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Research Article

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Burden of Diabetes Comorbidities Among Adults with Diabetes in Ethiopia: Systematic Review and Meta-Analysis 2025

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ABSTRACT

Background: Comparable to the increased prevalence of diabetes, the burden of the disease and its comorbidities has become a growing concern for health providers. Type 1 and type 2, are often associated with comorbidities. The comorbidities also, accelerate the progression of individual conditions; they encourage the development of other health problems and even lead to premature mortality. So, this study will give data on the pooled prevalence of diabetes Concordant Comorbidities among adults with diabetes in Ethiopia.

Methods and Materials: A comprehensive search of studies done on PubMed, Scopus, Web of Science, Google scholar, African journal online and manually from reference lists of identified studies in English language up to June 2025. This meta-analysis follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The quality of studies was assessed by using the Joanna Briggs Institute (JBI) quality appraisal tool for prevalence study. Meta-analysis was carried out using a random-effects method using the STATA™ Version 14 software.

Result: 18 studies involving 5662 participants were included in this meta-analysis. The prevalence of diabetes comorbidity ranged from 23.3 to 77.9%, with the highest 54.1% (95% CI: 29.9-78.4), in Addis Ababa and the lowest 42.2% (95% CI: 21.6-62.7) in southern region. The overall estimated pooled prevalence of diabetes comorbidity among diabetic patient with a random-effects model was 48.2% (95% CI: 39.7- 56.7).

Conclusion: According to this study almost half of diabetes patients develop comorbidity. The findings indicate regional variations, with the highest prevalence reported in Addis Ababa at 54.1%, contrasting with the lowest prevalence of 42.2% in the southern region. Moreover, type two diabetic patients exhibit a notable comorbidity rate. So, monitoring and addressing comorbid conditions in patients with diabetes to enhance overall health outcomes.

Keywords: Comorbidity, Systematic Review, Meta-Analysis, Prevalence, Diabetes Mellitus

Introduction

Comorbidity refers to medical conditions that exist at the time of diagnosis of the index disease or later but are not a consequence

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of the index disease. It also refers to one or more additional diagnoses for a patient, not the principal diagnosis that brought the patient into the health care system [1,2].

Non-communicable chronic diseases (NCCDs) can occur in patients in comorbid form; they are non-infectious medical conditions that are associated with long durations and slow progress which occurs due to several factors [3].

Diabetes Mellitus (DM) is a chronic, progressive metabolic disorder characterized by persistent hyperglycemia, arising from defects in insulin secretion, insulin action, or both. It is a significant public health challenge contributing to high morbidity and mortality rates [4].

In 2022, an estimated 828 million adults had diabetes. Almost half of all people with diabetes are unaware of their medical condition, with the highest prevalence of undiagnosed diabetes Mellitus in the regions of Africa and 2.0%–6.5% in Ethiopia [5-7].

Comparable to the increased prevalence of diabetes, the burden of the disease and its comorbidities has become a growing concern for health providers [8]. Type 1 and type 2, are often associated with comorbidities. Common comorbidities include hypertension, heart disease, and stroke; nephropathy; neuropathy, depression, and anxiety [9-11].

Furthermore, complications and comorbidities are important factors affecting subjective and objective health outcomes, reducing health-associated quality of life, and increasing healthcare needs among older adults with T2DM [12-14].

A blood sugar level is critical for diabetic patients not only to control their diabetes but also to reduce the risk of developing other comorbidities. The comorbidities also, accelerate the progression of individual conditions; they encourage the development of other health problems and even lead to premature mortality [15,16].

The single-disease approach, which does not include additional care modalities, complex healthcare demands of patients, and unrelated comorbidity with that specific chronic disease, had an impact on patients' health conditions. Additionally, due to limited emphasis, healthcare workers have limited guidance or experience regarding approaching care decisions for those patients [17-19]. There is no study in Ethiopia showing pooled prevalence of diabetic comorbidity. So, this study will give data on the pooled prevalence of diabetes Concordant Comorbidities among adults with diabetes in Ethiopia and will help to guide treatment care plans.

Objectives of the Review

- To determine prevalence of diabetes Concordant Comorbidities among adults with diabetes in Ethiopia.

Methods and Materials

Reporting

The result of this systematic review and meta-analyses was prepared and reported using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guideline (Supplementary file 1) [20].

Eligibility Criteria

Inclusion Criteria

Study Area: Studies conducted in Ethiopia were included.

Study Design: All type of study design which report prevalence of diabetic comorbidity were included.

Population: All diabetic patients on follow up.

Language: articles published in English language were included.

Publication Condition: Both published and unpublished studies were considered.

Publication Year: articles published from inception up to June 2025.

Exclusion Criteria

Conference reports and studies which didn't report overall prevalence was excluded.

Study Design, Settings and Search Strategies

We carried out a systematic review and meta-analysis to estimate the pooled prevalence of diabetic comorbidity in Ethiopia. To find potentially relevant articles, a comprehensive search was carried out on PubMed, Web of Science, Google Scholar, Scopus, and African journals online. Furthermore, gray literature was searched from a review of reference lists. MeSH (Medical Subject Headings), Boolean operators, and all fields within records were used to search in the advanced PubMed search engine. Search terms were: diabetes, hyperglycemia, DM, diabetes mellitus, comorbidity, prevalence, co-occurrence, and magnitude.

Data Selection Process and Extraction

The data from the included articles were extracted by, six authors using a standardized data extraction format. Any disagreements during screening and extraction were undertaken through discussion. The first author's name, publication year, study area, study design, sample size, and prevalence of comorbidity were included in the data extraction format.

Measurement Outcome Variables

This outcome of this review was to determine prevalence diabetic comorbidity (is the occurrence of other chronic diseases besides diabetes mellitus).

Quality Assessment

All authors independently assessed the quality of each original study using the Joanna Briggs Institute (JBI) quality appraisal tool for prevalence study [21]. If the quality assessment indicator score was 50% or higher, then the study was considered low risk. Any discrepancies between the two quality assessors were resolved by repeating the procedures and involving a third reviewer before computing the final appraisal scores.

Data Processing and Statistical Analysis

DerSimonian and Laird's random-effects model was used to estimate the overall pooled prevalence of diabetic comorbidity. The p-values of the Cochrane Q-test and I2-statics were computed to assess heterogeneity among reported prevalence.

Subgroup analysis was conducted to adjust random variation between point estimates of the original study. Outliers within the included articles were checked using sensitivity analysis. Publication bias across studies was assessed using a funnel plot and Egger's regression test. A forest plot and table were used to present all findings.

Results

Study Selection

Initially, a total of 7,362 studies were retrieved from the databases and manual searching. From this, 1275 duplicates were found and removed. The remaining 6087 articles were screened by their title and abstract, and 4,987 irrelevant articles were removed. Following further screening 1,100, articles were sought for retrieval, and then 996 articles were assessed for eligibility. Out of these, 978 of them were excluded due to the reported prevalence of specific comorbidity. Finally, a total of 18 studies fulfilled the inclusion criteria and enrolled in the study. The detailed retrieval process is shown in (Figure 1).

Characteristics of Study

The 18 studies [22-39] included 5662 participants. All studies were cross-sectional. The sample size ranged from 100 to 440 [38,39]. Most studies were conducted in Oromiya region. From the included studies, the prevalence of diabetes comorbidity ranged from 23.3 to 77.9 (Table 1) [34,39].

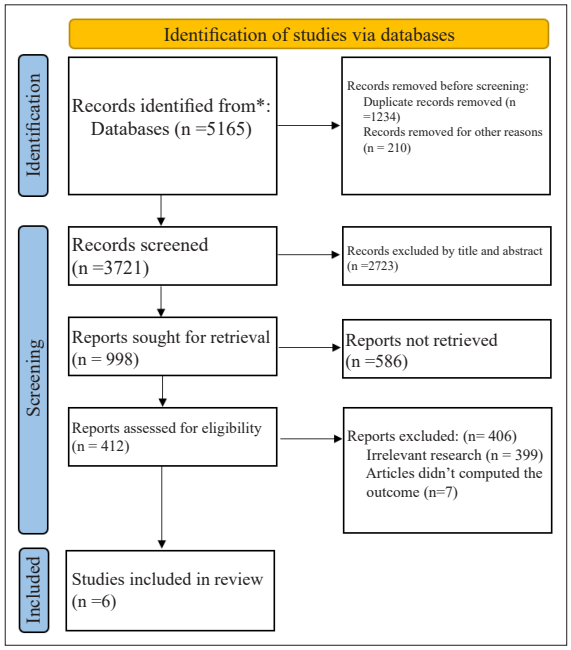

Figure 1: PRISMA Flowchart Diagram of the Study Selection

Table 1: Characteristics of the Included Studies in the Systematic Review and Meta-Analysis

Authors Name	Publication Year	Study area	Study design	Sample	Prevalence% (95%CI)
Girma H,	2024	Addis Ababa	Cross-sectional	397	73(68.6-77.3)
Ejeta A,	2021	Harar	Cross-sectional	319	55.8(50.3-61.2)
Negussie YM,	2023	Adama	Cross-sectional	398	41(36.1-45.8)
Meseret AA,	2025	Hawassa	Cross-sectional	422	58(53.2-62.7)
Belay E,	2017	Mekelle	Cross-sectional	188	68.1(61.4-74.7)
Abera RG	2022	Addis Ababa	Cross-sectional	325	40(34.6-45.3)
Alemu T,	2021	Addis Ababa	Cross-sectional	238	25.6(20.0-31.1)
YimamAhmed M,	2020	Mizan	Cross-sectional	100	40(30.3-49.6)
Gebrie A,	2020	Debre Markos	Cross-sectional	423	35.5(30.9-40.0)
Sheleme T,	2020	Mettu	Cross-sectional	330	43.3(37.9-48.6)
Yigazu DM,	2017	Jimma	Cross-sectional	174	51.7(44.2-59.1)
Nigussie S,	2021	Dire-Dawa	Cross-sectional	394	29.7(25.1-34.2)
Demoz GT,	2019	Addis Ababa	Cross-sectional	357	77.9(73.5-82.2)
Dubale M,	2023	Jimma	Cross-sectional	307	51.1(45.5-56.6)
Dimore AL,	2023	Hadiya	Cross-sectional	305	28.5(23.4-33.5)
Yosef T,	2021	Adama	Cross-sectional	245	55.1(48.87-61.3)
Bsc NA,	2022	Hararghe	Cross-sectional	440	71.1(66.8-75.3)
Yimama M,	2018	Jimma	Cross-sectional	300	23.3(18.5-28.0)

Accordingly, the overall estimated pooled prevalence of diabetes comorbidity among diabetic patient with a random-effects model was 48.2% (95% CI: 39.7-56.7) with heterogeneity index (I2) of 97.9% (p = 0.000) (Figure. 2).

Subgroup Analysis

From six regions included in the study, the subgroup analyses of three regions were valid because of the small study effect on the regions. Based on the subgroup analysis result, the highest 54.1% (95% CI: 29.9-78.4), I2 = 99.0%) seen in Addis Ababa and the lowest 42.2% (95% CI: 21.6-62.7), I2 = 97.2%) seen in southern region (Figure. 3).

Besides the subgroup analysis was conducted based on the type of diabetes, most of the articles were conducted on type two DM patients and the other on both types. So, the pooled prevalence of comorbidity among type two diabetic patients was, 44.3%

(95%CI: 30.3- 58.4, I2 = 98.4%), whereas the pooled prevalence of comorbidity on both types was 52.2 % (95% CI: 42.6- 61.7, I2 = 96.9%) (Figure. 4).

Heterogeneity and Publication Bias

Meta-regression was conducted to identify the source of heterogeneity using sample size and publication year as covariates (Table 2). It was indicated that there is no effect of sample size and year of publication year on heterogeneity between studies. The presence of publication bias was checked using Egger's test, and a graphical Funnel plot, the result of Egger's test was not significant (P= 0.847). Also, visual inspection of the funnel plot indicated asymmetrical distribution (Figure. 5), showing publication bias.

Table 2: Meta-Regression Analysis of Factors Affecting Between-Study Heterogeneity

Heterogeneity source	Coefficients	Std. Err.	P-value
Publication year	1.270996	5.130506	0.808
Sample size	0.0043518	0.1207553	0.972

Sensitivity Analysis

Additionally, in this systematic review and meta-analysis, sensitivity analysis was performed to determine how various sources of uncertainty contribute to the overall uncertainty among the studies, but the results indicated that uncertainty has an insignificant influence on pooled prevalence (Figure. 6). The exclusion of studies with the largest and smallest sample size had no significant effect on overall rate of diabetes comorbidity.

Discussion

Diabetes mellitus continues to affect people around the world, cutting across various socioeconomic groups in both developed and developing nations. In 2021, the estimated global prevalence of diabetes among individuals aged 20 to 79 years was 10.5%, with projections suggesting it could rise to 12.2% by 2045. As the prevalence of diabetes increases, the occurrence of related comorbidities due to hyperglycemia also rises. These comorbidities include hypertension, lipid disorders, cardiovascular conditions, microvascular complications, and depression [40-43].

In this systematic review and meta-analysis, the overall estimated pooled prevalence of diabetes comorbidity among diabetic patient with a random-effects model was 48.2% (95% CI: 39.7- 56.7). Which is higher than a study conducted Bangladesh 41.4%, Nigeria 22%, the discrepancy might be due to differences in population demographics, differences in study methodologies, and lifestyle factors [44,45]. However lower than a study conducted in USA 97.5%, Korea 88%, this inconsistency may be due to differences in study populations, methodologies, and life style [46,47].

Based on the subgroup analysis result, the highest (54.1%; 95% CI: 29.9-78.4), seen in Addis Ababa and the lowest (42.2 %; 95% CI: 21.6-62.7) seen in southern region this discrepancy might be related to variation in urbanization level, life style, socio-economic status, nutritional variation and demographic difference of the study participants. Furthermore, the pooled prevalence of comorbidity among type two diabetic patients was, 44.3% (95%CI: 30.3- 58.4) and the pooled prevalence of comorbidity on both types was 52.2 % (95% CI: 42.6- 61.7). This variation is might be variation in prevalence of comorbidity in included studies included in Meta-analysis, if most studies had higher prevalence the pooled will be higher and vice-versa. But due to shared risk factors like obesity, dyslipidemia, and endothelial dysfunction individuals with type 2 Diabetes Mellitus is often accompanied by other health conditions (comorbidities) [48].

Limitation of the Study

This systematic review and meta-analysis presented up-to-date evidence on burden of diabetes comorbidity in Ethiopia; it might have faced the following limitations. First, due to the presence of significant heterogeneity, the result should be interpreted cautiously. Second, we have faced difficulties in comparing our finding due to lack of regional and worldwide systematic reviews and meta-analysis.

Conclusion

This systematic review and meta-analysis highlights almost half of diabetes patients develop comorbidity. The findings indicate regional variations, with the highest prevalence reported in Addis Ababa at 54.1%, contrasting with the lowest prevalence of 42.2% in the southern region. Moreover, type two diabetic patients exhibit a notable comorbidity rate. So, monitoring and addressing comorbid conditions in patients with diabetes to enhance overall health outcomes

Declarations

Ethics Approval and Consent to Participant

Not applicable

Consent for Publication

Not applicable

Availability of Data and Materials

The data analyzed during the current systematic review and meta-analysis is available as Supporting Information files.

Competing Interests

All the authors declare that they have no competing interests

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References

1. Ording AG, Sørensen HT. Concepts of comorbidities, multiple morbidities, complications, and their clinical epidemiologic analogs. Clinical epidemiology. 2013. 5: 199.
2. Smith M, Nitz N, Stuart S. Severity and comorbidity. Understanding Health Care Outcomes Research (R. Kane, ed.). 2006: 219-262.
3. World Health Organization. Noncommunicable Diseases (NCD). 2019.
4. Yameny AA. Diabetes Mellitus Overview. Journal of Bioscience and Applied Research. 2024. 10: 641-645.

5. Zhou B, Rayner AW, Gregg EW, Sheffer KE, Carrillo-Larco RM, et al. Worldwide trends in diabetes prevalence and treatment from 1990 to 2022: a pooled analysis of 1108 population-representative studies with 141 million participants. The Lancet. 2024. 404: 2077-2093.
6. Hossain MJ, Al-Mamun M, Islam MR. Diabetes mellitus, the fastest growing global public health concern: Early detection should be focused. Health Science Reports. 2024. 7: 2004.
7. Bishu KG, Jenkins C, Yebyo HG, Atsbha M, Wubayehu T, et al. Diabetes in Ethiopia: a systematic review of prevalence, risk factors, complications, and cost. Obesity Medicine. 2019. 15: 100132.
8. Eilat-Tsanani S, Margalit A, Golan LN. Occurrence of comorbidities in newly diagnosed type 2 diabetes patients and their impact after 11 years' follow-up. Sci Rep. 2021. 11: 11071.
9. Akın S, Bölük C. Prevalence of comorbidities in patients with type–2 diabetes mellitus. Primary care diabetes. 2020. 14: 431-434.
10. Iglay K, Hannachi H, Xu J, Li X, Engel SS, et al. Prevalence and co-prevalence of comorbidities among patients with type 2 diabetes mellitus. Current medical research and opinion. 2016. 32: 1243-1252.
11. Oguz N. Anxiety and depression in diabetic patients. Eurasian J Med Invest. 2018. 2: 174-177.
12. Yen HY, Lee SC, Lin CF, Lee TI, Yamaguchi Y, et al. Complications and comorbidities as influencing factors of health outcomes in older adults with type 2 diabetes mellitus. Collegian. 2023. 30: 230-235.
13. Pati S, Van Den Akker M, Schellevis FF, Jena S, Burgers JS, et al. Impact of comorbidity on health-related quality of life among type 2 diabetic patients in primary care. Primary health care research & development. 2020. 21: 9.
14. Kovács N, Mahrouseh N, Monasta L, Andreella A, Campostrini S, et al. The diabetes mellitus comorbidity index in European Union member states based on the 2019 European Health Interview Survey. Scientific Reports. 2025. 15: 512.
15. Niksic M, Redondo-Sanchez D, Chang YL, Rodriguez-Barranco M, Exposito-Hernandez J, et al. The role of multimorbidity in short-term mortality of lung cancer patients in Spain: a population-based cohort study. BMC cancer. 2021. 21: 1-2.
16. Ferrer A, Formiga F, Sanz H, Almeda J, Padrós G. Multimorbidity as specific disease combinations, an important predictor factor for mortality in octogenarians: the Octabaix study. Clinical interventions in aging. 2017. 12: 223.
17. Struijs JN, Baan CA, Schellevis FG, Westert GP, Van Den Bos GA. Comorbidity in patients with diabetes mellitus: impact on medical health care utilization. BMC health services research. 2006. 6: 1-9.
18. Anderson RJ, Freedland KE, Clouse RE, Lustman PJ. The prevalence of comorbid depression in adults with diabetes: a meta-analysis. Diabetes care. 2001. 24: 1069-1078.
19. Stokes T, Tumilty E, Doolan-Noble F, Gauld R. Multimorbidity, clinical decision making and health care delivery in New Zealand Primary care: a qualitative study. BMC family practice. 2017. 18: 1-1.
20. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Bmj. 2021. 372.
21. Munn Z, Moola S, Lisy K, Riitano D, Tufanaru C. Systematic reviews of prevalence and incidence. Joanna Briggs Institute reviewer's manual Adelaide, South Australia: The Joanna Briggs Institute. 2017. 5: 1-5.
22. Ejeta A, Abdosh T, Hawulte B, Lamessa A, Fekadu G, et al. Diabetes concordant comorbidities and associated factors among adult diabetic out-patients at Hiwot Fana specialized university hospital, Harar, Eastern Ethiopia: a cross-sectional study. Diabetes, Metabolic Syndrome and Obesity. 2021. 14: 2281-2289.
23. Girma H, Shiferaw K, Aklilu M. Prevalence of Major Comorbidities and Associated Factors among Adult Diabetic Patients Attending Diabetic Follow up Clinic at Selected Public Hospitals of Addis Ababa, Ethiopia. Int J Diabetes Clin Res. 2024. 11: 184.
24. Negussie YM, Getahun MS, Bekele NT. Factors associated with diabetes concordant comorbidities among adult diabetic patients in Central Ethiopia: a cross-sectional study. Frontiers in Clinical Diabetes and Healthcare. 2023. 4: 1307463.
25. Meseret AA, Wondimagegne ZT. Comorbidities, level of education, and alcohol consumption are predictive factors of undernutrition among adult outpatients living with diabetes: a case at Hawassa governmental hospitals in Ethiopia. Journal of Nutritional Science. 2025. 14: 32.
26. Belay E, Abera A, Mehari A, Gebremeskel G, Endrias A, et al. Achievements of diabetes goals and their determinants in type 2 diabetic patients attending outpatient diabetic clinic in northern Ethiopia. International journal of chronic diseases. 2017. 2017: 5713187.
27. Abera RG, Demesse ES, Boko WD. Evaluation of glycemic control and related factors among outpatients with type 2 diabetes at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia: a cross-sectional study. BMC endocrine disorders. 2022. 22: 54.
28. YimamAhmed M, Hambisa Ejigu S, Zewudie Zeleke A, Yimam Hassen M. Glycemic control, diabetes complications and their determinants among ambulatory diabetes mellitus patients in southwest ethiopia: A prospective cross-sectional study. Diabetes, Metabolic Syndrome and Obesity. 2020. 13: 1089-1095.
29. Alemu T, Tadesse T, Amogne G. Glycemic control and its determinants among patients with type 2 diabetes mellitus at Menelik II Referral Hospital, Ethiopia. SAGE open medicine. 2021. 9: 20503121211023000.
30. Gebrie A, Tesfaye B, Sisay M. Evaluation of glycemic control status and its associated factors among diabetes patients on follow-up at referral hospitals of Northwest Ethiopia: a cross-sectional study, 2020. Heliyon. 2020. 6: 05655.
31. Sheleme T, Mamo G, Melaku T, Sahilu T. Glycemic control and its predictors among adult diabetic patients attending Mettu Karl Referral Hospital, Southwest Ethiopia: a prospective observational study. Diabetes Therapy. 2020. 11: 1775-1794.
32. Yigazu DM, Desse TA. Glycemic control and associated factors among type 2 diabetic patients at Shanan Gibe Hospital, Southwest Ethiopia. BMC research notes. 2017. 10: 1-6.

33. Nigussie S, Birhan N, Amare F, Mengistu G, Adem F, et al. Rate of glycemic control and associated factors among type two diabetes mellitus patients in Ethiopia: a cross-sectional study. PloS one. 2021. 16: 0251506.
34. Demoz GT, Gebremariam A, Yifter H, Alebachew M, Niriayo YL, et al. Predictors of poor glycemic control among patients with type 2 diabetes on follow-up care at a tertiary healthcare setting in Ethiopia. BMC research notes. 2019. 12: 1-7.
35. Dubale M, Gizaw K, Dessalegn D. Magnitude and predictors of poor glycemic control in patients with diabetes at Jimma Medical Center, Ethiopia. Scientific Reports. 2023. 13: 15952.
36. Dimore AL, Edosa ZK, Mitiku AA. Glycemic control and diabetes complications among adult type 2 diabetic patients at public hospitals in Hadiya zone, Southern Ethiopia. PloS one. 2023. 18: 0282962.
37. Yosef T, Nureye D, Tekalign E. Poor glycemic control and its contributing factors among type 2 diabetes patients at Adama Hospital Medical College in East Ethiopia. Diabetes, Metabolic Syndrome and Obesity. 2021. 14: 3273-3280.
38. Nesredin A, Letta S, Girma S. magnitude of comorbidities and associated factors among adult diabetes patients on follow-up at public hospitals in east hararghe zone, oromia regional state, ethiopia (Doctoral dissertation, Haramaya University). 2022.
39. Yimama M, Jarso H, Desse TA. Determinants of drug-related problems among ambulatory type 2 diabetes patients with hypertension comorbidity in Southwest Ethiopia: a prospective cross-sectional study. BMC Research Notes. 2018. 11: 1-6.
40. Soyoye DO, Abiodun OO, Ikem RT, Kolawole BA, Akintomide AO. Diabetes and peripheral artery disease: A review. World journal of diabetes. 2021. 12: 827.
41. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes research and clinical practice. 2022. 183: 109119.
42. Cicek M, Buckley J, Pearson-Stuttard J, Gregg EW. Characterizing multimorbidity from type 2 diabetes: insights from clustering approaches. Endocrinology and metabolism clinics of North America. 2021. 50: 531-558.
43. Khan A, Uddin S, Srinivasan U. Comorbidity network for chronic disease: A novel approach to understand type 2 diabetes progression. International journal of medical informatics. 2018. 15: 1-9.
44. Shuvo SD, Hossen MT, Riazuddin M, Hossain MS, Mazumdar S, et al. Prevalence of comorbidities and its associated factors among type-2 diabetes patients: a hospital-based study in Jashore District, Bangladesh. BMJ open. 2023. 13: 076261.
45. Kayode OO, Odukoya OO, Odeniyi IA, Olopade OB, Fasanmade OA. Pattern of complications and comorbidities among diabetic patients in a tertiary healthcare center in Nigeria. Journal of Clinical Sciences. 2015. 12: 29-35.
46. Iglay K, Hannachi H, Joseph Howie P, Xu J, Li X, et al. Prevalence and co-prevalence of comorbidities among patients with type 2 diabetes mellitus. Current medical research and opinion. 2016. 32: 1243-1252.
47. Abdulghani HM, AlRajeh AS, AlSalman BH, AlTurki LS, AlNajashi NS, et al. Prevalence of diabetic comorbidities and knowledge and practices of foot care among diabetic patients: a cross-sectional study. Diabetes, metabolic syndrome and obesity: targets and therapy. 2018. 11: 417-425.
48. Nowakowska M, Zghebi SS, Ashcroft DM, Buchan I, Chew-Graham C, et al. The comorbidity burden of type 2 diabetes mellitus: patterns, clusters and predictions from a large English primary care cohort. BMC medicine. 2019. 17: 145.