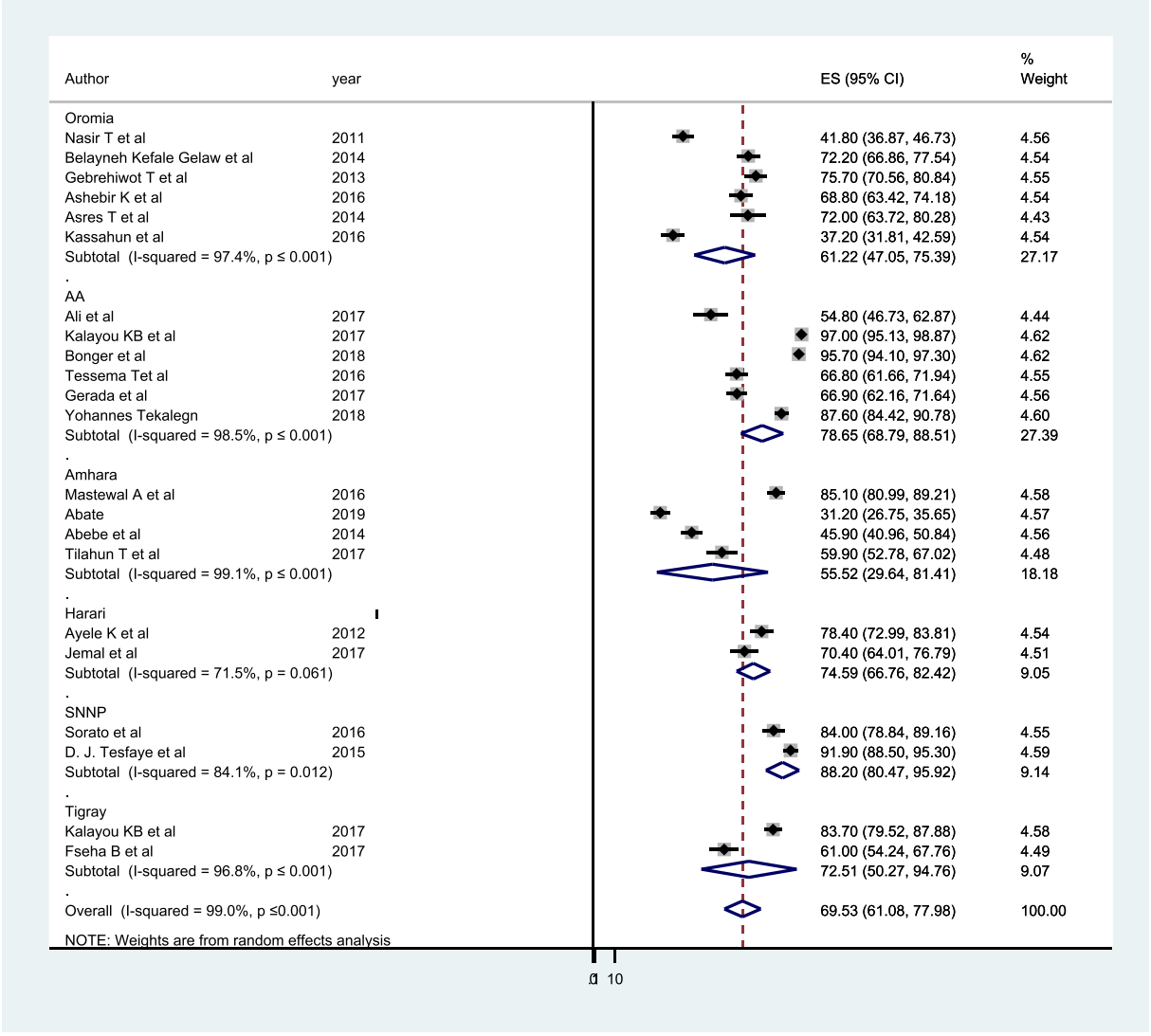

Fig. 3. Subgroup analysis by regions on the prevalence of adherence to anti-diabetic medication among DM adult patients in Ethiopia, 2019

Table 2
A meta-regression analysis of factors with the heterogeneity of the prevalence of adherence to anti-diabetic medication among DM adult patients in Ethiopia, 2019

Heterogeneity source	Coefficients	Std. err.	t	P > t	[95% Conf. Interval]
Publication year	0.0387889	0.2775356	0.14	0.890	−0.5420999, 0.6196776
Sample size	0.0002703	0.0032878	0.08	0.935	−0.0066113, 0.0071518

3.3. Prevalence of adherence to anti-diabetic medication among DM adult patients (meta-analysis)

The pooled prevalence using the fixed effect model was shown that significant heterogeneity between the studies. Hence, we analyses using the random effects model. Using a random effects model, the estimated pooled prevalence of anti-diabetic medication adherence among adult DM patients reported by the 22 studies was 69.533% (95% CI (61.083%, 77.982%)) with significant heterogeneity between studies (I^2 = 97.8%, p ≤ 0.001). The pooled prevalence of anti-diabetic adherence presented using the forest plot (Fig. 2).

Subgroup analysis by study area was conducted to assess the potential heterogeneity between studies. Of the 22 studies, the highest estimated adherence to anti-diabetic medication prevalence found in studies conducted in SNNP region, 88.19% (95% CI: 80.47 to 95.92%), I^2 = 84.1%, followed by studies conducted in Addis Ababa, was 78.65% (95% CI: 68.79, 88.51%), I^2 = 98.5% (Fig. 3).

3.4. Investigation of heterogeneity

Heterogeneity in systematic reviews and meta-analysis results of studies is inevitable due to the difference in study quality, methodology, sample size, and inclusion criteria for participants (Baker et al., 2009; Melsen et al., 2014). In this meta-analysis the value of I^2 is a definite indication of significant high heterogeneity, so we conducted the analysis with a random effects model to adjust for the observed variability. Further, the presence of heterogeneity was also assessed by subgroup analysis. However, the level of heterogeneity was high after subgroup analysis (Fig. 3). Then we further try to investigate the sources of heterogeneity using meta-regression model by using publication year and sample size as covariates. Meta-regression is a more multifaceted and better method than subgroup analysis for

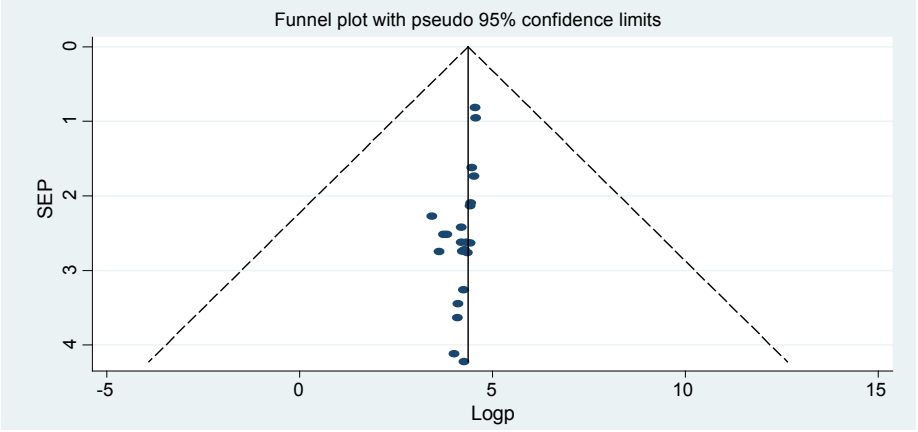

Fig. 4. Funnel plots to test, the publication bias of the 22 studies, 2019

Table 3
Publication bias of the adherence to anti-diabetic medication among DM adult patients in Ethiopia, 2019

Std_Eff	Coefficients	Std. err.	T	P > t	[95% Conf. Interval]
Slope bias	4.745377	0.1079323	43.97	0.000	4.520234, 4.97052
	−0.2163462	0.0553038	−3.91	0.001	−0.3317079, −0.1009845

investigating heterogeneity and has the potential advantage of allowing the assessment of one or more covariates simultaneously (Hardy and Thompson, 1998). The result of the meta-regression analysis showed that both covariates were not statistically significant for the presence of heterogeneity (Table2).

3.5. Publication bias

Occurrence of publication bias was observed using funnel plots and tests (Egger's and begs). In this meta-analysis funnel plots and tests demonstrating evidence of publication bias. Each point in funnel plots represents a separate study and asymmetrical distribution is evidence of the presence of publication bias (Egger et al., 1997). First, each study's effect size was plotted against the standard error and visual inspection of the funnel plot suggests asymmetry, as eight studies lay on the left side and fourteen studies on the midline of the line representing the pooled prevalence (Fig. 4). We also performed Egger's, and Bag's tests to investigate publication bias. The result of these tests showed significant evidence of publication bias (p value < 0.05) (Table 3). Therefore, trim and Fill analysis was done (Fig. 5).

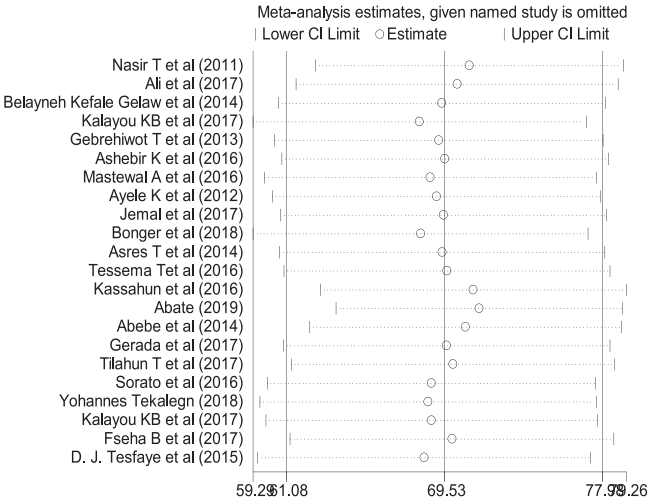

Fig. 6. Result of Sensitivity analysis of the 22 studies, 2019

3.6. Sensitivity analysis

The result of sensitivity analyses using a random effects model suggested that no single study unduly influenced the overall prevalence estimate of adherence to anti-diabetic medication among DM adult patients in Ethiopia, 2019 (Fig. 6).

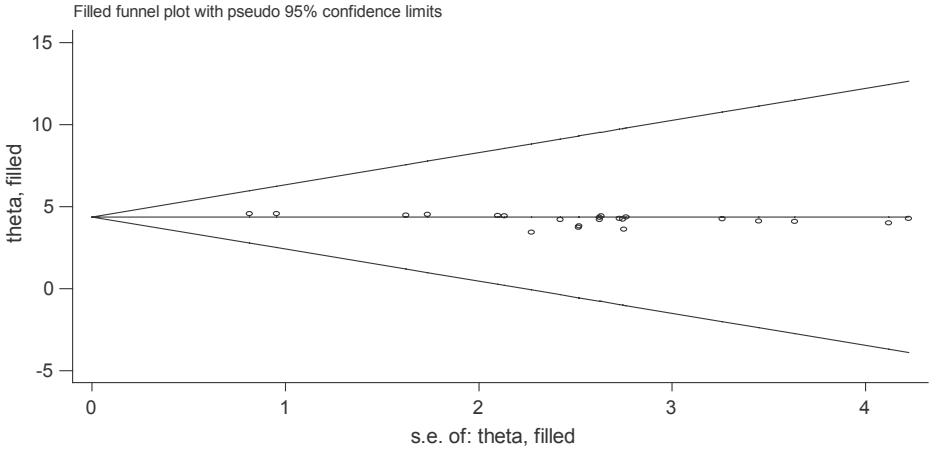

Fig. 5. Filled and trim plots to test the publication bias of the 22 studies, 2019

Table 4
Results of meta-analyses and test for heterogeneity of anti-diabetic adherence, 2019

Variable	OR (95% CI)	Heterogeneity between Studies			Test for overall effect (P)
		Q statistic	P-value	I^2	
Age	**1.82(1.27, 2.60)**	**1.88**	**0.390**	**0.00**	**0.001**
Marital status	0.66 (0.22, 2.00)	3.14	0.004	77.2%	0.463
Educational status	1.10(0.49, 2.50)	9.71	0.021	69.1%	0.814
Residency	**4.88 (1.71, 13.95)**	**30.42**	**0.001**	**90.1%**	**0.003**
Complexity of drug	0.58 (0.22, 1.51)	0.92	0.338	0.00%	0.265
Duration of the DM	0.576 (0.197, 1.685)	41.48	0.001	95.2%	0.313

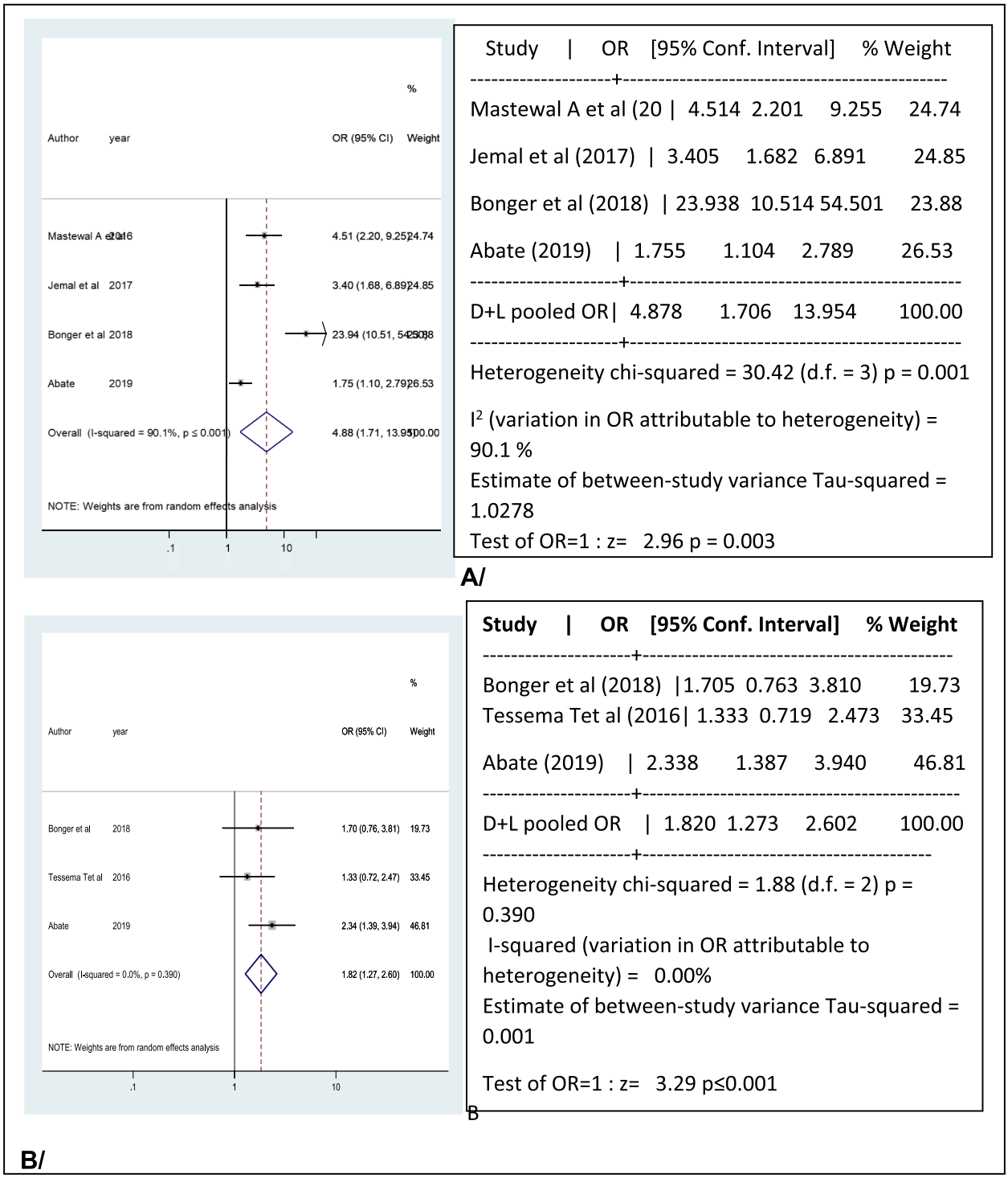

Fig. 7. Forest plots of a meta-analysis of factors associated with anti-diabetic adherence, 2019. OR and 95% CI for each of the 2 factors are given. Notes: A- Rural residency; B- age group < 40 years

3.7. Factors assessed

There were 6 studies described determinant factors with anti-diabetic medication adherence of the 22 studies. Among them, (3) studies were mentioned about the age of the patient, (4) educational status, (4) marital status, (4) patients residency, (2) complexity of drugs, and (3) durations of the DM, were found to be correlated with adherence. In this meta-analysis, educational status, duration, marital status and complexity of the drugs were not significantly associated, whereas patients age and residency were significantly associated with adherence of anti-diabetic medications at $P < 0.05$. The pooled effect sizes for the factors in these studies were shown in (Table 4). Odds ratio and 95% CI of this factor and its forest plot of a meta-analysis of factors associated with adherence of anti-diabetic medications is shown in (Fig. 7).

4. Discussion

This study is a meta-analysis and systematic review of Anti-diabetic medication adherence and determinant factors. The pooled prevalence of anti-diabetic medication adherence in this study was 69.53% (95% CI (61.083%, 77.982%)). This study was somehow in line with a survey conducted on A Systematic Review of Adherence with Medications for Diabetes 36–93% (Krass et al., 2015). However, this a Systematic Review and meta-Analysis pooled prevalence was higher than studies done in Japan 58% (Koyanagi et al., 2016) and A systematic mixed studies review in the Middle East and North Africa region 61% (Jaam et al., 2017).

Based on the regional subgroup analysis, the study area was conducted to assess the potential heterogeneity between studies. Of the 22 studies, the highest estimated adherence to anti-diabetic medication prevalence found in studies conducted in SNNP region, 88.19% (95% CI: 80.47 to 95.92%), $I^2 = 84.1\%$, followed by studies conducted in Addis Ababa, was 78.65% (95% CI: 68.79, 88.51%), $I^2 = 98.5\%$, whereas low prevalence was observed in the Oromia region 61.22 (47.05, 75.39), $I^2 = 97.4\%$, followed by studies conducted in Amhara region 55.52 (29.64,81.41%), $I^2 = 99.1\%$.

Age is one of the determining factors for the good practice of anti-diabetic medication adherence. Patients who have older age better adhere than the other age groups. In addition, residency also another determining factor, those patients from urban had better adherence than patients from rural residents of towards anti-diabetic medications. This was supported by A systematic mixed studies review in the Middle East and North Africa region (Jaam et al., 2017).

5. Conclusion

The result of the review suggests that the anti-diabetic medication adherence is low. The combined results of the six studies about the determinants of the good practice of anti-diabetic medications indicated that two factors: age and residency were the main determinants of adherence of the anti-diabetic medications in Ethiopia. Hence, we recommend that health organizations Diabetic care service should incorporate diabetic medication adherence services. Additionally, health educations and early screening of poorly adherent as well as training of the hospital health professional on the adherence of the anti-diabetic medications are highly recommended.

Limitations

The bias may be there because of the search was only in English language. Furthermore, Scarcity of data in some regions of Ethiopia may make a problem to generalize the findings.

Authors' contributions

KG, AW and TA developed the concept of this study. KG and AW performed the searches, extracted the data and wrote the first draft of the manuscript. KG and TA provided important intellectual input to revise the draft. All authors read and approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijans.2019.100167.

References

Joslin, E. P., & Kahn, C. R. (2005). In C. Ronald Kahn (Ed.). *Joslin's diabetes mellitus.* Lippincott Williams & Wilkins.

Alberti, K. G. M. M., & Zimmet, P. F. (1998). Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus. Provisional report of a WHO consultation. *Diabetic Medicine, 15*(7), 539–553.

Organization, W. H. (1999). *Definition, diagnosis and classification of diabetes mellitus and its complications: Report of a WHO consultation. Part 1, Diagnosis and classification of diabetes mellitus.* Geneva: World health organization.

Guariguata, L., Whiting, D. R., Hambleton, I., Beagley, J., Linnenkamp, U., & Shaw, J. E. (2014). Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes Research and Clinical Practice, 103*(2), 137–149.

Whiting, D. R., Guariguata, L., Weil, C., & Shaw, J. (2011). IDF diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes Research and Clinical Practice, 94*(3), 311–321.

Animaw, W., & Seyoum, Y. (2017). Increasing prevalence of diabetes mellitus in a developing country and its related factors. *PloS One, 12*(11), e0187670.

Farsaei, S., Sabzghabaee, A. M., Zargarzadeh, A. H., & Amini, M. (2011). Adherence to glyburide and metformin and associated factors in type 2 diabetes in Isfahan, Iran. *Iranian Journal of Pharmaceutical Research IJPR, 10*(4), 933.

Osterberg, L., & Blaschke, T. (2005). Adherence to medication. *New England Journal of Medicine, 353*(5), 487–497.

Organization, W. H. (2003). *Diet nutrition, and the prevention of chronic diseases: Report of a joint WHO/FAO expert consultation.* World Health Organization.

Gregg, E. W., Li, Y., Wang, J., Rios Burrows, N., Ali, M. K., Rolka, D., et al. (2014). Changes in diabetes-related complications in the United States, 1990–2010. *New England Journal of Medicine, 370*(16), 1514–1523.

Kamuhabwa, A. R., & Charles, E. (2014). Predictors of poor glycemic control in type 2 diabetic patients attending public hospitals in Dar es Salaam. *Drug Healthcare Patient Safety, 6*, 155.

Astrup, A. (2001). Healthy lifestyles in Europe: Prevention of obesity and type II diabetes by diet and physical activity. *Public Health Nutrition, 4*(2b), 499–515.

Association, A. D. (2010). Diagnosis and classification of diabetes mellitus. *Diabetic Care, 33*(Supplement 1), S62–S69.

Control, D., & Group, C. T. R. (1993). The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *New England Journal of Medicine, 329*(14), 977–986.

Wabe, N. T., Angamo, M. T., & Hussein, S. (2011). Medication adherence in diabetes mellitus and self management practices among type-2 diabetics in Ethiopia. *North American Journal of Medical Sciences, 3*(9), 418.

Polonsky, W. H., & Henry, R. R. (2016). Poor medication adherence in type 2 diabetes: Recognizing the scope of the problem and its key contributors. *Patient Preference and Adherence, 10*, 1299.

Arifulla, M., Lisha Jenny, J., Sreedharan, J., Muttappallymyalil, J., & Basha, S. A. (2014). Patients' adherence to anti-diabetic medications in a hospital at Ajman, UAE. *The Malaysian Journal of Medical Sciences: MJMS, 21*(1), 44.

Gellad, W. F., Grenard, J. L., & Marcum, Z. A. (2011). A systematic review of barriers to medication adherence in the elderly: Looking beyond cost and regimen complexity. *The American Journal of Geriatric Pharmacotherapy, 9*(1), 11–23.

Lin, L.-K., Sun, Y., Heng, B. H., Chew, D. E. K., & Chong, P.-N. (2017). Medication adherence and glycemic control among newly diagnosed diabetes patients. *BMJ Open Diabetes Research and Care, 5*(1), e000429.

Modesti, P. A., Reboldi, G., Cappuccio, F. P., Agyemang, C., Remuzzi, G., Rapi, S., et al. (2016). Panethnic differences in blood pressure in Europe: A systematic review and meta-analysis. *PloS One, 11*(1), e0147601.

Tura, G., Fantahun, M., & Worku, A. (2013). The effect of health facility delivery on neonatal mortality: Systematic review and meta-analysis. *BMC Pregnancy and Childbirth, 13*(1), 18.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ, 315*(7109), 629–634.

Gelaw, B. K., Mohammed, A., Tegegne, G. T., Defersha, A. D., Fromsa, M., Tadesse, E., et al. (2014). Nonadherence and contributing factors among ambulatory patients with antidiabetic medications in Adama Referral Hospital. *Journal of Diabetes*

Research.
Teklay, G. (2013). Patients at Jimma university specialized hospital. *Southwest Journal of Medical Science, 13*(7), 578–584.
Kassahun, A., Gashe, F., Mulisa, E., & Rike, W. A. (2016). Nonadherence and factors affecting adherence of diabetic patients to anti-diabetic medication in Assela General Hospital, Oromia Region, Ethiopia. *Journal of Pharmacy & Bioallied Sciences, 8*(2), 124.
Asres Teshome, G. M. G., Tegegne, Temesgen, Kefale, Belayneh, Amsalu, Gelaw, Defersha, Degu, Alebachew, Minyahil, & Likisa Linjesa, W. J. (2014). Non adherence and its contributing factors among ambulatory type two diabetic patients in bishoftu general hospital, south east, ethiopia. *International Journal of Universal Pharmacy and Bio Sciences, 3*(4).
Kassahun, T., Gesesew, H., Mwanri, L., & Eshetie, T. (2016). Diabetes related knowledge, self-care behaviours and adherence to medications among diabetic patients in Southwest Ethiopia: A cross-sectional survey. *BMC Endocrine Disorders, 16*(1), 28.
Ali, M., Alemu, T., & Sada, O. (2017). Medication adherence and its associated factors among diabetic patients at Zewditu Memorial Hospital, Addis Ababa, Ethiopia. *BMC Research Notes, 10*(1), 676.
Berhe, K. K., Demissie, A., Kahsay, A. B., & Gebru, H. B. (2012). Diabetes self care practices and associated factors among type 2 diabetic patients in Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia-A cross sectional study. *International Journal of Pharmaceutical Sciences and Research, 3*(11), 4219.
Bonger, Z., Shiferaw, S., & Tariku, E. Z. (2018). Adherence to diabetic self-care practices and its associated factors among patients with type 2 diabetes in Addis Ababa, ethiopia. *Patient Preference and Adherence, 12*, 963.
Tsehay, T., Engidawork, E., & Ahmed, A. (2016). Assessment of antidiabetic medication adherence and Its determinants among ambulatory patients with type 2 diabetes at Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia. *Journal of Pharmacy and Alternative Medicine, 11*.
Gerada, Y., Mengistu, Z., Demessie, A., Fantahun, A., & Gebrekirstos, K. (2017). Adherence to insulin self administration and associated factors among diabetes mellitus patients at Tikur Anbessa specialized hospital. *Journal of Diabetes & Metabolic Disorders, 16*(1), 28.
Tekalegn, Y., Addissie, A., Kebede, T., & Ayele, W. (2018). Magnitude of glycemic control and its associated factors among patients with type 2 diabetes at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. *PloS One, 13*(3), e0193442.
Abebaw, M., Messele, A., Hailu, M., & Zewdu, F. (2016). Adherence and associated factors towards antidiabetic medication among type II diabetic patients on follow-up at University of Gondar Hospital, Northwest Ethiopia. *Advances in Nursing, 2016*.
Abate, T. W.g. (2019). Medication non-adherence and associated factors among diabetes patients in Felege Hiwot Referral Hospital, Bahir Dar city administration, Northwest Ethiopia. *BMC Research Notes, 12*, 1–6.
Abebe, S. M., Berhane, Y., & Worku, A. (2014). *Barriers to diabetes medication adherence in North West Ethiopia* (pp. 195). Springerplus.
Tewabe, T., & Kindie, S. (2018). Level of insulin adherence among diabetes mellitus patients in Felege Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia, 2017: A cross-sectional study. *BMC Research Notes, 11*(1), 295.
Ayele, K., Tesfa, B., Abebe, L., Tilahun, T., & Girma, E. (2012). Self care behavior among patients with diabetes in Harari, Eastern Ethiopia: The health belief model perspective. *PloS One, 7*(4), e35515.
Jemal, A., Abdela, J., & Sisay, M. (2017). Adherence to oral antidiabetic medications among type 2 diabetic (T2DM) patients in chronic ambulatory wards of hiwot fana specialized university hospital, Harar, Eastern Ethiopia: a cross sectional study. *Journal of Diabetes Metabolism, 8*, 721 doi: 10.4172/2155-6156.1000721 Page 2 of 8 J Diabetes Metab, an open access journal ISSN: 2155-6156 Volume 8• Issue 1• 1000721. Socio-demographic characteristics frequency% Age. 2017:18-40.
Sorato, M. M., Tesfahun, C., & Lamessa, D. (2016). Levels and predictors of adherence to self-care behaviour among adult type 2 diabetics at Arba Minch general hospital, Southern Ethiopia. *Journal of Diabetes Metabolism, 7*(6), 11.
Tesfaye, D. J., Tessema, F., & Taha, M. (2015). Coexistence of chronic complications among diabetic patients at Nigist Eleni Mohammed Memorial Hospital, Hossana, South Ethiopia. *Open Access Library Journal, 2*(01), 1.
Berhe, K. K., Gebru, H. B., Kahsay, H. B., & Kahsay, A. A. (2017). Assessment of Self Care Management and its Associated Factors among Type 2 Diabetes Patients in Mekelle Hospital and Ayder Referral Hospitals, Mekelle City, Tigray, Northern Ethiopia, 2012/13. *Global Journal of Medical Research*.
Fseha, B. (2017). Glycemic control and it's associated factors in type 2 Diabetic patients in Suhul Hospital, Northwest, Tigray, Ethiopia. *Journal of Diabetes & Metabolism, 8*(3).
Baker, W., White, C. M., Cappelleri, J., Kluger, J., & Coleman, C. (2009). Understanding heterogeneity in meta-analysis: The role of meta-regression. *International Journal of Clinical Practice, 63*(10), 1426–1434.
Melsen, W., Bootsma, M., Rovers, M., & Bonten, M. (2014). The effects of clinical and statistical heterogeneity on the predictive values of results from meta-analyses. *Clinical Microbiology & Infection, 20*(2), 123–129.
Hardy, R. J., & Thompson, S. G. (1998). Detecting and describing heterogeneity in meta-analysis. *Statistics in Medicine, 17*(8), 841–856.
Krass, I., Schieback, P., & Dhippayom, T. (2015). Adherence to diabetes medication: A systematic review. *Diabetic Medicine, 32*(6), 725–737.
Koyanagi, K., Kubota, T., Kobayashi, D., Kihara, T., Yoshida, T., Miisho, T., et al. (2016). Prescription factors associated with medication non-adherence in Japan assessed from leftover drugs in the SETSUYAKU-BAG campaign: Focus on oral antidiabetic drugs. *Frontiers in Pharmacology, 7*, 212.
Jaam, M., Ibrahim, M. I. M., Kheir, N., & Awaisu, A. (2017). Factors associated with medication adherence among patients with diabetes in the Middle East and North Africa region: A systematic mixed studies review. *Diabetes Research and Clinical Practice, 129*, 1–15.