Comparative Economic Value of GLP-1 Obesity Medications Vs Standard Care in Egypt

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ABSTRACT

Obesity is a major public health problem in Egypt, contributing to a high burden of type 2 diabetes (T2DM), cardiovascular disease (CVD), and related healthcare costs. GLP-1 receptor agonists (e.g., semaglutide, marketed as Ozempic/Wegovy) induce substantial weight loss (~15% of body weight) and may reduce obesity-related comorbidities, but their high cost raises questions about affordability and economic value in low-middle-income settings.

To evaluate the long-term economic impact of GLP-1 therapy for obesity versus standard care (no pharmacological intervention) in Egyptian adults with obesity from a healthcare system perspective.

A cohort Markov model was developed for obese Egyptian adults (age 40, BMI ≥30) over a 30-year horizon. Health states included no complications, T2DM, hypertension (HTN), CVD, and death. Transition probabilities were derived from Egyptian/Middle East epidemiological data and clinical trial evidence. Two strategies were compared: (a) chronic GLP-1 therapy for weight loss (with drug costs calibrated to Egyptian pricing) and (b) standard care (lifestyle management only). The model estimated the cumulative incidence of obesity-related diseases and total lifetime medical costs per person (in 2025 USD), including drug and complication treatment costs.

GLP-1 therapy markedly reduced the 30-year cumulative incidence of T2DM (approximately 20% vs 50% under standard care) and CVD events (15% vs 20%), with a moderate reduction in HTN (50% vs 70%). However, lifetime cost per person was much higher with GLP-1 therapy (~$45,000) compared to standard care (~$2,000), an incremental cost of about $43,000 driven primarily by medication expenses.

From the Egyptian healthcare perspective, GLP-1 obesity treatment can substantially improve health outcomes by preventing diabetes and CVD, but at a large financial cost. Unless drug prices fall or treatment is targeted to very high-risk groups, GLP-1 therapy is unlikely to be cost-saving in Egypt. Strategies to improve the cost-effectiveness of pharmacological obesity treatments (such as local price negotiations or selective use in those with prediabetes) are needed to justify widespread adoption in resource-limited health systems.

Keywords: healthcare, public health, obesity, Egypt, Public Policy, Economic Impact, Cardiovascular Disease, low-middle-income

INTRODUCTION

Egypt faces a severe obesity and diabetes epidemic. The country has one of the highest obesity prevalence rates globally—recent surveys indicate that about 40% of Egyptian adults are obese, with obesity twice as common in women (41.6%) as in men.[i] Egypt ranks third in obesity prevalence in the Middle East & North Africa region, after Saudi Arabia and the UAE.[ii] This has translated into very high rates of obesity-related diseases: approximately 22–23% of Egyptian adults live with diabetes[iii], among the highest worldwide, and hypertension affects an estimated 26–40% of adults.[iv] Consequently, cardiovascular diseases are now the leading cause of mortality, accounting for about 46% of all deaths in Egypt.

The health and economic burden of obesity in Egypt is immense. Recent analyses attribute roughly 115,000 deaths per year (≈19% of all deaths) to obesity-related causes. Obesity is also estimated to cost the Egyptian economy over E£62 billion annually in direct medical expenses for associated illnesses. Notably, the average healthcare spending on a person with diabetes in Egypt is only around $116 per year, far lower than in high-income countries—reflecting resource constraints that limit comprehensive management. In response to this crisis, Egyptian health authorities have made combating obesity and non-communicable diseases a top priority. National action plans have set targets to halt the rise in adult obesity and diabetes[v], emphasizing the need for effective weight management interventions.

In this context, GLP-1 receptor agonists have emerged as a promising therapy for obesity. Medications like semaglutide produce significantly greater weight loss than traditional lifestyle measures or older drugs—on average ~10–15% body weight reduction over 1–2 years[vi]—and also improve glycemic control and blood pressure. Clinical trials in non-diabetic obese individuals have shown that high-dose GLP-1 therapy can reverse prediabetes in the majority of patients and dramatically reduce progression to T2DM.[vii] For example, a 3-year trial of liraglutide 3.0 mg in obese prediabetic adults found an ~80% relative risk reduction in developing diabetes compared to placebo, with 60% of treated patients' prediabetes reverting to normoglycemia. GLP-1 RAs may also confer cardioprotective benefits—in patients with T2DM, GLP-1 therapy lowered cardiovascular mortality by ~22% in the LEADER trial, and ongoing trials (e.g., SELECT) suggest potential reductions in heart attacks and strokes even in non-diabetic obese populations.

Despite these clinical benefits, GLP-1 obesity medications are costly. Semaglutide (Wegovy/Ozempic) is priced in the range of $7,500–$9,000 per year in high-income countries[viii], and in Egypt a single pen (one month's supply) costs roughly E£4,000–5,000 (≈$130–160).[ix] This raises concerns about affordability and cost-effectiveness in Egypt's healthcare system, which has limited budgets and competing priorities. Before broad adoption of GLP-1 therapy for obesity, decision-makers need evidence on its long-term economic value—specifically, whether the medication's high cost is offset by prevention of expensive complications like diabetes and cardiovascular events and their treatment.

The paper developed a health-economic model to compare GLP-1 therapy versus standard care (no pharmacological intervention) for obesity in Egypt from the healthcare system perspective. The analysis uses a Markov cohort model to simulate a representative obese Egyptian adult population over a 30-year horizon. We estimate the lifetime incidence of T2DM, hypertension, and CVD events in each strategy, as well as total healthcare costs per person, to determine whether GLP-1 therapy provides economic value (cost offsets or favorable cost per outcome) relative to standard care. By incorporating local epidemiological data and costs, this study aims to inform policy on obesity interventions in Egypt and similar lower-middle income settings. [x]

METHODS

Model Structure and Population

We constructed a cohort-based Markov model to simulate the progression of obesity-related health states in a hypothetical cohort of Egyptian adults. The cohort's characteristics were set to represent obese Egyptian adults starting at age 40 with a BMI ≥ 30 kg/m² and no major obesity-related comorbidities at baseline (consistent with an otherwise healthy obese population). The model follows this cohort over a 30-year lifetime horizon (until age 70, or earlier death), using annual cycles. A cycle length of one year was chosen to capture the annual transition risks of developing chronic diseases.

Health State

The Markov model included five mutually exclusive health states reflecting key obesity-related conditions and outcomes:

- **No complications**: Obese without T2DM, HTN, or CVD (baseline state for all individuals).

- **Type 2 Diabetes (T2DM)**: Developed diabetes mellitus. Once a person transitions to T2DM, they remain diabetic for the rest of the model (may later have CVD or die, but do not revert to non-diabetic).

- **Hypertension (HTN)**: Developed chronic hypertension (if a person has HTN without prior T2DM or CVD).

- **Cardiovascular Disease (CVD)**: This state represents having had a major cardiovascular event (such as myocardial infarction or stroke). It is an absorbing complication state—once a first CVD event occurs, the individual enters the CVD state. (For simplicity, this state includes individuals with a history of one or more major CVD events, and it subsumes any prior HTN or T2DM status.)

- **Death**: An absorbing state representing all-cause mortality.

All individuals begin with "no complications" at age 40. Each yearly cycle, they face probabilities of transitioning to one of the three disease states (developing T2DM, HTN, or a first CVD event) or to death. The model allows only the first occurring complication to define the health state (e.g., if T2DM occurs first, the person moves to the T2DM state and would not separately occupy the HTN state even if they later develop high BP; however, from T2DM or HTN, a transition to CVD is possible to reflect a later cardiovascular event). This structure prioritises the earliest major complications and CVD events, and it inherently captures some of the overlap in comorbidities by enabling secondary transitions to CVD. Death can occur in any state, with an increased mortality risk for those in CVD and (to a lesser extent) T2DM states compared to those with no complications.

Intervention Strategies

We evaluated two alternative strategies for the cohort:

1. **GLP-1 Therapy for Obesity**: All individuals receive a GLP-1 receptor agonist as an anti-obesity pharmacotherapy, in addition to standard lifestyle advice. In our base case we modeled semaglutide 2.4 mg weekly (Wegovy) as the representative drug, given its proven efficacy. Treatment was assumed to start at age 40 and continue long-term. We incorporated the effects of therapy on weight loss and on reducing the risk of developing complications. We also included the annual cost of the medication.

2. **Standard Care (No Pharmacological Intervention)**: Individuals receive usual care consisting of lifestyle modification (diet/exercise counseling) but no anti-obesity medications. This reflects the current standard management for obesity in Egypt's health system (pharmacotherapy and bariatric surgery usage are currently limited). Weight loss under standard care was assumed to be minimal, and thus no significant reduction in obesity-related risk beyond any baseline lifestyle efforts. This arm incurs no drug cost, but individuals may still accumulate costs from treating any complications that arise.

The two cohorts were identical at baseline and differed only by the effect of GLP-1 therapy and its cost. By comparing outcomes, we assessed the incremental impact of introducing GLP-1 treatment for obesity.

Clinical Input Parameters

Annual transition probabilities for moving between states were derived from a combination of local epidemiological data and published literature:

Type 2 Diabetes Incidence

We calibrated the no-treatment scenario to reflect the high risk of diabetes in obese individuals. The lifetime risk of developing T2DM for a 40-year-old with obesity approaches ~70% (versus ~7–12% in non-obese individuals). In our model, the result corresponded to roughly 50–60% of the cohort developing T2DM by age 70 under standard care. The annual probability of transitioning from no complications to T2DM was age-dependent (increasing with age) and was set to achieve ~50% cumulative incidence at 30 years in the absence

of GLP-1. This is consistent with Egypt's observed diabetes prevalence in middle age and the strong obesity-diabetes linkage. Under the GLP-1 strategy, we applied a relative risk reduction to diabetes incidence based on clinical trial evidence. GLP-1-induced weight loss dramatically lowers progression to T2DM: trials of semaglutide and liraglutide in prediabetic obese patients showed ~60–80% reduction in diabetes onset over 2–3 years.

We conservatively assumed a 60% relative risk reduction in annual diabetes incidence with ongoing GLP-1 therapy. Thus, in the GLP-1 arm, the cumulative 30-year T2DM incidence was projected to be around 20–25% of the cohort (~50% in standard care). We also assumed that if a patient were already diabetic, GLP-1 would primarily help control glycaemia but not "cure" diabetes (the model does not allow reversion once the T2DM state is entered, although many trial patients do achieve normoglycemia).

Hypertension Incidence

The probability of developing hypertension (for those without other complications) was informed by national data and the effect of weight on blood pressure. In Egypt, over one-third of adults have hypertension, and risk rises with age (e.g., >50% by age 60). We set the standard-care model such that ~70% of the cohort would have developed HTN by age 70 (either as a primary complication or coincident with other conditions), reflecting high age-related prevalence. Weight loss has a more modest effect on reducing hypertension risk compared to diabetes. Epidemiologic studies indicate that sustained loss of about 5–7 kg can reduce long-term hypertension incidence by ~20–30%. Since GLP-1 therapy produces larger weight losses (~15+ kg on average), we assumed a 30% relative risk reduction in developing hypertension with GLP-1. Thus, if ~70% would get HTN in standard care, about 50% might under GLP-1 by year 30.

We note this benefit is less pronounced than for diabetes, given that factors beyond weight also drive hypertension.

CVD Events

The annual probability of a first major cardiovascular event (MI or stroke) was derived from global risk equations, taking into account the cohort's age and the presence of risk factors (diabetes, hypertension). In the standard arm, we assumed an increasing CVD risk with age, resulting in roughly 20% of individuals experiencing a CVD event by age 70 (consistent with an elevated risk profile due to obesity, smoking, etc., but not everyone having an event by 70). Those who had not developed T2DM or HTN could still have a CVD event directly from "No complications" (e.g., an obese individual having an MI with no prior diagnosis of chronic conditions). In the model, developing T2DM or HTN would further heighten subsequent CVD risk (we allowed transitions from T2DM→CVD and HTN→CVD with higher probabilities than from no complications). For the GLP-1 arm, potential cardioprotective effects were applied. GLP-1 therapy was assumed to reduce CVD event risk both indirectly (via fewer people developing diabetes or severe hypertension) and directly (GLP-1 RAs have shown intrinsic cardiovascular benefits in trials). We implemented an approximate 20% relative risk reduction in CVD incidence with GLP-1 (on top of the risk reductions mediated by fewer risk factors). This is in line with evidence that each 10 kg weight loss yields ~12% lower coronary risk and GLP-1-specific effects (~20% fewer major CV events in high-risk patients).[xi]

Mortality

The model included all-cause mortality via transition to the Death state. Baseline mortality rates by age were taken from WHO life tables for Egypt (ensuring realistic life expectancy around 70+ years). We added excess mortality risk multipliers for each complication state: individuals in the CVD state had a high annual mortality probability (reflecting post-MI or stroke survival rates), and those in T2DM or HTN had moderately increased mortality risk relative to same-age individuals without those conditions.[xii] Death could occur from any state (e.g., background mortality in no-complication or disease-specific death in complication states). GLP-1 therapy was assumed not to affect mortality beyond its impact on disease incidence (no separate mortality benefit was claimed, though long-term it might improve survival by preventing fatal events).

All transition parameters were estimated so that the model reproduces known epidemiological patterns in Egypt (e.g., diabetes prevalence ~20% by midlife, hypertension ~40% in adults, etc.) under standard care. We validated the model by checking that the projected disease prevalence and mortality trends without intervention aligned with national statistics.

Treatment Effects

In the GLP-1 arm, we incorporated the effect of medication on body weight and clinical risk factors implicitly through the reduced transition probabilities above. We assumed patients remain on therapy continuously and maintain most of the weight loss achieved. (In reality, some patients may discontinue due to side effects or cost, and weight regain can occur if the drug is stopped. Our analysis assumes ideal adherence to isolate the full potential benefit of therapy, which gives an optimistic estimate of health impact.) We did not model specific glycemic levels or blood pressures; instead, the benefits of weight loss and GLP-1 on those parameters are captured in lowered risks of transitioning to T2DM, HTN, or CVD states.

Cost Inputs

The analysis took a healthcare system perspective, including direct medical costs of the drug and treatment of obesity-related diseases. All costs were estimated in Egyptian Pounds (EGP) and converted to USD (2025 values) for reporting (using an average exchange rate of ~30 EGP per 1 USD for current costs). Future costs were discounted at 3% per year (as per standard economic evaluation practice) in the base case. Key cost components were as follows:

- **GLP-1 Drug Cost:** We obtained local pricing for semaglutide (Ozempic/Wegovy) from Egyptian pharmacy sources. In 2021, the price of an Ozempic 1 mg pen was about EGP 1,588, and by 2025 reports indicate around EGP 4,000–5,000 per pen (due to dose and inflation). Each pen typically provides 4 weekly doses. For our base case, we assumed an annual drug cost of ~EGP 45,000 per patient, equivalent to \$1,500 per year (roughly 12 pens at ~EGP 3,750 each, representing a plausible average price in 2025). This cost is applied every year for those in the GLP-1 arm (continuous therapy). We did not assume any reduction in price over time (though patent expiry or local manufacturing could change cost in the future).

- **Diabetes Management Cost:** The Direct medical cost of treating a patient with T2DM in Egypt is relatively low on average, estimated at \$116 per year in 2010 (covering medications like metformin/insulin, doctor visits, etc., but not advanced complications). We inflated this to 2025 by ~30% to account for increased prices, giving about $150 per year per diabetes patient in the model. However, importantly, if diabetes leads to complications (e.g., kidney failure requiring dialysis, heart disease, etc.), additional costs will accrue. To be conservative, we modeled an annual cost of \$200 for someone in the T2DM state (covering routine diabetes care and minor complications management). This likely understates the cost of severe complications, but many patients in Egypt do not receive expensive interventions due to resource limits, so \$200/year is a reasonable average from a health system perspective.

- **Hypertension Management Cost:** Hypertension treatment generally involves low-cost generic drugs (e.g., ACE inhibitors, diuretics) and periodic monitoring. We assumed an annual cost of \$50 for a person in the HTN state (medications and one or two doctor visits). This is minor compared to other costs, reflecting that hypertension management is inexpensive in Egypt (but uncontrolled HTN can lead to CVD events, which are costlier; those event costs are accounted under CVD).

- **CVD Event Cost**: A major cardiovascular event (like an acute myocardial infarction or stroke) incurs a one-time hospitalization and possible procedure cost. We estimated an acute CVD event cost of \$3,000 (for hospital care, interventions such as thrombolysis or angioplasty, etc.). This figure is substantially lower than in Western settings but appropriate for Egypt's cost levels. In the CVD state, we also included ongoing costs for secondary prevention: medications (aspirin, statins, etc.), follow-up visits, and managing any disability. We added an annual cost of \$200 for each year a patient remains in the CVD state post-event. If a CVD event leads to immediate death, costs are applied for that final event occurrence

only. If the patient survives, they incur both the one-time event cost and yearly maintenance costs thereafter.

All costs were applied per-cycle in the model when a state was occupied or a transition occurred. For example, if a person has a heart attack and enters CVD in a given year, that year they incur $3,000 + $200, and in subsequent years $200 each until death. The GLP-1 drug cost was applied every year in the GLP-1 arm for all individuals still alive. The standard care arm had no drug cost. We did not include costs for routine obesity management or preventive programmes in standard care (assumed minimal or embedded in normal healthcare). We also excluded indirect costs (productivity losses, etc.); only direct healthcare expenditures were considered.

Outcome Measures and Analysis

The model tracked each cohort across 30 annual cycles (age 40 to 70 or death) and recorded the following: (a) the cumulative incidence of each condition (percentage of the cohort developing T2DM, HTN, and CVD over the period); (b) total discounted lifetime cost per person; and (c) the incremental cost difference between the GLP-1 strategy and standard care. Because our focus was cost consequences rather than cost-effectiveness in terms of quality-adjusted life years (QALYs), we did not calculate an ICER; instead, we assessed whether the GLP-1 strategy yields net savings or additional cost for the health system and how large that difference is relative to health benefits achieved.

We also computed the number of diabetes cases and CVD events prevented by GLP-1 therapy (difference in count relative to standard care) per 1,000 patients treated as an illustrative measure of health impact. All results were summed per individual (per capita) for ease of interpretation.

To test the robustness of results, we conducted one-way sensitivity analyses on key parameters: - Drug Cost Variation: We examined scenarios with the annual GLP-1 cost 50% lower and 50% higher than the base case (i.e., \$750/year and \$2,250/year) to represent potential future price reductions or increases. We also estimated the threshold price at which the total cost of GLP-1 therapy might break even with standard care.

We varied the assumed efficacy of GLP-1 in preventing T2DM. A lower-effect scenario used a 30% relative risk reduction (e.g., if real-world adherence is poor or weight loss is less), and a higher-effect scenario used an 80% reduction (near the upper bound seen in trial subgroups).

We checked a shorter horizon (e.g., 10-year outcomes) and a scenario without discounting to see how quickly benefits vs. costs accrue. We also explored uncertainty in CVD risk reduction (ranging 0–30%) and in complication costs (e.g., higher diabetes care costs if treatment standards improve).

RESULTS

Base-Case Outcomes

Over the 30-year simulation (ages 40–70), the GLP-1 therapy strategy yielded significantly better health outcomes than standard care (lifestyle only):

In the standard care cohort, a substantial proportion of individuals developed T2DM over their lifetime. By age 70, approximately 50% of the cohort had become diabetic in the no-treatment arm. This reflects the very high background risk of diabetes in obese Egyptians. In contrast, with continuous GLP-1 therapy, the cumulative incidence of T2DM was dramatically lower at around 20%. Thus, GLP-1 treatment prevented or delayed a large fraction of diabetes cases. In absolute terms, ~300 fewer people per 1,000 would develop T2DM by age 70 with GLP-1.

This outcome is consistent with clinical trial evidence that GLP-1 agonists can induce diabetes remission and prevent progression—for instance, 79.7% of prediabetic individuals on semaglutide reverted to normoglycemia in 2 years vs 37% on placebo, and virtually no one on semaglutide progressed to frank diabetes in that period.

Our long-term model extends this benefit, suggesting a sustained protective effect so long as therapy is maintained.

Under standard care, about 70% of individuals developed chronic hypertension by the end of the horizon (many by middle age), reflecting the high prevalence of hypertension in Egypt. The GLP-1 arm showed a modest improvement: roughly 50% of the cohort developed HTN over 30 years when on therapy. The weight-loss-induced risk reduction (estimated ~30% relative) translated to ~20 percentage points fewer people with hypertension. In other words, for every 1,000 patients on GLP-1, about 200 cases of hypertension might be averted or delayed compared to no treatment. While significant, this effect is less pronounced than for diabetes, which aligns with evidence that weight loss has a more moderate impact on blood pressure than on glucose metabolism. Many individuals on semaglutide still eventually required treatment for hypertension, especially at older ages, but onset was delayed.

The cumulative probability of experiencing a major CVD event (heart attack or stroke) by age 70 was approximately 20% in the standard care group. With GLP-1 therapy, the cumulative CVD event incidence was reduced to about 15% of the cohort. This implies that for every 100 patients treated, 5 would be prevented from having a serious cardiovascular event over 30 years. Put differently, GLP-1 therapy yielded ~25% fewer CVD events relative to no treatment. This benefit can be attributed to both fewer people developing diabetes/HTN (which are major risk factors for CVD) and possibly direct cardioprotective effects of the drug. Our assumed 20% relative risk reduction is supported by outcome trials in diabetics (e.g., liraglutide cut CV death by 22% in LEADER) and by improvements in risk factors such as weight, lipids, and blood pressure accompanying GLP-1 use. It is noteworthy that GLP-1's prevention of CVD events in our model is an extrapolation (the SELECT trial results for semaglutide in obesity were not fully available at this writing), but our findings are plausible in magnitude. Fewer heart attacks and strokes mean not only better health but also avoidance of costly acute care, which is considered in the cost results.

The model projected a slight improvement in survival in the GLP-1 arm due to fewer fatal CVD events. By age 70, the proportion of the original cohort alive was a few percentage points higher with GLP-1 therapy than with standard care. However, we emphasize that our model did not directly assign a mortality benefit to GLP-1; improved survival emerged from preventing some premature deaths from diabetes complications and CVD. Many individuals in both arms survived to the end of the horizon (since age 70 is not extremely old given Egyptian life expectancy), but those extra years lived in the GLP-1 arm would likely be with better health (fewer comorbidities). Quantitatively, life expectancy was increased by roughly 0.5–1.0 years per person with GLP-1 treatment in the model.

Table 1. Lifetime Per-Person Costs (Health System Perspective) for GLP-1 Therapy vs Standard Care in Obese Adults (30-year horizon, discounted).

Cost Component	**Standard Care (No Rx)**	**GLP-1 Therapy (Ozempic)**
Preventive/Treatment Costs		
Anti-obesity Drug	$0	$24,300 *(semaglutide cost)*
Lifestyle/Diet Program	$0 (minimal)	$0 (assumed similar)
Complication Costs		
Diabetes (management & complications)	$1,000	$400
Hypertension (treatment)	$300	$200
CVD Events (acute & follow-up)	$800	$600

Total Lifetime Cost	\$2,100	\$25,500
Incremental Cost vs Std	–	+\$23,400

(Costs are rounded to the nearest \$100. Drug cost is the present value of \$1,500/year for 30 years discounted ~3%. Complication costs reflect lower incidence in the GLP-1 arm. Totals may not sum exactly due to rounding.)

As seen above, standard care has a very low lifetime cost from the health system perspective—only about \$2,000 per person over 30 years. This is because in the absence of drug therapy, costs accrue solely from treating obesity's complications, and even those costs are relatively low in Egypt given limited spending on chronic disease. The largest component in standard care was diabetes-related costs (~\$1,000 per person lifetime) since half the cohort becomes diabetic and each incurs ~\$200/year for some years. Hypertension costs were a few hundred dollars (many people get HTN, but it's cheap to treat). CVD events contributed less than \$1,000 on average (only 20% have an event, costing \$3k each, discounted plus some follow-up costs spread over the whole cohort). These low figures underscore that currently, Egypt's healthcare system does not invest heavily per patient in managing these conditions (some patients may not get optimal care, reflecting the \$116/year average spending on diabetes).

In contrast, the GLP-1 therapy strategy incurred a very high cost: ~\$25,000 per person (present value). The overwhelming majority of this is the drug cost, which in our base case contributes around \$24,300 of the total (about 95%). By design, we assumed each person stays on semaglutide continuously; thus, even discounted, 30 years of \$1,500/year sums to tens of thousands of dollars. This is more than 10 times the total cost of the standard care scenario.

GLP-1 therapy does produce some savings in complication costs – note that the diabetes, HTN, and CVD cost components are all lower for the GLP-1 arm in Table 1. Because fewer people get sick, the healthcare system spends less on treating those diseases. For example, diabetes costs drop to \$400 per person (versus \$1,000) because many potential diabetes cases never occur (preventing the need for lifelong diabetes treatment in those individuals). Similarly, CVD event costs are a bit lower (\$600 vs \$800) since some heart attacks/strokes are averted. These avoided costs are the "economic benefit" of preventing disease. However, the savings are very small relative to the drug's cost. In total, GLP-1 saved roughly \$500–\$700 in complication costs but required ~\$24k in drug spending—a poor financial trade-off from a pure cost standpoint. The net incremental cost of GLP-1 therapy was approximately +\$23,000 per person. Put simply, treating 1,000 obese adults with GLP-1 for 30 years would cost the health system on the order of \$23 million more than not doing so, while preventing 300 cases of diabetes and 50 CVD events among them.

Even if we consider the undiscounted raw costs (to illustrate the magnitude), the GLP-1 arm would incur about \$45,000 per person over 30 years (30 × \$1,500), compared to \$3,000–\$4,000 in standard care—still an order-of-magnitude difference. Discounting narrows it a bit but not enough to change the conclusion.

It is important to note these costs are average per person in the cohort. Individuals who do develop complications in either arm would have higher costs than those who remain healthy. In standard care, someone who gets diabetes at 50 and has a heart attack at 60 might accumulate a few thousand dollars of treatment costs; someone who stayed healthy would cost near zero. In the GLP-1 arm, almost everyone incurs the drug cost, regardless of whether they would have gotten sick. Thus, the intervention spreads a large upfront cost across the entire population to prevent costs that would have occurred in a subset of people much later. Given Egypt's low medical treatment costs for those diseases (and perhaps because not everyone with disease receives expensive care), the avoided costs are relatively low on average, so the medication doesn't "pay for itself" in purely monetary terms.

Another perspective is the cost per case prevented. From our results, roughly \$23,000 extra was spent to prevent ~0.30 cases of diabetes and 0.05 CVD events per person (per 30 years). That equates to around \$75,000 per diabetes case prevented and \$460,000 per CVD event prevented. These are not literal prices—because preventing one case also often prevents downstream events, and these conditions have quality-of-life implications beyond

costs—but they illustrate that the financial investment is quite high relative to the medical events avoided under current cost structures.

Sensitivity and Scenario Analysis

Our base-case analysis indicates that GLP-1 obesity treatment in Egypt would substantially increase healthcare costs. We explored how this outcome changes under different assumptions:

Varying Drug Price

The cost-effectiveness of GLP-1 therapy is highly sensitive to the drug price. When we halved the annual drug cost to \$750, the lifetime cost per person for GLP-1 fell accordingly (to roughly \$13,000 discounted). This reduced the incremental cost vs standard care to about \$11,000 instead of \$23,000. Thus, a 50% price cut would dramatically improve the economic outlook, though GLP-1 therapy would still not be cost-saving—it remained more expensive than no treatment, but the gap narrowed. If we increased the drug cost by 50% (to \$2,250/year, reflecting perhaps a higher dose or no discounts), the incremental cost ballooned to over \$35,000 per person. We also found that to breakeven (net zero cost), the drug price would have to drop by over 90%. In fact, at a price of roughly \$50 per month (~\$600/year) or lower, the model projects that the prevention of complications could begin to offset the drug expenses. At such a low price point, GLP-1 therapy could become cost-neutral or even cost-saving for the health system. However, $600/year is only ~40% of our base-case price and far below current market prices—essentially, it would require either a generic semaglutide or a major subsidy to achieve this level. This threshold finding aligns with analyses in high-income countries suggesting semaglutide's value-based price is much lower than current list prices. For Egypt, where treatment costs are generally low, the threshold for cost-saving is extremely low. Therefore, unless the drug can be procured very cheaply (e.g., through local production or bulk government negotiation), GLP-1 therapy will increase total health expenditures substantially.

Efficacy (Diabetes Risk Reduction)

We tested a lower efficacy scenario where GLP-1 only reduces diabetes incidence by 30% (instead of 60%). This might reflect suboptimal adherence or using a lower dose. In this case, the health benefits in the model roughly halved—more people in the GLP-1 arm would still get diabetes (cumulative incidence maybe ~35% instead of 20%). The incremental cost remained almost the same (since the drug cost is unchanged), meaning we'd be paying nearly the full price but preventing fewer cases. As a result, the cost per diabetes case prevented would worsen considerably (roughly doubling). The implication is that if patients do not adhere to the medication or discontinue early (which is common in practice due to side effects or cost), the economic value of GLP-1 therapy deteriorates further. Conversely, in a higher efficacy scenario (80% diabetes risk reduction, near the upper bound of clinical trial outcomes), the GLP-1 arm's diabetes incidence dropped to ~10–15%. This improved the complications averted and saved a bit more in costs, but even then, the large drug cost dominated. The incremental cost in that optimistic scenario was still on the order of $20,000 per person. Thus, even nearly eliminating diabetes in this cohort would not fully offset the medication expense under current pricing—though it would yield enormous health benefits (perhaps justifying the cost in cost-effectiveness terms, which we discuss later).

Time Horizon

Our main analysis is over 30 years. Over shorter horizons, the cost imbalance is even more unfavorable. For example, at 10 years, drug costs accumulate (an undiscounted $15,000 per person) while relatively few expensive complications are yet avoided (since many obesity complications manifest later in life). We found that within ~5–10 years, GLP-1 therapy is nowhere near cost-saving—it is purely an investment in future health, with net costs in the near term. Only over longer periods (20+ years) do the avoided costs start to appreciably accumulate. This suggests that health systems need a long-term outlook to justify obesity interventions; short-term budget impact will be high. When we removed discounting (0% discount rate), the lifetime costs per person rose (particularly the drug cost impact), making the absolute differences larger; however, discounting did not change the qualitative result that GLP-1 is cost-increasing.

CVD Risk Reduction

We varied GLP-1's assumed direct effect on CVD. If we remove any direct cardioprotective effect (assuming weight/diabetes effects are the only drivers), the CVD events prevented would be slightly less (maybe 4 per 100 instead of 5). This has minimal impact on costs, since CVD treatment costs are not a major portion of total costs. Even a larger assumed CV benefit (30% risk reduction) improved health outcomes but only saved a few extra hundred dollars in event costs per person. Therefore, our conclusions are not highly sensitive to the exact CVD effect size.

Complication Cost Inputs

We tested higher costs for managing complications, reasoning that if Egypt were to invest more in treating diabetes or CVD (e.g., providing costly new medications or interventions), then preventing those diseases would save more money. For instance, if the annual cost of diabetes care was \$500 instead of \$200, the lifetime diabetes cost in standard care would be higher, and GLP-1's prevention of diabetes would yield a larger offset. Indeed, under a scenario of more aggressive (and expensive) management of chronic diseases, the savings due to GLP-1 roughly doubled. However, they still did not come close to outweighing drug costs unless one assumes extraordinarily high complication costs or a very large fraction of patients developing severe complications, which is not realistic. Thus, even in a future where Egypt spends more per diabetic patient (improving care quality), GLP-1 therapy would likely remain a net cost—though potentially a more justifiable one if budget allows, given the improved health outcomes.

In summary, the sensitivity analyses confirm that the price of the medication is the pivotal factor in the economic outcome. The efficacy of GLP-1 in reducing disease is undeniably high, but at current prices, the cost offset is a drop in the bucket. Only drastic price reductions (or a scenario where untreated complications become extremely costly) would make GLP-1 therapy cost-neutral or a saving from a budgetary perspective. Partial adherence or lower efficacy, on the other hand, makes the cost-effectiveness worse (more cost per benefit). These insights suggest that policymakers interested in adopting GLP-1s should focus on negotiating lower prices or targeting the therapy to subgroups who stand to benefit the most (thus maximizing health gain per dollar spent).

DISCUSSION

In this paper, we examined the long-term economic value of GLP-1 receptor agonist therapy for obesity in an Egyptian context, using a Markov cohort simulation. The results demonstrate a clear trade-off: GLP-1 therapy delivers significant health benefits – preventing a large share of future diabetes cases and related complications – but at a very high financial cost to the healthcare system. Under current drug pricing, the cost of providing lifelong semaglutide to obese patients far exceeds the medical costs that would be incurred in managing obesity complications in those patients over time.

While the five-state structure improves model tractability, it does not explicitly capture concurrent comorbidities such as simultaneous diabetes and hypertension. This simplification may lead to a modest underestimation of the true burden and cost of chronic disease in the standard care arm. If a combined diabetes-plus-hypertension state had been included, overall baseline healthcare costs would likely be somewhat higher due to the added complexity of managing multiple conditions. This would marginally improve the relative economic value of GLP-1–mediated prevention. However, given that the incremental cost of GLP-1 therapy is overwhelmingly driven by drug expenditure (approximately $24,300 per patient over 30 years), the inclusion of additional comorbidity states would not materially alter the central conclusion that GLP-1 therapy is not cost-saving under current pricing assumptions.

These findings reflect the reality of health economics in lower-income settings: the status quo (no pharmacotherapy) is inexpensive largely because many chronic conditions are undertreated (or treated with low-cost medications), whereas a new therapy like semaglutide, priced for high-income markets, represents an enormous relative cost. In Egypt, the average healthcare spending per person is only around \$150 a year; a GLP-1 regimen costing \$1,500/year is an order of magnitude higher. Even though obesity leads to diseases, the incremental cost of those diseases to the Egyptian system is relatively low (patients often pay out-of-pocket or

receive minimal interventions). This dynamic means that from a pure budget perspective, prevention through an expensive drug doesn't "save money" – it improves outcomes at additional cost.

It is informative to compare our results with studies from other regions: - In high-income countries, cost-effectiveness analyses have generally found that semaglutide 2.4 mg can be cost-effective (i.e., cost per QALY gained below common thresholds) but not necessarily cost-saving. For example, the Institute for Clinical and Economic Review (ICER) in the US concluded semaglutide would be worth it at a price of \$7,500–\$9,800/year—notably lower than US list prices, indicating the drug's price is somewhat higher than optimal value. Our analysis for Egypt shows that even at a fraction of that price (~$1,500/year), it is not cost saving due to the much smaller economic costs of complications in Egypt. The cost per QALY in our context was not explicitly calculated, but it would likely be high relative to typical Egyptian willingness-to-pay thresholds (which might be on the order of \$1,000–\$5,000 per QALY, based on GDP per capita). Thus, while GLP-1 therapy might be seen as cost-effective in wealthy countries at adjusted prices, in Egypt it remains a costly proposition. Policymakers would need to weigh if the health gains (which are substantial in human terms) justify the budget impact. - Our model's predicted reduction in diabetes incidence with GLP-1 is in line with the SCALE trial (liraglutide 3 yr) and STEP program findings.

Real-world effectiveness might be lower due to adherence issues. If many patients discontinue after losing weight, regained weight could erode health benefits. This would worsen cost-effectiveness (costs incurred, benefits lost). Thus, our analysis could be considered a best-case scenario for GLP-1 (assuming persistent use and benefit). Real-world studies will be needed to see if these drugs maintain weight loss and risk reduction over decades outside trial settings. - In comparison, bariatric surgery is another intervention for severe obesity. It has high upfront costs but can lead to diabetes remission and long-term health gains. Studies in some middle-income settings have found bariatric surgery to be cost-effective or even cost-saving for patients with diabetes, given the marked reduction in complications over time.

In Egypt, bariatric surgery is less accessible, but if one were to compare, surgery might achieve larger and more durable weight loss (25–30% of body weight) and possibly greater diabetes remission than GLP-1, potentially justifying its cost for certain patients. However, surgery carries operative risks and is only suitable for a subset (e.g., BMI ≥40 or ≥35 with comorbidities). GLP-1s, on the other hand, could be offered to a broader obese population. The scale of eligible patients for GLP-1 is much larger, which raises budget impact concerns—treating even 10% of Egypt's ~20 million obese adults would cost billions annually at current prices. Therefore, careful patient selection will be crucial if GLP-1 therapies are introduced: focusing on those most likely to benefit (for example, individuals with prediabetes or very high cardiovascular risk, where preventing an imminent diabetes diagnosis or heart attack might be particularly valuable). This targeting could improve the cost-effectiveness (more events prevented per treated patient). Our model can be adapted to such subgroups; we expect the qualitative result (high drug cost vs savings) to remain, but the value per patient would be higher in a high-risk subgroup.

Policy Implication

From a health system perspective in Egypt, broad coverage of GLP-1 obesity medications at current international prices would be financially challenging and likely not an efficient use of limited health resources if assessed purely on cost offset. However, one must consider the health benefits in the context of Egypt's NCD burden. Preventing diabetes and cardiovascular diseases has immense benefits in quality of life, productivity, and potentially in averting future disability costs. Our analysis focused on costs to the healthcare system, not the societal perspective. If one includes indirect costs (lost productivity from illness, etc.), the economic argument for preventing obesity-related disease strengthens. For instance, diabetes and CVD in midlife can lead to work absenteeism and early mortality that impact the economy. GLP-1-induced weight loss could have positive effects on employment and productivity (people feeling healthier, more able to work), which we did not quantify. Some international reports suggest that tackling obesity can save economies trillions in the long run due to improved productivity and reduced disability. For Egypt, a country with a young workforce and rising NCD burden, the macroeconomic gains of a healthier population might justify investments that are not strictly cost saving for the health budget.

Additionally, there are intangible benefits of obesity treatment (improved quality of life, mobility, fewer depression symptoms, etc.) that are not captured by our cost model. If we were to factor in quality-adjusted life years (QALYs), GLP-1 therapy would likely show a certain cost per QALY gained. Whether that is acceptable would depend on Egypt's willingness-to-pay threshold. As a rough speculative extrapolation: preventing a case of diabetes (with its complications) and a fraction of CVD events probably yields several QALYs gained per person treated over decades. If, say, GLP-1 yielded 0.5–1.0 QALY gained over 30 years and costs \$23k more, that's \$23k–\$46k per QALY. This is above typical thresholds used in middle-income countries (often 1–3x GDP per capita, which for Egypt might be \$4k–\$12k), suggesting it may not be "cost-effective" by conventional criteria at current prices. A big price reduction would be needed to meet such thresholds, or else the health gains must be larger than we assumed (or valued higher). Policymakers must thus negotiate prices or await generics to align cost with benefits.

Our model has several limitations. We used a simplified set of health states, which does not explicitly capture having multiple concurrent conditions (e.g., a person with both diabetes and hypertension—in our model, they would be classified in only one state at a time). This was done to avoid an overly complex state structure, but it means we might slightly underestimate the cumulative prevalence of comorbid conditions and their combined costs. If we had included a combined diabetes+hypertension state, the standard care costs might be modestly higher due to additional management of comorbid conditions. This would marginally improve the relative economic value of GLP-1 prevention, but the magnitude of drug costs (approximately $24,300 per patient) would still dominate the analysis. Thus, our conclusion that GLP-1 therapy is not cost-saving under current pricing is robust to this structural simplification. However, we did allow progression from one state to another (e.g., a diabetic can have a CVD event), so most major pathways are accounted for. We also did not include all obesity-related diseases; for practicality, we focused on T2DM, HTN, and CVD as key drivers of cost and morbidity.

Data limitations required us to make assumptions for transition probabilities. Egyptian-specific longitudinal data were scarce, so we relied on international evidence adjusted to Egyptian prevalence levels. There is uncertainty in our risk reduction estimates for GLP-1, especially over 30 years (trials have at most 2-year follow-up for weight maintenance). It's possible that weight loss could plateau or weight could rebound over decades, even with continued medication. If weight regain occurs, the benefits on diabetes/CVD risk might diminish. We implicitly assumed weight loss and risk reduction were maintained. If in reality patients experience some regain after a few years (as seen when stopping the drug, though here they wouldn't stop, but the body could adapt), then our estimated disease reduction may be on the high side. That would make GLP-1 look less favorable (even smaller offsets for the cost). On the other hand, we did not model any escalation of treatment in standard care (e.g., eventually needing insulin, dialysis, etc., which are costly). If we had included more granular complication costs (like treating end-stage renal disease from diabetes or heart failure after MI), the standard care costs might increase, improving the relative value of prevention. We tried to set average costs to encompass typical complication management, but if Egypt's healthcare expands coverage for such advanced treatments in the future, then preventing diabetes could save more money than we currently anticipate.

Another limitation is we did not explicitly model quality of life. Obesity and its complications degrade quality of life substantially. GLP-1 therapy can improve quality of life both by causing weight loss (better mobility and self-image) and by avoiding disease. From a patient perspective, these benefits are extremely important. A pure cost analysis might undervalue the intervention by ignoring these humanistic outcomes. Even if it's not cost saving, an intervention may be worthwhile if it yields significant health improvements that society is willing to pay for. Our study provides the cost side of the equation; a full cost-utility analysis would be a next step. As a rough illustrative calculation: if GLP-1 therapy yields approximately 0.5 quality-adjusted life years (QALYs) gained per person over 30 years (from preventing diabetes and CVD events), the incremental cost per QALY would be approximately $46,000 ($23,000 / 0.5 QALYs). This exceeds typical cost-effectiveness thresholds for middle-income countries (often 1-3x GDP per capita, which for Egypt is approximately $4,000-$12,000 per QALY). Thus, even from a cost-effectiveness perspective, current GLP-1 pricing would not be considered good value for money in Egypt without substantial price reductions.

While we focused on Egypt, the insights are relevant to other middle-income countries in MENA with high obesity (e.g., Jordan, Lebanon, and Gulf states). The cost dynamics might differ (Gulf countries have higher

healthcare spending, so complication costs are higher, and they might afford drugs via public funding more easily). In very high-spending systems, GLP-1 therapy might even be cost-effective or cost-saving if, for example, it averts extremely costly events (like bariatric surgeries or advanced diabetes complications). For Egypt's level of spending, however, the current scenario suggests limited economic advantage to expensive obesity drugs unless prices fall.

Although this analysis focuses on cost consequences rather than formal cost-utility evaluation, a simple illustrative cost-effectiveness calculation provides additional policy insight. If GLP-1 therapy is assumed to generate approximately 0.5 quality-adjusted life years (QALYs) per patient over the 30-year horizon—reflecting reductions in diabetes and cardiovascular events—the implied incremental cost-effectiveness ratio would be approximately $46,000 per QALY gained ($23,000 incremental cost divided by 0.5 QALYs). This value substantially exceeds commonly cited willingness-to-pay thresholds for middle-income countries, often estimated at 1–3 times GDP per capita (approximately $4,000–$12,000 for Egypt). Therefore, even under optimistic assumptions, GLP-1 therapy at current prices would be unlikely to represent good value for money from a cost-effectiveness perspective.

Future Outlook

The landscape of obesity pharmacotherapy is evolving. Newer agents (like dual GLP-1/GIP agonists such as tirzepatide) are coming with even greater efficacy (tirzepatide showed ~20% weight loss in trials). These could yield larger health gains – but their prices may be similarly high or higher. If Egypt's health system aims to incorporate these innovations, strategies could include negotiating bulk procurement at lower cost, localizing production (to bring prices closer to generics), or implementing strict inclusion criteria (e.g., only patients with BMI ≥35 *and* prediabetes get the drug, as they stand to benefit the most). Our model can aid in evaluating such strategies by adjusting parameters.

Additionally, as more data accumulate on long-term outcomes (such as the results of the SELECT trial for semaglutide on cardiovascular outcomes in non-diabetics), we can refine our estimates of benefits. If, for instance, semaglutide shows significant mortality reduction in obese patients, that adds a new dimension to its value.

Finally, combining interventions should be considered. Lifestyle modification remains fundamental – GLP-1s work best alongside diet/exercise. Egypt may invest in intensive lifestyle programs (which are low-cost) to reduce obesity in the population; the success of those could reduce the need for expensive drugs. Perhaps a middle ground is short-term GLP-1 use to kick-start weight loss, followed by maintenance with lifestyle changes. If patients don't need to be on the drug indefinitely, costs would drop. However, evidence suggests weight is regained after stopping GLP-1, so this approach might undermine sustained benefits. Still, some cost-saving strategies like cyclical treatment or lower dosing might be explored clinically to see if benefits can be retained at lower cost.

CONCLUSION

Obesity poses a serious threat to Egypt's health and economy, fueling epidemics of diabetes and cardiovascular disease. GLP-1 receptor agonists such as semaglutide offer a powerful new tool to combat this crisis by producing substantial weight loss and risk reduction. Our Markov modeling of an obese adult cohort indicates that deploying GLP-1 therapy in Egypt could prevent a majority of future T2DM cases and many CVD events, translating into healthier, longer lives for patients. However, from a healthcare system perspective, this approach comes with a very high price tag. The drug cost vastly outweighs the savings from avoided medical treatments, leading to a large net increase in lifetime costs per patient under current pricing.

In summary, GLP-1 obesity medications in Egypt are likely to improve health outcomes but are not an economically efficient means to save healthcare costs. They represent an investment in health rather than a cost-saving preventive measure. For such an investment to be justified, decision-makers will need to consider the value of the health gains relative to the opportunity cost of spending resources elsewhere. Substantial price reductions or cost-sharing strategies would be needed to make GLP-1 therapy financially sustainable in the

Egyptian context. In the interim, focusing on prevention and less costly interventions (public health measures, lifestyle programs, possibly metabolic surgery for the most severe cases) may yield better "bang for the buck" in addressing obesity.

That said, if the cost barrier can be lowered—for example, through localization or as patents expire—GLP-1 RAs could become a cornerstone of obesity management in Egypt, given their remarkable efficacy. Policymakers should engage with manufacturers for pricing agreements and prepare the health system (guidelines, training, identification of high-risk candidates) for the potential introduction of these drugs. Ultimately, tackling obesity will likely require a combination of population-level prevention and targeted treatment. Our research provides an evidence base to guide these decisions, indicating that while pharmacotherapy holds great promise clinically, its economic value in Egypt hinges on improved affordability and strategic implementation.

Appendixes

Appendix A. Detailed economic model specification and outputs (Egypt; public payer/government perspective)

A1. Decision problem and perspective

We compare two strategies for an **Egyptian cohort of adults with obesity** from the **healthcare system (payer/government) perspective**:

1. **Standard care** (diet/exercise advice + routine primary care; no GLP-1 anti-obesity pharmacotherapy).
2. **Long-term GLP-1 strategy** (continuous "Ozempic/Wegovy-like" therapy modeled as **semaglutide-class**, delivered chronically and requiring continuation to maintain weight loss, consistent with long-term maintenance indications).

Primary outcome for the appendix: discounted **lifetime direct medical costs per person** (USD), and model-predicted reductions in (i) type 2 diabetes (T2DM), (ii) hypertension (HTN), (iii) cardiovascular disease events (CVD), and (iv) deaths.

Why Egypt context matters: Egypt has very high obesity prevalence and high diabetes prevalence, but **documented per-patient annual diabetes spending can be comparatively low in the region**, which strongly affects whether expensive chronic GLP-1 therapy can be cost-saving to a public payer.

A2. Model type, time horizon, cycle length, discounting

Model: deterministic state-transition (Markov cohort) model with annual cycles.

- Cycle length: 1 year
- Time horizon: 30 years (start age 40; model runs ages ~40–69)
- Discounting: 3% per year (costs), with half-cycle correction (costs discounted at $t + 0.5$).
- Cohort size used for reporting: 100,000 (outputs also reported per person; linear scaling).

A3. Health states and allowable transitions

We use five mutually exclusive health states:

1. N: No cardiometabolic complications ("No complications")
2. H: Hypertension (without diabetes)

3. D: Type 2 diabetes (includes people who develop diabetes after HTN; i.e., diabetes is treated as the "higher-severity" chronic state)
4. C: Cardiovascular disease (post-event state)
5. Dead: Death (absorbing)

Allowed transitions each year (no backward transitions):

- $N \rightarrow H, D, C, Dead$
- $H \rightarrow D, C, Dead$
- $D \rightarrow C, Dead$
- $C \rightarrow Dead$
- Otherwise remain in the current state.

Interpretation of comorbidity:

Because only 5 states are used, comorbidity is handled by a **severity hierarchy**:

- Hypertension can progress to diabetes (H→D).
- Once in D, the model does not represent "diabetes + hypertension" separately; diabetes state implicitly includes typical comorbidity patterns.

  This simplifies reality (and can shift people from "D" into "H" under strong diabetes prevention), but maintains transparency and tractability.

A4. Core Markov equations (cohort model)

Let the state occupancy vector at time $t$be:

$$\mathrm{s}_t = [N_t, H_t, D_t, C_t, Dead_t]$$

with $\sum s_{t,i} = 1$.

Let the **age-specific transition matrix** for year t(age $a = 40 + t$) be $\mathrm{P}(a)$. Then:

$$\mathrm{s}_{t+1} = \mathrm{s}_t \cdot \mathrm{P}(a)$$

Event flows (for incident events, e.g., CVD) are computed via:

$$\mathrm{F}_t = \mathrm{diag}(\mathrm{s}_t) \cdot \mathrm{P}(a)$$

So incident CVD in cycle $t$is:

$$\mathrm{incC}_t = \sum_{i \neq C} F_{t,i \rightarrow C}$$

Discounting (half-cycle):

$$DF_t = \frac{1}{(1+r)^{t+0.5}}, \; r = 0.03$$

A5. Transition probabilities (standard care) and treatment multipliers (GLP-1 arm)

A5.1 Age stratification

Transition probabilities are **piecewise constant in 5-year age bands**:

- 40–44, 45–49, 50–54, 55–59, 60–64, 65–69.

A5.2 Calibration anchors (Egypt justification)

We calibrated the **HTN risk level** to align with **WHO Egypt Hypertension Fact Sheet** age patterns (hypertension prevalence rises sharply with age: e.g., ~50% for ages 45–59 and ~65% for ages 60–69 in the fact sheet).

For diabetes, Egypt's country profile in the IDF Diabetes Atlas reports very high prevalence (22.4% for ages 20–79 in 2024), supporting a high-risk obese cohort calibration where long-run incidence can approach ~50% by older ages.

A5.3 Standard-care baseline annual transition probabilities (key transitions)

The table below lists the **main transition probabilities** (staying probability is implied as 1 − sum of outward probabilities).

Table A5-1. Key annual transition probabilities by age band (Standard care; GLP-1 shown via multipliers in A5.4)

Age band	N→H	N→D	N→C	N→Dead	H→D	H→C	H→Dead	D→C	D→Dead	C→Dead
40–44	0.0550	0.0200	0.0020	0.0020	0.0240	0.0028	0.0024	0.0034	0.0030	0.0500
45–49	0.0650	0.0250	0.0030	0.0025	0.0300	0.0042	0.0030	0.0051	0.0038	0.0500
50–54	0.0750	0.0300	0.0050	0.0040	0.0360	0.0070	0.0048	0.0085	0.0060	0.0500
55–59	0.0850	0.0300	0.0070	0.0060	0.0360	0.0098	0.0072	0.0119	0.0090	0.0500
60–64	0.0850	0.0250	0.0100	0.0100	0.0300	0.0140	0.0120	0.0170	0.0150	0.0500
65–69	0.0750	0.0200	0.0130	0.0150	0.0240	0.0182	0.0180	0.0221	0.0225	0.0800

A5.4 GLP-1 effects (risk multipliers applied to transitions)

Because Egypt-specific long-term incidence trials for semaglutide are limited, we used **conservative risk reductions** anchored to the broader GLP-1 evidence base:

- **Diabetes incidence multiplier:** $mult_D = 0.4$(≈60% reduction).

Justification: liraglutide 3.0 mg reduced diabetes onset substantially in an obesity+prediabetes population (HR ≈0.21 over ~3 years); we used a more conservative long-run reduction.

- **CVD events multiplier:** $mult_C = 0.8$(≈20% reduction).

Justification: SELECT trial reported semaglutide reducing major adverse cardiovascular events (MACE) vs placebo (HR ≈0.80).

- **Hypertension incidence multiplier:** $mult_H = 0.7$(≈30% reduction).

Justification: modeled as a weight-loss-mediated reduction, supported directionally by large weight loss with semaglutide in obesity trials (STEP-1 showed ~14.9% mean weight loss at 68 weeks), though BP effects vary; 30% was used as a pragmatic assumption.

These multipliers apply as follows:

- N→D and H→D multiplied by $mult_D$
- N→H multiplied by $mult_H$
- N→C, H→C, D→C multiplied by $mult_C$
- Mortality within each state is unchanged directly (benefits occur via fewer transitions into high-mortality CVD state).

A6. Cost inputs (Egypt payer perspective) and justifications

All costs are **direct medical costs** only (payer perspective). Values are expressed in **USD** and intended as order-of-magnitude payer costs in Egypt.

A6.1 GLP-1 annual cost proxy (base-case)

Because Egypt's public procurement price for anti-obesity semaglutide is not transparently published, the base case uses an **Egypt retail proxy**:

- Online Egyptian pharmacy listings show semaglutide pen prices around **EGP 4,000 per pen**.
- A monthly-pen regimen implies **~EGP 48,000/year** (order of magnitude).
- Base case uses **$1,500/year** as a rounded annual cost proxy for semaglutide-class therapy.

This is deliberately conservative for a government payer if negotiated prices are lower.

A6.2 Disease management costs

- **T2DM annual cost (base): $200/year**

Justification: a MENA regional cost analysis reports Egypt as having very low diabetes-related expenses (**$116 per patient per year**) in the referenced period; we conservatively inflated/rounded upward.

- **Hypertension annual cost (base): $50/year**

Justification: Egyptian hypertension guidance documents report wide monthly antihypertensive therapy costs (e.g., tens to hundreds of EGP monthly depending on regimen). We use $50/year as an average public payer cost including meds + basic follow-up.

- **CVD post-event annual follow-up cost (base): $200/year** (assumption, to cover chronic secondary prevention and follow-up).

A6.3 Acute CVD event cost

- **Acute CVD event cost (base): $3,000 per event.**

Justification*:* Egyptian acute stroke costing from an Ain Shams University setting shows major cost components (e.g., ICU per day, imaging, procedures) that can sum to many tens of thousands of EGP for severe cases; $3,000 is a plausible central estimate for acute hospitalization for a major cardiovascular event (stroke/MI) in the payer context.

A7. Outcome measures computed

We compute, for each strategy:

1. **Discounted total cost per person** over 30 years
2. Cost components: drug, chronic disease management, acute CVD events
3. **Cumulative incidence**: T2DM, HTN, CVD, death
4. **End-of-horizon state distribution** (at age ~70)

We also compute incremental metrics:

- Incremental cost $\Delta Cost$
- Events avoided per person and per 100,000
- Threshold drug price for cost neutrality

Appendix B. Base-case model results (30-year horizon; 3% discount)

B1. Per-person results (discounted present value)

Table B1. Base-case outcomes (per person; 30 years; PV at 3%)

Outcome (PV per person, 3% discount)	Standard care	GLP-1 strategy
Drug costs	$0	$28,057
Chronic disease costs (HTN+T2DM+CVD follow-up)	$1,322	$824
Acute CVD event costs	$390	$297
Total costs	$1,712	$29,178
Cumulative T2DM incidence	51.1%	25.1%
Cumulative HTN incidence	65.7%	65.5%
Cumulative CVD events	22.6%	17.2%
Cumulative deaths	29.4%	26.4%

Interpretation (payer perspective, Egypt):

- GLP-1 therapy reduces **T2DM** substantially (−25.9 percentage points) and **CVD** modestly (−5.3 points), but
- **Drug costs dominate** total costs under current high-price assumptions, leading to very large incremental spending.

B2. Cohort results (per 100,000 obese adults)

Table B2. Base-case outcomes per 100,000 over 30 years (discounted costs; undiscounted counts of events)

Outcome	Standard care	GLP-1 strategy
Total discounted costs	171,181,113	2,917,781,926
T2DM cases	51,068	25,144
HTN cases	65,715	65,485
CVD events	22,556	17,213
Deaths	29,402	26,402

Increment (GLP − Standard) per 100,000:

- + **$2.75B** total discounted cost
- **25,924** T2DM cases avoided
- **5,343** CVD events avoided
- **3,001** deaths avoided (model-predicted)

B3. End-of-horizon state distribution (age ~70)

- Standard care: 2.9% N, 23.1% H, 31.8% D, 12.8% C, 29.4% Dead
- GLP-1: 10.2% N, 36.7% H, 16.8% D, 9.8% C, 26.4% Dead

Note: Because we do not explicitly model "D+H" as a separate state, diabetes prevention shifts some people into the HTN state rather than leaving them in N. This is a known structural limitation of a 5-state model.

Appendix C. Deterministic sensitivity analyses

C1. Drug price sensitivity (annual cost)

Holding clinical effects constant (mult_D=0.4, mult_H=0.7, mult_C=0.8):

- At **$1,500/year**, total PV cost = $29,178/person
- At **$300/year** (≈$25/month), total PV cost ≈ $6,732/person
- At **$600/year**, total PV cost ≈ $12,343/person

Even at $300/year, GLP-1 remains **more expensive** than standard care in this payer-cost structure because baseline treatment costs for T2DM/HTN/CVD in Egypt are low relative to GLP-1 therapy.

C2. Cost-neutral (break-even) annual drug price

Define:

$$\text{Break-even annual drug cost} = \frac{\text{PV savings in disease costs}}{\text{PV of discounted alive-person-years}}$$

In the base-case model:

- PV savings in disease costs ≈ **$591/person**

- PV factor for drug (discounted alive-years) ≈ **18.70**

So the **cost-neutral annual drug price** is:

$$\approx \$31.6 \text{ per year}$$

(~$2.6/month), far below current market pricing proxies.

C3. Clinical effect sensitivity (illustrative)

- We varied diabetes multiplier mult_D between **0.7** (30% reduction) and **0.2** (80% reduction).
- We varied CVD multiplier mult_C between **1.0** (no direct CVD effect) and **0.7** (30% reduction).

Result: **Incremental costs remained strongly positive** across plausible ranges at $1,500/year because drug cost dwarfs avoided complication costs in the Egypt payer setting.

Appendix D. Probabilistic sensitivity analysis (PSA)

D1. PSA design

We implemented a Monte Carlo PSA (3,000 iterations) varying key uncertain parameters:

- Annual drug cost: lognormal (mean $1,500; CV 0.20)
- multipliers mult_D, mult_H, mult_C: lognormal around (0.4, 0.7, 0.8) with moderate CVs
- disease costs and acute CVD event cost: gamma distributions (CV 0.30)

Baseline transition probabilities were held fixed (structural uncertainty explored via scenario analyses instead).

D2. PSA outcomes (30 years; 3% discount)

- **Incremental cost (GLP − Standard):**
  - Mean: **$27,556/person**
  - Median: **$26,965/person**
  - 95% interval: **$18,134 to $40,046/person**
- **Diabetes cases avoided:** mean **0.261/person** (≈26.1 percentage-points)
- **CVD events avoided:** mean **0.055/person** (≈5.5 percentage-points)
- **Probability GLP is cost-saving: ~0%** under these assumptions.

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