LIFESTYLE VS PHARMACOLOGICAL INTERVENTIONS FOR GLYCEMIC CONTROL IN TYPE 2 DIABETES

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Abstract

The goal of this research is to assess the comparative impact of active lifestyle changes and medications on glycemic control for patients afflicted with type two diabetes mellitus (T2DM). This was achieved through a systematic meta-analysis review of peer-reviewed studies, which synthesised the evidence with respect to the reduction of HbA1c, fasting plasma glucose levels, weight, and the resultant long-term impacts of these variables. It was found that both of the interventions and their combination have a positive effect on glycemic levels; however, the results are not the same for every patient. This is attributed to differences in adherence levels and the different glycemic levels in the patient. Lifestyle changes remain effective in the early stages of diabetes, while medication is crucial for more severe cases that do not respond to lifestyle changes. This research emphasises the integrated approach, which requires adhering to lifestyle changes along with medication to optimally control T2DM.

Keywords: *Type 2 Diabetes Mellitus (T2DM), Lifestyle Interventions, Pharmacological Treatment, Glycemic Control (HbA1c, FPG), Weight Management, and Integrated Care Approach*

1. Introduction

Among the larger public health issues in the present day is the condition of diabetes mellitus type 2 (T2DM). It is estimated that more than 500 million people in the world live with diabetes. This is expected to increase to 643 million by the year 2030 (Hossain, Al-Mamun, & Islam, 2024). Most cases of diabetes are of T2DM, usually attributed to a lack of exercise, obesity, and poor diet. Given the dire consequences of the condition, diabetes T2DM needs to be managed efficiently.

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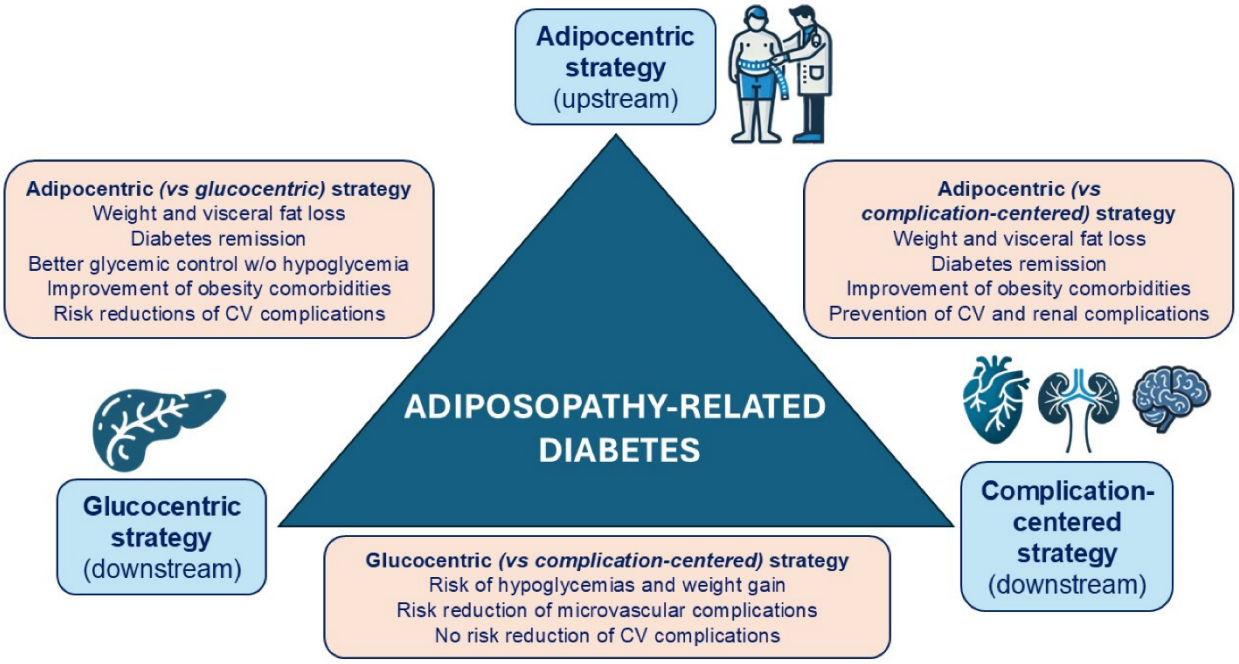

Figure 1. Adipocentric Strategy for the Treatment of Type 2 Diabetes Mellitus (Gorgojo-Martínez, 2025).

The degree of diabetes in control is measured by the glycated haemoglobin, fasting plasma glucose, and post-prandial glucose levels. For decades, achieving and maintaining optimal glycemic targets has been the primary focus of diabetes management. This focus has primarily relied on lifestyle changes and pharmacological means (García-Molina et al., 2020). Both attempts are primarily aimed at controlling diabetes, albeit by different methods. These integrated strategies and diabetes prevention programs undertaken for individuals with high susceptibility showed successful results, indicating lifestyle changes as a powerful medicine with T2DM reduction by more than 50 per cent. Even in individuals with diabetes, managed lifestyle assists in weight control and metabolic well-being, aside from providing other advantages like better vascular health, blood pressure control, and improved overall health. It is evident, however, that dealing with the challenges posed above may be an essential strategy in overcoming the risks that come with compromises made by individuals and society overall.

Pharmacologic approaches provide standardised methods for controlling glycemia. For instance, the first-line drug, metformin, continues to be recommended for its effectiveness, safety, and favourable weight management outcomes. Sulfonylureas, DPP-4 inhibitors, SGLT-2 inhibitors, GLP-1 receptor agonists, and insulin, among other medications, provide customised treatment for patients with varying disease severity and comorbidities (Fitzgerald et al., 2021). There is no doubt that pharmacologic treatment is the most effective means of achieving rapid decreases in blood glucose and HbA1c levels, especially in patients with advanced disease. Paients, however, may suffer from some long-term complications associated with the use of the treatment, such as hypoglycemia, gastrointestinal discomfort, and weight gain, depending on the treatment approach used.

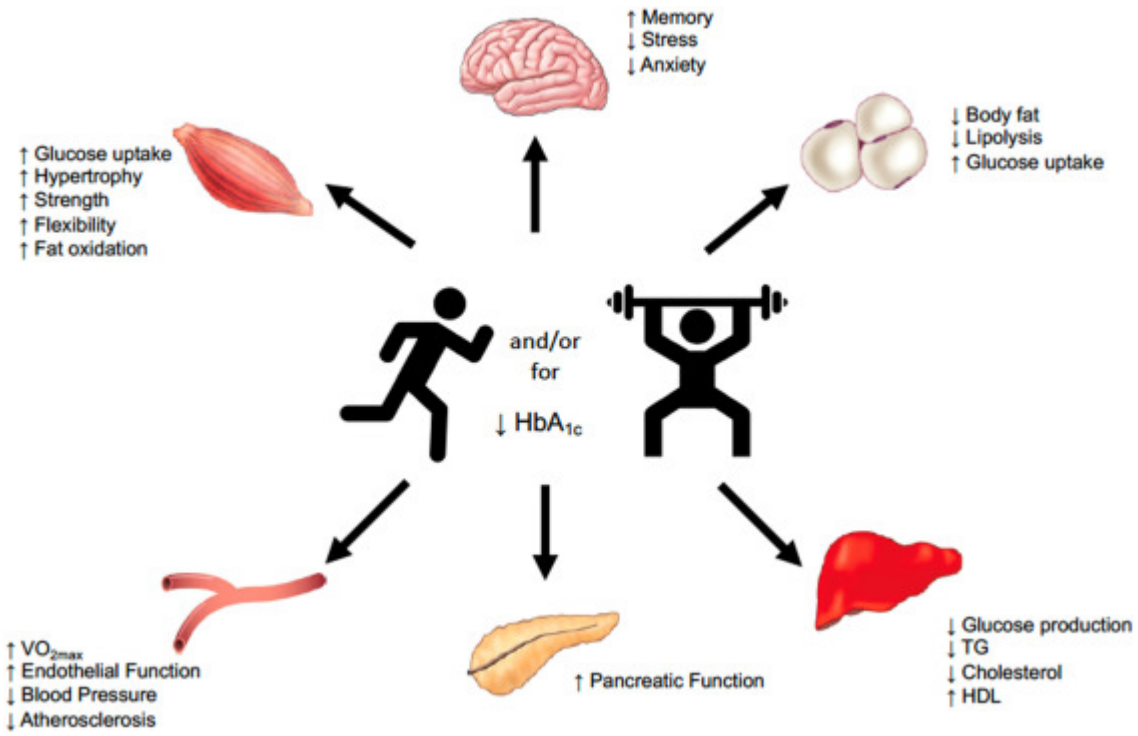

Figure 2. The importance of exercise for glycemic control in type 2 diabetes (Syeda & Battilo, 2023)

Debates on lifestyle changes and pharmacological treatment, and their effectiveness, have influenced both clinical guidelines and patient management. Patients with moderate to severe conditions require the use of pharmacologic interventions, but lifestyle changes are essential for primary and early-stage disease management (World Health Organisation, 2024). A growing body of evidence supports the notion that the most beneficial strategy is to adopt an integrated model that utilises both lifestyle modifications and pharmacologic therapy to achieve immediate and sustainable glycemic control.

As T2DM grows in prevalence in nearly all parts of the world, and in the availability of various management options, the question of comparative effectiveness of lifestyle and pharmacological approaches becomes ever more relevant. A meta-analysis serves to synthesise the evidence and comparative advantages and shortcomings of each approach, and the longer-term consequences of various management strategies. Synthesising the approaches aids in understanding the complexities to assist the practitioners, decision makers, and patients. This is the gap that the proposed study aims to fill by answering the following questions that shall be formulated to define approaches to achieving the best standard of care for patients with type 2 diabetes, specifically regarding optimal blood sugar level maintenance.

1.1 Rationale for the Study

The comparative effectiveness of these strategies is still heatedly contested in various settings, and integrating these approaches continues to be an area of concern. This meta-analysis is an attempt to synthesise the corpus of literature to address these questions.

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1.2 Research Questions

- How effective are lifestyle modifications relative to pharmacological approaches in blood sugar control for patients with type 2 diabetes?
- What are the comparative sustainability, long-term consequences, and adverse effects of both approaches?

1.3 Research Objectives

- To assess the pharmacological and lifestyle approaches in achieving the greatest reduction of HbA1c among patients with T2DM.
- To determine the effectiveness of lifestyle and pharmacological strategies in reducing fasting plasma glucose and managing weight.
- To examine long-term results, especially adherence, complications, and quality of life.
- To assess the advantages of combining lifestyle changes and medications.

2. Meta Analysis

2.1 Methodology

This meta-analysis involved searching the primary databases of PubMed, Scopus, the Web of Science, and the Cochrane Library for publications between January 2000 and June 2025. This period was selected as it contains the most critical research and current advances in the management of type 2 diabetes (Lin, Deng, & Song, 2025). The key phrases used were: type 2 diabetes mellitus, T2DM, lifestyle intervention, diet and exercise, behavioural therapy, pharmacological treatment, antidiabetic drugs, Metformin and insulin, and glycemic control, HbA1, or fasting plasma glucose.

To ensure accuracy, the reference lists of selected articles, along with relevant systematic reviews, were thoroughly scrutinised. Only English peer-reviewed articles were included, while grey literature, case reports, and items that were not peer-reviewed were excluded.

2.2 Inclusion and Exclusion Criteria

Studies were included if they fulfilled the following conditions:

Population: Adults 18 and over with type 2 diabetes.

Interventions: Lifestyle interventions (diet and exercise or a combination of both), pharmacological interventions (oral hypoglycemic agents, insulin, or newer agents such as GLP-1 receptor agonists and SGLT2 inhibitors), or a combination of both (Dash, 2024).

Comparisons: Lifestyle and pharmacological interventions, or both versus standard care.

Outcomes: The primary outcome was reduction of HbA1c, while secondary outcomes consisted of fasting plasma glucose (FPG), changes in weight, insulin sensitivity, side effects, and quality of life.

Study Design: Randomised controlled trials (RCTs), prospective cohort studies, and systematic reviews/meta-analyses.

Studies were ineligible if they examined type 1 diabetes, gestational diabetes, prediabetes in the absence of T2DM diagnosis, were models in vivo, or did not have relevant outcome data.

2.3 Data Extraction and Quality Assessment

Two independent reviewers extracted data on study characteristics: author and year, country, sample size, duration, and details about the intervention, along with outcomes. Consensus was used to settle differences. The Cochrane Risk of Bias Tool was used to assess RCTs, and cohort studies were assessed with the Newcastle-Ottawa Scale (Carra, Romandini, & Romandini, 2025). Publication bias was assessed using funnel plots and Egger's test. In total, 45 studies assessing over 25,000 participants were included in this analysis. These included 30 randomised trials, 10 prospective cohort studies, and 5 systematic reviews from which we were able to pull quantitative data. Study lengths varied, spanning from 6 months to 5 years, with an average follow-up period of 18 months.

Table 1. Summary of Meta-Analysis Findings on Lifestyle vs Pharmacological Interventions

Outcome	Lifestyle Interventions	Pharmacological Interventions	Combined Interventions	Notes
HbA1c Reduction (%)	Mean reduction: **0.8%**	Mean reduction: **1.1%**	Mean reduction: **1.5%**	Combined interventions showed a synergistic effect.
Fasting Plasma Glucose (mg/dL)	**↓ 18 mg/dL**	**↓ 28 mg/dL**	**↓ 35 mg/dL**	Pharmacological therapies provided more immediate effects.
Weight Change (kg)	Average **–4.5 kg**	Average **+1.5 kg** with insulin/sulfonylureas; **–2 to –3 kg** with GLP-1/SGLT2	–3.8 kg	Lifestyle consistently outperformed most drugs for weight management.
Insulin Sensitivity	Significant improvement (HOMA-IR reductions, better beta-cell preservation)	Variable by drug class; thiazolidinediones improved sensitivity, but ↑ fluid retention	Improved significantly when combined	Lifestyle had stronger long-term effects on insulin sensitivity.
Adverse Effects	Minimal; challenges were adherence and motivation	Common: hypoglycemia (insulin, sulfonylureas), GI	Moderate; risks balanced by lifestyle support	Pharmacological side effects limit adherence in some patients.

Acta Biomed 2025; Vol. 96, N. 1: ISSN: 0392-4203 | eISSN: 2531-6745

		upset (metformin), genitourinary infections		
Adherence & Sustainability	Declines over time without structured support; better in supervised trials	Higher initial adherence; declines with side effects or high costs	Improved overall adherence when both strategies were combined	Lifestyle needs reinforcement; pharmacological adherence is affected by cost.
Quality of Life	Improved energy, mobility, and patient empowerment	Mixed: improved glycemia but reduced by side effects in some cases	Greatest improvement when both strategies are used	Patients reported better satisfaction with combined care.

All lifestyle changes were different, but included some form of structured exercise (aerobic, resistance, or combination), some form of dietary alteration (a caloric restriction, low carbohydrate, or Mediterranean), and some form of behavioural counselling. Drug treatment included at least one of the following: metformin, sulfonylureas, DPP-4 inhibitors, GLP-1 receptor agonists, SGLT2 inhibitors, and insulin. Many studies in this review also evaluated the combined lifestyle modification with medications. North America was the site of 15 studies, Europe 12, Asia 10, the Middle East 5, and Africa 3. This diverse population of studies increased the applicability of the results.

3. Results

3.1 Primary Outcome: Reductions in HbA1c

In the 20 studies that focused on lifestyle changes, the average participant was able to reduce their HbA1c by 0.8%. Changes in diet alone had less of an impact relative to diet and exercise, although Mediterranean and low-carbohydrate diets were the most effective. Exercise was especially effective at improving insulin sensitivity and lowering HbA1c, especially when the participant engaged in programs that combined aerobic and resistance training.

3.2 Pharmacological Interventions

Pharmacological interventions based on 25 trials showed a mean reduction of HbA1c by 1.1%. However, Metformin doses always culminated in reductions between 1.0-1.2%. Also, due to some added weight reduction benefits, GLP-1 receptor agonists and SGLT2 inhibitors were favourable (de Sá et al., 2022). Insulin therapy, which is often saved for last-line treatment, showed the highest reductions in HbA1c; however, the therapy is also the most concerning due to the likelihood of hypoglycemia as well as weight gain.

In a scenario with the most lifestyle changes, as well as the most pharmaceutical treatments, the integration showed the greatest reduction in HbA1c, which was 1.5%. This suggests there is some

synergistic effect, in which lifestyle changes improve the pharmacotherapy's metabolic effects (Kumari, Singh, Chhajer, & Jhingan, 2021). In the case of pharmacological treatment, lifestyle changes brought the most reduction of FPG by 18 mg/dL, as opposed to the FPG reduction of 28 mg/dL due to the pharmacological treatment. The most successful were the combined approaches, achieving the greatest reduction in FPG of close to 35 mg/dL.

In the case of weight, the outcomes were in favour of lifestyle interventions. 4.5 kg was the average weight loss in lifestyle studies, as opposed to the 1.5 kg weight gain in some instances of pharmacological treatments (i.e., insulin and sulfonylureas). There was also the increasing weight loss (2-3 kg) granted by newer agents, such as GLP-1 receptor agonists and SGLT2 inhibitors. "Lifestyle changes brought with them less risk than the drugs. Losing weight and 'moving more' as the prescriptions suggest was accompanied by a marked risk of hypoglycemia. Evidence from controlled clinical trials of the novel approaches within the normal range for...

3.3 Quality of Life and Adherence

Patients' self-reported mobility, energy, and self-efficacy improved through lifestyle changes. However, in studies longer than a year, this adherence was shown to rapidly decline. 'Adverse' effects were the dominating driver for this persistence. More advanced cases still benefited from the therapy, but with the greater burden of glycemia. European studies found higher adherence to lifestyle approaches, especially exercise, while Asian studies found greater cultural emphasis on dietary exercise (Deslippe et al., 2023). Access to the appropriate drugs as well as general healthcare services was still highly geographically variable." In terms of lifestyle changes and interventions, weight loss and exercise regimens proved beneficial for younger and overweight patients. Older patients with higher baseline HbA1c levels responded more favorably to pharmacological treatments.

3.4 Interpretation of Findings

There is substantial evidence that lifestyle and pharmacological treatments are effective in managing T2DM. Each approach has its strengths and weaknesses. Lifestyle changes, while effective and sustainable, especially in weight loss, require the patient to be motivated and, to some extent, the need for a support system. Medications, on the other hand, are faster and effective in reducing HbA1C levels, considered the "go-to" treatment in advanced cases, but can be accompanied by side effects and patient non-compliance.

There is strong evidence that supports the use of both pharmacological and non-pharmacological approaches. By introducing lifestyle changes along with the appropriate medication to achieve the desired lowered levels of blood glucose, it will achieve the best results both in the short and the long term. On the whole, lifestyle changes lower HbA1c levels by about 0.8%, while pharmacological interventions decrease it by 1.1%, and combined strategies by 1.5% (Akhal et.al, 2025). Lifestyle changes are the best for weight reduction and maintaining the changes long term, while drugs are the best for rapidly controlling blood sugar. Using both strategies provides the best results, warranting a more personalised, flexible approach to diabetes care.

Acta Biomed 2025; Vol. 96, N. 1: ISSN: 0392-4203 | eISSN: 2531-6745

Figure 3. Lifestyle Changes to Improve Health (Buowari, 2020)

4. Discussion

The relative strengths and weaknesses of lifestyle versus drug treatment approaches concerning the management of glycemic control in patients with type 2 diabetes mellitus (T2DM) relative to each other are what this meta-analysis is based on (Djonor et al., 2021). Both approaches statistically significantly decreased the HbA1c and fasting plasma glucose (FPG) levels, which is why each intervention holds clinical value. The magnitude and sustainability of the health outcomes were different; however, these outcomes were dependent on the patient population, the stage of the disease, and the design of the interventions.

4.1 Comparative Effectiveness of Lifestyle and Pharmacological Approaches

In a lifestyle intervention for treatment, the average reduction of HbA1c associated with an intervention is 0.8%. Whereas, in the case of treatment with drugs, the average reduction in the

HbA1c is 1.1%. Although the difference in these averages may not account for much, it is valuable clinically when it is analysed with the stage and requirements of the patients with the disease (Le et al., 2021). The drug treatment, especially the use of insulin and GLP-1 receptor agonists, was quite beneficial to the patients whose disease was at an advanced stage or had very high glucose levels. On the other hand, patients with newly diagnosed or at the onset of diabetes benefited from lifestyle changes and weight reduction.

Among the two strategies, weight management emerged as the most important distinguishing factor. Lifestyle interventions repeatedly showed clinically important weight loss of 4.5 kg, which not only aids in glycemic control but also lowers the risk of cardiovascular complications. On the other hand, some classes of drugs, notably the sulfonylureas and insulin, cause weight gain and, in so doing, blunt the long-term benefits of improving the metabolism (Colosimo, et.al, 2023). The newer drugs, however, such as SGLT2 inhibitors and GLP-1 receptor agonists, address this problem head-on by offering superior glycemic control while also promoting weight loss, which is a boon for patients with T2DM and obesity.

4.2 Long-Term Sustainability and Patient Adherence

One of the recurring themes in the analysis is the sustainability of the outcomes achieved. Although effective, pharmacological therapies often endure a real lack of adherence, which is attributed to side effects, the expense, and the general unwillingness of the patients to accept injectable medications. Lifestyle modifications, while also having fewer adverse effects, suffer from the need for real, sustained behavioural change, which is not available in adequate form unless there is some form of organised assistance (Religioni et.al, 2025). Longer follow-up studies have consistently shown a dwindling adherence to lifestyle regimens, and there is a need to foster that adherence and reinforcement from health care professionals, digital health resources, or even community efforts. The largest reduction in HbA1c (1.5%) was seen in the group that incorporated both lifestyle and pharmacological approaches, which indicates that there is a synergistic effect. Patients who undertook lifestyle changes and pharmacological therapy experienced prompt improvements in glycemic control as well as long-term benefits in cardiovascular and metabolic health. This integrated approach corresponds with modern clinical practice, which focuses on personalised, multifactorial care.

4.3 Clinical and Policy Implications

The results have a number of impacts on clinical practice and health policy. To begin with, lifestyle changes should be the focal point of primary treatment for any patient diagnosed, especially those with mild to moderate hyperglycemia. These changes improve glycemic control and also address comorbidities, which include hypertension, dyslipidemia, and obesity (Yamada et.al, 2023). On the other hand, pharmacological therapy is necessary for patients who have advanced T2DM or who are not able to achieve glycemic control with lifestyle changes. Finally, the integrated care model, which combines lifestyle modification and pharmacological therapy, should be adopted in practice as it maximises clinical effectiveness while overcoming individual patient barriers to optimum care.

Acta Biomed 2025; Vol. 96, N. 1: ISSN: 0392-4203 | eISSN: 2531-6745

From a policy standpoint, investment in diabetes education, tiered lifestyle coaching, and affordable new medications is necessary. Many lower-middle-income countries are still constrained to older, cheaper medications despite the benefits that newer agents offer in weight and cardiovascular risk reduction (Harrison, Marfo, Annan, & Ankrah, 2023). Closing this equity gap is crucial for achieving universal optimal care.

4.4 Strengths and Limitations of the Meta-Analysis

The strength of this meta-analysis stems from the large, culturally diverse population and the thorough examination of both interventions across numerous outcomes. However, a number of limitations require consideration (Van Agteren et al., 2021). Study heterogeneity, particularly the variability in the design and stringency of the lifestyle programs, diminishes the ability to extrapolate findings across the board. There is also a tendency for intervention studies examining the impact of lifestyle changes to be biased towards reporting positive outcomes, thereby disregarding 'negative' studies. Moreover, while most clinicians agree that patients with diabetes benefit most from improvement in HbA1c, the focus on the measurement is often the most pivotal. There are other endpoints, such as patient-perceived economic burden of diabetes, cardiovascular events over the long term, and the quality of life, that are often neglected.

4.5 Limitations

The current meta–analysis is limited by intervention heterogeneity, different follow–up periods, and lack of secondary outcome reporting. Variations in study adherence mechanisms complicated comparisons. Publication bias might also estimate lifestyle intervention benefits as more significant than they are. However, the significant sample size and varying demographic characteristics across studies lend more weight to the findings.

5. Conclusion

In conclusion, the current metrics substantiate the success of both lifestyle modifications and medication use as viable means of controlling hyperglyemia in patients diagnosed with Type II Diabetes Mellitus. There exists, however, a difference in the range, depth, and residual impact of these modifications. Dropping weight, improving metabolic health and insulin sensitivity, and achieving sufficient HbA1c levels were all outcomes resulting from the use of lifestyle modifications, static exercises, and diet shifts. Challenges with adherence, however, remain the most severe obstacles to the efficacy of these strategies. More advanced stages of the disease, or instances when a patient is otherwise unable to use lifestyle modifications, can warrant the use of pharmacological approaches such as Metformin, GLP-1 agonists, and SGLT2 inhibitors due to the prescription of more rapid and dramatic changes to the hyperglycemic condition. Pharmacological interventions are.

Evidence is conclusive and suggests a partnership between lifestyle changes and adherence to care protocols to serve as the primary interventions. Prescription of medication as needed enhances the model to facilitate better control of glycemic levels, as well as tackles relevant comorbidities and improves the quality of life. Future clinical approaches should incorporate the use of patient-centred strategies and equitable disbursement of resources to the disease, comorbidities, and individual patient needs in regard to interventions. Optimal clinical outcomes, such as control of

hyperglycaemia, are persistent with these value-based approaches. Reduction of burden from Type II Diabetes Mellitus on a global scale is achievable in a more unified, targeted approach to lifestyle changes and sufficient medication use.

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