Dyslipidemia and Hypertension Among Type 2 Diabetics at a Tertiary Care Hospital of South Gujarat, India

Jash Kotak[1], Kirtida Tandel[2], Mithil Kotak[3], Diwakar Sharma[4]

[1]Medical Officer, GMERS Medical College, Valsad, India
[2]Professor and Head, Department of Pharmacology, GMERS Medical College, Valsad, India
[3]Indian Institute of Science Education and Research (IISER), Pune, India
[4]Statistician, Department of Preventive and Social Medicine, GMERS Medical College, Valsad, India

Correspondence: Dr. Jash Kotak; Email: drjashkotak@gmail.com

Abstract:

Introduction: The number of diabetes cases are rising globally along with comorbidities like hypertension and dyslipidemia. **Objectives:** To estimate the prevalence of dyslipidemia and hypertension in type 2 diabetes (T2DM) patients of Valsad, Gujarat, India. **Methods:** This is a cross-sectional study of total 62 blood samples of T2DM patients selected by convenience sampling which analysed fasting blood sugar (FBS), postprandial blood sugar (PP2BS), cholesterol, triglyceride (TG) and high-density lipoprotein (HDL) using standard methods at a tertiary care hospital of Valsad. Low density lipoprotein (LDL) and very low-density lipoprotein (VLDL) were also estimated using Martin-Hopkins and Friedewald equations respectively. **Results**: In the study participants, 11.29% had neither hypertension (HTN) nor dyslipidemia, 64.52% had HTN, 77.42% had dyslipidemia and 53.22% patients had HTN and dyslipidemia along with diabetes. **Conclusion:** Results suggest a high prevalence of dyslipidemia and HTN in study subjects. Early screening and administration of lipid-lowering agents are required in these patients.

Keywords: Blood sugar, Diabetes, Dyslipidemia, Hypertension, Lipid profile

Introduction:

Diabetes mellitus is a group of metabolic disorders characterized by chronic hyperglycemia with disturbances in carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both.[1] The chronic hyperglycemia is associated with microvascular and macrovascular complications including coronary artery disease (CAD), retinopathy, nephropathy and neuropathy. The number of diabetic patients is increasing worldwide, including in India where cases reached 74 million in 2021,[2] and are expected to reach 93 million by 2030 and 125 million by 2045. The World Health Organization (WHO) projects that diabetes will be the seventh leading cause of death in 2030,[3] with the number of worldwide diabetics reaching 643 million from the current estimate of 537 million.[2]

Lipid metabolism disorders are more frequent in diabetic patients and it is aggravated by the presence of hyperglycemia and insulin resistance. One study showed that the prevalence of dyslipidemia in diabetes mellitus patients is 95%.[4] Even in non-diabetics, FBS

Quick Response Code	Access this article online	How to cite this article :
	Website : www.healthlinejournal.org	Kotak J, Tandel K, Kotak M, Sharma D. Dyslipidemia and Hypertension Among Type 2 Diabetics at a Tertiary Care Hospital of South Gujarat, India. Healthline. 2025;16(2): 142-148
	DOI : 10.51957/Healthline_687_2025	

Received : 20-01-2025 **Accepted** : 20-06-2025 **Published :** 30-06-2025

concentration and glycated haemoglobin (HbA1c) are associated with the risk of vascular disease.[5]

Out of more than 75,000 individuals having T2DM in the Swedish National diabetes register, 37% to 38% had untreated hypertriglyceridemia.[6] Higher levels of fasting TG are associated with higher levels of glucose, HbA1c, insulin and mortality risk.[7] Improved glycemic control decreases circulating VLDL and increases LDL catabolism by reduced glycation and upregulation of LDL receptors, thus reducing cholesterol and TG levels and having a favourable effect on lipoprotein levels.[8]

Like dyslipidemia, HTN is also a common disease that coexists with diabetes at a greater frequency;[9] it is more than thrice as frequent in those with diabetes than in those without. The reasons for the development of HTN in diabetics are inappropriate activation of renin-angiotensin-aldosterone system and sympathetic nervous system, endothelial dysfunction due to excessive reactive oxygen species production and mitochondrial dysfunction, inflammatory cytokines which impair insulin metabolic signalling and reduce insulin mediated nitric oxide production, increased circulating extracellular vesicles and their micro RNAs, and upregulation of sodium-glucose cotransporter 2 causing increased glucose reabsorption from proximal tubule.[10]

The impact of diabetes, dyslipidemia and HTN is thought to be additive in their contribution towards CVD events.[11] Thus, the combination of any of these diseases should be taken more seriously. It is also concerning that the combination of these three diseases has been rising.[12] India has the largest number of diabetes cases after China and this will continue to rise in the coming decades. Early detection and proper management of dyslipidemia in diabetic patients will help in the prevention of related complications. There is very little data available on the prevalence of dyslipidemia and diabetes from the Indian subcontinent, that available being mainly from the South Indian urban population and some from the North Indian urban population.[13,14] At present, there is a need for regional studies investigating diabetic dyslipidemia. Such studies in diabetic patients of South Gujarat could not be found. Therefore, the present study is an attempt to bridge this gap with the aim to detect the prevalence and pattern of dyslipidemia among diabetics in a district of South Gujarat.

Methods:

It was a cross-sectional study of 2 months which included 62 known or newly diagnosed T2DM cases selected by convenience sampling, attending medicine outpatient department (OPD) of Gujarat Medical Education and Research Society (GMERS) Hospital at Valsad between July 2022 to September 2022. Institutional Human Ethics Committee clearance was obtained prior to the initiation of the study. Study participants were enrolled according to inclusion criteria and informed consent (verbal and written) was obtained from them before documentation. Detailed history was taken, and clinical examination was done for all enrolled patients. Anthropometric measurements (weight, height, waist circumference, hip circumference) were taken using standard methods. Blood pressure was measured with a mercury sphygmomanometer in a sitting position after 5 minutes of rest. A fasting blood sample was collected for serum lipid profile and FBS investigation after 10 hours of an overnight fast. Again, patients were called after 2 hours of lunch for PP2BS analysis . Serum cholesterol, serum TG and serum HDL levels were measured by Trinders method, glycerol phosphate oxidase Trinders method and direct enzymatic method respectively. The laboratory tests and their sample collection were done at the same hospital and no charges were levied on the participants. Serum LDL was calculated by Martin-Hopkins novel equation using a free, online access, automated Excel-based calculator developed by Johns Hopkins Medicine and serum VLDL was estimated using the Friedewald equation.[15-17] Cut-off normal values for individual lipid levels and blood pressure were taken as per the National Cholesterol

Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) (ATP III).[18] American Diabetes Association criteria for the treatment of diabetes (fasting plasma glucose ≥126 mg/dl or postprandial glucose ≥200 mg/dl for two consecutive visits i.e., current and previous) were used to divide the patients into controlled and uncontrolled groups.[1] Patients having a body mass index (BMI) of more than 23 kg/m^2 were considered to be overweight by WHO criteria for the Asian population.[19] For evaluating the effect of antidiabetic medication patients were divided into three groups viz., newly diagnosed, patients on metformin and patients on metformin with other blood-sugar-lowering agents which included sulfonylureas, voglibose, teneligliptin and insulin. These other agents are collectively referred to as "others" in the treatment group section of Table 1.

Inclusion criteria

- Cases of T2DM of either sex who attended the medicine OPD during the study period.

Exclusion criteria

- T2DM patients with a history of or diagnosed with CAD, cerebrovascular accidents and other chronic systemic or metabolic disorders during enrolment.
- T2DM patients already taking lipid-lowering drugs or any other drug which can affect plasma lipid levels like oral contraceptive pills, steroids and diuretics.

Statistical analysis

Raw data calculation and statistical analysis by LibreCalc Version: 7.3.4.2 (Windows x64) / Libre Office Community.

The p-value was calculated using one-way analysis of variance (ANOVA). The results were presented as mean ± standard error. Statistical significance was considered at the level of $p < 0.05$.

Results:

The prevalence of dyslipidemia in the studied diabetic population was 77.42% (n = 48) and the prevalence of HTN was 64.52% (n = 40) (Figure 1). The mean age of the study population was 54.02 ± 10.78 years (male: 54.94 ± 11.2 and female: 52.82 ± 10.29). The mean duration from the first diagnosis of diabetes for the study patients was 6.83 ± 5.96 years. (Table 1). The mean BMI of the study population was 24.86 ± 6.24 kg/m^2 (male: 24.17 ± 5.16 and female: 25.76 ± 7.42). The mean systolic blood pressure of all patients was 124.45 ± 16.32 mmHg and diastolic was 79.22 ± 10.3 mmHg. The mean systolic blood pressure of hypertensive patients was 131.9 ± 13.14 mmHg and diastolic was 82.35 ± 11.06 mmHg.

Figure 1. Venn diagram of dyslipidemic and hypertensive diabetics (n = 62)

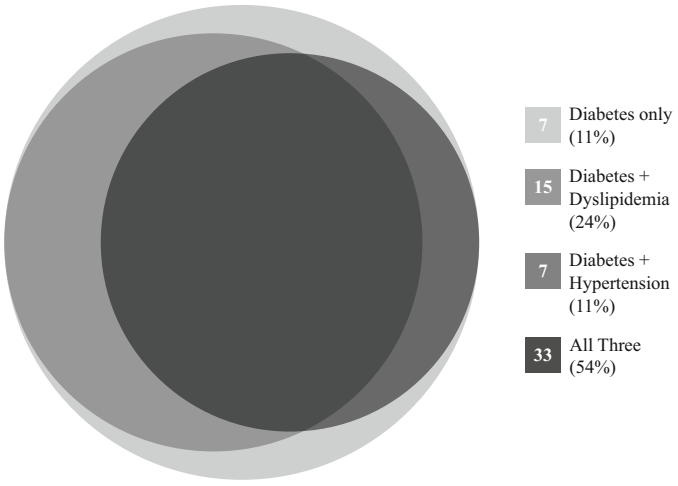

Table 1: Characteristics of Study Participants (n = 62)

Characteristic	Number of patients n (%)	Dyslipidemia n (%)	Hypertension n (%)
Age (years)			
≤45	14 (22.58)	10 (71.43)	7 (50)
46-60	31 (50)	24 (77.42)	20 (64.52)
>60	17 (27.42)	14 (82.35)	13 (76.47)
Gender			
Male	35 (56.45)	25 (71.43)	25 (71.43)
Female	27 (43.55)	23 (85.19)	15 (55.56)
Locality			
Urban	40 (64.52)	30 (76.92)	26 (65)
Rural	22 (35.48)	18 (78.26)	14 (63.64)
Control of diabetes			
Controlled	16 (25.81)	10 (62.50)	12 (75)
Uncontrolled	46 (74.19)	38 (82.61)	28 (60.87)
Obesity			
Overweight (BMI ≥23)	39 (62.90)	30 (76.92)	26 (66.67)
Non-overweight (BMI<23)	23 (37.10)	18 (78.26)	14 (60.87)
Hypertension			
Hypertensive (≥130/85)	40 (64.52)	33 (82.50)	
Normotensive (<130/85)	22 (35.48)	15 (68.18)	
Dyslipidemia			
Dyslipidemic	48 (77.42)		33 (68.75)
Nondyslipidemic	14 (22.58)		7 (50)
Duration of diabetes (years)			
<2	18 (29.03)	14 (77.78)	12 (66.67)
≥5	15 (24.19)	12 (80.00)	11 (73.33)
≥10	14 (22.58)	10 (71.43)	7 (50)
≥10	15 (24.19)	12 (80.00)	10 (66.67)
Treatment group			
Newly diagnosed	15 (24.19)	11 (73.33)	10 (66.67)
Metformin	7 (11.29)	5 (71.43)	4 (57.14)
Metformin + others*	40 (64.52)	32 (80)	26 (65)

Note. *Other includes sulfonylureas, voglibose, teneligliptin and insulin

Table 2. Serum lipid levels of Diabetic Patients. (n = 62)

Serum Lipid	Mean ± SD (mg/dl)	Abnormal value (mg/dl)	Deranged lipid level n (%)	Relative residuals from recommended values of dyslipidemic*
Cholesterol	172.44 ± 27.30	>200	10 (16.13)	9.35%
Triglycerides	116.03 ± 25.69	>150	8 (12.90)	9.747%
HDL	43.74 ± 5.75	<40	12 (19.35)	10.8%
LDL	106.79 ± 21.25	>100	42 (67.74)	17.48%
VLDL	23.21 ± 5.14	>32	5 (8.06)	29%

Note. *Values were calculated by subtracting the average of the corresponding deranged group from recommended values and then finding their percentage relative to the recommended values.

Discussion:

The obtained results indicate a very high prevalence of dyslipidemia in the Gujarati diabetic study population, similar to reports from America where they noted an overall prevalence of lipid abnormalities of 70% among diabetic patients.[20] A multinational multicentric study of 28 countries from Asia, Europe, Central America, South America and North America, reports that around 30% of diabetics had dyslipidemia.[21]

The findings of this study were consistent with those of Pandya H. et al.[14] and Borle A. et al.[22] who found the prevalence of dyslipidemia to be 82.5% and 86% respectively. A higher prevalence of dyslipidemia was observed due to the fact that many patients had uncontrolled diabetes which was reflected by their elevated blood sugar levels. The most prevalent lipid abnormality in diabetic patients in this study is high LDL, followed by low HDL, hypercholesterolemia and hypertriglyceridemia. These patterns were not quite surprising because of similar trends in previous studies.[23,24] There was a slightly greater prevalence of dyslipidemia in females than males which was in agreement with a retrospective study in Kolkata involving 150 diabetic patients and other Indian as well as international studies.[23-25] Prevalence of dyslipidemia increased with ageing, though it was not as steep compared to a study of the Nepalese population.[26] It was observed that dyslipidemia prevalence in diabetics was almost the same irrespective of its duration.

Similar trends were seen in HTN. According to previous literature, HTN and diabetes are strongly associated with the elderly age group.[27] The prevalence of HTN is comparable to a study conducted in Punjab which showed that 60% of diabetics had raised blood pressure.[28] The prevalence of HTN in diabetes found in the present study falls in the range reported by African studies, theirs being 50% to 70%.[29,30] According to a systematic review, the rates of HTN among diabetics in Asia were at or above 70% which is close to this study.[31] A greater prevalence of HTN is observed in males which is in concordance with a retrospective cohort involving the original and offspring diabetic subjects from the Framingham Heart Study.[32]

Interestingly, comparable dyslipidemia and HTN were seen in both overweight and non-overweight as well as in urban and rural populations.

The lipid profile of the metformin-taking group was expected to be near optimal values, but it was not so. This might be due to less number of patients in the metformin group as compared to other groups. Large sample and baseline values are required for better comparison.

Conclusion:

From this study, it can be concluded that dyslipidemia and HTN are prevalent respectively in 77.42% and 64.52% of the diabetics of Valsad. Particularly, those who are older than 60 years of age have lower HDL than younger ages. Therefore, early screening of diabetics for dyslipidemia is highly imperative.

Limitations:

Parameters of non-diabetics were not collected due to which comparison with baseline characteristics was not possible. Sample size in this study was quite less. Moreover, patients taking different classes of blood sugar lowering agents were all grouped as one. These findings are not representative of the entire population and hence should not be generalised for South Gujarat as patients were selected by convenience sampling. Despite above mentioned limitations, this study was conducted as per standard protocols to minimise bias.

Declaration:

Funding: Nil

Conflict of Interest: Nil

References:

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2014 Jan;37 Suppl 1:S81-90. doi: 10.2337/dc14-S081. PMID: 24357215.
2. Magliano DJ, Boyko EJ; IDF Diabetes Atlas 10th edition scientific committee. IDF DIABETES ATLAS [Internet]. 10th ed. Brussels:

International Diabetes Federation; 2021. PMID: 35914061.

3. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med. 2006 Nov;3(11):e442. doi: 10.1371/journal.pmed.0030442. PMID: 17132052; PMCID: PMC1664601.
4. Chattanda S, Mgonda Y. Diabetic Dyslipidemia Among Diabetic Patients Attending Specialized Clinics in Dar es Salaam. Tanzan Med J. 2008 ;23(1):8–11. doi: 10.4314/tmj.v23i1.39221
5. Selvin E, Steffes MW, Zhu H, Matsushita K, Wagenknecht L, Pankow J, Coresh J, Brancati FL. Glycated hemoglobin, diabetes, and cardiovascular risk in nondiabetic adults. N Engl J Med. 2010 Mar 4;362(9):800-11. doi: 10.1056/NEJMoa0908359. PMID: 20200384; PMCID: PMC2872990.
6. Eriksson M, Zethelius B, Eeg-Olofsson K, Nilsson PM, Gudbjörnsdottir S, Cederholm J, Eliasson B. Blood lipids in 75,048 type 2 diabetic patients: a population-based survey from the Swedish National diabetes register. Eur J Cardiovasc Prev Rehabil. 2011 Feb;18(1):97-105. doi: 10.1097/HJR.0b013e32833ba61e. PMID: 21354969.
7. Wang Y. Higher fasting triglyceride predicts higher risks of diabetes mortality in US adults. Lipids Health Dis. 2021 Dec 20;20(1):181. doi: 10.1186/s12944-021-01614-6. PMID: 34930280; PMCID: PMC8686260.
8. Pietri AO, Dunn FL, Grundy SM, Raskin P. The effect of continuous subcutaneous insulin infusion on very-low-density lipoprotein triglyceride metabolism in type I diabetes mellitus. Diabetes. 1983 Jan;32(1):75-81. doi: 10.2337/diab.32.1.75. PMID: 6848399.
9. Teuscher A, Egger M, Herman JB. Diabetes and hypertension. Blood pressure in clinical diabetic patients and a control population. Arch Intern Med. 1989 Sep;149(9):1942-5. doi: 10.1001/archinte.149.9.1942. PMID: 2774774.
10. Jia G, Sowers JR. Hypertension in Diabetes: An Update of Basic Mechanisms and Clinical Disease. Hypertension. 2021 Nov;78(5):1197-1205. doi: 10.1161/HYPERTENSIONAHA.121.17981. Epub 2021 Oct 4. PMID: 34601960; PMCID: PMC8516748.
11. Neaton JD, Wentworth D. Serum cholesterol, blood pressure, cigarette smoking, and death from coronary heart disease. Overall findings and differences by age for 316,099 white men. Multiple Risk Factor Intervention Trial Research Group. Arch Intern Med. 1992 Jan;152(1):56-64. PMID: 1728930.
12. Song Y, Liu X, Zhu X, Zhao B, Hu B, Sheng X, Chen L, Yu M, Yang T, Zhao J. Increasing trend of diabetes combined with hypertension or hypercholesterolemia: NHANES data analysis 1999-2012. Sci Rep. 2016 Nov 2;6:36093. doi: 10.1038/srep36093. PMID: 27805013; PMCID: PMC5090961.
13. Misra A, Pandey RM, Devi JR, Sharma R, Vikram NK, Khanna N. High prevalence of diabetes, obesity and dyslipidaemia in urban slum population in northern India. Int J Obes Relat Metab Disord. 2001 Nov;25(11):1722-9. doi: 10.1038/sj.ijo.0801748. Erratum in: Int J Obes Relat Metab Disord. 2002 Sep;26(9):1281. PMID: 11753596.
14. Pandya H, Lakhani JD, Dadhania J, Trivedi A. The Prevalence and Pattern of Dyslipidemia among Type 2 Diabetic Patients at Rural Based Hospital in Gujarat, India. Indian Journal of Clinical Practice 2012;22(12):36-44.
15. Martin SS, Blaha MJ, Elshazly MB, Toth PP, Kwiterovich PO, Blumenthal RS, Jones SR. Comparison of a novel method vs the Friedewald equation for estimating low-density lipoprotein cholesterol levels from the standard lipid profile. JAMA. 2013 Nov 20;310(19):2061-8. doi: 10.1001/jama.2013.280532. PMID: 24240933; PMCID: PMC4226221.
16. LDL Calculator [Internet]. Johns Hopkins University; c2022 [cited 2022 Oct 30]. Available from: https://ldlcalculator.com/
17. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972 Jun;18(6):499-502. doi: 10.1093/clinchem/18.6.499. PMID: 4337382.
18. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA. 2001 May 16;285(19):2486-97. doi: 10.1001/jama.285.19.2486. PMID: 11368702.
19. World Health Organization. Regional Office for the Western Pacific. (2000). The Asia-Pacific perspective : redefining obesity and its treatment. Sydney : Health Communications Australia.
20. O'Brien T, Nguyen TT, Zimmerman BR. Hyperlipidemia and diabetes mellitus. Mayo Clin Proc. 1998 Oct;73(10):969-76. doi: 10.4065/73.10.969. PMID: 9787748.
21. Brenner BM, Cooper ME, de Zeeuw D, Keane WF, Mitch WE, Parving HH, Remuzzi G, Snapinn SM, Zhang Z, Shahinfar S; RENAAL Study Investigators. Effects of losartan on renal and cardiovascular outcomes in patients with type 2 diabetes and nephropathy. N Engl J Med. 2001 Sep 20;345(12):861-9. doi: 10.1056/NEJMoa011161. PMID: 11565518.
22. Borle AL, Chhari N, Gupta G, Bathma V. Study of prevalence and pattern of dyslipidaemia in type 2 diabetes mellitus patients attending rural health training centre of medical college in Bhopal, Madhya Pradesh, India. Int J Community Med Public Health. 2017 Jan. 31;3(1):140-4. doi: 10.18203/2394-6040.ijcmph20151549
23. Dixit AK, Dey R, Suresh A, Chaudhuri S, Panda AK, Mitra A, Hazra J. The prevalence of dyslipidemia in patients with diabetes mellitus of ayurveda Hospital. J Diabetes Metab Disord. 2014 May 22;13:58. doi: 10.1186/2251-6581-13-58. PMID: 24918095; PMCID: PMC4051117.
24. Parikh RM, Joshi SR, Menon PS, Shah NS. Prevalence and pattern of diabetic dyslipidemia in Indian type 2 diabetic patients. Diabetes

Metab Syndr Clin Res Rev. 2010;4(1):10–12. doi: 10.1016/j.dsx.2009.04.005

25. Howard BV, Cowan LD, Go O, Welty TK, Robbins DC, Lee ET. Adverse effects of diabetes on multiple cardiovascular disease risk factors in women. The Strong Heart Study. Diabetes Care. 1998 Aug;21(8):1258-65. doi: 10.2337/diacare.21.8.1258. PMID: 9702430.
26. Pokharel DR, Khadka D, Sigdel M, Yadav NK, Acharya S, Kafle R, Sapkota RM, Sigdel T. Prevalence and pattern of dyslipidemia in Nepalese individuals with type 2 diabetes. BMC Res Notes. 2017 Apr 4;10(1):146. doi: 10.1186/s13104-017-2465-4. PMID: 28376848; PMCID: PMC5379598.
27. Lin H, Li Q, Hu Y, Zhu C, Ma H, Gao J, Wu J, Shen H, Jiang W, Zhao N, Yin Y, Pan B, Jeekel J, Hofman A, Gao X. The prevalence of multiple non-communicable diseases among middle-aged and elderly people: the Shanghai Changfeng Study. Eur J Epidemiol. 2017 Feb;32(2):159-163. doi: 10.1007/s10654-016-0219-6. Epub 2016 Dec 20. PMID: 27999971.
28. Tripathy JP, Thakur JS, Jeet G, Jain S. Prevalence and determinants of comorbid diabetes and hypertension: Evidence from non communicable disease risk factor STEPS survey, India. Diabetes Metab Syndr. 2017 Nov;11 Suppl 1:S459-S465. doi: 10.1016/j.dsx.2017.03.036. Epub 2017 Mar 31. PMID: 28395951.
29. Berraho M, El Achhab Y, Benslimane A, El Rhazi K, Chikri M, Nejjari C. Hypertension and type 2 diabetes: a cross-sectional study in Morocco (EPIDIAM Study). Pan Afr Med J 2012;11:52.
30. Otieno CF, Vaghela V, Mwendwa FW, Kayima JK, Ogola EN. Cardiovascular risk factors in patients with type 2 diabetes mellitus in Kenya: levels of control attained at the Outpatient Diabetic Clinic of Kenyatta National Hospital, Nairobi. East Afr Med J. 2005 Dec;82(12 Suppl):S184-90. doi: 10.4314/eamj.v82i12.9380. PMID: 16619731.
31. Colosia AD, Palencia R, Khan S. Prevalence of hypertension and obesity in patients with type 2 diabetes mellitus in observational studies: a systematic literature review. Diabetes Metab Syndr Obes. 2013 Sep 17;6:327-38. doi: 10.2147/DMSO.S51325. PMID: 24082791; PMCID: PMC3785394.
32. Chen G, McAlister FA, Walker RL, Hemmelgarn BR, Campbell NR. Cardiovascular outcomes in framingham participants with diabetes: the importance of blood pressure. Hypertension. 2011 May;57(5):891-7. doi: 10.1161/hypertensionaha.110.162446. Epub 2011 Mar 14. PMID: 21403089; PMCID: PMC3785072.