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ECONOMIC BURDEN OF TYPE 2 DIABETES MELLITUS (T2DM) IN UGANDA:
A COST-OF-ILLNESS ANALYSIS

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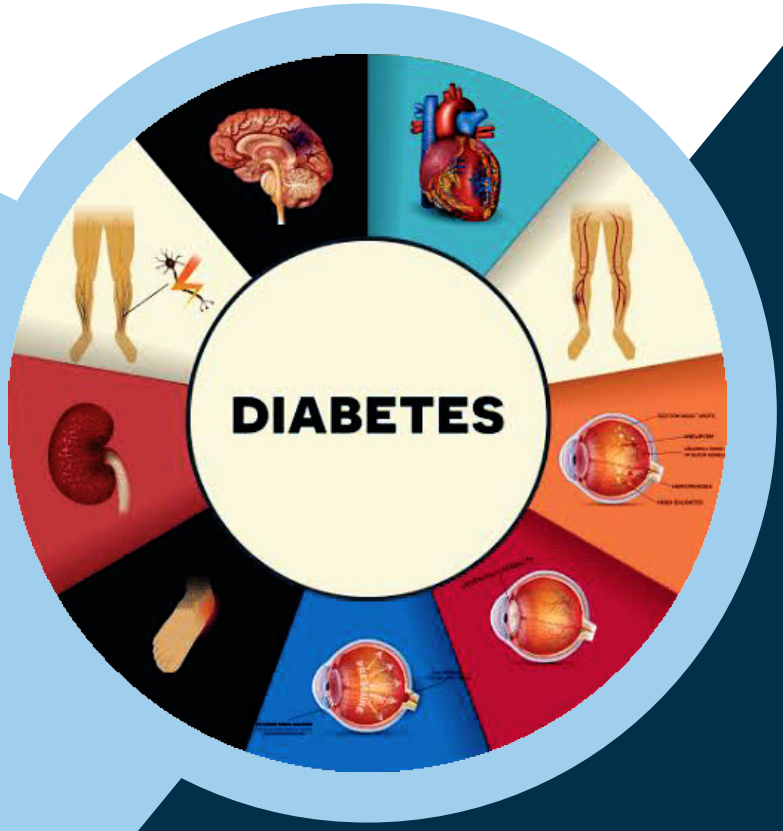

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ABSTRACT

Type 2 diabetes mellitus (T2DM) is a chronic disease that requires continuous medical care and management which consumes significant resources, especially when compounded with complications. This study aimed to estimate the total direct economic costs of managing and treating T2DM in Uganda from both a public and private healthcare perspective. The analysis used estimates the economic burden of diabetes by applying a cost-of-illness (COI) approach by estimating the 2022 direct medical cost related to cost areas such as diabetes diagnosis and control or treatment of diabetes and its associated complications. Diagnosed T2DM management and treatment costs in public and private facilities are high, even with a high prevalence of undiagnosed cases. In 2022, up to UGX 2.2 trillion was spent, on medication, treatment and management of complications. Households bear the largest financial burden (UGX 1.7 trillion). On the other hand, government expenditure of UGX435 billion on diagnosed T2DM patients accounted for 13% of the MoH budget. Oral medications and outpatient appointments were the main cost drivers for treating T2DM without complications. At the same time, diabetic eye treatment of laser and cataract type, haemodialysis, and strokes drove the costs of T2DM-related complications high. Given this, emphasis must be on spreading knowledge about T2DM and, more significantly, developing prevention programs. This can be done through improved planning and prioritisation for diabetes, with particular attention to subsiding the direct economic costs of medications (insulin and oral drugs), Investing in creating national awareness and prevention programs as well as early screening to save on healthcare costs and improve the health outcomes of the Ugandan population.

1. INTRODUCTION

Diabetes Mellitus, precisely type 2 diabetes mellitus (T2DM), is rising. In 2019, the global age-standardised prevalence of T2DM was 536.6 million worldwide, with 18.5 million death rates of T2DM (Saeid *et al.* 2022; GBD, 2019). In addition, four out of every five adults (20-79 years) with undiagnosed diabetes live in low- and middle-income countries, and more specifically, in Africa, three in five people with diabetes are undiagnosed (IDF, 2021). Worse still, 87% of DM-related deaths occur in the low-and middle-income countries, with only 35% diabetes-related health expenditure undertaken (*ibid*). Even more worrying is that three in four deaths due to DM were in people under 60 years. Notably, T2DM[1] contributes up to 90% of all cases of diabetes (IDF,2023)[2] and is the leading cause of death among Non-Communicable Diseases (NCDs)[3](GBD 2019; Guwatudde *et al*. 2022). It is primarily attributed to rapid urbanisation due to population expansion, inactive lifestyles resulting from rise in desk jobs coupled with technology advancements, and unhealthy eating patterns attributed to presence of affordable and accessible processed foods (WHO, 2023; Kiguli *et al*. 2019).

Diabetes, given its chronic nature, is costly to treat and manage. Global estimates put this cost at USD 825 billion per year. IDF (2021) estimated this to be even higher to at least USD 966 billion, with developing nations experiencing a more significant economic burden as a percentage of GDP. For instance, Priyadi *et al*. (2021) estimated that DM caused an economic burden of $1.27 billion in Indonesia *in* 2020. In addition, Butt e*t al.* (2022) estimate the cost of T2DM in developing and middle-income countries at USD 740.1, amongst which the share of the direct cost was USD 646.7 billion and the indirect cost was USD 93.65 billion. In many countries, out-of-pocket expenses are likely to exceed 50% of overall health spending, and direct medical costs accounted for over 55% of the total cost (Davies *et al*. 2017). Butt et al. (2022), Davies *et al*. (2017), and Baradaran *et al*. (2011) found that the most significant contributions to the total treatment cost were medical services, hospitalisation, and medicines for the treatment of T2DM without complications.

Uganda is a low-income country. According to IDF (2023), Uganda has a 4.6%[4] prevalence of DM and is gradually rising, with 44% of persons undiagnosed. Concerning T2DM, the latest evidence shows an overall prevalence of 1.4% (Bahendeka *et al*. 2016). Chiwanga et al. (2016) observed that the prevalence of diabetes rises when considering factors such as location and gender, even though it may seem low initially.[5] For example, Chiwanga et al., (2016) noted that rural Ugandan residents have a higher diabetes prevalence rate (16%) compared to peri-urban Ugandan residents' 7.6%, female rural Ugandans have a higher prevalence rate (20%) than female residents in peri-urban areas (6.6%). Likewise, male rural Ugandans have a higher prevalence rate (12%) than male residents in peri-urban Uganda (8.8%). Further, public and private health systems continue to struggle to treat and manage T2DM (Birabwa *et al*. 2019) given the inadequacies in awareness (Atun *et al*. 2017), infrastructure and equipment (Nuche-Berenguer and Kupfer 2018; Chiwanga *et al.,* 2016), qualified personnel (Guwatudde *et al*. 2022; Birabwa *et al*. 2019), and limited budget (MoH, 2020). While efforts to treat DM by the government of Uganda exist, there are numerous limitations, such as limited healthcare infrastructure, inadequately qualified health workers and budget constraints, among other factors (Birabwa *et al,* 2019). For instance, Uganda's health budget in 2018/19 was 7.2% of GDP, with 23% expenditure towards managing and treating NCDs (MoH, 2020). The expenditure on managing and treating endocrine and metabolic disorders (including diabetes and others) was about 5.3% of the budget (ibid). Less than 1% of the Ugandan population has health insurance (UBOS, 2020). While the government is making efforts to create a National Health Insurance Scheme to address inequalities in access to comprehensive care and meet

1 T2DM is characterised by hyperglycemia and dyslipidemia due to underlying insulin resistance. The condition commonly progresses to include microvascular [e.g., retinopathy, nephropathy, and neuropathy] and macrovascular [e.g., heart, cerebral, and peripheral vascular disease] complications (Baradaran et al. 2011)

2 https://idf.org/aboutdiabetes/type-2-diabetes.html

3 Hypertension, diabetes, and cancer

4 For the age-adjusted comparative diabetes prevalence (20-79 years) in 2021

5 UDA (undated) estimates that rural Eastern Uganda has a diabetes prevalence of 7.4% and a pre-diabetes prevalence of 8.6%.

SDG 3 aspirations[6], efforts to pass are yet to be futile because of limited evidence on the extent of how to manage its functionality. Households (through out-of-pocket expenditures) currently bear the burden of treating and managing complicated diseases such as DM, more so T2DM. About 38.7% of health expenditures and the government (MoH, 2020; UBOS, 2020).

Studies assessing the extent and magnitude of treatment and management of T2DM and its related complications exist (Ng *et al*.2014). For Africa, while they are very few, they are growing (Mutyambizi *et al*. 2018). The systematic global and African cost of DM reviews indicates that most studies are needed to distinguish between the various types of DM (Priyadi *et al*. 2021; Mutyambizi *et al*. 2018). However, others have specifically costed T2DM (Erzse *et al.* 2019; Butt *et al*. 2022; Davies *et al*. 2017; Baradaran *et al*. 2011). In Uganda, despite the increase in the prevalence of T2DM, the extent of the direct economic cost burden remains piecemeal[7] and, to a greater extent, yet to be discovered. Researchers have shown evidence that costing for a broader spectrum of DM has been limited to drugs (Mutyambizi *et al*., 2018). For specific diabetic-related complications such as kidney disease (Hoogeveen, 2022), diabetic eyes (Jinji *et al.*, 2014) and foot (Vahwere *et al.*, 2023), these have concentrated on the prevalence rather than costs and not necessarily focused on Uganda alone. Complications increase the financial burden of treating and managing DM (Alouki *et al.* 2015).

The cost of illness (COI) for T2DM is determined by several factors that include the number and severity of complications, demographic characteristics of the population, access to medical care (public or private) and the quality of care received (Zawudie *et al*. 2022; Erzse *et al*. 2019). This paper aims to contribute to the broad spectrum of growing literature on COI, focusing on T2DM and Uganda. In this regard, measuring the direct economic impact of T2DM and its cost drivers is the central ethos of this paper. By painting a more realistic picture of the extent of the burden related to T2DM, policymakers can make timely decisions in passing the National Health Insurance Bill and its implementation. In addition, the evidence can be a robust advocacy tool for programming and creating awareness among the Ugandan people. Therefore, the paper:

i. Estimates the total annual direct costs of treating type 2 diabetes in 2022.
ii. Analyses these direct annual costs by the most common complications.
iii. Investigates the cost drivers of the annual direct costs.

2. METHODS AND MATERIALS

2.1 Why undertake T2DM for Uganda's costing?

The basis of selecting diabetes for costing analysis.

Non-communicable diseases (NCDs) are chronic and very expensive to treat. Given that Ugandans also suffer from various forms of cancer, diabetes and hypertension, there is a growing demand to understand the extent of the economic burden (direct and indirect) on households and the government. Despite this demand, not all NCDs could be costed. Hence, prioritisation had to be undertaken by stakeholders as a first measure in endeavouring to understand the depth of a select NCD by the study team for this project. Thus, a consultative process through Key Informant Interviews (KIIs) with guiding questions was implemented between April and May 2022.[8] Seventeen KIIs were conducted (See details in Annex 1 Table A1). The stakeholders provided insights on the NCDs, risk factors, and why NCDs are a priority for Uganda to cost. As a result, 33% of the stakeholders prioritised T2DM, 13% were for hypertension and 7% for cancer. About 47% noted that obesity was the highest risk factor driving NCDs in Uganda. Box 1 summarises stakeholder views on why T2DM was selected COI analysis. In summary, stakeholder views were that it is problematic and lifestyle-related, exacerbated by the

6 The World Health Organization (WHO) has set a global target of halting the rise in diabetes and obesity and reducing NCDs by 25 % by 2025

7 IDF (2021) puts the diabetes cost per person at USD 227.8 per year for those aged 20-79.

8 Interviews were conducted with key public health stakeholders and experts in the NCD realm; NCD Division of the Ministry of Health; Ministry of Education and Sports; National Children Authority; Uganda NCD Alliance; Uganda Cancer Society; and Civil Society Organizations—others were from academia, research, and Development Partners.

rate of urbanisation (Norris *et al.* 2015) and middle-income households. Families felt burdened, but the extent of the burden was unknown.

Box 1: Reasons for prioritising diabetes by stakeholders

"Diabetes is a condition which needs much attention since it leads to other Non-Communicable Diseases – diabetes should be prioritised because it's a root cause of several NCDs". Understanding the cost of its care, treatment, and prevention is paramount.

"Diabetes is so disturbing to the health of the population. It is too destructive and on the rise. We need diabetes cost information to support or guide decisions and advocacy in the fight against it regarding prevention, care, and treatment". "It is critical to understand the health/medical cost. There is also a need for evidence on the cost of diabetes to the economy (i.e., "how it brings down GDP"), the economic impact of diabetes on the productive segment of the population as well as the skilled labour force and the middle class".

"Diabetes because its complications affect the kidney and the heart. It affects both rich and the poor, and it's highly preventable".

"Diabetes is increasing and affecting many people, including children, and its treatment is costly".

"Diabetes because it is rapidly growing in the population – it is proving to be a dangerous public health issue".

"Diabetes because it also causes hypertension and is costly. This needs early screening and a careful lifestyle. It also affects other body parts - some parts must get limbs cut off, etc."

"Diabetes. This is because one can spend over 40 years with diabetes, and the patient spends all the income on treatment. People lose body parts and stop working because they are in and out of the hospital. And all this is because of poor feeding and lack of physical activity".

"Diabetes has a higher financial cost for managing it – anecdotally. This needs to be fully understood. The fees (e.g., for care and management) are poorly documented.
Source: Compiled using stakeholder's qualitative responses from KIIs in Uganda, 2022

2.2 Approach and Data Parameters

The study adopted a 'bottom-up' (person-based) approach to calculating the direct cost of diagnosing and controlling T2DM and its complications in public and private facilities. It used a standard cost of illness (COI) approach to the different population groups.

The costing follows five key methodological steps, namely.

(i) Case definition includes diabetes condition and type, related complications and establishing the prevalence.
(ii) Identifying cost-generating components based on relevant cost ingredients (e.g., costs related to screening, diagnosis, and treatment).
(iii) Converting resource utilisation into unit costs.
(iv) Attributing a monetary value to cost components.
(v) Aggregating across relevant population cohorts.

The costing follows a payer's perspective in the public and private healthcare sectors. Note that private costs are synonymous with household/individual costs and they reflect the true market treatment costs. Costs are annualised (1 year without discounting). Specifically, we estimate the cost of illness analysis by considering four broad costing parameters. We obtained population estimates from the Uganda National Household Survey (UNHS, 2019/20), and we sourced epidemiological parameters from the Institute for Health Metrics and Evaluation (IHME, 2021) to undertake the cost of illness analysis. and published studies (See details in Annex 1 Table A2), treatment coverage from protocols and guidelines indicating standard control and treatment of diabetes, and direct medical cost were obtained through primary data collection from hospitals and pharmacies. (Table 1). The compilation, costing model and data analysis were developed in Microsoft Excel 2013. Given that all costs were sourced from primary data collected of the year of COI estimates, this did not necessitate adjusting for inflation or conversion rates as these were true market costs.

2.3. Population size estimates, prevalence data and healthcare utilisation

Population size estimates are obtained using the Uganda

Table 1 Data parameters and sources

Main data parameter	Sub-parameter	Sources
Grouping of direct costs	T2DM controlled and T2DM-related complications	KIIS Focused literature
Time horizon, 2022	One year	
Costing approach	COI, Payer's perspective	Expert consultation (2022) Desk reviews of published studies
Population estimates	Population, 20+yrs, 20 – 79yrs & all age-standardised	Secondary data: Uganda Demographic and Health Survey (UDHS), Uganda National Household Survey (UNHS), Institute for Health Metrics and Evaluation (IHME), Published studies, e.g., trials, observational studies, systematic reviews and meta-analyses. Protocols and guidelines indicating standard control and treatment of diabetes. Unit costs were obtained through primary data collection from hospitals and pharmacies.
Epidemiology parameters	Disease burden – considering both diagnosed and undiagnosed cases. Prevalence rate, Medicine and technology need and usage. Hospitalisation Outpatient visits	
Treatment coverage	Screened, diagnosed, treated, controlled cases, complications[1], undiagnosed	
	payer perspective	
Direct medical costs	Medication	
	Examinations and investigations	
	Health worker's wages	

Note: Health workers' wages were incorporated in the unit cost for medical care

1 Complications costed related to T2DM included diabetic eye diseases (Cataracts, & retinopathy), diabetic foot ulcers (amputations), Ischaemic heart disease (cardiovascular disease), stroke, and renal disease (chronic kidney disease)

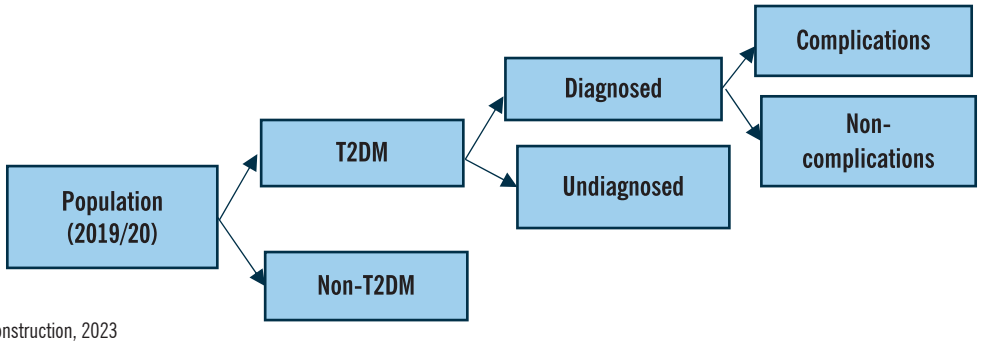
Source: Authors own construction

National Household Survey (UNHS) of 2019/20. The year also resonates with the up-to-date prevalence data on T2DM. Therefore, we disaggregate the population into three age groups for all age-standardised, 20+ years, and 20-79 years.

Due to the unavailability of accurate national prevalence data on T2DM, the paper obtained its prevalence data from the Global Disease Burden Report (IHME, 2021). In 2019, the prevalence for all T2DM (diagnosed and undiagnosed) in Uganda was 4.1%, 4.05% and 3.6% for all age-standardised, 20+ years, and 20-79 years, respectively. Yet, for the T2DM-diagnosed persons treated and controlled, the prevalence of all age-standardised was 0.4, while for 20+ and 20-79 years, it was 0.46.

To estimate the population with T2DM, as illustrated in Figure 1, prevalence data was applied to respective population sizes and age groups covering undiagnosed

Figure 1 Analytical framework for estimating T2DM epidemiology



Source: Authors construction, 2023

Table 2 Proportion of T2DM patients accessing healthcare services by treatment type

Treatment type (excluding complications)	Type 2 diabetes in need (%)	Treatment type (with Complications) concerning:	Type 2 diabetes in need (%)
Medicines and equipment		Laser treatment for retinopathy & follow-up outpatient consultation	66.2
On insulin	10	Treatment of cataracts	20
Using syringes and needles	10	Amputation (Diabetic vasculopathy)	18.8
Using glucose strips and lancets	10	Below knee prosthesis (per prosthesis)	26.2
With glucose meter plus batteries	10	Stroke	2
On oral drugs	66.2	Ischemic heart disease (cardiovascular disease)	2.3
Patient visit		Renal imagining	33.3
Going for an OPD consultation	78.9	Renal biopsy (per kidney)	2
Going to hospitalisation	29.5	On Haemodialysis	51
Investigations		On Peritoneal Dialysis	0.56
Who take blood test, urine test, ECG, retinal screening	100	Going for kidney transplant (per transplant + hospitalisation of recipient & donor + follow-up consultation + post-transplant dietitian + post-transplant physiotherapist + post medication for year)	1.24
		Who attended 5/ESRD investigations	2

Note: Peritoneal dialysis is mainly received in Kenya because this treatment is currently unavailable in Uganda.
Source: Authors compilation from literature, 2023

and diagnosed persons and only diagnosed persons irrespective of treatment and management type.

Researchers make assumptions to determine the number of individuals with T2DM based on their healthcare-seeking behavior. We use estimates from UNHS 2019/20 on healthcare access for people who became ill in the 30 days before the survey. About 34.6% and 62.6% of persons who sought health care in 2019/20 were in public (hospitals, health centres III, IVs) and private (hospitals/clinics and pharmacies) healthcare facilities, respectively. In this regard, we apply these proportions to T2DM persons (undiagnosed and diagnosed) by age group to derive population estimates of T2DM persons who sought public and private healthcare in Uganda.

To estimate the population of diagnosed T2DM persons by treatment and management type, proportion estimates for each T2DM recourse are obtained from various peer-reviewed literature. Further, the number of persons with complications from diagnosed T2DM was also obtained using specific T2DM-related complication proportions from the literature. Table 2 provides the proportions.

The incidence rates of those with T2DM and complications were determined. These rates were then applied to percentages from the published literature (Annex 1 Table A2) to obtain the estimated number of persons with T2DM and its complications. While calculating the number of persons for each treatment type, excluding T2DM complications, is straightforward, estimating the number of the same complications is not. For example, to estimate the number of persons undergoing below-knee prosthesis, we obtained 26.2% of the 18.8% of persons who had undergone amputations. Also, the number of T2DM-diagnosed patients undergoing renal biopsy is 2% of the 33.3% of patients who had undergone renal imagining.

Lastly, combining the assumptions on the share of T2DM patients attending public and private healthcare and the total number of T2DM patients using the assumptions in Table 2, we get the total annual number of T2DM patients (Annex 1 Table A3) accessing public and private healthcare for the three age groups. The formula below is what is used:

$$TN_{Public} = TotalT2DM * 34.6/100 \quad 1$$

$$TN_{Private} = TotalT2DM * (62.6/100) \quad 2$$

Where TN is the annual total number of T2DM patients.

2.4 Measurement and Costing T2DM

2.4.1 Measurement approach

The treatment and management of T2DM used the Uganda Clinical Guidelines of 2016 (MOH 2016)[9] to identify the cost components in this study. A structured questionnaire was developed to guide primary data collection on unit costs by resource use. The questionnaire was divided into four segments to capture costs of medicines and equipment (pharmacotherapy), patient visits to a health facility (consultations), laboratory investigations conducted, and complications as listed in Table 2. The valuation of examinations and investigations was based on primary data collected from the public (health centre IVs and one public hospital) and private hospitals (private hospitals also included faith-based non-for-profit facilities), and Joint Clinical Research Centre (JCRC), all located in the central region in the major districts of Kampala and Wakiso. These also provided costs by the different treatment parameters (see Annex 2 for details of the interview guide). Using clinical recommendations, two large chain private pharmacies also provided cost data on medicines and equipment for T2DM diabetes-related recourses and complications.

Unit costs were provided for daily doses multiplied by the number of days required for treatment and how many times a patient must seek this treatment per year. In this regard, all costs used are the annual actual market price per T2DM patient from a payer and healthcare facility perspective. We assume that while costs were collected in February 2023, the costs provided in Uganda Shilling (UGX) were as of Dec 31, 2022.

2.4.1 Cost estimation approach from a public and private healthcare perspective

Two scenarios of total annual direct costs were obtained. These direct costs apply to those incurred while treating T2DM in hospitals/health centres/clinics/pharmacies and exclude costs of treatment and services from herbal and traditional medicine providers. The total T2DM Direct Economic Cost (DEC), private and public, are estimated using 2022 actual market prices gathered using the structured questionnaire. To estimate facility-level costs, the following assumptions are:

a) First, the public expenditure on T2DM is calculated using the IHME (2014) report[10]. This is compared with the costs estimated by Kalyesubula *et al*. (2022)[11] on the cost of treating chronic kidney disease (CDK) in a government facility. Here, the average costs over the CDK components, OPD, In-patient, medicines, and dialysis, resulted in a 45.4% cost to the public sector on treating T2DM. To determine the unit costs for treating T2DM per person per year in a public facility, we assume that the public sector incurs a 45.4% share of the annual real market prices (private cost) as shown in Annex 1 Table A4. Total public expenditure is calculated as the product of the number of persons accessing public facilities multiplied by public spending per person per annum for a specific T2DM treatment resource, i.e.,

$$TDEC_{Public} = TN_{Public} * (RMP * {}^{45.4}/_{100}) \quad 3$$

Where:

- $TDEC_{Public}$ is the total annual direct economic costs for patients accessing treatment and managing T2DM at a public healthcare facility. In other words, how much government is subsiding to treat and manage T2DM and its complications.
- RMP is the annual real marker unit cost per T2DM patient for each treatment resource.

9 MoH (2016). Uganda Clinical Guidelines 2016: National guidelines for the management of common conditions

10 https://www.healthdata.org/sites/default/files/files/policy_report/2014/ABCE/Uganda/ABCE_Uganda_full_report_2014.pdf

11 https://journals.lww.com/kidney360/pages/articleviewer.aspx?year=2022&issue=05000&article=00018&type=Fulltext).

b) Second, the private expenditure assumes real market prices per annum per T2DM patient and reflects the actual private unit expenditure per person per annum (Annex 1 Table A5). To calculate the total private costs (OOP and non-OOP), we multiplied the real cost per person per year for complications and management of complications with the number of persons accessing private health facilities (hospitals/clinics and pharmacies)-

$$TDEC_{Private} = TN_{Private} * RMP \quad 4$$

Where;

- $TDEC_{Private}$ is the total annual direct economic costs for patients who access treatment and management of T2DM at a private healthcare facility. In other words, how much households/individuals are spending to treat and manage T2DM and its complications.
- The RMP is equivalent to private annual unit costs per T2DM patient for treatment resources.

Subtracting the cost of healthcare for the diagnosed population from the combined cost of healthcare for the diagnosed and undiagnosed populations, after standardizing for age, allowed us to calculate the total annual cost of care for the undiagnosed population.

3. RESULTS

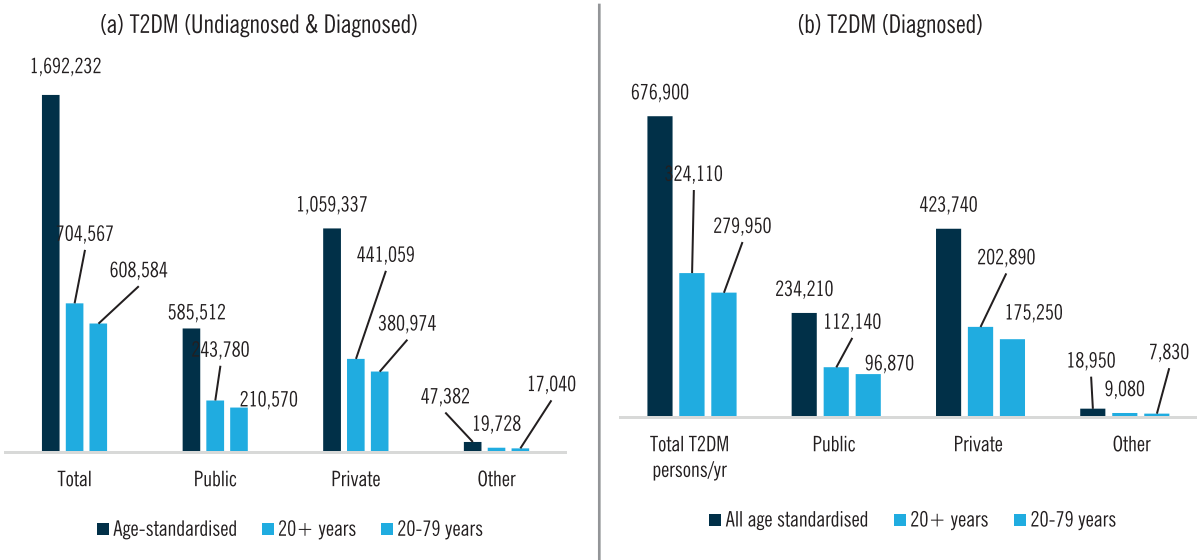
3.1 Demographic profile of T2DM disease

Uganda's population in 2019/20 was 40.947 million. Further estimates by age groups show that 17.408 million were aged 20 plus while 16.905 million were aged 20-79 years. Using T2DM prevalence data for each specific age group and the share of patients seeking public and private health care, equations 1 and 2 estimates are presented in Figure 2 for the diagnosed & undiagnosed cases (a) and diagnosed patients only (b). From Figure 2 (a), about 1,69million people have T2DM overall (diagnosed and undiagnosed), while only 40%, 46%, and 48% for all ages standardised, 20+ years and 20-79 years, respectively, have T2DM that was diagnosed, treated, and controlled (Figure 2a and 2b).

At the healthcare facility level, 585,520 people have T2DM overall (diagnosed and undiagnosed) and access public facilities in Uganda (Figure 2a). In contrast, the public sector has diagnosed, treated, and controlled only 40%, 46%, and 46% of people with T2DM for all ages standardized, 20+ years, and 20-79 years, respectively (Figure 2b).

At least 1,059,340 people with type 2 diabetes (diagnosed and undiagnosed) access private facilities

Figure 2 Number of T2DM patients who access treatment recourse by age group and healthcare facility, 2020.



Source: Authors calculations, 2023

to treat T2DM (Figure 2a). Figures 2b reveal that only 40%, 46%, and 46% for all ages standardized, 20+ years, and 20-79 years, respectively, have their T2DM diagnosed, treated and controlled in private facilities. Annex1 Table A3 details the number of persons who access treatment of T2DM by complication.

3.2 Direct costs of diagnosed T2DM

3.2.1 Annual unit cost for T2DM patients per year

The unit cost of managing, controlling, and treating T2DM with or without complications is generally higher in private than public healthcare facilities (Table 3). For instance, the combined unit cost of medication for only insulin and oral drugs in a private facility is approximately UGX3 million, while it's about UGX1.3 million in a public facility. Patient visits (consultation and hospitalisation) cost about UGX1.4 million in private healthcare, whereas it costs UGX617,440 in public healthcare facilities. The cost of investigations is about UGX353,000 in a private health facility, while it can be as low as UGX 160,262 in a public health

Table 3 Provides the annual unit costs at real market prices per person with T2DM by complication and health facility, 2022 (UGX)

	45.4% of the market cost	Market costs
Item	**Public**	**Private**
Total annual costs-Medicines and equipment		
Insulin	502,101	1,105,950
Syringes and needles	45,400	100,000
Glucose strips and lancets	129,254	284,700
Glucose meter plus batteries	31,598	69,600
Oral drugs	836,836	1,843,250
Total annual cost of patient visit		
OPD consultation	435,840	960,000
Hospitalisation	181,600	400,000
Total cost -Investigations		
Blood test; urine test; ECG; retinal screening	160,262	353,000
Total cost on-Complications		
Laser treatment for retinopathy & follow-up outpatient consultation	2,292,700	5,050,000
Treatment of cataracts	2,270,000	5,000,000
Amputation	708,240	1,560,000
Below knee prosthesis (per prosthesis)	227,000	500,000
Stroke	2,270,000	5,000,000
Ischaemic heart disease	908,000	2,000,000
Renal imagining	22,700	50,000
Renal biopsy (per kidney)	363,200	800,000
Haemodialysis	14,164,800	31,200,000
Peritoneal Dialysis	2,270,000	5,000,000
Kidney transplant (per transplant + hospitalisation of recipient & donor + follow-up consultation + post-transplant dietician + post-transplant physiotherapist + post medication for year)	0	120,000,000
Stage 5/ESRD investigations	221,098	487,000
Other T2DM complication		
Total annual cost-Hypertension	908,000	2,000,000
Total annual cost-Antihypertensive therapy	149,671	329,671

Note: 1/2- Kidney transplant is a privately handled activity without government support as this procedure is done outside of Uganda
2/2- All costs are in real 2022 prices.
Source: Authors compilation and computations, 2023

Table 4 **Total Direct Economic Cost Expenditure on Diagnosed T2DM Patients by Treatment Facility, UGX Billion (2022)**

	Age-standardised		20+years		20-79yrs	
	Public	Private	Public	Private	Public	Private
Cost excl' complications	266.4	1,061.6	131.3	523.4	113.4	452.1
Cost of complications	169.4	681.7	98.9	397.2	70.1	282.0
Total	435.8	1,743.3	230.2	920.6	183.5	734.0

Note: Costs excluding complications is the combined sum of total costs spent on medicines and equipment, patient visits and investigations
Source: Authors compilation and computations, 2023

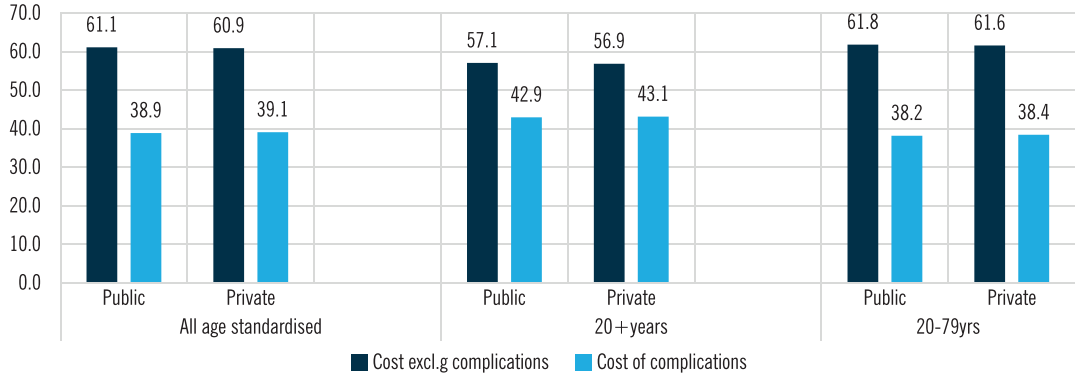
facility. Complications such as diabetic eye treatment cost UGX10.1 million in private facilities. Yet, in public facilities, it would cost UGX4.6 million. The costliest complication is a kidney transplant at UGX120 million and undergoing Haemodialysis (UGX14-31 million), depending on the health care provider. The care is only provided privately for kidney transplants and not in Uganda. Some key informants reported that the service providers in the destination country and the duration of post-transplant treatment recommended could further increase the cost. According to some key informants, the cost of a kidney transplant can differ based on the destination country and the duration of post-transplant treatment recommended, and the patient bears this expense.

As the epidemiology data shows, about 61% of T2DM patients are hypertensive (Annex 1 Table A2). This is equally translated into more expenditure burden on individuals with both complications to manage and treat the diseases. Thus, individuals suffering from T2DM spend about UGX900,000 to UGX2 million to control hypertension (Table 3).

3.2.2 Direct economic cost burden of treatment and management of diagnosed T2DM

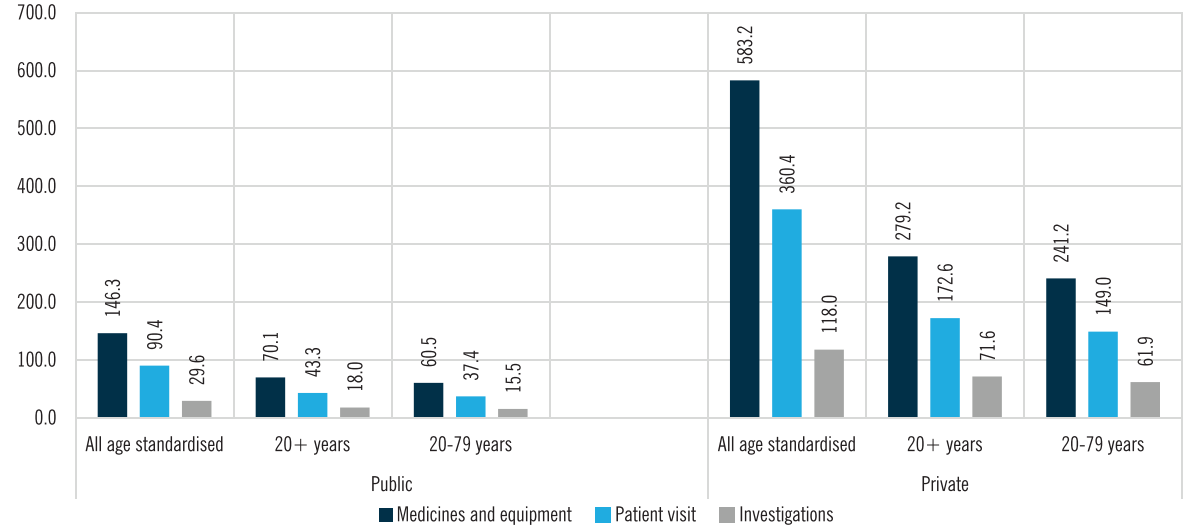
In 2022, the total direct economic cost (TDEC) attributed to the diagnosed T2DM patients' treatment and management was broken down by the health service provider and different age groups (Table 4). The direct costs are also broken down by treatment and management of diagnosed T2DM (referred to as cost excluding complications) and its complications. As Table 4 highlights, under the public healthcare service provision, the TDEC in 2022 on T2DM patients, including complications, was estimated at UGX 435.8billion, UGX 230.2billion and UGX183.5 billion for the age-standardised, 20+ and 20-79 years age groups, respectively. In all demographic age groups, the direct cost of treatment was driven by expenditure on treatment and management of diagnosed T2DM patients without consideration of complications. These accounted for about 61%, 57% and 62% of spending in public facilities for the age-standardised, 20+ and 20-79 age groups, respectively (Figure 3). In 2021/22, the approved budget to MoH was UGX3.331 trillion. This implies that the MoH spent at least 13% of its budget to

Figure 3 **Share of direct costs in total expenditure by healthcare facility on diagnosed T2DM patients in 2022**



Source: Authors compilation and computations, 2023

Figure 4 Cost drivers of treatment and management of uncomplicated diagnosed T2DM (UGX Billion) in 2022



Source: Authors compilation and computations, 2023

manage and treat diagnosed T2DM patients, based on age-standardized data.

Concerning TDEC in private_healthcare facilities incurred by households/individuals in 2022, the control and treatment of T2DM and its related complication cost about UGX 1,743.3 billion, UGX 920.6 billion and UGX 734.0 billion for all age-standardised, the 20+ and 20-79 age groups respectively (Annex 1 Table A5). Like public healthcare costs, these accounted for 61%, 57% and 62% of expenditures in private facilities for the age-standardised, 20+ and 20-79 age groups, respectively. The direct economic costs in the public healthcare sector are lower (20%) than those in the private healthcare sector (80%). This is because treating and managing T2DM and its complications is unaffordable; only a few T2DM patients can access the services. Besides, given that the numbers of patients seeking healthcare directly drive costs, it is thus not surprising that TDEC's burden of treating and managing diagnosed T2DM falls heavily on individuals/households as many seek private healthcare facilities for treatment.

3.3 Cost drivers of diagnosed T2DM

3.3.1 Drivers for treatment and management (excluding complications)

At a broad level, when broken down by resource category for treatment and management of uncomplicated diagnosed T2DM patients, the single most cost driver was costs incurred in the purchase of medicines and equipment at both public and private health facilities. This covers more than 54% of TDEC, excluding complications across different age groups (Figure 4). Specifically, for example, in a private health sector setting, pharmacologic expenditures on insulin, oral drugs, syringes and needles, glucose meters and batteries, glucose strips and lancets in private facilities account for UGX583.2 billion, UGX279.2 billion, UGX 241.2billion for all ages standardised, 20+ years and 20-79 years respectively. Furthermore, the costs were mainly driven by expenditure on oral drugs, accounting for over 88% of the TDEC on diagnosed T2DM patients.

About patient visits at private health facilities, TDEC amounted to UGX 321.0 billion, UGX153.7 billion, and UGX132.7 billion for all ages standardised, 20+ years and 20-79 years, respectively, attributed to OPD consultations (about 90%) (Annex1 Table A5). For T2DM-related investigations/tests such as HBA1c, Full blood count, Urea and Electrolytes, cholesterol, cholesterol (HDL), Urine test of Microalbumin, Electrocardiogram (ECG), and Retinal screening, these costed UGX118.0billion, UGX 71.6billion and UGX61.9billion for all age-standardised, 20+ years and 20-79 years respectively.

Similar trends in cost drivers are observed in the public healthcare facility setting (Figure 3, Annex 1 Table A4). The breakdown by resource category under public healthcare facilities shows that they spend UGX 146.3 billion, UGX 70 billion, and UGX 60.6 billion on pharmacologic resources for all age-standardised, 20+ years and 20-79 years, respectively. Outpatient Department (OPD) consultations contribute UGX80.5 billion, UGX38.6 billion, and UGX33.3 billion for all age-standardised, 20+ years and 20-79 years, respectively. Additionally, investigations account for UGX29.6 billion, UGX18.0 billion, and UGX15.5 billion for all ages standardised, 20+ years and 20-79 years, respectively. This implies that governments and households endeavour to control and manage T2DM in diagnosed patients before it becomes uncontrolled.

3.3.2 Cost drivers of T2DM complications

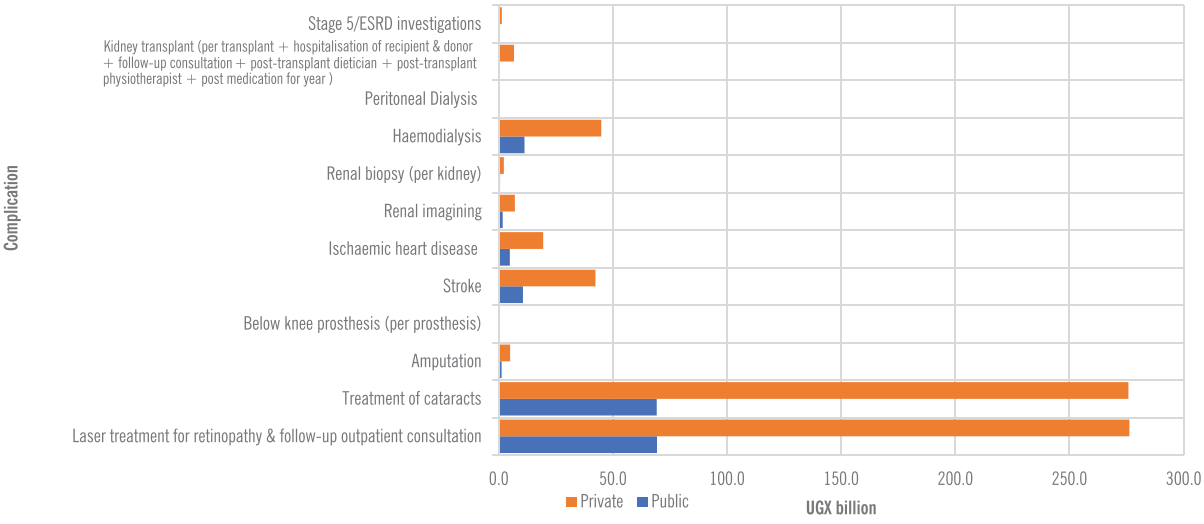
The management of diabetic eyes is the single most cost driver of the T2DM complication among diagnosed patients and accounts for over 80% of the costs related to treating complications across all age groups and healthcare facility types. This is particularly illustrated in Figure 5 for only the age-standardised group, which mimics the other age groups. This is followed by expenditure on haemodialysis, strokes, and Ischaemic heart disease, irrespective of facility type. The cost details by resource category for all age groups are provided in Annex 1 Tables A4 and A5.

If combined, the TDEC of diagnosed T2DM-related hypertension and antihypertensive therapy drive direct costs excessively high (i.e., UGX565.5 billion and UGX2.3 trillion for T2DM patients seeking public and private healthcare facilities, respectively). The government spends UGX129.7 billion through public health facilities to subsidise the treatment and management of hypertensive patients with diagnosed T2DM for the age-standardised category (Annex 1 Table A4). Households/individuals are similarly spending UGX517 billion to manage the same disease. (Annex 1 Table A5).

3.4 Cost of providing care to the undiagnosed population

Undiagnosed T2DM among patients contributes about 48% to the TDEC on treating and managing uncomplicated and complicated T2DM for the age-standardised group (Figure 6 and Figure 7). The findings (Figure 7) reveal that both public and private facilities spend UGX404.5 billion and UGX1,612.1 billion, respectively, to provide care to T2DM patients who are undiagnosed. This is higher than the cost of caring for patients who have already been diagnosed with T2DM without complications, which is UGX266.4 billion (public) and UGX1,061.6 billion (private) as shown in

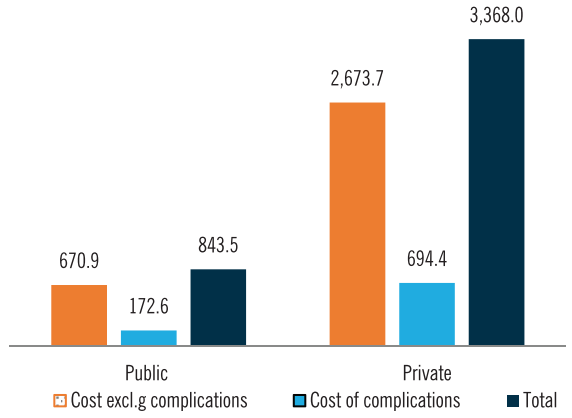
Figure 5 Drivers of TDEC among diagnosed T2DM patients with complications, UGX billion, 2022



Source: Authors compilation and computations, 2023

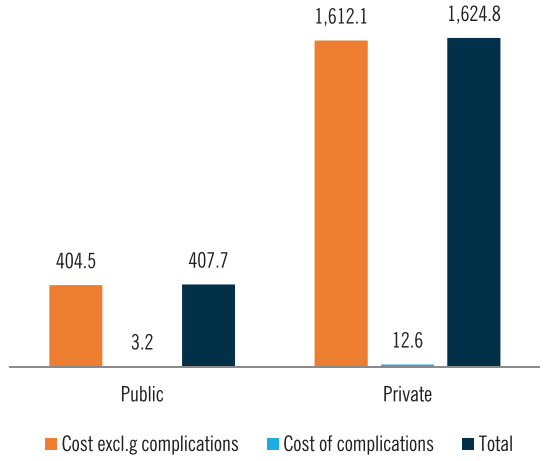
Table 4. Public and private healthcare facilities spend minimal on treating complications for undiagnosed T2DM patients because only a few complications can be treated for free or at minimal cost.. However, the cost of treating complicated diabetes per person is much higher than that of treating uncomplicated T2DM. Therefore, early screening and treating T2DM is worthwhile for saving resources, and delayed diagnosis poses the risk of presenting late with complications.

Figure 6 TDEC for age-standardised T2DM (diagnosed and undiagnosed) by a health service provider, UGX Billion, 2022.



Source: Authors own compilations, 2023

Figure 7 TDEC for age-standardised T2DM (undiagnosed) by a health service provider, UGX Billion, 2022.



Source: Authors own compilations, 2023

4. DISCUSSION

In 2019, T2DM (diagnosed and undiagnosed) affected 4.1% of the population in Uganda. Out of all T2DM cases, only 0.4% had been diagnosed, treated, and under control (IHME, 2021). Given that Uganda's population in 2019/20 was 40.947 million (UNHS 2019/20), Uganda has over 1.679 million T2DM, and only 676,900 are diagnosed with T2DM. This implies that 6 out of 10 Ugandans live in ignorance of what ails them and are likely to present late with complications that worsen their quality of life.

The government and households spent about UGX 2.2 trillion on the 676,900 diagnosed T2DM patients in public and private health facilities. Out of this amount, the government only spent UGX435.8 billion. This implies that most patients meet the cost burden of the disease out-of-pocket, which affects expenditure on other aspects of life. Further, if all those in need of care (diagnosed and undiagnosed) were to be treated, it would cost the country about UGX 4.2 trillion, about 8.7% of the 2022/23 total National budget. However, if healthcare providers emphasize early screening for T2DM and manage it before complications arise, the cost can be minimized.

An emerging body of literature estimates the magnitude of the cost of T2DM in developing and developed countries to which our study relates (Erzse *et al.* 2019, Baradaran *et al*. 2011, Butt *et al.* 2022). Our findings are consistent with other studies in developing countries where medication, diagnostic tests, and control of uncomplicated T2DM represent a significant amount of the total direct costs (Davies *et al*. 2017, Erzse *et a*l. 2019, Butt *et al.* 2022 and Prayidi *et al.* 2021). Like Prayidi *et al*. (2021) and Erzse *et al.* (2019), costly complications are Diabetic Retinopathy and kidney complications. We find that treating diabetic eyes is the main cost driver, accounting for over 80% of complications-related costs. This is followed by kidney complications in which a single dialysis session costs about UGX 300,000, and a T2DM patient with this condition requires three sessions per week. Even worse, a kidney plant costs about UGX 120 million. These costs are unaffordable for the majority of Ugandans.

Therefore, given the importance of the cost of medicines as a primary driver of T2DM expenditures, we propose that attention be directed to better diabetes policy, planning, and prioritisation, primarily focusing on the price of medications. Intensifying screening and expanding coverage to all undiagnosed patients will lead to a significant rise in spending on medicines. It would be ideal if effective systems were in place for evaluating health technologies that guide, restrict and boost efficiency in purchasing more medicine.

Notably, the study had some limitations, especially with regard to data availability. Therefore, some cost elements were from other developing countries such as Kenya, Tanzania, and other Sub-Saharan countries. These cost elements were applied to the population to get the cost estimates. In addition, many assumptions (Table 2) were adopted in calculating the cost estimates for complicated T2DM for which primary data was inadequate. Assumptions were also applied to estimate patients accessing public and private services.

5. CONCLUSION AND POLICY ACTIONS

The results highlight existing gaps in the knowledge and present new information that may be used to reduce expenditure in the future while improving health outcomes, particularly for Ugandans with T2DM. The high rates of undiagnosed disease represent a serious concern. Further, the heavy burden of comorbidities and present patterns in epidemiology indicate a potentially higher future burden. The findings revealed significant cost variations in managing T2DM and related complications in private and public facilities, placing a heavier burden on individuals who use private facilities.

To reduce the future burden of diabetes, we can identify patients who are at risk, improve the detection and monitoring of T2DM patients, implement efficient healthcare programs to increase awareness and promote the prevention of T2DM, and improve planning and prioritisation for diabetes by subsidising medication costs.

The costs of treating and managing T2DM in public and private facilities are significant, even with a high prevalence of undiagnosed cases. The government of Uganda currently requires about UGX435.8 billion. In contrast, private individuals need an average out-of-pocket expenditure of about UGX1,743.3 billion per annum to manage T2DM and its related complications for all age-standardised populations. Ugandan parliament passed the NHI bill in 2021. However, this will not remove the cost; it only helps to provide equitable access to health services. To address the significant impact of uncomplicated T2DM on the total costs of T2DM, we must pay attention to the following:

- Improved planning and prioritisation for diabetes, focusing on subsiding the direct economic costs of medications (insulin and oral drugs).
- Invest in creating national awareness and prevention programs. Prevention will require the government to invest in cleaning up the food environment and ensuring access to healthy diets for all Ugandans.
- Invest in early screening to save on healthcare costs and improve the health outcomes of the Ugandan population. Early detection would necessitate improved diagnoses, targeted screening of higher-risk individuals, and pharmacological management of T2DM to be prioritised to reduce the incidence of T2DM and its associated complications.

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ANNEX 1

Table A1: List of Key informants that selected which NCDs to be prioritised for costing.

No	Institution	Department
	Government MDAs	
1	Ministry of Health	NCD division
2	Ministry of Education and Sports (MoES)	Physical Education and Sports.
3	Ministry of Gender, Labour, and Social Development's	National Children Authority
4	Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)	Nutrition and Home Economics Department
5	Uganda National Bureau of Standards (UNBS)	standards office
	Civil society organisations	
6	Uganda Cancer Society	
7	Food rights alliance (FRA)	
8	Center for Food and Adequate Living Rights (CEFROHT)	
9	Uganda NCD Alliance	
10	Caritas Uganda	Social Development Department
11	Consumer Centre (CONSENT)	
	Academia	
12	Makerere University, School of Public Health	Health policy & systems management
13	Makerere University, School of Food and Nutrition	Department of Health Policy Planning and Management
14	Makerere University, School of Public Health	Department of Community Health and Behavioural Sciences
15	Makerere University, School of Food technology Nutrition & Bioengineering	Department of Food Technology and Human Nutrition
16	Makerere University, School of Agricultural Sciences	Department of Agricultural Production
17	Kyambogo University	Department of Nutritional Science and Dietetics

Table A2: Proportion of individuals with T2DM that consume resources

Source	Assumptions	Proportion of T2DM patients	Type of treatment/complication
Medicines and equipment			
Warren & Abhishek, 2015		10	On insulin
Warren & Abhishek, 2015	Those that use insulin also use syringes and needles	10	Using syringes and needles
Warren & Abhishek, 2015	Those that use insulin also use glucose strips and lancets	10	Using glucose strips and lancets
Warren & Abhishek, 2015	Those that use insulin also use glucose meters and plus batteries	10	With glucose meter plus batteries
Nyanzi et al (2014)	https://www.thelancet.com/action/showPdf?pii=S2666-7568%2821%2900089-1	66.2	On oral drugs
Patient visit			
Jujara Smith Junior (2017)		78.9	Going for OPD consultation
Lemma Demissie Regassa and Assefa Tola (2021)	https://bmcendocrdisord.biomedcentral.com/articles/10.1186/s12902-021-00744-3	29.48	Going to hospitalisation
			Investigations
Jujara Smith Junior (2017)	All who go for OPD consultations had these tests done.	100	Taking blood test; urine test; ECG; retinal screening
Complications type with regard to:			
Jingi at al (2014)	66.2% of severe DR prevalence rate are treated	66.2	Laser treatment for retinopathy & follow-up outpatient consultation
Than et al (2020)	Study is on Singapore on cataract treatment of DR in which 20% of DR people were treated	20	Treatment of cataracts

Vahwere et al. (2023)	http://doi.org/10.1186/s12889-023-15383-7	18.8	Amputation (Diabetic vasculopathy)
Basimabe et.al (2022)	26.2% of the amputee cases use prosthetics	26.2	Below knee prosthesis (per prosthesis)
Mwavua et al, 2016	Used statistics from Kenya	2	Stroke
		2.3	Ischaemic heart disease (cardiovascular disease)
Kalima et al (2015)	CKD in patients admitted to medical ward of Mbarara Regional Referral hospital Uganda	33.3	Renal imagining
Kalyesubula et al (2022)	RRT-Global Dialysis Perspective: Uganda (% of those that get renal imaging)	2	Renal biopsy (per kidney)
Kalyesubula et al (2022); Babau et al (2015)	% of those on RRT	51	On Haemodialysis
Kalyesubula et al (2022)	% of those on RRT (PD is not readily available in Uganda)	0.5698	On Peritoneal Dialysis
Ayamba Peter Mpaka (2020)	% of those on RRT and use the Tanzanian no of transplants done per year	1.24	Going for kidney transplant (per transplant + hospitalisation of recipient &donor + follow-up consultation + post-transplant dietitian + post-transplant physiotherapist + post medication for year)
Kalyesubula et al (2022)	same as RRT	2	Attended Stage 5/ESRD investigations
Other T2DM related complication			
Guwatudde et al. 2022	Prevention and management of type 2 diabetes mellitus in Uganda and South Africa: Findings from the SMART2D pragmatic implementation trial - PMC (nih.gov) & https://doi.org/10.2147/JMDH.S379293	61	Hypertension
Mwavua et al, 2016	Used statistics from Kenya (% of those with T2DM related hypertension)	57	Antihypertensive therapy

Source: Authors own compilation, 2023

Table A3: Number of patients who access treatment recourses for T2DM and its complications by age (2020)

	T2DM (Undiagnosed & Diagnosed)	T2DM (Diagnosed)		
Item	All age standardised	All age standardised	20+ years	20-79 years
Medicines and equipment (Number of patients)				
On insulin	169,230	67,690	32,420	28,000
Using syringes and needles	169,230	67,690	32,420	28,000
Using glucose strips and lancets	169,230	67,690	32,420	28,000
With glucose meter plus batteries	169,230	67,690	32,420	28,000
On oral drugs	1,120,260	448,110	214,560	185,330
Patient visit (Number)				
OPD consultation	1,335,180	534,070	255,720	220,880
Hospitalisation	157,450	157,450	75,390	65,120
Investigations (Number)				
Blood test; urine test; ECG; retinal screening	1,692,240	534,070	324,110	279,950
No. with Complications requiring				
Laser treatment for retinopathy & follow-up outpatient consultation	87,390	87,390	41,840	36,140
Treatment of cataracts	88,140	88,140	64,830	36,450
Amputation (Diabetic vasculopathy)	5,100	5,100	2,440	2,110
Below knee prosthesis (per prosthesis)	1,340	1,340	640	560
Stroke	13,540	13,540	6,490	5,600
Ischaemic heart disease (cardiovascular disease)	15,570	15,570	7,460	6,440
Renal imagining	563,520	225,410	107,930	93,230

Renal biopsy (per kidney)	4,510	4,510	2,160	1,870
Haemodialysis	2,300	2,300	1,110	960
On Peritoneal Dialysis	30	30	20	20
Undergo kidney transplant (per transplant + hospitalisation of recipient & donor + follow-up consultation + post-transplant dietician + post-transplant physiotherapist + post medication for year)	60	60	30	30
Undergo stage 5/ESRD investigations	11,280	4,510	2,160	1,870
Other T2DM complication				
Number with Hypertension	1,032,270	412,910	197,710	170,770
On antihypertensive therapy	588,390	235,360	112,690	97,340
Total T2DM persons/year estimates	1,692,240	676,900	324,110	279,950

Source: Authors own compilation, 2023

Table A4: Total direct economic cost by the public for T2DM patients seeking public health care facilities and complication, 2022 (UGX Billion)

	T2DM (Undiagnosed & Diagnosed)	T2DM (Diagnosed)		
Item	All age standardised	All age standardised	20+ years	20-79 years
Total annual costs-Medicines and equipment				
Insulin	29.4	11.8	5.6	4.9
Syringes and needles	2.7	1.1	0.5	0.4
Glucose strips and lancets	7.6	3.0	1.4	1.3
Glucose meter plus batteries	1.9	0.7	0.4	0.3
Oral drugs	324.4	129.7	62.1	53.7
Total annual costs-Patient visit				
OPD consultation	201.3	80.5	38.6	33.3
Hospitalisation	9.9	9.9	4.7	4.1
Total cost -Investigations				
Blood test; urine test; ECG; retinal screening	93.8	29.6	18.0	15.5
Total cost on-Complications				
Laser treatment for retinopathy & follow-up outpatient consultation	69.3	69.3	33.2	28.7
Treatment of cataracts	69.2	69.2	50.9	28.6
Amputation	1.2	1.2	0.6	0.5
Below knee prosthesis (per prosthesis)	0.105	0.105	0.050	0.043
Stroke	10.6	10.6	5.1	4.4
Ischaemic heart disease	4.9	4.9	2.3	2.0
Renal imagining	4.4	1.8	0.8	0.7
Renal biopsy (per kidney)	0.6	0.6	0.3	0.2
Haemodialysis	11.3	11.3	5.4	4.7
Peritoneal Dialysis	0.020	0.020	0.010	0.008
Kidney transplant (per transplant + hospitalisation of recipient & donor + follow-up consultation + post-transplant dietician + post-transplant physiotherapist + post medication for year)	0.0	0.0	0.0	0.0
Stage 5/ESRD investigations	0.9	0.3	0.2	0.1
Total cost excluding complications	670.9	266.4	131.3	113.4
Total cost of complications	172.6	169.4	98.9	70.1

GRAND TOTAL	843.5	435.8	230.2	183.5
Other T2DM complication				
Total annual cost-Hypertension	324.3	129.7	62.1	53.7
Total annual cost-Antihypertensive therapy	30.5	12.2	5.8	5.0

Source: Authors own compilation, 2023

Table A5: Total direct economic cost by private providers (Private) for T2DM patients seeking private health care facilities and complication, 2022 (UGX Billion)

	T2DM (Undiagnosed & Diagnosed)		T2DM (Diagnosed)		
Item	All age standardised		All age standardised	20+ years	20-79 years
Total annual costs-Medicines and equipment					
Insulin	117.2		46.9	22.4	19.4
Syringes and needles	10.6		4.2	2.0	1.8
Glucose strips and lancets	30.2		12.1	5.8	5.0
Glucose meter plus batteries	7.4		2.9	1.4	1.2
Oral drugs	1,292.6		517.1	247.6	213.8
Total annual costs-Patient visit					
OPD consultation	802.4		321.0	153.7	132.7
Hospitalisation	39.4		39.4	18.9	16.3
Total cost -Investigations					
Blood test; urine test; ECG; retinal screening	373.9		118.0	71.6	61.9
Total cost on-Complications					
Laser treatment for retinopathy & follow-up outpatient consultation	276.2		276.2	132.3	114.2
Treatment of cataracts	275.9		275.9	202.9	114.1
Amputation	5.0		5.0	2.4	2.1
Below knee prosthesis (per prosthesis)	0.4		0.4	0.2	0.2
Stroke	42.4		42.4	20.3	17.5
Ischaemic heart disease	19.5		19.5	9.3	8.1
Renal imagining	17.6		7.1	3.4	2.9
Renal biopsy (per kidney)	2.3		2.3	1.1	0.9
Haemodialysis	44.9		44.9	21.5	18.6
Peritoneal Dialysis	0.1		0.1	0.0	0.0
Kidney transplant (per transplant + hospitalisation of recipient & donor + follow-up consultation + post-transplant dietician + post-transplant physiotherapist + post medication for year)	6.7		6.7	3.2	2.8
Stage 5/ESRD investigations	3.4		1.4	0.7	0.6
Total cost excluding complications	2,673.7		1,061.6	523.4	452.1
Total cost of complications	694.4		681.7	397.2	282.0
GRAND TOTAL	3,368.0		1,743.3	920.6	734.0
Other T2DM complication					
Total annual cost-Hypertension	1,292.4		517.0	247.5	213.8
Total annual cost-Antihypertensive therapy	121.4		48.6	23.3	20.1

Source: Authors own compilation, 2023

ANNEX 2: INTERVIEW GUIDE

Assessment of policies and identification of context-specific regulatory interventions for a healthier food environment to prevent diet-related Non-Communicable Diseases in Uganda

Objective: This costing work aims at analysing the economic burden of diabetes in Uganda, as a growing NCD in the population.

Interview guide

Section A: MEDICINES AND EQUIPMENT

1. What kind of medication is needed to treat diabetes mellitus and how much does it cost?

Medicine	*Form (Oral or injectable)*	*Dose/unit/day*	*Unit price*	*Total annual cost*
Benzathine penicillin 2.4 MU				
Furosemide tablet 40 mg				
Glibenclamide 5 mg				
Bendrofluazide 5 mg				
Atenolol 50 mg				
Cardiac aspirin 75 mg				
Digoxin tablet 0.25 mg				
Metformin 500 mg				
Captopril 25 mg				
Nifedipine 20 mg				
Amlodipine 5 mg				
Warfarin 5 mg				
Glimepiride 2 mg				
Spironolactone 25 mg				
Furosemide i.v vial 20 mg				
Hydralazine tablet 25 mg				
Telmisartan 40 mg				
Bisoprolol 5 mg				
Pioglitazone 30 mg				
Losartan 50 mg				
Soluble insulin 1vial				
Amlodipine 10 mg				
Intermediate insulin 1vial				

Medicine	*Form (Oral or injectable)*	*Dose/unit/day*	*Unit price*	*Total annual cost*
Pre-mixed insulin 1vial				
Clopidogrel 75 mg				
Losartan H 62.5 mg				
Telmisartan H 52.5 mg				
Nebivolol 5 mg				
Simvastatin 20 mg				
Isosorbide mononitrate 10 mg				
Atovastatin 20 mg				
Rosuvastatin 10 mg				
Carvedilol 6.25 mg				
Metformin 1000 mg				
UFHb 5000 units				
LMWHa 60 mg				
LMWHa 80 mg				
Other (Name)				

2. What is the equipment required in the treatment of DM and how much does each equipment cost?

Equipment	*Unit price*	*Cost of maintenance*	*Total cost per year*
Syringes and needles			
Glucose strips and lancets			
Glucose meter plus batteries			
Other (Name)			

Section B: OUTPATIENT AND HOSPITALISATION

3. What is the cost of Outpatient department (OPD) consultation?

Number of Visits per month	
Cost of consultation	
Any other costs incurred	
Total cost per year	

4. On average how many times a month does a diabetic patient gets hospitalised?

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5. What is the total cost of hospitalisation?

Section C: INVESTIGATIONS

6. What kind of investigations/ tests are performed and how much does each test cost?

Type of investigation	*How many times it's done in a month*	*Unit cost*	*Total cost per year*
Blood Test - HbA1c			
Blood Test - Full blood count			
Blood Test - Urea & Electrolytes			
Blood Test - Cholesterol (Total)			
Blood Test - Cholesterol (HDL)			
Urine Test - Microalbumin			
ECG			
Retinal screening (visual acuity and retinal examination)			

Section D: COMPLICATIONS

7. What kind of complications are associated with DM and what is the cost of treating such complications?

Complications	*Form of treatment*	*Unit cost*	*Total cost per year*
Diabetic eye			
Diabetic Retinopathy: laser treatment			
Follow-Up Outpatient Consultation			
Cataracts: treatment			
Diabetic foot			
Total cost of amputation			
Amputation: foot			
Hospitalisation due to amputation			
Follow-Up Outpatient Consultation			
Total cost of below knee prosthesis			
Diabetic Nephropathy			
Renal imagining			
Renal biopsy: needle (per kidney)			
Total annual cost of Haemodialysis (HD)			
Costs of consumables per procedure			
Cost of HD per procedure			
Total cost of Peritoneal dialysis (PD)			
Cost of PD procedure			
Annual Costs of solutions and tubing in PD			
Total cost of kidney transplantation			

Complications	***Form of treatment***	***Unit cost***	***Total cost per year***
Procedure of kidney transplantation			
Hospitalisation: recipient			
Hospitalisation: donor			
Follow-Up Outpatient Consultation			
Post-transplant dietitian consultation			
Post-transplant Physiotherapist			
Post-transplant medication			
Total annual cost of Stage 5/ESRD investigations			
Urea			
Calcium			
Creatinine			
Parathyroid Hormone			
HIV phosphate			
Hepatitis B			
potassium			
HB			
Diabetic Heart Disease			
Stroke (Total annual direct care cost)			
Ischaemic heart disease			
Comorbidities			
Hypertension			
Antihypertensive therapy			
Registrar Gr 5			

Thank you for your interest in participating in this research.

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