ESJ Social Sciences

Estimating the Economic Burden of Diabetes Mellitus in Kenya: a Cost of Illness Study

Ebrahim Adamjee
Medical Doctor, MSc in Health Economics and Pharmaco-economics
Jean de Dieu Harerimana
School of Economics, University of Nairobi, Kenya

Doi:10.19044/esj.2022.v18n22p104

Submitted: 27 March 2022
Accepted: 19 July 2022
Published: 31 July 2022

Cite As:
Adamjee E., Harerrimana J.D.D. (2022). *Estimating the Economic Burden of Diabetes Mellitus in Kenya: a Cost of Illness Study*. European Scientific Journal, ESJ, 18 (22), 104. https://doi.org/10.19044/esj.2022.v18n22p104

Abstract

Diabetes mellitus is one of the non-communicable diseases that depletes the wealth of any individual directly and indirectly due to the cost associated with treating the illness and its complications. The study aims to estimate the economic burden of Diabetes mellitus in Kenya from a societal perspective using a cost-of-illness approach. The study's results and findings for the economic burden of diabetes mellitus in Kenya relied on the cost of illness approach. The approach identifies and measures all the costs of Diabetes mellitus, including direct and indirect costs. The 552,400 adult cases reported in 2019 resulted in a total economic cost of USD 372,184,585, equivalent to USD 674 per diabetes mellitus patient. The total direct costs accounted for the highest proportion of the overall costs at 61% (USD 227,980,126), whereas indirect costs accounted for 39% of the total economic costs (USD 144,204,459). Costs of medicines accounted for the highest costs over the total economic costs at about 29%, followed by the income lost while seeking care at 19.7%. Other costs that accounted for more than 10% of the total costs include productivity losses (19%), diagnostic tests (13%), and travel (12%). The rest of the cost categories accounted for less than 5%. Efforts should be made to reduce the costs of these medicines to enhance care. The high indirect costs reported, majorly in income lost by patients while seeking medical care, are 19%. Access to affordable health services such as diabetes mellitus education, regular blood glucose screening initiatives, and increasing

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

local manufacturing of medicines can reduce the economic burden of diabetes mellitus and increase the health outcomes of the population and their contributions to society.

Keywords: Economic evaluation, income, health spending, inpatient

Introduction

Diabetes mellitus (DM) is a chronic illness characterised by high blood glucose levels due to the body's inability to produce enough energy and insulin. A hormone is involved in the metabolism from the entry of glucose (Saeedi et al., 2019). However, the prolonged presence of elevated blood sugar (hyperglycaemia) causes multi-organ damage leading to life-threatening conditions (i.e. cardiovascular disease, nerve damage (neuropathy), eye disease (retinopathy), kidney injury (nephropathy), among other complications) (Preis et al., 2009). Furthermore, despite the persistent hyperglycemia associated with complications of the illness, the demand for healthcare and control and monitor DM dynamism thus increases the cost of care to patients and burdens individuals with limited income, and depletes the household income.

The global projection estimated 463 million in 2019 to 624 million cases by 2040; about two-thirds of all people living with Diabetes came from low- and middle-income countries in 2013 (WHO, 2016).In Africa, the estimated prevalence goes around 4.7%, with high rates of underdiagnosis around 59.7%(WHO, 2016; 2020). Hence, the literature characterises that increased urbanisation, diet changes, and sedentary lifestyles fueled and increased the incidence of DM in Low and Low Middle-Income Countries (LMICs)(Atun et al., 2017). From a societal perspective, USD 760 billion in 2019 marked the global expenses as "*direct costs of diabetes*", and the estimates might increase by 8.6% to reach USD 825 billion over the next ten years (WHO, 2020).

In Africa, in 2019, healthcare providers estimated USD 9.6 billion was spent on DM healthcare-seekers, among other non-communicable diseases (NCDs). Therefore, there is a high likelihood of exponentially increased health expenditure on the same chronic disease in the years to come. Unfortunately, in East Africa, the incidence of DM remains under-reported and reduces the facts during the awareness and campaigns to prevent DM. For example, in Kenya, awareness relied on the national DM incidence published in 2015. However, the Ministry of Health dubbed the Kenya STEPwise Survey (latest survey) for Noncommunicable Disease Risk estimated the prevalence of Diabetes at 2.4% in Kenya. Hence, the recent reports motivated the study. As of April 2020, the country had about 552,400 diabetes mellitus adult cases out of an adult population of 25,587,600. The government reported around USD

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

78.6 as the total health expenditure per capita, with health expenditures accounting for about 4.5% of total government spending(World Bank, 2018).

However, DM patients risk carrying high economic burdens resulting from catastrophic spending and financial depletion. Such burdens resulted from three conditions that predict a financial disaster (*i.e*. out-of-pocket health care costs, the inability of individuals to pay and the lack of subscription mechanisms to pool financial risks prevail)(Ahmed & Almulla, 2020; Kirigia et al., 2009a).In addition, the chronic nature of DM and its numerous complications make it a costly disease. Thus, the study aims to shade the costs of illness from a DM perspective in Kenya, where 1 in 3 Kenyans, i.e.,15.9 million people, live under the poverty line(Barasa et al., 2017; Chuma & Maina, 2012; Mohajan, 2013). The current adult equivalent consumption estimate is below Ksh 3,252 in rural areas and Ksh 5,995 in urban areas (KNBS, 2020).

The economic burden of Diabetes poses a significant public health challenge for health insurers to identify ways to improve diabetes monitoring and control the dynamics of diabetes-related spending(de Lagasnerie et al., 2018). Hence, from the methodological perspective, the estimation of the overall economic burden of DM includes the direct costs of treating the disease and the costs of treating the complications of DM, the costs of productivity and its complications, and the costs of social benefits due to DM-related disability(Peters et al., 2017). Therefore, looking at the current overall economic burden of DM and its complications is crucial for decision-makers and payers, especially at this time of rising health care spending, pressure on payers, and cost reduction initiatives.

Literature shows that cost-of-illness studies rely more frequently on descriptive studies and use the value of the costs of a particular health problem in currency terms, which allows the estimation of the economic burden of the problem (Ahmed & Almulla, 2020; Kirigia et al., 2009a). Moreover, the cost of illness studies traditionally divides costs into three categories: direct, indirect, and intangible(Atun et al., 2017; Bahia, da Rosa, et al., 2019; Mapa-Tassou et al., 2019). Diabetes care incurs substantial costs to patients, families, and society, not only for direct costs of medical care for Diabetes but also indirect and intangible costs.

Methods

Data source

Prevalence, frequency, and cost data were mainly collected from published studies and official reports, and where none was found, grey literature was used.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Costing approach

The full economic cost of DM illness was estimated for 2019 and served as a reference year. A societal perspective was employed to include costs incurred by the country's Ministry of Health, DM patients, and family members. The bottom-up costing approach was used where each resource was identified and then multiplied by the quantity (Q) consumed with its respective price (P). The quantities consumed were majorly imputed using the number of DM patients, while the prices were identified from various published studies and in some cases, from the grey literature. Additionally, prices were inflated from their reported year to the base year of 2019 using the Kenya GDP deflator.

Capital costs identified were few and annualised accordingly; we used their estimated useful life and a discount rate of 3%. Future earnings were also discounted at 3% to calculate their present value. In Kenya, 2019 was used to estimate the lost income per annual gross national income (GNI) per capita while patients sought care or premature deaths (hereunder defined as indirect costs). Other assumptions used are presented as analytical assumptions in the text. All costs are reported in 2019 USD. The Kenya shillings/US dollar exchange rates used were derived from the OANDA currency converter.

Cost Typology

The study's results and findings on the economic burden of Diabetes mellitus in Kenya relied on the cost of illness approach(Athanasakis et al., 2015; Krensel et al., 2019; Mapa-Tassou et al., 2019; Zhu et al., 2019). The approach identifies and measures all the costs of Diabetes mellitus, including direct and indirect costs. Direct costs comprise direct medical and non-medical costs. Direct medical costs are costs of transactions for medical services, including diagnostic tests, medicines, outpatient, hospitalisation, and cost of complications. On the other hand, direct non-medical costs are additional costs in accessing treatment, such as travel costs. Indirect costs include the opportunity cost of time lost while seeking care (morbidity) and productivity losses due to premature deaths (mortality).

Analytical approach

The analytical approach to estimate Total cost (TC) from the public health spending, marginal cost per diabetes mellitus patient, and experienced cost as per family member. This cost can be summarised as follows: TC=TDC+TIC, TDC-Total Direct Costs, and TIC-Total Indirect costs.

Estimating direct costs

The total direct costs of DM were calculated as
TDC=TCdt+TCopd+TCm+TChp+TCcomp+TCtrav

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Where: TDC-Total Direct Costs, TCdt-Total costs of diagnostic tests, TCopd-Total costs of outpatient visits, TCm-Total costs of medication, TChp-Total costs of hospitalisation, TCcomp-Total costs of complications and TCtrav-Total costs of travel.

Estimating indirect costs

Productivity losses due to lost income while seeking medical care: the annual costs of productivity losses due to lost income while seeking care were calculated by multiplying the proportion of patients who reported having lost time while seeking care by the annual GNI per capita.

Productivity losses due to premature deaths

A total number of 1,141,543 died from DM in Kenya. The distribution of these deaths across age groups (0-4, 4-14, 15-44, 45-59, 60+) was obtained by multiplying the total number of diabetes deaths by the probability of diabetic patients dying across these age groups(Murray & Lopez, 1996). Their study provides the average age of onset and the average duration of life lived with Diabetes for these age groups(Kirigia et al., 2009a). The productive life years lost (PLYL) for 15–44, 45–59 and 60+ years age brackets were obtained by subtracting the average age of onset and average duration of life lived with Diabetes from the maximum life expectancy in the African Region(Kirigia et al., 2009a).

The future PLYL for 0–4 and 5–14 years age brackets were obtained by subtracting the average age of onset, the average duration of life lived with Diabetes, and 14 years from the maximum life expectancy of Kenya, respectively. The cost of premature diabetes-related mortality among persons of a specific age group is the product of the number of deaths, total number of productive discounted life years lost (i.e. years above 14 years of age), and gross national income per capita per year. The discount used to calculate the present value of future costs for age groups 0-4, and 5 – 14 years is 3% (Drummond et al., 2015) and Kenya's life expectancy = 66 years (World Bank, 2018).

Table 1: Distribution and epidemiology of DM cases across different age groups

Age group	DM prevalence (%)	Av. Age at onset	Av. duration of morbidity	Deaths (%)	PLYL
0 - 4	581 (0.05%)	2.4	0.61	46	49
5 - 14	581 (0.05%)	10	2.97	46	39
15 – 44	176,315 (15%)	29.45	30.1	7,053	6
45 - 59	390,971 (34%)	52.15	16.025	62,555	(2)
60+	573,095 (50%)	69.2	7.175	343,857	(10)

Source - (Murray & Lopez, 1996)

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Table 2: Cost component and assumptions

Costs	Ingredients	Estimation	Assumptions
Diagnostic tests	Glucometers	The annual cost of glucometers was calculated as follows: TCg=(RCg×Qg)/A(r,n) Where TCg is the total cost pf glucometers, RCg is the replacement cost of one glucometer, Qg is the quantity of glucometers used in a year and A(r,n) is the annuitization factor assuming a discount rate of 3% and a useful life of 5 years.	▪ Replacement cost of one glucometer = USD 20 (Brown et al., 2015) (inflated to 2019 USD = USD 25) ▪ Discount rate (r) = 3% (Drummond et al., 1998) ▪ Useful life of glucometers (n) = 5 years ▪ Quantity of glucometers needed is equal to the number of patients on insulin ▪ Proportion of patients on insulin is 32% (Subramanian et al., 2018a) of all 552,400 DM patients (32%×552,400=176,768)
	Reagent strips	The annual costs of reagent strips needed was obtained as follows: TCrs=Nrs×ACrsl Where Nrs is the number of DM using reagent strips, ACrsl is the average costs reagent strips and lancets per year.	▪ Number of DM patients using reagents strips = number of DM patients on insulin. ▪ Proportion of patients on insulin is 32% (Subramanian et al., 2018a) of all 552,400 DM patients (32%×552,400=176,768) ▪ Annual average costs of reagent strips and lancets = USD 165.50 (Oyando et al., 2020a)(inflated to 2019 USD = USD 176.22)
	Random blood sugar test	The annual cost of random blood sugar test was calculated as follows: TCrbst=NDMp×ACrbst×NTrbst where nDMp is the number of diabetes mellitus patients, ACrbst is the average cost of a random blood sugar test, and NTrbst is the number of times a random blood sugar test is done in a year.	▪ Number of DM patients in y2020 = 552,400 ▪ Cost of one random blood sugar test in a public facility = USD 4.95 (adjusted for inflation USD. 5.27) (Subramanian et al., 2018a) ▪ Number of times the random sugar test is done in a year = 4
	HBA1c test	The annual cost of HBA1c test is calculated as follows TcHBA1c=pHBA1c×nDMp×ACHBA1c×nHBA1c, where pHBA1c is the proportion of patients that undertake as least one HBA1c per year, ACHBA1c is the average cost of a HBA1c test in a public facility,	▪ Proportion of patients that undertake as least one HBA1c per year = 20.8%(Matheka et al., 2013) ▪ Number of DM patients = 552,400 ▪ Average cost of a HBA1c test in a public facility = USD 10 (Park & Pastakia, 2018) (adjusted to 2019 USD = USD 17.05)

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

		and nHBA1c is the number of times HBA1c tests are done in a year.	▪ Number of times, HBA1c test done in a year = 2 to 4 times (Matheka et al., 2013), average = 3 times
Outpatient (OPD) visits		The annual costs DM patients OPD visit in a was calculated a s follows: TCopd=nOPD×nDM×cOPD	▪ Number of DM patients = 552,400 ▪ Number of OPD visits by DM patients in a year = 4 (based on expert opinion) ▪ Cost per OPD visit = USD 4.09 (Stenberg et al., 2018) (adjusted for inflation cost – USD 8.79)
Medicines	Insulin	The annual cost of insulin is calculated as follows TCins=pDMins×nDM×aCINS Where pDMins is the proportion of DM patients on insulin in public facilities, nDM is the number of DM patients, aCINS is the annual cost of insulin for patients in a public facility	▪ Proportion of patients on insulin only in public facilities = 32% (Subramanian et al., 2018a) ▪ Number of DM patients = 552,400 ▪ Annual cost of insulin for patients in a public health facility = USD 186 (adjusted for inflation USD 199) (Subramanian et al., 2018a)
	Oral medication	The annual cost of oral medication is calculated as follows TCins=pDMom×nDM×aCOM, Where: pDMins is the proportion of DM patients on oral medication in public facilities, nDM is the number of DM patients, aCINS is the annual cost of oral medication for patients in a public facility.	▪ Proportion of patients on oral medication in public facilities = 25% (Subramanian et al., 2018a) ▪ Number of DM patients = 552,400 ▪ Annual cost of oral medication for patients in a public health facility = USD 89 (adjusted for inflation USD 94) (Subramanian et al., 2018a)
	Both insulin and oral medication	The annual cost of both insulin and oral medication is calculated as follows TCins=pDMinsom×nDM×aCINSOM, where pDMinsom is the proportion of DM patients on both insulin and oral medication in public facilities, nDM is the number of DM patients, aCINSOM is the annual cost of both insulin and oral medication for patients in a public facility	▪ Proportion of patients on both insulin and oral medication in public facilities = 43% (Subramanian et al., 2018a) ▪ Number of DM patients = 552,400 ▪ Annual cost of both insulin and oral medication for patients in a public health facility = USD 234 (adjusted for inflation USD 250) (Subramanian et al., 2018a)
Hospitalisation		The annual costs of hospitalisation of DM patients was calculated as follows: TCip=nIPp×LoS×cIPpd	▪ Proportion of patients that require hospitalisation (both Type 1 and Type 2 DM patients) o All Type 1 diabetes – 5% of the total diabetics

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

		Where nIPp is the number of DM patients that require hospitalisation, LoS is the length of stay in hospital for DM patients, and cIPpd is the inpatient cost per day.	○ 5% of the Type 2 diabetes (Barceló et al., 2003) ▪ Number of DM patients = 552,400 ▪ Average length of stay for DM patients = 8.2 days(Comino et al., 2015) ▪ Inpatient cost per day = USD 11.20 (adjusted for inflation – USD 24,12) (Stenberg et al., 2018)
Complication	Diabetic foot	The annual costs of DM patients with diabetic foot was calculated as TCdf=pDMdf×nDM×cDMdf, Where pDMdf if the proposition of DM patients with diabetic foot, nDM is the number of Dm patients, and cDMdf is the annual costs of DM with diabetic foot.	▪ Proportion of DM patients with diabetic foot – 12% ▪ Number of DM patients = 552,400 ▪ Annual cost of patients with diabetic foot in a public facility = USD 70 (adjusted for inflation – USD 75) (Subramanian et al., 2018a)
	Diabetic retinopathy	The annual costs of DM patients with diabetic foot was calculated as TCdr=pDMdr×nDM×cDMdr, Where pDMdf if the proposition of DM patient s with diabetic retinopathy, nDM is the number of Dm patients, and cDMdr is the annual costs of DM with diabetic retinopathy	▪ Proportion of DM patients with diabetic retinopathy – 12% (Abdissa et al., 2020) ▪ Number of DM patients = 552,400 ▪ Annual cost of patients with diabetic retinopathy in a public facility = USD 70 (adjusted for inflation – USD 75) (Subramanian et al., 2018a)
Transport		Transport costs=share of transport costs over the total direct costs×Total direct costs	Share of transport costs over the total direct costs – 23.2% (Oyando et al., 2020a)

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Results

Table 3 presents the distribution of DM's direct and indirect economic costs. The total economic burden of DM for an adult population of 552,400 is USD 372,184,585, equivalent to USD 674 per DM patient. The total direct costs accounted for the highest proportion of the overall costs at 61% (USD 227,980,126). On the other hand, the indirect costs accounted for 39% of the total economic costs. Examining the overall costs by cost categories, costs of medicines took up the largest share at 29%, followed by the income lost due to lost due time while seeking care at 19.7%. Other costs that consumed a considerable share of costs include productivity losses due to premature deaths (19%), diagnostic tests (13%), and travel (12%).

Table 3: Cost estimation of the diabetes cases and related costs

Type of cost	Costs (2019 USD)	% of the total sub categories (A and B)	% of the total
Direct costs			
Diagnostic tests	49,638,168	22%	13%
Glucometer	962,545	0.4%	0.3%
Reagent strips	31,150,745	14%	8%
Random blood sugar test	11,646,238	5%	3%
HBA1c	5,878,640	3%	2%
OPD costs	4,853,619	2%	1%
Medicines Costs			
Cost of medication	107,409,897	47%	29%
Insulin	35,084,585	15%	9%
Oral medication	13,029,964	6%	4%
Both	59,295,349	26%	16%
Hospitalization costs	10,652,265	5%	3%
Complication costs	12,494,854	5%	3%
Diabetic foot	4,772,722	2%	1%
Diabetic retino-therapy	7,722,132	3%	2%
Travel costs	42,931,323	19%	12%
Total direct costs (A)	227,980,126		61%
Indirect costs			
Income lost while seeking medical acre	USD 73,416,230	51%	19.7%
Productivity losses due to premature deaths	USD 70,788,229	49%	19%
Total indirect losses (B)	USD 144,204,459		39%
Economic burden (A + B)	USD 372,184,585		100%

The total direct costs of DM were USD 227,980,126, equivalent to unit costs of USD 413 per DM patient. Of these costs of medicines accounted for the largest share at about 47% (USD 107,409,897), followed by costs pf diagnostic tests at 22% (USD 49,638,168), and travels at 19% (USD 42,931,323). Other cost centres, each accounted for 5% and below. The distribution of these costs is shown in Figure 2. The total indirect costs of DM

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

were USD 144,204,459, equivalent to the unit cost of USD 216 per DM patient. Income lost by DM patients while seeking medical care accounted for the largest share of the indirect costs at 51% (USD 73,416,230). The productivity losses due to premature deaths accounted for 49% (USD 70,788,229). Figure 3 illustrates the distribution of the indirect costs.

Direct costs accounted for the largest share of the total economic costs at 61% compared to indirect costs at 39% (Table 2). Costs of medicines accounted for the largest costs over the total economic costs at about 29%, followed by the income lost while seeking care at 19.7%. Other costs that accounted for more than 10% of the total costs include productivity losses (19%), diagnostic tests (13%), and travel (12%). The rest of the cost categories accounted for less than 5%.

Discussion

The total economic costs were estimated at USD 372,184,585, equivalent to 10% of Kenya's total expenditure on health (THE) or 0.4% of the country's GDP. This represents a substantial proportion of overall health expenditures in a country that is still grappling with both communicable and non-communicable diseases. However, the study did not investigate how these expenditures are financed, an activity that would help to identify areas where financial protection efforts should be channeled. The study conducted in Kenya reported that patients incur catastrophic costs while seeking DM care, making it unaffordable (Oyando et al., 2020b). The unit costs reported in this study of USD 413 indirect costs per DM patient, and USD 213 indirect costs are also reported closely elsewhere (Oyando et al., 2020b).

From this study, the main drivers of the overall cost are the costs of medicines at 29%, a finding that has been reported elsewhere (Kirigia et al., 2009b; Oyando et al., 2020b; Subramanian et al., 2018b). Efforts should be made to reduce the costs of these medicines to enhance care. The high indirect costs reported, majorly in income lost by patients while seeking medical care is noteworthy at 39%. This is primarily because DM presents in the working-age population who often are at their prime from a career perspective. A study conducted in Brazil reported that indirect consumed 32.4% of the total costs(Bahia, Da Rosa, et al., 2019).

The decision to employ a cost-of-illness approach was important to enhance the robustness of our findings. Disintegrating and reporting both direct and indirect costs separately would aid the decision-makers in prioritising and targeting interventions to protect the population(Jo, 2014). Additionally, it is evident that DM impacts several actors in a health system. Adopting a societal perspective to encompass both the Ministry of health, patients, and caregivers enables this study to identify and estimate all the costs borne by the health system due to DM.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Conclusion

The scarcity of health financial data in Kenya and generally within Sub-Saharan Africa was made even more evident during the literature search exercise for this study. However, DM is a rising threat globally and especially in Africa due to the changing lifestyle patterns. The 552,400 adult cases reported in 2019 resulted in a total economic cost of USD 372,184,585, equivalent to USD 674 per diabetes mellitus patient. The total direct costs accounted for the highest proportion of the overall costs at 61% (USD 227,980,126), whereas indirect costs accounted for 39% of the total economic costs (USD 144,204,459).

Costs of medicines accounted for the highest costs over the total economic costs at about 29%, followed by the income lost while seeking care at 19.7%. Other costs that accounted for more than 10% of the total costs include productivity losses (19%), diagnostic tests (13%), travel (12%). The rest of the cost categories accounted for less than 5%. Efforts should be made to reduce the costs of these medicines to enhance care. The high indirect costs reported, majorly in income lost by patients while seeking medical care, are 19%.

This study emphasised its implications and expect to become a tool to support policymakers and stakeholders to increase knowledge, and awareness of preventive measures around non-communicable diseases including DM through lifestyle changes, adequate screening to detect the disease early, and robust measures to maintain adherence to treatment and timely management of complications.

In addition, According to 2018 figures, health spending as a percentage of GDP in Kenya stood at 5.17%, low compared to the Abuja declaration stated to allocate 15% of the national budget each year. In the same period, the average global allocation was 6.53% and from a list of 183 countries, Kenya's position was 122 as one of the countries with low healthcare allocation. There's a need to be sustained funding in the health system and overall improve the health and longevity of its population.

Capacity building on leadership principles, accountability, reporting structures, and healthcare management in partnership with public and private entities could go a long way in optimizing the various other healthcare resources for better patient management.

Conflicts of Interests:

The authors declare that they have no competing interests.

References:

1. Abdissa, D., Adugna, T., Gerema, U., & Dereje, D. (2020). Prevalence of Diabetic Foot Ulcer and Associated Factors among Adult Diabetic

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Patients on Follow-Up Clinic at Jimma Medical Center, Southwest Ethiopia, 2019: An Institutional-Based Cross-Sectional Study. *Journal of Diabetes Research*, *2020*. https://doi.org/10.1155/2020/4106383

2. Ahmed, A. A., & Almulla, N. N. (2020). Economic burden of diabetes care: The economic burden on health systems of low and middle-income African countries. *WORLD FAMILY MEDICINE*, *18*(12).
3. Athanasakis, K., Kyriopoulos, I. I., Sideris, M., Rentzos, M., Evdokimidis, J., & Kyriopoulos, J. (2015). Investigating the economic burden of ALS in Greece: A cost-of-illness approach. *Amyotrophic Lateral Sclerosis and Frontotemporal Degeneration*, *16*(1–2). https://doi.org/10.3109/21678421.2014.932384
4. Atun, R., Davies, J. I., Gale, E. A. M., Bärnighausen, T., Beran, D., Kengne, A. P., Levitt, N. S., Mangugu, F. W., Nyirenda, M. J., Ogle, G. D., Ramaiya, K., Sewankambo, N. K., Sobngwi, E., Tesfaye, S., Yudkin, J. S., Basu, S., Bommer, C., Heesemann, E., Manne-Goehler, J., … Werfalli, M. (2017). Diabetes in sub-Saharan Africa: from clinical care to health policy. In *The Lancet Diabetes and Endocrinology* (Vol. 5, Issue 8). https://doi.org/10.1016/S2213-8587(17)30181-X
5. Bahia, L. R., da Rosa, M. Q. M., Araujo, D. V., Correia, M. G., dos Rosa, R. D. S., Duncan, B. B., & Toscano, C. M. (2019). Economic burden of diabetes in Brazil in 2014. *Diabetology and Metabolic Syndrome*, *11*(1). https://doi.org/10.1186/s13098-019-0448-4
6. Bahia, L. R., Da Rosa, M. Q. M., Araujo, D. V., Correia, M. G., Dos Rosa, R. D. S., Duncan, B. B., & Toscano, C. M. (2019). Economic burden of diabetes in Brazil in 2014. *Diabetology and Metabolic Syndrome*, *11*(1), 54. https://doi.org/10.1186/s13098-019-0448-4
7. Barasa, E. W., Maina, T., & Ravishankar, N. (2017). Assessing the impoverishing effects, and factors associated with the incidence of catastrophic health care payments in Kenya. *International Journal for Equity in Health*, *16*(1). https://doi.org/10.1186/s12939-017-0526-x
8. Barceló, A., Aedo, C., Rajpathak, S., & Robles, S. (2003). The cost of diabetes in Latin America and the Caribbean. *Bulletin of the World Health Organization*, *81*(1).
9. Brown, E., Natoli, N., McLaughlin, R., & Mehta, K. (2015). Pathways and Barriers to Diabetes Screening: Observations from Rural Kenya. *Procedia Engineering*, *107*. https://doi.org/10.1016/j.proeng.2015.06.096
10. Chuma, J., & Maina, T. (2012). Catastrophic health care spending and impoverishment in Kenya. *BMC Health Services Research*, *12*. https://doi.org/10.1186/1472-6963-12-413

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

11. Comino, E. J., Harris, M. F., Islam, M. D. F., Tran, D. T., Jalaludin, B., Jorm, L., Flack, J., & Haas, M. (2015). Impact of diabetes on hospital admission and length of stay among a general population aged 45 year or more: A record linkage study. *BMC Health Services Research*, *15*(1). https://doi.org/10.1186/s12913-014-0666-2
12. De Lagasnerie, G., Aguadé, A. S., Denis, P., Fagot-Campagna, A., & Gastaldi-Menager, C. (2018). The economic burden of diabetes to French national health insurance: a new cost-of-illness method based on a combined medicalized and incremental approach. *European Journal of Health Economics*, *19*(2). https://doi.org/10.1007/s10198-017-0873-y
13. Drummond, M. F., O'Brien, B., Stoddart, G. L., & Torrance, G. W. (1998). Methods for the Economic Evaluation of Health Care Programmes, Second Edition. In *American Journal of Preventive Medicine* (Vol. 14, Issue 3). https://doi.org/10.1016/S0749-3797(97)00069-X
14. Jo, C. (2014). Cost-of-illness studies: concepts, scopes, and methods. In *Clinical and molecular hepatology* (Vol. 20, Issue 4, pp. 327–337). Korean Association for the Study of the Liver. https://doi.org/10.3350/cmh.2014.20.4.327
15. Kirigia, J. M., Sambo, H. B., Sambo, L. G., & Barry, S. P. (2009a). Economic burden of diabetes mellitus in the WHO African region. *BMC International Health and Human Rights*, *9*(1). https://doi.org/10.1186/1472-698X-9-6
16. Kirigia, J. M., Sambo, H. B., Sambo, L. G., & Barry, S. P. (2009b). Economic burden of diabetes mellitus in the WHO African region. *BMC International Health and Human Rights*, *9*(1), 1–12. https://doi.org/10.1186/1472-698X-9-6
17. KNBS. (2020). Economic Survey 2020. In *Economic Survey 2020*.
18. Krensel, M., Schäfer, I., & Augustin, M. (2019). Cost-of-illness of melanoma in Europe – a modelling approach. *Journal of the European Academy of Dermatology and Venereology*, *33*. https://doi.org/10.1111/jdv.15308
19. Mapa-Tassou, C., Katte, J. C., Mba Maadjhou, C., & Mbanya, J. C. (2019). Economic Impact of Diabetes in Africa. In *Current Diabetes Reports* (Vol. 19, Issue 2). https://doi.org/10.1007/s11892-019-1124-7
20. Matheka, D. M., Kilonzo, J. M., Munguti, C. M., & Mwangi, P. W. (2013). Pattern, knowledge and practices of HbA1C testing among diabetic patients in a Kenyan tertiary referral hospital. *Globalization and Health*, *9*(1). https://doi.org/10.1186/1744-8603-9-55

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

21. Michael F. Drummond, Mark J. Sculpher, Karl Claxton, Greg L. Stoddart, G. W. T. (2015). *Methods for the Economic Evaluation of Health Care Programmes*. https://global.oup.com/academic/product/methods-for-the-economic-evaluation-of-health-care-programmes-9780199665884?cc=ke&lang=en&
22. Mohajan, H. (2013). Poverty and economic development of Kenya. *International Journal of Information Technology and Business Management*, *18*(1).
23. Murray, C. J. L., & Lopez, Alan D, . (1996). The Global burden of disease : a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020,. In *Harvard School of Public Health,*.
24. Oyando, R., Njoroge, M., Nguhiu, P., Sigilai, A., Kirui, F., Mbui, J., Bukania, Z., Obala, A., Munge, K., Etyang, A., & Barasa, E. (2020a). Patient costs of diabetes mellitus care in public health care facilities in Kenya. *International Journal of Health Planning and Management*, *35*(1). https://doi.org/10.1002/hpm.2905
25. Oyando, R., Njoroge, M., Nguhiu, P., Sigilai, A., Kirui, F., Mbui, J., Bukania, Z., Obala, A., Munge, K., Etyang, A., & Barasa, E. (2020b). Patient costs of diabetes mellitus care in public health care facilities in Kenya. *International Journal of Health Planning and Management*, *35*(1), 290–308. https://doi.org/10.1002/hpm.2905
26. Park, P. H., & Pastakia, S. D. (2018). Access to Hemoglobin A1c in Rural Africa: A Difficult Reality with Severe Consequences. In *Journal of Diabetes Research* (Vol. 2018). https://doi.org/10.1155/2018/6093595
27. Peters, M. L., Huisman, E. L., Schoonen, M., & Wolffenbuttel, B. H. R. (2017). The current total economic burden of diabetes mellitus in the Netherlands. *Netherlands Journal of Medicine*, *75*(7).
28. Preis, S. R., Hwang, S. J., Coady, S., Pencina, M. J., D'Agostino, R. B., Savage, P. J., Levy, D., & Fox, C. S. (2009). Trends in all-cause and cardiovascular disease mortality among women and men with and without diabetes mellitus in the framingham heart study, 1950 to 2005. *Circulation*, *119*(13). https://doi.org/10.1161/CIRCULATIONAHA.108.829176
29. Saeedi, P., Petersohn, I., Salpea, P., Malanda, B., Karuranga, S., Unwin, N., Colagiuri, S., Guariguata, L., Motala, A. A., Ogurtsova, K., Shaw, J. E., Bright, D., & Williams, R. (2019). Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Atlas, 9th edition. *Diabetes Research and Clinical Practice*, *157*. https://doi.org/10.1016/j.diabres.2019.107843

30. Stenberg, K., Lauer, J. A., Gkountouras, G., Fitzpatrick, C., & Stanciole, A. (2018). Econometric estimation of WHO-CHOICE country-specific costs for inpatient and outpatient health service delivery. *Cost Effectiveness and Resource Allocation*, *16*(1). https://doi.org/10.1186/s12962-018-0095-x
31. Subramanian, S., Gakunga, R., Kibachio, J., Gathecha, G., Edwards, P., Ogola, E., Yonga, G., Busakhala, N., Munyoro, E., Chakaya, J., Ngugi, N., Mwangi, N., Rege, D. von, Wangari, L. M., Wata, D., Makori, R., Mwangi, J., & Mwanda, W. (2018a). Cost and affordability of non-communicable disease screening, diagnosis and treatment in Kenya: Patient payments in the private and public sectors. *PLoS ONE*, *13*(1). https://doi.org/10.1371/journal.pone.0190113
32. Subramanian, S., Gakunga, R., Kibachio, J., Gathecha, G., Edwards, P., Ogola, E., Yonga, G., Busakhala, N., Munyoro, E., Chakaya, J., Ngugi, N., Mwangi, N., Rege, D. Von, Wangari, L. M., Wata, D., Makori, R., Mwangi, J., & Mwanda, W. (2018b). Cost and affordability of non-communicable disease screening, diagnosis and treatment in Kenya: Patient payments in the private and public sectors. *PLoS ONE*, *13*(1), 1–16. https://doi.org/10.1371/journal.pone.0190113
33. WHO. (2016). World Health Organization (WHO). World health statistics 2019: monitoring health for the SDGs, sustainable development goals. *World Health Organization*, *8*(5).
34. WorldBank. (2018). *Life expectancy at birth, total (years) - Kenya | Data*. https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=KE
35. World Bank. (2018). *United Nations Population Division. World Population Prospects: 2019 Revision*. World Development Indicators.
36. World Health Organization. (2016). World Health Statistics: monitoring health for the SDGs, sustainable development goals. Geneva, Switzerland. In *World Health Statistics: monitoring health for the SDGs, sustainable development goals. Geneva, Switzerland*.
37. World Health Organization 2020. (2020). World health statistics 2020: monitoring health for the SDGs, sustainable development goals. In *World Health Organization 2020* (Vol. 43, Issue 1).
38. Zhu, B., Pang, R., Chevallier, J., Wei, Y. M., & Vo, D. T. (2019). Including intangible costs into the cost-of-illness approach: a method refinement illustrated based on the PM2.5 economic burden in China. *European Journal of Health Economics*, *20*(4). https://doi.org/10.1007/s10198-018-1012-0