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Research Article

Cost and Its Determinants of Treating Type 2 Diabetes Mellitus in the North West Region of Cameroon: Quantile Regression Analysis

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Abstract

Background: Type 2 Diabetes Mellitus (T2DM) is, particularly, known to require continuous clinical care and management that consumes significant healthcare resources. As a result, most people living with type 2 Diabetes in Cameroon, are prone to suffer from financial hardship. This research seeks to estimate the direct cost and its determinants of treating T2DM in the Northwest of Cameroon. *METHOD:* A cost of illness using a cross-sectional research design study was conducted in 13 facilities in Cameroon's Northwest region during a 4-month field survey. Data was obtained with the help of a semi-structured questionnaire administered by trained nurses. Summary statistics were computed to understand the socio-demographic characteristics of participants, and the various elements of treatment costs of type 2 diabetes. The direct cost of treating type 2 diabetes was computed by summing all the diabetes-attributable resource utilization costs incurred by the patient The determinants for treating T2DM were investigated using an ordinary least squares (OLS) regression and a quantile regression analysis. *RESULTS:* According to the findings, the average cost of treating type 2 diabetes among patients in the Northwest region of Cameroon, was 36,235 FCFA ($60) monthly or 424,000 FCFA ($720) yearly. The determinants were; the type of facility which was significant for the 10^{th} and 25^{th} quintiles, and age influence cost across the various models and quantiles, the study also revealed the effect of age on the cost increase from the lower to the higher quintile. The level of education influenced the direct cost and this was significant from the 50^{th} quintile to the 90^{th} quintile with higher levels of education leading to higher costs. Other factors included the household head, frequency of check-up visits to the facility, self-care management, and means of transportation. Gender and marital status influence cost but not across the quintiles. *CONCLUSION:* The studies revealed that T2DM places a significant cost burden on the patient and their household with determinants being the type of facility where care is sorted, age, level of education, and means of transport. Increased financial resources are required to provide T2DM patients with effective services in the Northwest region of Cameroon. A sincere call is sent to health decision-makers to give more importance to including diabetes care in the package of universal health coverage soonest.

Keywords

Diabetes, Prevalence, Non-communicable Diseases, Determinants, Cameroon, Direct Cost

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1. Introduction

Diabetes Mellitus is a chronic incurable and potentially disabling disease that presents an important public health challenge worldwide [1]. It occurs when the body cannot produce or make use of insulin or both. Insulin is the hormone that regulates sugar. It usually presents as hyperglycemia or raises blood sugar and over time can lead to severe damage to the body's system, especially nerves, and blood vessels. According to World Health Organisation (WHO), approximately 422 million people are living with diabetes worldwide. The report projected that this number would rise to 522 million by the year 2030 [2]. In 2019, it was estimated that about 1 in 11 adults globally, or 436 million people had diabetes; of these, 19 million lived in Sub-Sahara Africa. Fast forwarding to 2021, the International Diabetes Federation (IDF) estimated that the number of people with diabetes in the African Regions had increased to around 24 million. [3] This represents a regional prevalence rate of 4.5%. However, projections indicate that this number is expected to rise significantly by approximately 129%, by the year 2045. A 2021 research by IDF holds that about 537 million adults (aged 20-79) live with diabetes worldwide, accounting for 10.5% of the world's population in this age group [3]. In Cameroon specifically, diabetes prevalence has steadily increased from 0 % in 2000 to 5.5 % in 2021 growing at an average annual rate of 9.84%, according to the World Bank collection of development indicators, compiled from officially recognized sources. [4]

In WHO African Region, countries with less than 2000 gross national income per capita, have a diabetes cost of about $5,510,000, in 2005 [5] They reported a total economic loss of $2,551 in 2000 for the WHO African Region. Countries with gross national income (GNI) per capita greater than 8000 international dollars lost $ 11,436, countries with a GNI between $2000- $7999 spent $4,770.6 while countries with GNI less than 2000 incurred a cost of $2,144.3 per diabetic per year. This shows a heavy economic burden of Diabetes in this region. This demonstrates the huge negative economic impact that diabetes has on society beyond the personal costs of illness and premature death [5]. The economic expenditure on diabetes in Burundi is less than $10 while in Cote d'Ivoire, Myanmar, Ethiopia, Liberia, Niger, Guinea Bissau, Madagascar, Eritrea, Sierra Leone, Montenegro, and Somalia the expenditure is less than $20. Most of these costs could not cover the annual wholesale cost of a generic oral agent capable of preventing acute complications of diabetes [6]. In 2001, the average cost of treating patients with DM in Cameroon was 3.5% of the National budget for 2001-2002 [7].

Diabetes is a costly health condition' and its financial implications is too heavy for high-income earners let alone poor families. This is usually related to direct costs, and productivity costs incurred by the patients [5]. [8] reported that the monthly cost of treatment in Nigeria ranged from N44.70 in rural areas to N1, 477.00 for urban. Transportation was N35.30 in urban and N162.30 for the rural areas of Southeast Nigeria. budget for 2001-2002. In 2015, the overall cost of diabetes in sub-Saharan Africa was $19.45 billion. More than 55% of this was ascribable to direct medical costs. [9] Out of pocket payment is estimated to exceed 50% of the total health expenditure in many countries, with Cameroon reaching 75.6%, higher than the globally recommended 20% [10].

Type 2 Diabetes Mellitus (T2DM) is, particularly, known to require continuous clinical care and management that consumes significant healthcare resources. The direct costs of managing T2DM and caring for diabetic sequelae like blindness, amputations, and renal failure include hospital and medication costs incurred by individuals, families, governments, and private insurers. Direct costs are those generated by the resources used in treating or coping with the condition. It includes expenditures on inpatient treatment, physician and other specialist consultation fees, prescriptions, drugs (insulin and oral hypoglycaemic) agents and adjuvants, laboratory tests, medical supplies, employment of extra workers, transportation for treatment, etc. It may include the cost of comorbidity attributed to diabetes [11, 12]). Typically, direct costs are often easily measured by the survey. This measurement could assume any of three designs: Diagnostic category data from the general population, cost projection from previous studies, and responses from persons with diabetes. This study assumes the individual-based approach (Bottom-up). The economic cost of diabetes is estimated based on the cost of individual units of services performed or received. It uses the average cost of service estimate and applies the data to the total number of healthcare encounters related to diabetes to arrive at an estimate of the cost of diabetes. Complete treatment will encompass all contacts of a patient with the medical system [12].

Oyando et al., estimated the direct cost of type 2 diabetes and found out that the mean annual direct patient cost was KES 53 907 (95% CI, 43 625.4-64 188.6) (US$ 528.5 [95% CI, 427.7-629.3]). Medicines accounted for 52.4%, transport 22.6%, user charges 17.5%, and food 7.5% of total direct costs. Overall mean annual indirect cost was KES 23 174 (95% CI, 20 910-25 438.8) (US$ 227.2 [95% CI, 205-249.4]). Patients reporting hypertension comorbidity incurred higher costs compared with diabetes-only patients [13].

Schafermann et al., investigated the availability and affordability of seven antibiotics and six medicines against non-communicable diseases in the northeast of the Democratic Republic of Congo and the west of the Republic of Cameroon. Data on the availability and prices of these medicines were collected in 60 different sites (34 in DR Congo, 26 in Cameroon), including government health facilities,

church health facilities, private pharmacies, and informal vendors, as part of a study on medicine quality. The data were analyzed using a standardized procedure developed by WHO and Health Action International (HAI). Average availability for medicines against NCDs in the different types of facilities showed a higher variation in both countries, ranging from 11% up to 87%. The average availability of medicines against NCDs in government health facilities was only 33% in Cameroon, and as low as 11% in DR Congo. In contrast, the availability of medicines against NCDs in church health facilities in Cameroon was 70%, not far from the 80% availability goal set by WHO. Medicine prices were higher in Cameroon than in DR Congo, with median price ratios to an international reference price of 5.69 and 2.17, respectively ($p < 0.001$). [14]

The direct cost and determinants of treating T2DM have not been enumerated in Cameroon's North West Region, as recent estimates focused on the broader sub-Saharan African region, with the two forms of diabetes (type 1 and 2) sometimes conflated. Therefore, accurate estimates of particular categories of treatment and complication costs as well as the determinants are necessary for the development of cost-effective strategy for the management and treatment of type 2 diabetes. It is thus of crucial importance to understand the resource implications of the prevalence of diabetes in the NWR of Cameroon in the context of proposals for National Health Insurance (NHI). This paper seeks to address this gap by estimating direct medical costs and determinants associated with treating T2DM in 13 facilities in the North West Region of Cameroon.

2. Methods

2.1. Study Design and Setting

A prevalence-based cost-of-illness study was conducted in thirteen (13) health facilities drawn from eleven (11) health districts from the North West Region, with specialized units and a medical team for taking care of patients with diabetes and hypertension. This region has a population estimated at 2 million inhabitants [15], and is distributed within seven administrative Divisions which include: Bui, Boyo, Donga Mantung, Menchum, Mezam, Momo, and Ngoketunjia. Bamenda, the chief town of Mezam Division, is the third-ranked city in Cameroon and is situated some 366 km northwest of the administrative capital of Yaoundé, and about 450 km from Cameroon's economic capital, Douala. The North West Region is chosen for this research work because of the high rates of diabetes noticed. Also, there is a need to curb the high rate of morbidity and mortality linked to non-communicable diseases including diabetes in this era of COVID-19.

The work made use of primary data that was collected over 4 months (from May to August 2022) from 13 health facilities in the North West Region of Cameroon (see appendix I). The health facilities each had specialized units for taking care of diabetic clients.

2.2. Study Participants

This study included any participant aged 21 years or more, diagnosed with diabetes, and on treatment for at least three months at the time of recruitment, presenting at any of the 13 health facilities, who provided free informed consent. This study targeted outpatients with type 2 diabetes from 13 health facilities in the North West Region of Cameroon. We used a probability sampling technique, precisely, the simple random sampling technique. Computer-generated random numbers were used in recruiting participants who came for outpatient consultation in the 13 health facilities until the desired sample size was attained. Also, the confidence interval-based sample size calculation as described by Charan and Biswas was employed. [16] This gave an estimated sample size of 384, Considering a 10% non-response rate, the final sample size was adjusted to 426. However, for convenience purposes, we administered 500 questionnaires in 13 health facilities in direct proportion to the number of clients currently served at the facility. A total of 439 questionnaires were returned, making a return rate of 87.8% and an effective sample size of 439 type 2 diabetes patients.

2.3. Data Collection and Analysis

The data used were both of primary (collected using a semi-structured and tested questionnaire) and secondary (obtained by reviewing all documented services from facility registers, patients' medical booklets, and patients' files). Questionnaires were administered to patients by trained nurses. Data obtained from the field was entered in Excel, and then transferred to SPSS for wrangling to ensure that the data is reliable and complete. For data visualization, we used Excel while for data analysis, we used Stata15. Both descriptive and inferential statistics were used in analyzing the data. For the descriptive part which consists of describing the characteristics of the data as they are, frequency tables, bar charts, and pie charts etc were used. For the inferential part which consists in making inferences about population parameters based on sample properties, hypotheses were accepted or rejected based on certain test results. Student t-statistics and z-statistics were used to make inferences about individual parameter estimates for the linear and non-linear models, respectively. The Fisher F-statistics were used to make inferences about model significance. Other specific tests were used to judge model characteristics such as the variance inflation factors (VIF) to test the presence of multicollinearity, the Breusch-Pagan chi2 statistic to test for heteroskedasticity, and so on.

2.4. Costing Perspectives and Approach

The study employed the methods elaborated by Tunceli et

al. and their application by Wiley et al., to estimate the treatment cost of type 2 diabetes among patients in the North West Region of Cameroon [17, 18]. Accordingly, the direct cost of treating type 2 diabetes for the patient was computed by summing all the diabetes-attributable resource utilization costs incurred by the patient, including, costs incurred during check-up visits, the costs incurred to transport the patient and his/her helper(s) to and from the health facility, the cost of affording a special diet as a result of the disease, the cost of obtaining strips and injecting insulin for patients who self-managed the disease, and the cost of hiring a household helper due to the disease. Thus, the total direct cost of treating diabetes was computed as follows:

$$C_i = \sum_i \sum_{j=1}^{m} C_{ij} \quad (1)$$

Where C_i is the total treatment cost incurred by the individual i, and C_{ij} is the cost incurred on the individual i on item j where the items include the monthly cost per check-up visit, transportation cost, cost of special diet, cost of self-managing the disease and cost of caregiver or household helper.

The direct cost is the treatment and access cost which also corresponds to the out-of-pocket payments incurred by the participants and their households for the various services directly involved in treatment. This was factored into direct medical cost that is, cost from registration, consultation, laboratory investigations, prescriptions made, and direct non-medical costs such as cost of transportation, hospitalization, caregivers, food, and so on.

2.5. Investigating the Determinants of Treating Type 2 Diabetes

For the determinants, a multiple linear regression (MLR) model was estimated using the ordinary least squares (OLS) technique. In addition to the OLS regression, a quantile regression analysis was performed to investigate if the effect of these determinants varied across different quantiles of direct treatment cost. The quantiles retained for analysis were the 10 percent quantile (q10), the 25 percent quantile (q25), the median or 50 percent quantile (q50), the 75 percent quantile (q75) and the 90 percent quantile (q90). The functional relationship between direct treatment cost and its determinants was stated as follows:

$$\text{Cost} = f(\text{facility type, sex, marital status, age, education, HH head, self-management, check-up freq., transport means}) \quad (2)$$

This model can be stated in econometric form as follows:

$$\text{Cost}_i = \alpha_0 + \alpha_1 \text{facilitytype}_i + \alpha_2 \text{female}_i + \alpha_3 \text{married}_i + \alpha_4 \text{age}_i + \alpha_5 \text{edu}_i + \alpha_6 \text{HHhead}_i + \alpha_7 \text{selfmanage}_i + \alpha_8 \text{checkupfreq}_i + \alpha_9 \text{transportmeans} + u_i \quad (3)$$

Where cost_i represents the monthly direct cost of treating type 2 diabetes incurred by an individual representingi while α_i represent the parameters to be estimated and u_i is the error term.

Table 1. *Variables and their meaning in the direct treatment cost model.*

Variable	Meaning/measurement	Expected sign
Cost	Total monthly direct cost of treating diabetes. It is continuous.	
facility type	Facility type is a binary variable, equal to 1 if the respondent chose a public facility, and 0 if they chose a private facility	- If facility type=1
female	It is the sex of the respondent which is binary. It is equal to 1 if the respondent is female, and 0 otherwise	+/-
married	Marital status of respondent. It is binary, equal to 1 if the respondent is married, and 0 otherwise	+/-
Age	Age of respondent. It is binary, equal to 1 if above 50 and 0 if below 50 years	+ if age = 1
edu	Education level of respondent, equal to 1 if they have some post-primary education, and 0 otherwise	+/-
HHhead	Status of respondent in the household, equal to 1 if they are they are the household head, and 0 otherwise.	
check-up freq.	Frequency of check-up visits. It is either twice monthly, once monthly, or once in 3 months	+/-
self-manage	It asks whether the patient self-manages their disease. It is binary, equal to 1 if they do, and 0 otherwise.	+ if self-manage =1
transport means	It asks whether the respondent treks, uses a motor bike or uses a car to get to the health facility.	+/-

The model in equation 3 was estimated by OLS since the dependent variable is continuous. However, the OLS model examines the relationship between the independent variables and the conditional mean of the dependent variable. However. if the mean of the dependent variable does not adequately represent the data, then OLS would yield inconsistent results. This situation can arise where there are significant outliers in the data, in which case the median becomes a better representation of the data than the mean [19]. Quantile regression would also be more appropriate than OLS in the case where the error variances are heteroskedastic, meaning they are not constant across individuals in the sample. The test for heteroskedasticity reported on Appendix II shows the existence of heteroskedasticity in the treatment cost model, thus necessitating the quantile regression approach.

Thus, to verify if the coefficients of model varied significantly across different quantiles, a quantile regression analysis was performed. The quantile regression approach allows us to investigate if the effect of the independent variables varies at different levels of the dependent variable in a situation where the mean does not adequately represent the nature of the data, or in a situation where significant outliers exist in the response measurements, or in the situation of misspecification of the error distribution [20].

From equation 3, let y_i represent the dependent variable (treatment cost) incurred by an individual i and let x_i represent the vector of independent variables (right-hand side variables) measured for individual i. Now let q represent the quantile of interest $(0 < q < 1), e.g., q = 0.5$ refers to the median or 50 percent quantile. Then the equation of the quantile regression for the q-quantile is specified as follows;

$$y_i = x_t^i \beta_q \quad (4)$$

Where $\beta_q$is the vector of unknown parameters related to the q^{th} quantile. Whereas the OLS estimator minimizes the sum of squared errors $\Sigma_i e_i^2$, the quantile regression on its part minimises $\Sigma_i q|e_t| + \Sigma_i(1-q)|e_t|$ for over-prediction. The estimator for the q^{th} quantile, $\hat{\beta}q$, minimizes over β_q, the objective function expressed as;

$$\min_{beR^K}[\Sigma_{i\epsilon(i:y_i \geq x_i\beta)} q|y_i - x_t'\beta_q| + \Sigma_{i\epsilon(i:y_i<x_i'\beta)}(1-q)|y_i - x_t'\beta_q|] \quad (5)$$

Unlike the OLS and maximum likelihood estimators, quantile regression uses linear programming methods to estimate the β_q coefficients [19, 20].

2.6. Ethical Considerations

Ethical clearance was obtained from the IRB of Cameroon Baptist Health Board and administrative clearance from the Regional Delegation of Public Health for the North West Region and various health facilities. All respondents gave their consent voluntarily to participate after reading (or listening to) the informant form.

3. Results

A total number of 439 patients with Diabetes Mellitus type 2 participated in this study. See Appendix III for sociodemographic factors, The indicators retained for the estimation of the direct cost of treating type 2 diabetes among patients in the Northwest region of Cameroon are in appendix IV.

3.1. Estimation of Direct Cost of Treatment

Following the methods elaborated by Tunceli et al. and their application by Wiley et al., the direct cost of treating type 2 diabetes was computed by summing all the diabetes-attributable resource utilization costs incurred by the patient. [17, 18]

The cost incurred per check-up visit included many items, namely, the cost of registration; the cost of consulting with a general practitioner; the cost of consulting with a specialist; the cost of insulin; the cost of tablets for treating the disease, for preventing complications and for treating complications related with the disease. These complications include hypertension (cardiovascular), nerve damage, kidney damage, eye damage, foot damage, skin damage, hearing impairment, Alzheimer's and depression. Other expenditures that constituted check-up costs included the cost of laboratory tests, eye test and kidney test. The expenditures on these items together formed the cost per check-up visit. They are expressed on the monthly estimate and summarized on table 2.

Table 2. *Elements of check-up cost.*

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
Cost of tests for first diagnosis	439	43203.59	151347.26	500	3000000	17.22	333.73
Registration	439	969.93	853.44	0	10000	8.12	86.35
GP consultation	439	431.89	773.76	0	10000	5.7	61.09

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
Specialist consultation	439	439.18	2302.13	0	40000	12.84	205.63
Insulin cost	439	2095.56	3384.89	0	19800	1.49	4.9
Tablets for diabetes	439	3753.27	3680.25	0	20500	1.07	4.5
Cost of tablets to prevent or delay diabetes	439	427.79	2161.42	0	20000	6.05	41.9
Drugs for treatment of complications	439	669.93	3905.71	0	56000	9.68	113.83
Lab test FBS	439	584.4	713.49	0	12000	10.95	160.1
Cost of RBS	439	335.76	654.8	0	10000	8.92	121.59
Cost of glycated HB	439	2308.66	3525	0	12000	1.14	2.84
Cost of fasting lipid profile	439	2299.09	4258.34	0	16000	1.65	4.17
Eye test	439	806.61	2294.02	0	18000	4.12	21.26
Kidney test	439	1562.64	3039.14	0	15000	1.89	5.45

The monthly expenditures for check-up visits, for transportation, for special diet, for strips and insulin, and the home caregiver were summed to obtain the direct cost of treating type 2 diabetes. The direct cost computed is summarized on Table 3.

Table 3. *Summary statistics of the direct cost of treating type 2 diabetes.*

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew	Kurt
DirectCost	439	36235.614	42827.573	500	363000	3.123	16.884

Source: Researcher's fieldwork (2022)

The results show that the average cost of treating type 2 diabetes among patients in the Northwest region of Cameroon is 36,235 FCFA per month. This cost ranges from 500 FCFA to 363,000 FCFA per month. However, this cost does not include the cost of tests before the first diagnosis or the amount of money spent by the patients before they were diagnosed with the disease, the cost of obtaining an electronic glucometer (for those who choose to manage the illness at home), although these two costs are also summarized on table 3. This is because the cost of tests before the first diagnosis as well as the cost of the electronic glucometer are incurred usually once and not on a monthly basis.

The direct treatment cost of type 2 diabetes was further divided into two types: medical cost or expenses and non-medical expenses (see Table 4). The medical cost includes expenditures on consultations, lab tests, drugs, and other medical supplies. The non-medical expenses include diabetes-attributable expenditures that are not medical in nature, such as the cost of hiring a household help, the cost of going on a special diet, and the cost of transportation.

Table 4. *Direct medical, direct non-medical and total direct cost of treating diabetes.*

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew	Kurt.
Direct medical cost	439	17641.15	23352.13	0	295000	5.87	57.87
Direct non-medical cost	439	18594.46	30567.06	0	256000	3.21	17.77
Total direct cost	439	36235.61	42827.57	500	363000	3.12	16.88

Note: the values reported are monthly expenditures
Source: Researcher's field work (2022)

The average direct cost of treating type 2 diabetes among patients in the Northwest region of Cameroon is 36,235 FCFA of which 17,641 FCFA consists of medical expenditures and 18,594 FCFA consists of non-medical expenditures (table 4).

Table 5 and Table 6 summarize the distribution of the monthly direct cost of treating type 2 diabetes by breaking up this cost into quantiles. While table 5 reports the total direct costs per quantile, table includes the average direct costs per quantile, the number of patients in each quantile and the summation of the costs incurred for each quantile. (this paragraph should be removed completely, tables not there)

3.2. Determinants of the Direct Cost of Treating Type 2 Diabetes

Results of the determinants of the direct cost of treating type 2 diabetes in the North West Region of Cameroon are reported on Table 5. The dependent variable was the monthly direct cost of treating diabetes which is a continuous variable, hence the choice of the OLS estimator. The independent variables that were hypothesized to influence direct treatment cost seen on table 1.

Table 5. *OLS and Quantile Regression Results of the Determinants of the Direct Treatment Cost of Diabetes.*

VARIABLES	OLS	q10	q25	q50	q75	q90
Facility type	-5,004.5	-3,062.5*	-2,525.0*	-533.3	5,233.3	-673.3
	(4,043.5)	(1,171.9)	(1,050.4)	(1,961.1)	(5,035.5)	(9,958.0)
female	8,466.9*	-612.5	900.0	3,066.7	9,000.0	14,546.7
	(4,149.4)	(1,657.9)	(1,864.0)	(2,866.6)	(6,123.9)	(10,347.6)
married	6,580.3	1,212.5	1,175.0	3,666.7	5,750.0	-1,000.0
	(3,850.9)	(1,429.0)	(1,436.5)	(2,497.3)	(5,426.2)	(8,905.8)
Age above50	-10,537.9	-3,875.0*	-6,775.0*	-7,066.7*	-8,583.3	-18,673.3
	(5,443.2)	(1,927.1)	(2,161.0)	(2,527.2)	(6,003.2)	(10,537.0)
Education: base no formal						
primary	56.1	-1,962.5	700.0	800.0	183.3	-2,946.7
	(3,250.5)	(1,275.9)	(1,283.4)	(1,834.4)	(4,558.2)	(9,558.2)
secondary	15,743.7*	-3,175.0	500.0	5,433.3	18,516.7*	59,953.3*
	(5,300.8)	(1,962.2)	(2,286.6)	(2,892.1)	(6,610.2)	(24,763.7)
university	16,048.4*	75.0	8,950.0	14,833.3	22,516.7*	42,026.7*
	(6,538.8)	(4,208.6)	(5,766.2)	(8,570.6)	(11,323.9)	(13,683.4)
Household head	5,274.0	1,150.0	1,900.0	5,100.0	7,250.0	5,600.0
	(4,460.1)	(1,519.6)	(1,700.6)	(2,497.4)	(5,357.6)	(12,037.3)
Self-management	29,234.6*	7,200.0*	14,225.0*	19,933.3*	32,333.3*	42,700.0*
	(4,748.7)	(2,478.4)	(2,357.9)	(3,184.1)	(6,759.7)	(17,600.5)
Check-up freq.: base twice monthly						
monthly	-36,660.2*	-13,250.0*	-29,875.0*	-33,733.3*	-29,250.0*	-43,500.0*
	(9,037.7)	(6,091.8)	(6,712.6)	(4,189.6)	(9,913.5)	(18,727.8)
every 3months	-47,492.9*	-15,429.2	-33,591.7*	-23,666.7	-27,833.3	-61,180.0*
	(12,612.5)	(8,506.2)	(8,859.9)	(12,102.5)	(14,528.0)	(24,170.4)
Transport means: base trekking						
Motorbike	4,392.6	2,837.5*	2,000.0	4,100.0*	-233.3	2,173.3
	(4,130.5)	(1,197.5)	(1,160.4)	(1,836.5)	(5,154.7)	(9,292.2)

VARIABLES	OLS	q10	q25	q50	q75	q90
Car	5,325.3	2,575.0	1,700.0	4,933.3	4,100.0	17,373.3
	(5,298.0)	(1,576.6)	(2,144.3)	(2,660.1)	(6,305.6)	(14,319.6)
Constant	48,613.0*	21,312.5*	39,875.0*	41,133.3*	43,066.7*	80,200.0*
	(12,984.0)	(6,942.4)	(7,213.3)	(6,426.6)	(13,410.5)	(29,033.3)
Observations	439	439	439	439	439	439

Robust standard errors in parentheses
*= p<0.05
Source: computed by researcher using Stata 15.

The results reveal that patients who attend public health facilities incur a direct treatment cost that is less than the cost incurred by those who attend private health facilities. However, this result is only significant among the bottom 10% and 25% of the spenders. Among the bottom 10% spenders, patients who attend public health facilities incur a monthly direct treatment cost that on average is 3,062 FCFA less than the cost incurred by those who attend private health facilities. Among the bottom 25% spenders, patients who attend a public health facility incur a monthly direct treatment cost that on average is 2,525 FCFA less than the cost incurred by patients who attend a private health facility. These results are statistically significant at 5% level. Since the signs of health facility is negative for all the models, we can conclude that patients who attend public health facilities incur a smaller cost than those who attend private health facilities, or, put differently, private health facilities are more expensive than public health facilities for patients suffering from type 2 diabetes in the Northwest region of Cameroon.

The OLS estimation reveals that females incur a monthly direct treatment cost that is 8,467 FCFA higher than the treatment cost incurred by their male counterparts, which is statistically significant at 5%. However, this effect is insignificant when the sample is divided into expenditure quantiles. The same observation is true for married patients who, on average, incur a direct treatment cost that is 6,580 FCFA higher than the cost incurred by their unmarried counterparts but the effect is insignificant when the patients are divided into different expenditure quantiles.

Age is one of the variables that significantly influence the direct cost of treating diabetes, and this is true for all the models estimated and for all the quantiles. The results reveal that age has a negative influence on direct treatment cost. Specifically, patients who are above 50 years of age incur a monthly direct cost that, on average, is 10,537 FCFA lower than the cost incurred by their counterparts who are less than 50 years of age. The quantile regression results reveal in addition that this effect is not uniform, rather, the effect of age on direct treatment cost increases (becomes more negative) as we move from lower quantiles to higher quantiles. For instance, for the 10% quantile, patients who are above 50 years of age incur a monthly direct cost that is 3.875 FCFA lower than their counterparts who are below 50 years, but for the 90% quantile, the average direct cost is 18,673 FCFA lower for patients who are above 50 years than it is for patients who are below 50 years.

The level of education of the patient also influences their direct treatment cost. The results show that while patients with primary education do not significantly incur more direct treatment costs than those with no formal education, patients with secondary or university education spend more on diabetes treatment than those with no formal education. Patients with secondary education incur a monthly treatment cost that, on average, is 15,743 FCFA higher than the cost incurred by those with no formal education while patients with some university education incur a monthly treatment cost that, on average, is 16,048 FCFA higher than the cost incurred by those with no formal education. These results are significant at 5%. However, the influence of education on direct treatment cost is totally insignificant at lower quantiles (10% and 25% quantiles). It only becomes significant as from the 50% quantile, and increases steadily as we move from the 50% quantile to the 75% quantile and to the 90% quantile, with higher levels of education leading to higher direct treatment costs.

Patients who are household heads incur a higher direct treatment cost than their counterparts who are not household heads, but this result is only statistically significant for the 50% quantile. For this reason, we cannot conclude that being a household head necessarily means the patient will incur more direct treatment cost. This is only true for the 50% quantile who incur a monthly direct treatment cost that, on average, is 5,100 FCFA higher than the cost incurred by patients who are not household heads.

Self-management of diabetes is another factor that significantly influences the direct cost of treating diabetes. On average, patients who choose to self-manage type 2 diabetes incur a monthly direct treatment cost that is 29,234 FCFA higher than the direct cost incurred by those who do not self-manage the disease, and this result is statistically significant at 5%. The influence of self-management of diabetes on direct treatment costs increases as we move from lower quan-

tiles to higher quantiles. At the 10% quantile, patients who self-manage the disease incur an average treatment cost that is 7,200 FCFA higher than those who do not self-manage the disease. This difference increases to 14,225 FCFA as we move to the 25% quantile, then to 19,933 FCFA as we move to the 50% quantile. At the 75% quantile, the difference is 32,333 FCFA while at the 90% quantile the difference is 42,700 FCFA. Self-management of diabetes thus leads patients to incur more direct treatment costs at all quantiles.

In addition, the frequency of check-ups significantly determines the direct treatment cost incurred by the patient. The influence of check-up frequency on the direct cost of treating diabetes is negative and statistically significant for the whole sample and different quantiles. Patients who do check-ups once a month incur a monthly direct cost that, on average, is 36,660 FCFA lower that the cost incurred by patients who do check-up twice a month, and this result is significant at 5%. But for patients who do check-up once in three months, they incur a monthly direct treatment cost that, on average, is 47,492 FCFA lower than the cost incurred by patients who do their check-up twice a month. This result is also statistically significant at 5%. However, the effect is not uniform across the different quantiles. Rather, the influence of check-up frequency is smaller (in terms of magnitude) at lower quantiles than it is at higher quantiles.

The results of the OLS regression show that even though the direct costs incurred by patients who use a motorbike or a car to get to the health facility are higher than the costs incurred by those who trek to the health facility, we cannot conclude that transportation means significantly determines direct treatment cost for the whole sample. It is only for the 10%, 25% and 50% quantiles that we can say that patients who use a motorbike to get to the health facility incur more direct treatment costs than patients who simply trek to the health facility. It is only for the 50% quantile that we also can conclude that patients who go to the health facility in a car incur more direct treatment costs than those who trek to the health facility.

4. Discussion

The findings from this study reveal a high direct cost of treating diabetes type 2 in the North West Region of Cameroon (36,235 FCFA per month, ranging from FCFA 500-363,000 FCFA). Previous studies have shown that the management of diabetes is very expensive. Wiley et al., [18] for instance estimated the cost of treating 19.3 million diabetes patients in the United States in 2014 to be about 314.8 billion dollars, which is the equivalence of 16,310 dollars per patient per year. This estimate of Wiley and his colleagues is very close to the 16,750 dollars that a diabetes patient is reported to incur on average in the United States in a given year [21]. The American Diabetes Association reported that the cost of treating diagnosed diabetes had risen from 245 billion dollars in 2012 to 327 billion dollars in 2017, representing a 26% increase over the five years. Of this amount, 237 billion represented direct medical costs, and 90 billion represented indirect costs in terms of reduced productivity [22]. The minimum salary in Cameroon as of May 2023 is 36,270 FCFA established by law on 30 July 2014. This amount is roughly equal to the 36,235 FCFA that the average type 2 diabetes patient spends on diabetes treatment per month, without accounting for their indirect costs like reduced productivity and lost earnings. This implies that the burden of diabetes treatment in the Northwest region of Cameroon is extremely high, given the rising inflation and the high unemployment rate in the country. Such patients need all the help they can get in terms of financial support and subsidization of medical expenses.

Although the average direct cost of treating T2DM per month is 29,234 FCFA higher (42,700 FCFA higher at 90% quantile) for patients who self-manage the disease, over half of the patients (53.99%) still practise self-management. Diabetes self-management involves engaging in recommended behaviors like eating a healthy diet, adhering to medication, being proactive, monitoring blood sugar and blood pressure, risk reduction, problem solving and healthy coping [23, 24]. The finding that most diabetes patients self-manage the disease corroborates the observation by DIABETES UK that about 95% of diabetes management is self-management. [25] But this figure is much lower in sub-Saharan Africa and in Cameroon in particular where there is poor adherence to good self-management. For instance, Geneti et al. found that among 414 diabetes patients at public hospitals in Addis Ababa, Ethiopia, 52.7% of the patients had poor adherence to overall diabetes self-management while only 47.3% of the patients had good adherence to diabetes self-management. [26] However, consistent diabetes self-management may cause a conflict between the disease and the patient's daily life mainly because the disease itself complicates the life of the patient and has an impact on their social roles. Even though consistent and effective self-management of diabetes can be very challenging for patients, Angelos has shown that self-management of diabetes is strongly associated with a high quality of life. [27] Basevi et al. have also found that consistent and effective self-management of diabetes leads to optimal blood glucose levels, improved psychological and social functioning, a higher quality of life for the patients, and a reduced risk of developing complications. [24] Diabetes self-management can also help to prevent or reduce hospital admissions or reduce the length of stay at the hospital if such an admission were to occur in the first place.

5. Conclusion

This cost-of-illness study has provided a relatively comprehensive estimate of the economic burden, in terms of the direct costs of treating T2DM in Cameroon's North West Region. The average direct cost of treating diabetes type 2 is 36,235 FCFA per month and 424,000 FCFA per year. Given

that the minimum salary in Cameroon is 36000FCFA a month, this is quite expensive and infeasible to afford. Also, patients who attend public health facilities incur a smaller cost than those who attend private health facilities for patients suffering from type 2 diabetes in the Northwest region of Cameroon. Typically, choice of health facilities, self-management, and medical procedures were essential drivers of elevated costs. Despite the challenges, consistent and effective self-management is associated with a higher quality of life, improved health outcomes, and reduced risks of complications. Addressing barriers to self-management is crucial in supporting patients in effectively managing their diabetes and improving their overall well-being.

6. Recommendations

These findings are important for health policymakers as they provide evidence of the contemporary economic burden of T2DM that would guide them in making informed decisions on priority setting and resource allocation for the prevention and control of Diabetes Mellitus as well as other non-communicable diseases in Cameroon.

Abbreviations

DM	Diabetes Mellitus
CDC	Center for Disease Control
FCFA	Franc of the Comminuate Financiere Africaine
IRB	Internal Review Board
SPSS	Statistical Packages for Social Sciences

Conflicts of Interest

The authors declare no conflicts of interest.

Appendix

Appendix I. Name and Type of Health Facilities Included in the Study

Table 6. Name and Type of health facility.

Health District	Facility	Type of Facility
Bamenda Health District	Bamenda Regional Hospital	Public
Bamenda 3 Health District	Nkwen Baptist Hospital	Private
	Nkwen District Hospital	public
Ndop Health District	Ndop District Hospital	Public
Mbengwi Health District	Mbengwi District Hospital	Public
Nkambe Health District	Nkambe District Hospital	Public
Santa Health District	Santa District Hospital	Public
Fundong Health District	Mbingo Baptist Hospital	Private
	Fundong District Hospital	public
Kumbo West Health District	Banso Baptist Hospital	Private
Kumbo East Health District	Shisong Catholic Hospital	Private
Tubah Health District	Tubah District Hospital	Public
Bali Health District	Bali District Hospital	Public

Source: Researcher's field survey, 2022.

Appendix II. Heteroskedasticity Test of the Treatment Cost Model

Breusch-Pagan / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance
Variables: fitted values of DirectCost

chi2(1) = 217.77
Prob > chi2 = 0.0000

Appendix III. Descriptive Statistics of Socio-Demographic Variables

Table 7. Socio-demograhic variables.

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
Sex	439	.69	.46	0	1	-.83	1.7
Age	439	3.07	.77	1	4	-.42	2.6
Marital status	439	2.58	1.01	1	4	.46	1.75
Employment status	439	1.25	1.09	0	3	.42	1.89
Occupation	439	4.05	3.84	0	21	.99	4.43
Education level	439	1.22	.93	0	3	.35	2.27
Income level	439	1.64	1.09	1	5	1.81	5.37
Household head	439	.63	.48	0	1	-.54	1.29
Status in the household	439	1.75	.59	1	4	.67	5.21

Source: Researcher's fieldwork (2022)

Appendix IV. Summary Statistics of Indicators of Direct Treatment Costs

Table 8. Variables of direct treatment cost.

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
Cost for check-up visits per month	439	11995.482	15994.961	0	200000	6.088	57.883
Transport cost per month	439	2853.797	6193.95	0	45000	3.995	20.501
Cost of special diet per month	439	9833.713	19852.559	0	225000	4.529	37.438
Cost of strips per month a	439	3170.843	10233.315	0	150000	8.59	108.351
Cost of injecting insulin per month a	439	2474.829	5831.011	0	50000	3.484	19.631
Cost of household help per month	439	5906.95	16952.766	0	200000	6.132	57.323

Note: a only applies to patients who self-manage the disease
Source: Researcher's field work (2022)

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