

# The Impact of Co-morbidities on Quality of Life in Diabetic Patients

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## ABSTRACT

Diabetes mellitus (DM) is a chronic metabolic disorder that significantly affects individuals' health-related quality of life (HRQoL). The presence of comorbidities such as cardiovascular disease, nephropathy, neuropathy, and retinopathy further complicates the lives of diabetic patients, contributing to physical, emotional, and social burdens. Cardiovascular diseases, often resulting from prolonged hyperglycemia, significantly increase mortality and reduce physical functioning. Diabetic nephropathy, a major cause of chronic kidney disease, leads to progressive kidney damage, requiring complex management. Neuropathy and retinopathy, both of which result from long-term uncontrolled blood sugar, cause pain, disability, and vision impairment, further diminishing HRQoL. Moreover, mental health disorders like depression and anxiety are common among diabetic patients, creating a cycle of poor glycemic control and psychological distress. These comorbidities not only exacerbate the direct impact of diabetes on physical health but also affect mental and social well-being. Addressing both diabetes and its associated comorbidities through comprehensive care, psychosocial support, and lifestyle interventions is crucial for improving the overall quality of life in diabetic patients.

**Keywords:** Diabetes mellitus, Comorbidities, Quality of life, Diabetic Patients

## INTRODUCTION

Diabetes mellitus (DM) is a global public health concern that affects millions of people worldwide [1]. It is a chronic disease characterized by high blood glucose levels due to defects in insulin secretion, insulin action, or both [2]. Type 1 diabetes is an autoimmune disorder that destroys pancreatic beta cells [3], while Type 2 diabetes results from insulin resistance combined with inadequate insulin production [4]. The prevalence of diabetes has risen significantly, leading to various complications and comorbidities, such as cardiovascular diseases, nephropathy, neuropathy, and retinopathy [5]. These complications not only affect the physical health of diabetic patients but also have a profound impact on their quality of life [6]. Diabetes mellitus, particularly type 2 diabetes, is a chronic condition that significantly affects individuals' health-related quality of life (HRQoL)

[7]. HRQoL encompasses various dimensions of well-being, including physical, mental, and social health. In diabetic patients, HRQoL is often compromised due to the disease's direct effects and the complications arising from it [8]. Studies indicate that individuals with diabetes frequently experience lower HRQoL scores compared to the general population, with significant reductions observed as the number and severity of comorbidities increase [9]. The presence of comorbidities has been shown to exacerbate the challenges faced by diabetic patients, leading to a marked decline in their overall quality of life [10]. This review article synthesizes recent findings on the impact of comorbidities on HRQoL among diabetic patients, emphasizing the need for comprehensive management strategies.

## METHODOLOGY

This review article was developed through a comprehensive literature search to examine the impact of comorbidities on the quality of life (QoL)

in diabetic patients. Peer-reviewed articles, clinical studies, and systematic reviews published between 2010 and 2024 were retrieved from scientific

databases such as PubMed, Scopus, and Google Scholar. Keywords used included "diabetes mellitus," "comorbidities," "quality of life," "cardiovascular disease," "diabetic nephropathy," "diabetic neuropathy," "diabetic retinopathy," "mental health in diabetes," and "health-related quality of life." Studies focusing on Type 1 and Type 2 diabetes, comorbidities, and their impact on physical, emotional, and social aspects of QoL were prioritized. Data from these studies were synthesized to highlight the key comorbidities affecting diabetic patients and the mechanisms through which they reduce QoL. The review also examined evidence-based strategies for mitigating the effects of these comorbidities, focusing on multidisciplinary management, lifestyle interventions, mental health support, and technological innovations.

### Comorbidities in Diabetes Mellitus

As of 2024, the global burden of diabetes has continued to rise, with an estimated 537 million adults affected [11]. The condition is closely associated with various long-term complications and comorbidities, which contribute significantly to morbidity and mortality among diabetic patients [12]. Comorbidities in diabetes often develop as a result of prolonged exposure to elevated blood glucose levels, which leads to multi-organ dysfunction [13]. These comorbidities often require additional medications, monitoring, and interventions, increasing the complexity of treatment plans. Moreover, managing multiple conditions increases the risk of polypharmacy, drug interactions, and treatment adherence challenges [14]. For example, patients with diabetic nephropathy may require medications to control blood pressure and reduce proteinuria (e.g., ACE inhibitors or ARBs), in addition to glucose-lowering therapies [15]. Again, diabetic patients with cardiovascular disease may need statins, antihypertensives, and antiplatelet therapy, increasing the burden of daily medications [16]. Effective management of diabetes and its comorbidities requires a multidisciplinary approach, with personalized care plans that address both glycemic control and the management of complications [17].

- i. Cardiovascular Disease (CVD): CVD is the leading cause of death among diabetic patients. The risk of CVD is two to four times higher in individuals with diabetes compared to non-diabetic individuals [16]. This increased risk is attributed to several factors: such as atherosclerosis, hypertension and dyslipidemia [18].

Prolonged hyperglycemia leads to endothelial dysfunction, increased oxidative stress, and inflammation, promoting the development of atherosclerotic plaques in large arteries [19]. These plaques narrow the blood vessels, increasing the risk of myocardial infarction, stroke, and peripheral artery disease. Diabetes is strongly associated with hypertension, with up to 80% of Type 2 diabetes patients also having high blood pressure [20]. Hypertension accelerates the development of atherosclerosis and increases the risk of heart failure [21]. Diabetic dyslipidemia, characterized by high triglyceride levels, low high-density lipoprotein (HDL) levels, and the presence of small, dense low-density lipoprotein (LDL) particles, further contributes to cardiovascular risk. These lipid abnormalities promote plaque formation and vascular occlusion [22,23].

- ii. Diabetic Nephropathy: Diabetic nephropathy, a leading cause of chronic kidney disease (CKD) and end-stage renal disease (ESRD), affects approximately 20-40% of patients with diabetes [24]. It is characterized by: glomerular hyperfiltration, proteinuria and progressive kidney function decline [25]. In the early stages of diabetic nephropathy, hyperglycemia causes increased pressure and hyperfiltration within the glomeruli, leading to damage of the glomerular filtration barrier [26]. As nephropathy progresses, the damaged glomeruli allow proteins, especially albumin, to leak into the urine (albuminuria), a key marker of kidney damage [27]. Without intervention, nephropathy leads to a gradual decline in glomerular filtration rate (GFR), eventually resulting in ESRD, requiring dialysis or kidney transplantation [28].
- iii. Diabetic Retinopathy (DR) is the leading cause of blindness in working-age adults. The pathophysiology of DR involves: microvascular damage, neovascularization and macular edema [29]. Hyperglycemia induces damage to retinal blood vessels through mechanisms such as increased advanced glycation end-products (AGEs), oxidative stress, and inflammation [30]. In response to ischemia caused by damaged retinal blood vessels, new, fragile blood vessels form (neovascularization). These

- vessels are prone to leakage and rupture, leading to vision loss [31]. Fluid leakage from damaged retinal blood vessels leads to swelling of the macula, the central part of the retina responsible for sharp vision. Macular edema significantly impairs vision if untreated [32].
- iv. **Diabetic Neuropathy:** Diabetic neuropathy affects approximately 50% of people with diabetes and is classified into several subtypes, including peripheral, autonomic, and focal neuropathies [33]. Peripheral neuropathy is the most common form, characterized by sensory loss, tingling, and pain in the extremities. It results from damage to peripheral nerves due to chronic hyperglycemia, leading to impaired blood flow and ischemia of the nerves [34]. Autonomic neuropathy affects the autonomic nervous system, leading to dysfunction in various organ systems, including the cardiovascular, gastrointestinal, and genitourinary systems [35]. Symptoms include orthostatic hypotension, gastroparesis, and bladder dysfunction. Focal neuropathy involves the sudden weakness of one nerve or group of nerves, leading to localized pain or muscle weakness, often in the face, chest, or leg [36].
  - v. **Mental Health Comorbidities:** Mental health disorders, particularly depression and anxiety, are prevalent among diabetic patients [37]. The bi-directional relationship between diabetes and mental health is well-established. The chronic burden of managing diabetes, fear of complications, and the physical impact of comorbidities often lead to psychological distress. Diabetes distress includes feelings of frustration, burnout, and helplessness related to diabetes management [38]. Diabetic patients are twice as likely to develop depression compared to non-diabetic individuals [39]. Depression negatively impacts glycemic control by reducing motivation for self-care, leading to poor treatment adherence and worsened outcomes. Anxiety disorders, including generalized anxiety and fear of hypoglycemia, are common in diabetes [40]. Patients may experience constant worry about their blood sugar levels, future

complications, and the long-term impact of their disease.

### **Impact of Comorbidities on Quality of Life in Diabetic Patients**

Diabetes mellitus (DM) is a chronic metabolic disorder with far-reaching complications affecting nearly all organ systems. Over time, patients with diabetes often develop comorbidities such as cardiovascular disease, neuropathy, nephropathy, and retinopathy, which significantly affect their quality of life (QoL) [41]. The cumulative burden of managing both diabetes and its comorbidities introduces complexities into daily life, affecting physical, emotional, and social well-being [42].

- i. **Physical Health Decline:** The presence of comorbidities such as chronic lung disease or cardiovascular issues has been associated with significant reductions in physical functioning [43]. For instance, studies have shown that diabetic patients with multiple comorbid conditions report higher levels of pain and discomfort, which adversely affects their mobility and self-care abilities [44].
- ii. **Mental Health Challenges:** Mental health comorbidities like depression are particularly detrimental. They not only lower HRQoL but also complicate diabetes management by affecting medication adherence and self-care practices [45]. The interplay between diabetes and depression creates a vicious cycle where poor glycemic control can exacerbate depressive symptoms [46].
- iii. **Social and Economic Impacts:** Comorbidities can lead to increased healthcare costs due to more frequent medical visits and treatments [47]. This financial burden can further strain the emotional well-being of patients, contributing to a decline in their overall quality of life. Physical limitations due to comorbidities like neuropathy, nephropathy, or retinopathy often restrict patients' ability to participate in social activities [48]. Loss of independence and reliance on caregivers can lead to social withdrawal, negatively affecting social QoL [49].

### **Strategies to Mitigate the Impact of Comorbidities**

To improve the quality of life in diabetic patients, a multifaceted approach that addresses both diabetes management and comorbidities is essential. Some strategies include:

1. **Comprehensive Management Programs:** Integrated care programs that address diabetes and comorbidities can help reduce complications and improve QoL. These programs should focus on individualized care plans, patient education, and regular monitoring [50].
2. **Psychosocial Support:** Mental health interventions, such as counseling and therapy, can alleviate the psychological burden of comorbidities [51]. Group therapy and community support programs can also help diabetic patients connect with others facing similar challenges, reducing feelings of isolation [52].
3. **Lifestyle Modifications:** Adopting healthy lifestyle changes, such as regular physical activity, a balanced diet, and smoking cessation, can reduce the risk of complications. These changes also improve overall well-being, including emotional and social health [53].
4. **Technological Interventions:** Continuous glucose monitoring (CGM) systems, insulin pumps, and mobile health applications can help patients better manage their diabetes, reducing the risk of complications [54]. Artificial intelligence (AI)-driven tools for early detection of comorbidities can also play a role in improving outcomes [55].

### CONCLUSION

Comorbidities in diabetic patients significantly exacerbate the challenges of managing diabetes and profoundly impact their quality of life (QoL). Conditions such as cardiovascular disease, nephropathy, neuropathy, retinopathy, and mental health disorders introduce complex physical, emotional, and social burdens, leading to a decline in health-related quality of life (HRQoL). Effective management of diabetes, therefore, requires a comprehensive and multidisciplinary approach that addresses both glycemic control and the prevention

and treatment of comorbidities. Interventions such as lifestyle modifications, integrated care programs, mental health support, and the use of advanced technologies like continuous glucose monitoring and artificial intelligence-driven tools can improve patient outcomes and alleviate the burden of comorbidities. By focusing on individualized care and proactive management strategies, the overall QoL of diabetic patients can be significantly enhanced.

### REFERENCES

1. Lovic D, Piperidou A, Zografou I, Grassos H, Pittaras A, Manolis A. The growing epidemic of diabetes mellitus. *Current vascular pharmacology*. 2020 Mar 1;18(2):104-9.
2. Kumar R, Saha P, Kumar Y, Sahana S, Dubey A, Prakash O. A review on diabetes mellitus: type1 & Type2. *World Journal of Pharmacy and Pharmaceutical Sciences*. 2020 Aug 2;9(10):838-50.
3. Roep BO, Thomaidou S, van Tienhoven R, Zaldumbide A. Type 1 diabetes mellitus as a disease of the  $\beta$ -cell (do not blame the immune system?). *Nature Reviews Endocrinology*. 2021 Mar;17(3):150-61.
4. Nellaiappan K, Preeti K, Khatri DK, Singh SB. Diabetic complications: an update on pathobiology and therapeutic strategies. *Current diabetes reviews*. 2022 Jan 1;18(1):31-44.
5. Marušić M, Paić M, Knobloch M, Liberati Pršo AM. NAFLD, insulin resistance, and diabetes mellitus type 2. *Canadian Journal of Gastroenterology and Hepatology*. 2021;2021(1):6613827.
6. Pham TB, Nguyen TT, Truong HT, Trinh CH, Du HN, Ngo TT, Nguyen LH. Effects of diabetic complications on health-related quality of life impairment in Vietnamese patients with type 2 diabetes. *Journal of diabetes research*. 2020;2020(1):4360804.\
7. Zare F, Ameri H, Madadzadeh F, Reza Aghaei M. Health-related quality of life and its associated factors in patients with type 2 diabetes mellitus. *SAGE Open Medicine*. 2020 Oct; 8:2050312120965314.
8. Shah H, Shah R, Sanghani H, Lakhani N. Health related quality of life (HRQoL) and its associated surgical factors in diabetes foot ulcer patients. *J Clin Invest Surg*. 2020 Nov 25;5(2):83-90.
9. Pati S, Pati S, Van Den Akker M, Schellevis FF, Jena S, Burgers JS. Impact of comorbidity on health-related quality of life among type 2 diabetic patients in primary care. *Primary health care research & development*. 2020 Jan;21:e9.

10. Lygidakis C, Uwizihiwe JP, Bia M, Uwinkindi F, Kallestrup P, Vögele C. Quality of life among adult patients living with diabetes in Rwanda: a cross-sectional study in outpatient clinics. *BMJ open*. 2021 Feb 1;11(2):e043997.
11. Dong C, Wu G, Li H, Qiao Y, Gao S. Type 1 and type 2 diabetes mortality burden: Predictions for 2030 based on Bayesian age period cohort analysis of China and global mortality burden from 1990 to 2019. *Journal of Diabetes Investigation*. 2024 May;15(5):623-33.
12. Munir MK, Khan S, Rehman S, Ahmed D, Jabbar A. Tuberculosis Among Diabetes Patients: A Review of Epidemiology, Pathophysiology, Clinical Manifestations, and Management. *Chronicles of Biomedical Sciences*. 2024 Sep 2;1(3):125-32.
13. Safieddine B, Sperlich S, Epping J, Lange K, Geyer S. Development of comorbidities in type 2 diabetes between 2005 and 2017 using German claims data. *Scientific reports*. 2021 May 27;11(1):11149.
14. Atak Tel BM, Aktas G, Bilgin S, Baltaci SB, Taslamacioglu Duman T. Control level of type 2 diabetes mellitus in the elderly is associated with polypharmacy, accompanied comorbidities, and various increased risks according to the beers criteria. *Diagnostics*. 2023 Nov 13;13(22):3433.
15. Papademetriou V, Alataki S, Stavropoulos K, Papadopoulos C, Bakogiannis K, Tsioufis K. Pharmacological management of diabetic nephropathy. *Current Vascular Pharmacology*. 2020 Mar 1;18(2):139-47.
16. Ma CX, Ma XN, Guan CH, Li YD, Mauricio D, Fu SB. Cardiovascular disease in type 2 diabetes mellitus: progress toward personalized management. *Cardiovascular diabetology*. 2022 May 14;21(1):74.
17. Pontoppidan JR, Nielsen EE, Olsen MH, Skjødt MK, Christensen JO, Raymond IE, Møller SH, Soja AM, Gæde PH. A multidisciplinary, shared care clinic using personalized medicine and coordinated care in patients with concomitant type 2 diabetes and cardiovascular disease. Protocol and baseline characteristics. *Preventive medicine reports*. 2024 Feb 1; 38:102594.
18. Uti, D. E., Igile, G. O., Omang, W. A., Umoru, G. U., Udeozor, P. A., Obeten, U. N., Ogbonna, O. N., Ibiam U. A., Alum, E. U., Ohunene, O. R., Chukwufumnanya, M. J., Oplekwu, R. I. and Obio, W. A. Anti-Diabetic Potentials of Vernonioid E Saponin; A Biochemical Study. *Natural Volatiles and Essential Oils*. 2021; 8(4): 14234-14254.
19. An Y, Xu BT, Wan SR, Ma XM, Long Y, Xu Y, Jiang ZZ. The role of oxidative stress in diabetes mellitus-induced vascular endothelial dysfunction. *Cardiovascular Diabetology*. 2023 Sep 2;22(1):237.
20. Akalu Y, Belsti Y. Hypertension and its associated factors among type 2 diabetes mellitus patients at Debre Tabor general hospital, northwest Ethiopia. *Diabetes, Metabolic Syndrome and Obesity*. 2020 May 13:1621-31.
21. Poznyak AV, Sadykhov NK, Kartuesov AG, Borisov EE, Melnichenko AA, Grechko AV, Orekhov AN. Hypertension as a risk factor for atherosclerosis: Cardiovascular risk assessment. *Frontiers in Cardiovascular Medicine*. 2022 Aug 22; 9:959285.
22. Rizvi AA, Stoian AP, Janez A, Rizzo M. Lipoproteins and cardiovascular disease: an update on the clinical significance of atherogenic small, dense LDL and new therapeutical options. *Biomedicines*. 2021 Oct 29;9(11):1579.
23. Ndrepepa G. High-density lipoprotein: a double-edged sword in cardiovascular physiology and pathophysiology. *Journal of Laboratory and Precision Medicine*. 2021 Oct 30;6.
24. Samsu N. Diabetic nephropathy: challenges in pathogenesis, diagnosis, and treatment. *BioMed research international*. 2021;2021(1):1497449.
25. Sagoo MK, Gnudi L. Diabetic nephropathy: an overview. *Diabetic nephropathy: methods and protocols*. 2020:3-7.
26. Yang Y, Xu G. Update on pathogenesis of glomerular hyperfiltration in early diabetic kidney disease. *Frontiers in Endocrinology*. 2022 May 19; 13:872918.
27. Chebotareva N, Vinogradov A, McDonnell V, Zakharova NV, Indeykina MI, Moiseev S, Nikolaev EN, Kononikhin AS. Urinary protein and peptide markers in chronic kidney disease. *International journal of molecular sciences*. 2021 Nov 9;22(22):12123.
28. Liang R, Chen X, Zhang Y, Law CF, Yu S, Jiao J, Yang Q, Wu D, Zhang G, Chen H, Wang M. Clinical features and gene variation analysis of COQ8B nephropathy: Report of seven cases. *Frontiers in Pediatrics*. 2023 Feb 9; 10:1030191.

29. Mounirou BA, Adam ND, Yakoura AK, Aminou MS, Liu YT, Tan LY. Diabetic retinopathy: an overview of treatments. *Indian Journal of Endocrinology and Metabolism*. 2022 Mar 1;26(2):111-8.
30. Khalid M, Petroianu G, Adem A. Advanced glycation end products and diabetes mellitus: mechanisms and perspectives. *Biomolecules*. 2022 Apr 4;12(4):542.
31. Nian S, Lo AC, Mi Y, Ren K, Yang D. Neurovascular unit in diabetic retinopathy: pathophysiological roles and potential therapeutical targets. *Eye and Vision*. 2021 May 1;8(1):15.
32. Alum, E. U., Umoru, G. U., Uti, D. E., Aja, P. M., Ugwu, O. P., Orji, O. U., Nwali, B. U., Ezeani, N., Edwin, N., Orinya, F. O. Hepato-protective effect of Ethanol Leaf Extract of *Datura stramonium* in Alloxan-induced Diabetic Albino Rats. *Journal of Chemical Society of Nigeria*. 2022; 47 (3): 1165 – 1176. <https://doi.org/10.46602/jcsn.v47i5.819>.
33. Anandhanarayanan A, Teh K, Goonoo M, Tesfaye S, Selvarajah D. Diabetic neuropathies. *Endotext* [Internet]. 2022 Mar 15.
34. Zhu J, Hu Z, Luo Y, Liu Y, Luo W, Du X, ShengLiang P, Luo Z, Hu J. Diabetic peripheral neuropathy: pathogenetic mechanisms and treatment. *Frontiers in Endocrinology*. 2024 Jan 9; 14:1265372.
35. Kaur D, Tiwana H, Stino A, Sandroni P. Autonomic neuropathies. *Muscle & nerve*. 2021 Jan;63(1):10-21.
36. Terrelonge M, Rosow L. Common focal neuropathies in the hospitalized patient. *Neurologic Clinics*. 2022 Feb 1;40(1):175-90.
37. Al-Sofiani ME, Albunyan S, Alguwaihes AM, Kalyani RR, Golden SH, Alfadda A. Determinants of mental health outcomes among people with and without diabetes during the COVID-19 outbreak in the Arab gulf region. *Journal of diabetes*. 2021 Apr;13(4):339-52.
38. Poole L, Hackett RA. Diabetes distress: the psychological burden of living with diabetes. *The Lancet Diabetes & Endocrinology*. 2024 May 30.
39. AbdElmageed RM, Hussein SM. Risk of depression and suicide in diabetic patients. *Cureus*. 2022 Jan;14(1).
40. Schmitt A, Bendig E, Baumeister H, Hermanns N, Kulzer B. Associations of depression and diabetes distress with self-management behavior and glycemic control. *Health Psychology*. 2021 Feb;40(2):113.
41. Ugwu, O. P.C., Alum, E. U., Okon, M. B., Aja, P. M., Obeagu, E. I. and Onyeneke, E. C. Ethanol root extract and fractions of *Sphenocentrum jollyanum* abrogate hyperglycemia and low body weight in Streptozotocin-induced diabetic Wistar albino Rats, *RPS Pharmacy and Pharmacology Reports*. 2023; 2,1-6. <https://doi.org/10.1093/rpsppr/rqad010>.
42. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I. Beyond Pregnancy: Understanding the Long-Term Implications of Gestational Diabetes Mellitus. *INOSR Scientific Research*. 2024; 11(1):63-71. <https://doi.org/10.59298/INOSRSR/2024/1.1.16371>
43. Dos Santos NC, Miravittles M, Camelier AA, De Almeida VD, Maciel RR, Camelier FW. Prevalence and impact of comorbidities in individuals with chronic obstructive pulmonary disease: a systematic review. *Tuberculosis and respiratory diseases*. 2022 Jul;85(3):205.
44. Polikandrioti M, Vasilopoulos G, Koutelekos I, Panoutsopoulos G, Gerogianni G, Babatsikou F, Zartaloudi A, Toulia G. Quality of life in diabetic foot ulcer: associated factors and the impact of anxiety/depression and adherence to self-care. *The international journal of lower extremity wounds*. 2020 Jun;19(2):165-79.
45. Bhat NA, Muliya KP, Kumar S. Psychological aspects of diabetes. *Diabetes*. 2020 Nov;8(1):90-8.
46. Wilson JB, Epstein MA, Lopez B, Brown AK, Lutfy K, Friedman TC. The role of neurochemicals, stress hormones and immune system in the positive feedback loops between diabetes, obesity and depression. *Frontiers in Endocrinology*. 2023 Aug 17; 14:1224612.
47. Tran PB, Kazibwe J, Nikolaidis GF, Linnosmaa I, Rijken M, van Olmen J. Costs of multimorbidity: a systematic review and meta-analyses. *BMC medicine*. 2022 Jul 19;20(1):234.
48. Gautam Roy P, Bhardwaj R, Goel A. Health and Social Concerns in Elderly Men. *Gerontological Concerns and Responses in India*. 2021:69-98.

49. Bimou C, Harel M, Laubarie-Mouret C, Cardinaud N, Charenton-Blavignac M, Toumi N, Trimouillas J, Gayot C, Boyer S, Hebert R, Dantoine T. Patterns and predictive factors of loss of the independence trajectory among community-dwelling older adults. *BMC geriatrics*. 2021 Dec; 21:1-3.
50. Ugwu, O. P. C., Alum, E. U. and Uhama, K. C. (2024). Dual Burden of Diabetes Mellitus and Malaria: Exploring the Role of Phytochemicals and Vitamins in Disease Management. *Research Invention Journal of Research in Medical Sciences*. 3(2):38-49.
51. Chimaroke Onyeabo, Paul Anyiam Ndubuisi, Anthony Cemaluk Egbuonu, Prince Chimezie Odika, Simeon Ikechukwu Egba, Obedience Okon Nnana, Polycarp Nnacheta Okafor. Natural products-characterized Moringa oleifera leaves methanolic extract and anti-diabetic properties mechanisms of its fractions in streptozotocin-induced diabetic rats *The Nigerian Journal of Pharmacy*, 2022; 56(1) :18-29
52. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I. Beyond Pregnancy: Understanding the Long-Term Implications of Gestational Diabetes Mellitus. *INOSR Scientific Research*. 2024; 11(1):63-
71. <https://doi.org/10.59298/INOSRSR/2024/1.1.16371>
53. Represas-Carrera, F., Couso-Viana, S., Méndez-López, F., Masluk, B., Magallón-Botaya, R., Recio-Rodríguez, J.I., Pombo, H., Leiva-Rus, A., Gil-Girbau, M., Motrico, E. and Martí-Lluch, R. Effectiveness of a multicomponent intervention in primary care that addresses patients with diabetes mellitus with two or more unhealthy habits, such as diet, physical activity or smoking: multicenter randomized cluster trial (EIRA Study). *International journal of environmental research and public health*, 2021; 18(11), p.5788.
54. M.C. Udeh Sylvester, O.F.C. Nwodo, O.E. Yakubu, E.J. Parker, S. Egba, E. Anaduaka, V.S. Tatah, O.P. Ugwu, E.M. Ale, C.M. Ude and T.J. Iornenge. Effects of Methanol Extract of *Gongronema latifolium* Leaves on Glycaemic Responses to Carbohydrate Diets in Streptozotocin-induced Diabetic Rats. *Journal of Biological Sciences*, 2022; 22: 70-79.
55. Alsaleh MM, Allery F, Choi JW, Hama T, McQuillin A, Wu H, Thygesen JH. Prediction of disease comorbidity using explainable artificial intelligence and machine learning techniques: A systematic review. *International Journal of Medical Informatics*. 2023 Jul 1; 175:105088.

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