Review Article

Review of the Relationship between Anti-Hypertensive and Anti-Diabetes Drugs with Psychiatric Disorders

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Abstract

Background: Diabetes and hypertension are two common diseases all over the world. There are several treatment options for the management of these diseases. Some studies have reported that drugs used to manage diabetes and hypertension may have an impact on psychiatric disorders such as depression and dementia. In this article, we aimed to review the results of recent studies about the impact of anti-hypertensive and antidiabetic drugs on psychiatric disorders.

Materials and Methods: We reviewed studies with keywords of "diabetes", OR "diabetic", OR "anti-diabetes", OR "anti-diabetes", OR "antidiabetic", AND "drug", OR "hypertension", OR "hypertensive", OR "anti-hypertension", OR "anti-hypertensive", OR "anti-hypertensive", AND "psychology", OR "psychological" in PUBMED, ELSEVIER, and CENTRAL databases from 2015 to 2025.

Results: The results of the studies were contradictory. There was no consensus idea about antidiabetic drugs, but it seems that sodium-glucose cotransporter two inhibitors can reduce the risk of depression and dementia. The results of studies about anti-hypertensive drugs had more similarities, and some anti-hypertensive drugs, like angiotensin-converting enzyme inhibitors and angiotensin II receptor blockers, may reduce the risk of psychiatric disorders.

Conclusion: There is a strong need for evaluation of the effects of anti-hypertensive and antidiabetic drugs on psychiatric disorders because the results of current studies are discrepant.

Keywords: Anti-hypertensive, Antidiabetics, Drug, Psychiatry, Mental disorders

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Introduction

The global prevalence of obesity and type 2 diabetes is increasing, driven by lifestyles that are characterized by low energy expenditure and high caloric intake, especially in lower-income and developing nations. The incidence of type 2 diabetes is projected to increase from 415 million to 642 million by the year 2040. Hypertension is increasingly prevalent, with a recent global estimate indicating 1.39 billion cases worldwide[1,2].

T2D and hypertension are readily diagnosed at the

bedside; however, they represent complex and heterogeneous phenotypes linked to an increased risk of life-threatening cardiovascular disease (CVD). The frequent coexistence of these conditions in the same individual is not coincidental, as they share aspects of pathophysiology, particularly those associated with obesity and insulin resistance. It was reported that 85% of individuals with type 2 diabetes had hypertension by their fifth decade of life, while 50% of those with hypertension exhibited impaired glucose tolerance or T2D[3-5].

Psychological impairments such as anxiety and depression, along with cognitive impairments including memory and orientation, are related to hypertension and diabetes[6-8]. On the other hand, some studies illustrated that drugs for hypertension and diabetes treatment impact psychological conditions[9-12].

In this study, we aimed to review the results of previous studies on the psychological effects of anti-hypertensive and antidiabetic drugs.

Methods

In this study, we reviewed studies performed on the psychological effects of anti-hypertensive and antidiabetic drugs.

Keywords of “diabetes,” OR “diabetic,” OR “anti-diabetes,” OR “anti-diabetes,” OR “antidiabetic,” AND “drug,” OR “hypertension,” OR “hypertensive,” OR “anti-hypertension,” OR “anti-hypertensive,” OR “anti-hypertensive,” AND “psychology,” OR “psychological” were searched in PUBMED, ELSEVIER, and CENTRAL databases from 2015 to 2025. Review articles, case reports, and editorials were excluded from this review.

Results

In this part, we describe the results of the previous study based on anti-hypertensive and antidiabetic drugs.

Kullenberg et al. examined the relationships between metformin and behavioral and psychological symptoms of dementia in patients with Alzheimer's disease and type 2 diabetes mellitus. Metformin use has been associated with reduced odds of experiencing symptoms of depression and anxiety following adjustments for demographic information and medication use. This association could not be demonstrated with other antidiabetic medications. Interaction effects were confined to a growing correlation between eating and appetite disorders when utilizing metformin and other antidiabetic medications, excluding insulin, sulfonylureas, or dipeptidyl peptidase-4 inhibitors[13].

Ganz et al. assessed the impact of antidiabetic drugs on psychological aspects. A total of 23,575 participants were evaluated, of which 7,862 were diagnosed with T2DM. A notable disparity in age and BMI was identified between the diabetic and non-diabetic cohorts. Non-diabetic individuals exhibited a significantly reduced likelihood of depression in comparison to diabetic patients not receiving sodium-glucose co-transporter-2 (SGLT-2) inhibitors. Nonetheless, there was no statistically significant difference in depression levels between diabetic patients receiving SGLT2 inhibitors and those not receiving these medications[14].

Wium-Andersen et al. evaluated the association between antidiabetic medication and dementia. They reported that using metformin, DPP-4 inhibitors, GLP-1 analogs, and SGLT-2 inhibitors was associated with reduced odds of dementia after multiple adjustments, with odds ratios of 0.94, 0.80, 0.58, and 0.58, respectively. Furthermore, there was a gradual decrease in the odds of dementia with each increase in the daily defined dose of these drugs. Analysis of the most common treatment regimens revealed no synergistic effects from combined treatment[15].

In another study, Wium-Andersen et al. assessed the association between diabetes and its treatment drugs with the risk of depression. They found that individuals with diabetes exhibited an increased risk of depression relative to those without diabetes, with a hazard ratio of 1.14. Low doses of metformin, DPP4 inhibitors, GLP1 analogs, and SGLT2 inhibitors were linked to a reduced risk of depression in diabetic patients compared to non-users, with sodium-glucose transport protein two inhibitor users exhibiting the lowest risk (odds ratio 0.55). The use of insulin, sulfonylurea, and high doses of metformin is associated with an increased risk of depression[16].

Chen et al. evaluated GLP-1 receptor agonist's psychiatric adverse effects. A total of 8,240 psychiatric

adverse events were analyzed from 181,238 adverse event reports associated with GLP-1 receptor agonist treatment. More cases involved women, accounting for 65.89%, compared to men at 30.96%. The median time to onset of overall GLP-1 receptor agonist-related adverse events was 31 days, with variability observed among different GLP-1 receptor agonist regimens. Exenatide exhibited a notably prolonged onset time of 45 days, demonstrating statistically significant differences compared to the onset times of the other five GLP-1 receptor agonists. Additionally, eight categories of psychiatric adverse events were identified as related to GLP-1 receptor agonists through disproportionality analysis. These categories include nervousness, stress, eating disorders, fear of injection, sleep disorders due to a general medical condition (insomnia type), binge eating, fear of eating, and self-induced vomiting[17].

Tobaiqy and Elkout assessed psychiatric adverse events of liraglutide, semaglutide, and tirzepatide. In this study, a total of 31,444 adverse event reports were identified: semaglutide (n=13,956; 44.4%), liraglutide (n=16,748; 53.2%), and tirzepatide (n=740; 2.3%). A total of 372 reports documented psychiatric adverse events (n=372; 1.18%), encompassing 481 adverse events overall. Women comprised 65% (n=242) of the reports. Depression was the most frequently reported adverse event (n=187; 50.3%), followed by anxiety (n=144; 38.7%) and suicidal ideation (n=73; 19.6%). Nine fatalities were reported, with eight linked to liraglutide and one to semaglutide. Additionally, there were 11 life-threatening outcomes, comprising four associated with liraglutide and seven with semaglutide. The majority of fatal outcomes, specifically 8 out of 9, were observed in men and were attributed to completed suicide attempts and depression[18].

Anti-hypertensive drugs: Colbourne et al. assessed the relationship between psychiatric disorders and different types of anti-hypertensive drugs. Calcium channel blockers (CCBs) demonstrated a lower incidence of psychotic, affective, and anxiety disorders compared to β-blockers, with risk ratios ranging from 0.69 to 0.99. Conversely, CCBs exhibited a higher incidence than angiotensin receptor blockers (ARBs), with risk ratios between 1.04 and 2.23, applicable to initial and recurrent diagnoses. Comparative analyses of calcium channel blockers (CCBs) with angiotensin-converting enzyme inhibitors (ACEIs) or diuretics revealed reduced risk ratios that differed across disorders and between initial episodes and recurrences. Anti-hypertensive drug classes were correlated with the occurrence of substance use and sleep disorders. The results were consistent following more comprehensive cohort matching for additional potential confounders. A secondary analysis revealed that ARBs are associated with lower rates of psychotic, affective, and substance use disorders compared to ACEIs while presenting higher risks for anxiety and sleep disorders[19].

Gammoh et al. evaluated the association between psychiatric conditions and anti-hypertensive drug use. They found that various classes of anti-hypertensives did not associate with mental health symptoms; however, physical activity was associated with reduced adjusted odds of anxiety, depression, and insomnia[20].

Gammoh et al., in another study, evaluated the impact of anti-hypertensive drugs on symptoms of severe depression. They found that among the 431 participants using anti-hypertensive medications, 197 (45.2%) received ACE inhibitors or angiotensin receptor blockers; 203 (47.1%) were administered metformin; and 133 (30.9%) were on sulfonylurea therapy. Severe depressive symptoms, as evidenced by scores exceeding the cut-off of 14 on the PHQ-9, were observed in 165 patients, representing 38.3% of the patients. Severe depression had no association with anti-hypertensive drugs, but other factors like age and other psychiatric problems correlated to severe depression[21].

Kessing et al. evaluated the risk of depression in anti-hypertensive drug use. They showed that the ongoing use of angiotensin agents, calcium antagonists, and β-blockers correlated with significantly lower rates of depression, while diuretic use did not demonstrate this association. Two of the sixteen angiotensin agents, enalapril and ramipril, were linked to reduced depression. Among the ten calcium antagonists, amlodipine, verapamil, and verapamil combinations showed similar effects. Four of the fifteen β-blockers—propranolol, atenolol, bisoprolol, and carvedilol—were associated with decreased depression. No medication was linked to a heightened risk of depression[22].

Boal et al. evaluated the effects of anti-hypertensive

medications on the risk of hospitalization due to mental disorders. They resulted in patients receiving angiotensin-converting enzyme inhibitors or angiotensin receptor blockers exhibiting the lowest risk for mood disorder admissions. In contrast, individuals on β-blockers (hazard ratio=2.11) and calcium antagonists (hazard ratio=2.28) demonstrated an elevated risk. No significant difference was observed in those not on anti-hypertensives and those on thiazide diuretics[23].

Discussion

Diabetes is considered a significant contributor to global disability and mortality rates[24]. In 2017, an estimated 476 million individuals globally had diabetes, resulting in 1.37 million deaths attributed to the condition. The global trend indicates a consistent annual increase in diabetes prevalence of 2.5%[25, 26]. Therefore, the management of diabetes is one concern for the healthcare system. This concern is also true for hypertension. Hypertension represents the primary risk factor for global mortality, contributing to approximately 50% of all cardiovascular events and nearly 11 million deaths annually. We expect this crisis to deteriorate further due to its increasing prevalence and persistently inadequate control rates. Only 20% of adults globally successfully treat high blood pressure to levels below 140/90 mm Hg. Although the most concerning statistics are observed in lower-income countries in Africa and South Asia, there is increasing apprehension regarding the deterioration of blood pressure control in the United States[27, 28].

Different medications are used to manage hypertension and diabetes. Recently, some studies showed some concerns about the impact of these medications on the occurrence or worsening of psychiatric disorders[29]. In this review, we aim to illustrate the results of previous studies to facilitate access to the recent data for better practice management of patients.

In terms of the effects of anti-diabetes drugs, although there are some valuable data, the number of studies is limited, and the results show diversity. In this respect, Kullenberg et al. mentioned that metformin reduced symptoms of depression and anxiety, and other antidiabetic medications did not have such effects in patients with Alzheimer's disease. Interaction effects were confined to a growing correlation between eating and appetite disorders when utilizing metformin and other antidiabetic medications, excluding insulin, sulfonylureas, or dipeptidyl peptidase-4 inhibitors[13]. Alzheimer's disease is a neurodegenerative disease characterized by a progressive and irreversible decline in memory and other cognitive abilities. It may also be commonly associated with additional manifestations, like psychosis, depression, and behavioral changes[30]. Type 2 diabetes mellitus and Alzheimer's disease are associated with each other[31, 32]. Kullenberg et al. suggest that metformin may be utilized in patients with Alzheimer's disease and diabetes; however, further research is necessary due to insufficient data in this respect.

The relationship between antidiabetic medications and depression remains ambiguous, particularly concerning insulin, metformin, and sulfonylurea. A recent meta-analysis of 28 studies revealed a positive association between insulin use and depression in comparison to non-insulin use and non-drug treatment[33]. Metformin and sulfonylurea, both independently and in combination, reduce the risk of depression based on a study on the Taiwanese population, without adjustments for psychiatric or somatic comorbidities or other medication use[34]. On the other hand, a study on the Japanese population did not show any association between metformin, sulfonylureas, and glitazones and depression[35]. Therefore, the impact of these drugs on depression needs further studies.

Ganz et al. evaluated the effects of antidiabetic medications on psychological factors. Non-diabetic individuals demonstrated a markedly lower probability of depression compared to diabetic patients not treated with SGLT2 inhibitors. No statistically significant difference in depression levels was observed between diabetic patients receiving SGLT2 inhibitors and those not receiving these medications[14]. Canagliflozin, empagliflozin, dapagliflozin, and ertugliflozin are four drugs of the SGLT2 inhibitor category. These drugs target the SGLT-2 proteins in the renal proximal convoluted tubules. They function to reduce the reabsorption of filtered glucose, lower the renal threshold for glucose, and enhance urinary glucose excretion[36, 37]. Based on the results of Ganz et al.'s

study, SGLT-2 inhibitors do not affect depression in diabetics. So, it appears that these drugs are safe in terms of depression induction, and depression in these patients occurs due to diabetes, although this issue was not confirmed in Wium-Andersen et al.'s study[16].

Wium-Andersen et al. demonstrated that low doses of metformin, DPP4 inhibitors, GLP1 analogs, and SGLT2 inhibitors reduced the risk of depression in diabetic patients compared to non-users, with sodium-glucose transport protein two inhibitor users exhibiting the lowest risk (odds ratio 0.55). The use of insulin, sulfonylurea, and high doses of metformin is associated with an increased risk of depression[16]. Glucagon-like peptide-1 (GLP-1) is an incretin, a gastrointestinal polypeptide hormone that interacts with specific receptors on pancreatic beta cells, enhancing insulin secretion. Exenatide, liraglutide, albiglutide, dulaglutide, lixisenatide, and semaglutide represent various GLP-1 analogs[38, 39]. Based on the study of Wium-Andersen et al., a low dose of metformin decreases the risk of depression, but a high dose of metformin increases this risk. In contrast to the study of Ganz et al., SGLT2 inhibitors reduce the risk of depression, and these two studies were different in this issue. Based on these two studies, SGLT2 inhibitors not only are safe but also have an improving effect on the depression of patients with diabetes.

Although the above studies demonstrated the beneficial effects of GLP-1 analogs on depression improvement, Chen et al. reported that psychiatric adverse events of GLP-1 receptor agonists were not uncommon in diabetics, and nervousness, stress, eating disorders, fear of injection, insomnia, binge eating, fear of eating, and self-induced vomiting were the psychiatric adverse effects of GLP-1 analogs[17]. Tobaiqy and Elkout assessed psychiatric adverse events of liraglutide, semaglutide, and tirzepatide. Depression was the most frequently reported adverse event, followed by anxiety and suicidal ideation. Nine fatalities were reported, with eight linked to liraglutide and one to semaglutide. There were 11 life-threatening outcomes, comprising four associated with liraglutide and seven with semaglutide. Although the rate of adverse psychiatric events was higher in women, the majority of fatal outcomes, specifically 8 out of 9, were observed in men and were attributed to completed suicide attempts and depression[18]. Therefore, GLP-1 may reduce the risk of depression but may induce other psychiatric adverse effects.

Wium-Andersen et al. mentioned that metformin, DPP-4 inhibitors, GLP-1 analogs, and SGLT-2 inhibitors were associated with reduced odds of dementia with odds ratios of 0.94, 0.80, 0.58, and 0.58, respectively, and higher doses of drugs decreased the level of dementia gradually[15]. Diabetes mellitus and dementia are prevalent long-term conditions that frequently coexist in a significant portion of the elderly population[40]. Therefore, metformin, DPP-4 inhibitors, GLP-1 analogs, and SGLT-2 inhibitors may help manage dementia in people with diabetes.

In terms of the psychiatric effects of anti-hypertensive drugs, Gammoh et al. reported that various classes of anti-hypertensives did not associate with mental health symptoms, and severe depression had no association with anti-hypertensive drugs[20, 21].

Colbourne et al. mentioned that CCBs had a lower incidence of psychotic, affective, and anxiety disorders compared to β-blockers, and they also exhibited a higher incidence than ARBs. Anti-hypertensive drug classes were correlated with the occurrence of substance use and sleep disorders. ARBs are associated with lower rates of psychotic, affective, and substance use disorders compared to ACEIs while presenting higher risks for anxiety and sleep disorders[19]. These findings were different from the findings of the studies of Gammoh et al. drugs[20, 21]. It should be noted that Gammoh et al. mentioned that age and other patients' conditions were associated with psychiatric conditions drugs[20, 21]. Consequently, the results of Colbourne et al. may be influenced by confounding factors such as age. This issue highlights the necessity for further research in this respect.

Kessing et al. demonstrated that ACEI, ARB, CCB, and β-blockers correlated with significantly lower rates of depression. ACEI, ARB, enalapril, and ramipril reduced the risk of depression. Amlodipine, verapamil, and verapamil combinations showed similar effects. Propranolol, atenolol, bisoprolol, and carvedilol decreased depression[22]. The study of Kessing et al. was valuable because they assessed the impact of a wide range of anti-hypertensive drugs on depression. Based on this study, ACEI, ARB, CCB, and β-blockers reduce depression in patients with hypertension. These results were in contrast with the results of Colbourne et al.'s

study. Boal et al. reported that patients receiving ACEI or ARB had the lowest risk for mood disorder admissions, but β-blockers and CCB had an elevated risk[23]. Due to the diversity between the results of studies, it seems that further studies should assess the psychiatric effects of anti-hypertensive drugs.

Conclusion

The results of studies are different in terms of the psychiatric effects of antidiabetic and anti-hypertensive drugs. Regarding antidiabetic drugs, it seems that SGLT-2 inhibitors reduce the risk of depression and dementia. Results of studies are different about GLP-1 analogs, metformin, and other antidiabetic drugs; some studies demonstrated positive effects on them, and some of them showed negative effects on different psychiatric conditions. Therefore, there is a strong need for future studies to assess the psychiatric effects of antidiabetic drugs. This situation was also true with anti-hypertensive drugs. The results of studies about the psychiatric effects of anti-hypertensive drugs were different. However, it seems that anti-hypertensive drugs, especially ACEIs and ARBs, have positive or no effects on psychiatric conditions.

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Conflict of interest

The authors further declare that they have no conflict of interest.

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