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Comparative Study of Efficacy and Adverse Effects of Metformin Plus Empagliflozin Versus Metformin Plus Sitagliptin in Diabetes Mellitus Type II Patients

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ABSTRACT

Introduction: This study aims to compare the efficacy and adverse effects of metformin combined with empagliflozin versus metformin combined with sitagliptin in Type II DM patients in Pakistan. Given the rising prevalence of diabetes in Pakistan, evaluating these widely used combination therapies in a local population is essential for optimizing treatment strategies. This research will provide valuable insights into glycemic control and safety profiles in a population with unique genetic, dietary, and lifestyle factors, which are often underrepresented in global studies. **Materials and Procedures:** This single-blinded RCT enrolled 112 patients aged 35–65 with HbA1c 7–9%, diabetes >1 year. Patients were randomized into two groups: Group A received Metformin plus Empagliflozin, and Group B received Metformin plus Sitagliptin. Exclusions included irregular medication, prior hypoglycemic use, high creatinine, or glucose-altering drugs. HbA1c was measured monthly; compliance and side effects were monitored. **Results:** In my research, patients treated with metformin + empagliflozin had a higher likelihood of being in the metformin + empagliflozin group than those treated with metformin + sitagliptin (48.21% vs. 26.79%, respectively) if their HbA1c was under 7%. Side effects with empagliflozin are less than sitagliptin i.e. diarrhea (3.57% vs 8.93%), rash (0.0% vs 5.36%), hypoglycemia (12.50% vs 16.07%), UTI (0.0% vs 7.14%) and increased urination (19.64% vs 10.71%) respectively. **Conclusion:** When used in conjunction with metformin, SGLT-2 inhibitors are just as safe, effective, and well-tolerated in individuals with Type 2 diabetes mellitus as DPP4 inhibitors.

INTRODUCTION

Type II diabetes mellitus (TII, DM) is a continuing and advanced disease that ascends from reduced insulin secretion, increased output of hepatic glucose, and insulin resistance. Globally, diabetes Mellitus (DM) is one of the most common reason of mortality and morbidity and is accountable for 3.9 million deaths yearly. From 30 million cases in 1985 to 177 million new cases in 2000, the incidence of DM has increased exponentially during the past 20 years.[1] A 10% to 30% reduction in life expectancy is also associated with diabetes mellitus. Metformin plus empagliflozin, a biguanide mediator that predominantly acts to lesser hepatic glucose output and is the most broadly recommended first line oral antihyperglycemic agent (AHA).[2,3]

Nevertheless, metformin plus empagliflozin is often effective in achieving or keeping acceptable glycemic control.[4] Certainly, patients who primarily respond to metformin plus empagliflozin normally require supplementary medication actively to maintain glycemic control due to the advanced nature of TII, DM.[5] Glucose-dependent insulin tropic polypeptide (GIP) and the incretion of peptide hormones glucagon like peptide (GLP)-1 arouse glucose-dependent release of insulin. In addition, GLP-1 overcomes the secretion of glucagon from pancreas. Under physiological situations, these incretions are rapidly deactivated by the enzyme dipeptidyl peptidase (DPP)-4.[6]

An orally active and highly selective DPP-4 inhibitor called Sitagliptin that avoids the enzymatic inactivation and deprivation of GIP and GLP-1.[7] Sitagliptin proliferate insulin secretion and depresses glucagon release in a glucose-dependent mode. In that way, posturing negligible risk for hypoglycemia when directed as either monotherapy or in grouping with agents not known to cause hypoglycemia.[8] The mutual use of sitagliptin and metformin has been revealed to be an efficient and well tolerated management in patients with TII DM.[9]

A study[10] found that individuals treated with metformin + empagliflozin had a higher likelihood of being in the metformin + empagliflozin group than those treated with metformin + sitagliptin (44% vs. 22%, respectively) if their HbA1c was under 7%. In

their study, Ahmad et al. (2022)[11] found that using SGLT-2i before and during Ramadan improved HbA1c (7.2 ± 0.8 vs 6.9 ± 0.9 for Metformin + Empagliflozin and 7.8 ± 1.5 vs 7.6 ± 1.6 for Metformin and sitagliptin). Following SGLT-2i treatment, weight and BMI improved (BMI 36.5 ± 4.8 prior to Ramadan and 33.7 ± 2.4 following). In similar study, side effects with empagliflozin are less than sitagliptin i.e. diarrhea (4.5% vs 9.1%), rash (0.0% vs 5.7%), hypoglycemia (15.9% vs 15.9%), UTI (0.0% vs 6.8%) and increased urination (22.7% vs 14.8%) respectively.[11]

This study aims to compare the efficacy and adverse effects of metformin combined with empagliflozin versus metformin combined with sitagliptin in Type II DM patients in Pakistan. Given the rising prevalence of diabetes in Pakistan, evaluating these widely used combination therapies in a local population is essential for optimizing treatment strategies. This research will provide valuable insights into glycemic control and safety profiles in a population with unique genetic, dietary, and lifestyle factors, which are often underrepresented in global studies. The findings will guide healthcare providers in tailoring treatment plans, improving patient outcomes, and minimizing adverse effects. Furthermore, this study will contribute to the existing literature by offering region-specific data, filling a critical gap, and enhancing the global understanding of diabetes management in diverse populations.

MATERIALS AND METHODS

This single blinded, randomized controlled trial included 112 patients (56 in each group) of either gender, aged 35 to 65, who visited the Department of Internal Medicine, PAEC General Hospital, Islamabad between March 2025 to May 2025 and who had HbA1c (glycated hemoglobin ≥7 and ≤9%) duration > 1 year. The calculated sample size will be 112 i.e. 56 in each group with 5% level of significance, 80% power of study, taking efficacy of metformin + empagliflozin as 44.0% and metformin + sitagliptin as 22.0%.[10] Patients who are not taking drugs regularly in past 3 months, history of previous hypoglycemic medications e,g. insulin and those with abnormal liver function or nephropathy, serum creatinine >1.5mg/dl and taking any drug which affect glucose metabolism e,g steroids were excluded.

The subjects were randomly assigned by blind balloting into one of two groups of 56 patients each group. CONSORT 2010 flowchart for randomized control trial was used. The patients were enrolled by the primary investigator. Patients in Group A were given to the Metformin (500 mg twice daily) plus empagliflozin (5mg twice daily) and patients in Group B were administered to Metformin (500 mg twice daily) with Sitagliptin (50 mg twice daily). Blood samples for the HbA1c level were collected, and all patients were monitored for one, two, and three months. Patients were interviewed to verify compliance, and adverse effects were noted. To prevent bias and confounders from influencing the study's findings, strict exclusion criteria was adhered to. Data was recorded for each patient on pre-designed proforma. All patients were asked to follow-up in OPD.

For the statistical analysis, SPSS version 24 was utilized. The following quantitative data were summarized using the mean ± standard deviation (SD): age, height, weight, BMI, baseline HbA1c and follow-up HbA1c values. The normality of these variables was evaluated using the Shapiro-Wilk test. Frequencies and percentages of qualitative characteristics, such as gender, efficacy, and side effects like rash, diarrhea, hypoglycemia, UTI, and increased urination, were displayed. The Chi-square test or, if appropriate, Fisher's exact test were used to compare the effectiveness and side effects of the various groups.

RESULTS

The study's participants ranged in age from 35 to 65, with a mean age of 45.31 ± 6.16 years. Patients in groups A and B had mean ages of 45.51 ± 6.04 and 45.16 ± 6.19 years, respectively. Of the 63 patients, the majority (56.25%) were in the 35–50 age range. With a male to female ratio of 1:1.6, 43 (38.39%) of the 112 patients were male and 69 (61.61%) were female. DM lasted an average of 8.78 ± 4.89 years. A mean BMI of 28.94 ± 3.23 kg/m2 was recorded. The average height was 14.76 cm ± 165.86 cm. A mean weight of 75.63 ± 8.35 cm was recorded. (Table I).

In my study, pre-treatment and post-treatment HbA1c levels in Group A (Empagliflozin plus metformin) was 8.09 ± 0.42 and 6.23 ± 0.40% respectively while in Group B (Sitagliptin plus metformin) was 8.18 ± 0.41 and 6.91 ± 0.36% respectively. Mean reduction in HbA1c levels in Group A (Empagliflozin plus metformin) was 1.86 ± 0.48% while in Group B (Sitagliptin plus metformin) was 1.34 ± 0.18%.

According to Table II, participants in my study who had under 7% HbA1c are more likely to be in the metformin + empagliflozin group than those receiving metformin + sitagliptin (48.21% vs. 26.79%, respectively). Side effects with empagliflozin are less than sitagliptin i.e. diarrhea (3.57% vs 8.93%), rash (0.0% vs 5.36%), hypoglycemia (12.50% vs 16.07%), UTI (0.0% vs 7.14%) and increased urination (19.64% vs 10.71%) respectively (Table III).

Table I

Distribution of patients with other confounding variables (n=112)

Confounding variables		Group A (n=56)	Group B (n=56)
Age (years)	35-50	30 (53.57%)	33 (58.93%)
	51-65	26 (46.43%)	23 (41.07%)
Gender	Male	24 (42.86%)	19 (33.93%)
	Female	32 (57.14%)	37 (66.07%)
Duration (years)	≤10	32 (57.14%)	35 (62.50%)
	>10	24 (42.86%)	21 (37.50%)
BMI (kg/m²)	≤25	21 (37.50%)	22 (39.29%)
	>25	35 (62.50%)	34 (60.71%)

Table II

Comparison of efficacy between both Groups (n=112).

		Group A (n=56)		Group B (n=56)	
		No. of Patients	%age	No. of Patients	%age
EFFICACY	Yes	27	48.21	15	26.79
	No	29	51.79	41	73.21

P-value is 0.0192 which is statistically significant

Table III

Comparison of the frequency of side effects (n=112).

Side effects	Group A (n=56)		Group B (n=56)		P-value
	Yes	No	Yes	No	
Diarrhea	02 (3.57%)	54 (96.43%)	05 (8.93%)	51 (91.07%)	0.242
Rash	00 (0.0%)	56 (100.0%)	03 (5.36%)	53 (94.64%)	0.079
Hypoglycemia	07 (12.50%)	49 (87.50%)	09 (16.07%)	47 (83.93%)	0.589
UTI	00 (0.0%)	56 (100.0%)	04 (7.14%)	52 (92.86%)	0.042
Increased Urination	11 (19.64%)	45 (80.36%)	06 (10.71%)	50 (89.29%)	0.188

DISCUSSION

Sitagliptin and empagliflozin were examined as alternative treatments for T2D patients in case diet plus metformin failed to maintain glycemic control. A 12-week course of twice-daily 12.5 mg empagliflozin reduced mean HbA1c, FPG, and PP in individuals with type 2 diabetes whose condition was not sufficiently controlled following at least 12 weeks of diet control and metformin therapy. On the other hand, sitagliptin 100 mg each day. In addition to metformin and diet control, sitagliptin 50 mg twice daily was administered to about twice as many people with an initial HbA1c of ≥7.0% who achieved a HbA1c of <7.0% after 12 weeks. Additionally, there were significantly fewer patients receiving empagliflozin whose HbA1c continued to rise (>10.0%) and required the addition of insulin treatment than patients receiving sitagliptin.

Our study's male to female ratio of 1:1.6 is comparable to that seen in other research.[12,13] But according to some studies, men are more prevalent.[14,15] The median age range in our study was in line with global and national averages.[16,17] On average, both groups had T2DM for at least four years. Many people choose to use alternative medicines and home remedies to treat their symptoms instead of seeking medical attention, even after receiving an initial diagnosis. People frequently ignore their symptoms until they get really bad, at which point they go to a doctor for assistance. In line with worldwide data, our study discovered that the HbA1c presentation mean was between 8.6 and 8.9 percent.[18,19] Although individuals in Group B experienced larger drops in their weight and HbA1c than those in Group A, both groups responded favorably to treatment. This suggests that when taken with metformin, empagliflozin works better than sitagliptin.

Numerous clinical trials have demonstrated that the combination of empagliflozin and metformin lowers body weight, arterial blood pressure, and HbA1c levels without resulting in hypoglycemia.[20,21] Additionally, it has been noted that when administered as an initial treatment, especially in patients with coronary vascular disease, greater clinical improvement is observed.[22] Consequently, more people are using this approach as their initial course of treatment. To further enhance patient convenience and adherence, research and trials on single-pill combinations are now in progress.[20,22] According to clinical research, taking metformin and empagliflozin together results in better long-term HbA1c levels than taking metformin alone.[21]

Both the Empagliflozin and Sitagliptin groups in our study saw similar incidence of hypoglycemia episodes (12.50% vs. 16.07%). These findings are consistent with another study by Wan Seman WJ et al. that examined the effects of SGLT2i and Sulphonylureas in the management of diabetes and discovered that SGLT2i users had fewer bouts of severe and symptomatic hypoglycemia than Sulphonylurea users.[24,25] While patients reported more frequent urination with Empagliflozin, no substantial volume depletion was observed in blood pressure measurements.[26]

Our investigation did not uncover a statistically significant difference between the two groups in terms of urinary tract infection risk. A Singaporean observational research found that a cohort taking SGLT2i did not see an elevation in ketone levels.[27] However, it has been discovered that abruptly reducing or stopping exogenous insulin is linked to the risk of diabetic ketoacidosis in people with SGLT2i. When beginning SGLT2i with lowering insulin dose, care should be taken and the patient should receive the proper counseling, as it is normal practice to modify and/or lower insulin dose with altered meal timings and frequency.

There are some limitations to our study that should be considered when interpreting the results. Since the rate of symptomatic hypoglycemia and dehydration was based on patient reports, the observational study's inherent biases, such as recall bias, cannot be ruled out in this instance. Second, the study's limited sample size restricts the generalizability of our findings to other demographic groups.

CONCLUSION

When used in conjunction with metformin, SGLT-2 inhibitors are just as safe, effective, and well-tolerated in individuals with Type 2 diabetes mellitus as DPP4 inhibitors. HbA1c can be improved with either combination. But compared to SGLT-2 inhibitors, DPP4 inhibitors were linked to more negative side effects.

REFERENCES

1. Tarhini, Z., Manceur, K., Magne, J., Mathonnet, M., Jost, J., & Christou, N. (2022). The effect of metformin on the survival of colorectal cancer patients with type 2 diabetes mellitus. *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-16677-3
2. LIN, Z. W. (2019). Pioglitazone-metformin and basal insulin for type 2 diabetes mellitus patients with overweight or obesity and poor blood glucose control: A comparison of efficacy and metabolic effects. *Academic Journal of Second Military Medical University*, 1089-1096.
3. Grammatiki, M., Sagar, R., & Ajjan, R. A. (2021). Metformin: Is it still the first line in type 2 diabetes management algorithm? *Current Pharmaceutical Design*, *27*(8), 1061-1067. https://doi.org/10.2174/1381612826666201222154616
4. Vilsbøll, T., Ekholm, E., Johnsson, E., Dronamraju, N., Jabbour, S., & Lind, M. (2019). Dapagliflozin plus Saxagliptin

add-on therapy compared with insulin in patients with type 2 diabetes poorly controlled by metformin with or without Sulfonylurea therapy: A randomized clinical trial. *Diabetes Care*, *42*(8), 1464-1472. https://doi.org/10.2337/dc18-1988

5. El Shaer, O., Issaa, H., El Falah, A., Abd El Aziz, S., & Salah, R. (2020). Role of dipeptidyl peptidase 4 in type 2 diabe tes mellitus. *Benha Journal of Applied Sciences*, *5*(1), 1-9. https://doi.org/10.21608/bjas.2020.135406
6. Shima, K. R., Ota, T., Kato, K., Takeshita, Y., Misu, H., Kaneko, S., & Takamura, T. (2018). Ursodeoxycholic acid potentiates dipeptidyl peptidase-4 inhibitor sitagliptin by enhancing glucagon-like peptide-1 secretion in patients with type 2 diabetes and chronic liver disease: A pilot randomized controlled and add-on study. *BMJ Open Diabetes Research & Care*, *6*(1), e000469. https://doi.org/10.1136/bmjdrc-2017-000469
7. Jia, W., Ma, J., Miao, H., Wang, C., Wang, X., Li, Q., ... & Ji, L. (2021). Chiglitazar monotherapy with sitagliptin as an active comparator in patients with type 2 diabetes: a randomized, double-blind, phase 3 trial (CMAS). *Science bulletin*, *66*(15), 1581-1590. https://doi.org/10.1016/j.scib.2021.02.027
8. Scheen, A. (2020). Reduction in HbA1c with SGLT2 inhibitors vs. DPP-4 inhibitors as add-ons to metformin monotherapy according to baseline HbA1c: A systematic review of randomized controlled trials. *Diabetes & Metabolism*, *46*(3), 186-196. https://doi.org/10.1016/j.diabet.2020.01.002
9. Trueck, C., Hsin, C., Scherf-Clavel, O., Schaeffeler, E., Lenssen, R., Gazzaz, M., Gersie, M., Taubert, M., Quasdorff, M., Schwab, M., Kinzig, M., Sörgel, F., Stoffel, M. S., & Fuhr, U. (2019). A clinical drug-drug interaction study assessing a novel drug transporter Phenotyping cocktail with Adefovir, Sitagliptin, metformin, Pitavastatin, and digoxin. *Clinical Pharmacology & Therapeutics*, *106*(6), 1398-1407. https://doi.org/10.1002/cpt.1564
10. Zakaraia, H. G., Salem, H. F., Mostafa, M. A., Ali, A. M., & Rabea, H. M. (2023). Empagliflozin versus Sitagliptin as add-on dual therapy in Egyptian patients with type 2 diabetes inadequately controlled with metformin: A 12-week randomized, open-label, parallel-group trial. *Beni-Suef University Journal of Basic and Applied Sciences*, *12*(1). https://doi.org/10.1186/s43088-023-00442-0
11. Ahmed, I., Raja, U. Y., Wahab, M. U., Rehman, T., Ishtiaq, O., Aamir, A. H., Ghaffar, T., Raza, A., Kumar, S., Sherin, A., Masood, F., Randhawa, F. A., Asghar, A., & Khan, S. (2022). Efficacy and safety of combination of empagliflozin and metformin with combination of sitagliptin and metformin during Ramadan: An observational study. *BMC Endocrine Disorders*, *22*(1). https://doi.org/10.1186/s12902-022-01168-3
12. Raja, R., Kumar, V., Khan, M. A., Sayeed, K. A., Hussain, S. Z., & Rizwan, A. (2019). Knowledge, attitude, and practices of complementary and alternative medication usage in patients of type II diabetes mellitus. *Cureus*. https://doi.org/10.7759/cureus.5357
13. Sujata, & Thakur, R. (2021). Unequal burden of equal risk factors of diabetes between different gender in India: A cross-sectional analysis. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-02012-9
14. Maiti, S., Akhtar, S., Upadhyay, A. K., & Mohanty, S. K. (2023). Socioeconomic inequality in awareness, treatment and control of diabetes among adults in India: Evidence from national family health survey of India (NFHS), 2019–2021. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-29978-y
15. Chaudhary, G. M., Chaudhary, F. M., Tanveer, A., Tameez Ud Din, A., Chaudhary, S. M., Tameez Ud Din, A., & Shafi, A. (2019). Demographic and clinical characteristics of 4556 type 2 diabetes mellitus patients at a tertiary care hospital in southern Punjab. *Cureus*. https://doi.org/10.7759/cureus.4592
16. Khan, P., Qayyum, N., Malik, F., Khan, T., Khan, M., & Tahir, A. (2019). Incidence of anxiety and depression among patients with type 2 diabetes and the predicting factors. *Cureus*. https://doi.org/10.7759/cureus.4254
17. Jatoi, N., Elamin, Y. A., Said, A. H., Al-Namer, B., Al-Muallim, F. A., Al-Nemer, F. F., & Al-Halal, F. M. (2022). Prevalence of cardiovascular risk factors among patients with diabetes mellitus type 2 at King Fahad University hospital, Saudi Arabia. *Cureus*. https://doi.org/10.7759/cureus.29489
18. Bhutto, A. R., Abbasi, A., & Abro, A. H. (2019). Correlation of hemoglobin A1c with red cell width distribution and other parameters of red blood cells in type II diabetes mellitus. *Cureus*. https://doi.org/10.7759/cureus.5533
19. Thomsen, R. W., Knudsen, J. S., Kahlert, J., Baggesen, L. M., Lajer, M., Holmgaard, P. H., Vedin, O., Ustyugova, A., & Sørensen, H. T. (2021). Cardiovascular events, acute hospitalizations, and mortality in patients with type 2 diabetes mellitus who initiate Empagliflozin versus Liraglutide: A comparative effectiveness study. *Journal of the American Heart Association*, *10*(11). https://doi.org/10.1161/jaha.120.019356
20. Goldman, J. D. (2018). Combination of Empagliflozin and metformin therapy: A consideration of its place in type 2 diabetes therapy. *Clinical Medicine Insights: Endocrinology and Diabetes*, *11*. https://doi.org/10.1177/1179551418786258
21. Scheen, A. J. (2018). The safety of empagliflozin plus metformin for the treatment of type 2 diabetes. *Expert Opinion on Drug Safety*, *17*(8), 837-848. https://doi.org/10.1080/14740338.2018.1497159
22. American Diabetes Association. (2018). Cardiovascular disease and risk management: Standards of medical care in diabetes—2018. *Diabetes Care*, 41, 86–104. https://doi.org/10.2337/dc18-s009
23. Hirst, J. A., Farmer, A. J., Ali, R., Roberts, N. W., & Stevens, R. J. (2012). Quantifying the effect of metformin treatment and dose on glycemic control. *Diabetes Care*, *35*(2), 446-454. https://doi.org/10.2337/dc11-1465
24. Wan Seman, W. J., Kori, N., Rajoo, S., Othman, H., Mohd Noor, N., Wahab, N. A., Sukor, N., Mustafa, N., & Kamaruddin, N. A. (2016). Switching from sulphonylurea to a sodium-glucose cotransporter2 inhibitor in the fasting month of Ramadan is associated with a reduction in hypoglycaemia. *Diabetes, Obesity and Metabolism*, *18*(6), 628-632. https://doi.org/10.1111/dom.12649
25. Hassanein, M., Echtay, A., Hassoun, A., Alarouj, M., Afandi, B., Poladian, R., Bennakhi, A., Nazar, M., Bergmans, P., Keim, S., Hamilton, G., & Azar, S. T. (2017). Tolerability of canagliflozin in patients with type 2 diabetes mellitus fasting during Ramadan: Results of the Canagliflozin in Ramadan tolerance observational study (CRATOS). *International Journal of Clinical Practice*, *71*(10), e12991. https://doi.org/10.1111/ijcp.12991
26. Hassanein, M., Al-Arouj, M., Hamdy, O., Bebakar, W. M., Jabbar, A., Al-Madani, A., Hanif, W., Lessan, N., Basit, A., Tayeb, K., Omar, M., Abdallah, K., Al Twaim, A., Buyukbese, M. A., El-Sayed, A. A., & Ben-Nakhi, A. (2017). Diabetes and Ramadan: Practical guidelines. *Diabetes Research and Clinical Practice*, *126*, 303-316. https://doi.org/10.1016/j.diabres.2017.03.003

27. Shao, Y., Lim, G. J., Chua, C. L., Wong, Y. F., Yeoh, E. C., Low, S. K., & Sum, C. F. (2018). The effect of Ramadan fasting and continuing sodium-glucose Co-transporter-2 (SGLT2) inhibitor use on ketonemia, blood pressure and renal function in Muslim patients with type 2 diabetes. *Diabetes Research and Clinical Practice*, *142*, 85-91. https://doi.org/10.1016/j.diabres.2018.05.022