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Complications of Diabetes Among Adolescents Attending A Diabetic Clinic in Kigali City, Rwanda : A Cross Sectionnal Study

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ABSTRACT

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Background: Diabetes mellitus (DM) is a growing problem all over the world, including Africa. This disorder accounts for high morbidity and mortality due to microvascular complications especially in type 1 diabetics. This study was conducted to assess prevalence of microvascular complications as well as associated risk factors among adolescents aged 10-19 years obtaining care in Kigali city, in Rwanda.

Methods: This cross-sectional study was conducted in 261 adolescents with type 1 DM attending care in a Rwandan Diabetic clinic in Kigali city. Participants were examined for microvascular complications and possible risk factors.

Results: Thirteen of 261 participants had diabetic nephropathy (5%), 12 had diabetic retinopathy (4.6%), and 9 had diabetic neuropathy (3.4%). Risk factors for development of a microvascular complication included place of residence as well as previous hypoglycemia or hospitalization. In addition, 232 patients (88.9%) had poor levels of glycemic control.

Conclusion: Microvascular complications seem to be common in adolescents with type 1 DM in our study setting. They appear to be associated with other morbid diabetic complications, which are indicative of poor diabetic disease control. Actions should therefore be directed towards glycemic control to prevent these complications.

KEYWORDS:

Complications; type 1 Diabetes; Rwanda

INTRODUCTION

Diabetes Mellitus (DM) is a non-communicable disease becoming a challenge to global development. It is a growing problem with current estimation of 439 million adults world-wide affected in 2030 contrasting with 108 million in 1980 (1,2). Moreover, four out five cases of diabetes are found in less developed countries, most of them being in Sub-Saharan Africa (SSA). Of these patients, approximately 8.4 million people suffer from type 1 diabetes (3,4). Naturally, 1.5 million (18%) of them are under the age of 20 (5). In Africa, some early population-based studies across different countries stated that the prevalence of type 1 diabetes was <11/1000, with incidence rates rising from 1.5 to 10.1/100000 per year (6). This disorder accounts for high morbidity and mortality due to complications like renal failure, blindness, amputations, cardiovascular disease, and cerebrovascular events.

The prevalence of diabetes in Rwanda is estimated to be between 3.1% and 4.3% with an annual death toll of 1,918 per year (7,8,9,10). A small number of studies have suggested that factors such as socioeconomic status, food accessibility and cost, or medicine availability may contribute to the development of diabetic problems (11). In general, studies showed that among patients with diabetes, those with lower socioeconomic status had higher odds of developing retinopathy, neuropathy, and nephropathy. It was noted that around 4.3% of diabetic individuals in Rwanda experienced

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erectile dysfunction, coronary artery disease, nephropathy, and stroke (12). Most of the studies carried out in Rwanda to assess the extent and factors associated with microvascular complications concern type 2 diabetes. Actually, no study has focused on prevalence of theses complications and factors associated among adolescents (10-19 years) in Rwanda especially in Kigali city. It is become an area of increasing concern and addressing this problem will have practical benefice in understanding this public health phenomenon. The main objective of this study was to assess the prevalence and factors associated with complications of diabetes among adolescents aged 10-19 years obtaining care in Kigali city, Rwanda. This will help to implement targeted interventions to improve control in this population and prevent chronic complications.

MATERIAL AND METHODS

Setting and Research Design:

The study was a cross-sectional design and patients were enrolled through attending care in a Rwanda Diabetic clinic in Kigali city. This clinic is managed by the Rwanda Diabetes Association (RDA). RDA is a private organization with a mission to educate and improve the well being of diabetic patients in Rwanda. It runs a specialized clinic "La Fraternité" in the city of Kigali, whose main mission is to prevent and treat diabetes as well as it's complications. The clinic care for all diabetic patients from the five districts of Rwanda.

Study Population:

The study population was adolescents aged 10-19 years who were attending this diabetic clinic and who were obtaining care at this facility from 1st August 2021 to 31th August 2024 (3 years).

Sample Design

- Sample Size Determination

The size of the sample from the total population is calculated using Yamane's formula (13) as follows: $n = N / (1 + Ne^2)$

Whereby: n= Sample Size

N=Population Size

e= Level of significance that was given as 0.05

After calculation, the sample size was set at 261 patients

- **Data Collection Methods**

To collect quantitative data for this study, in order to further investigate associated factors and learn about the medical history for diabetes, we used an existing computerised medical records database (EDMRS) to collect information about patients. Socio-demographic, clinical data and some behavioural factors were collected in order to assess complications prevalence and associated risk factors.

Before collecting the data, we carried out a pre-test which involved patients with diabetes who were not included in the final sampled population. These were patients involved in pilot research conducted among nearby health facilities in the Rwamagana District. The aim of this pre-test was to facilitate and assess the consistency, uniformity of research tools and to acquaint with the process of distributing research tools for their further amelioration.

- **Operational definitions:**
  - Diabetic nephropathy: presence of protein in urine using urine dipstick or eGFR less than 60 mL/min/1.73 m2
  - Diabetic peripheral neuropathy: sensations of pain or heat on the sole of the foot and upper limb by the monofilament test
  - Diabetic autonomic neuropathy: decrease of systolic BP more 20 mmHg or diastolic more 10 mmHg after three minutes of moving from a supine to a standing position, accompanied by constipation or diarrhea.
  - Diabetic retinopathy: the presence of exudates, hemorrhages or new vessels in the disc on the fundus, confirmed by an ophthalmologist.

Data Analysis Procedures

In order to assess statistical significance and analyze statistical data to determine the relationship between diabetes-related factors and complications, this study used quantitative data analysis using the Statistical Package for Social Sciences (SPSS). Thus, frequency, percentages, mean, and standard deviation were shown and calculated using descriptive statistics, and bivariate and multivariate analysis will be produced using inferential statistics.

Ethical Consideration

The study ensured that the informed consent with highlights major ethical issues (respect for anonymity, confidentiality and respect for privacy) will be used to notify respondent on the aim of the present research. Data was confidentially and anonymously kept. Permission letter to carry out research was sought and obtained from Mount Kenya University, school of research postgraduate studies when clearance was sought and obtained from Mount Kenya University Ethic clean community [REF: MKU/ETHICS/23/01/2024(1)]. All required permissions were sought and obtained from the relevant authority.

RESULTS

A total of 261 type I diabetics took part in the study, the majority from the southern province (33.7%) and the city of Kigali (24.1%). They were evenly distributed according to sex, and of these 70.5% were over 16 years of age. In terms of socio-economic data, the parents and guardians of the vast majority of patients had an income of less than Frw 200,000 per month, including 15% with an income of less than Frw 50,000. Nevertheless, most of them were affiliated to a health insurance scheme (Table I). In terms of diabetic disease, the majority had been followed up in the clinic for less than 5

years (67%), and 92% had their own self-monitoring device. Unfortunately, their disease was predominantly poorly controlled, with 88.9% having an Hb1AC level above 6.5%. In terms of complications, nephropathy was found in 13 patients (5%), retinopathy in 12 (4.6%) and neuropathy in 9 (3.4%) (Table II). In multivariate analysis, a significant correlation between place of residence and retinopathy was observed (p=0.019). When comparing the Southern region to the reference (the City of Kigali), an adjusted OR of 45.61 (1.12-1863.39) was found. Two other factors showed a statistical association with retinopathy. These were hypoglycemia [aOR : 26.4 (0.1-7294.3)] and previous hospitalization [aOR : 3.4(0.01-1946.1)]. The same strong correlation was found for the nephropathy and the neuropathy (Table III).

DISCUSSION

Our study noted that renal complications were the most numerous (5%) and appear to be within the margins of those found in most African studies (0-29%), but appear to be lower than those found in some contries in the Great Lakes region of Africa (14,15). However, the rate seems slightly higher than that previously reported in another study conducted in Rwanda (16). Some data seem to show that these complications are more frequent in Africa than elsewhere in the world, notably because of some genetic factors (e.g primary glomerular diseases related to the APOL1 gene mutation), but also because of the presence of other risk factors (e.g. schistosomiasis, sickle cell disease, etc.) (17,18,19). However, some studies have shown that young age in itself could be considered as an independent factor in renal microvascular complications (20). This could be attributed to the immaturity of the renal system at the onset of diabetic disease.

Furthermore, the prevalence of neuropathy and retinopathy seems to be lower than nephropathy. It appears even lower than rates observed in another previous study conducted in Rwanda (16). Methodological differences and particularities in study populations could explain these differences. Some studies conducted in the region nevertheless show higher rates in Tanzania (10.3% and 13,3%) but relatively similar rates (4.7 % of retinopathies) in Ethiopia (15,21), compared to 3.4 % and 4.6 % in our study.

The prevalence of neuropathy and retinopathy in studies from Western countries showed significantly lower rates, such as in one study conducted in Turkey that found only 0.6% rate of neuropathy, and no cases of retinopathy (22, 23).

The main factor most frequently reported in the occurrence of microvascular complications is poor control of diabetic disease. This has been demonstrated in previous studies carried out in Rwanda and elsewhere in the region (15,16, 24). Although it was not found to be a risk factor in our study, we nevertheless noted a large number of patients with uncontrolled diabetic disease (88.6% based on glycated hemoglobin assessment).

In our study, the main risk factors were residence and history of hypoglycemia or previous hospitalization. Southern residence could be related to the poverty of this population, as well as to low levels of education, while a history of hypoglycemia or previous hospitalization could be indirect markers of poor diabetic disease control. Therefore, the main objective for minimizing microvascular complications in African children with type 1 DM should be improving glycemic control.

Some limitations of our study need to be underlined. First, the cross-sectional nature of the study means that no causal link can be established between studies factors. On the other hand, the use of random urine dip-stick as a nephropathy diagnostic method is not very specific and could lead to some biased results. All these limitations should be taken into account when interpreting our results.

Conclusions

Microvascular complications seem to be common in adolescents with type 1 DM in our study setting. They appear to be associated with other morbid diabetic complications, which are indicative of poor diabetic disease control. So, improving glycemic control should be the first priority for preventing theses complications.

Table I : Socio-demographic characteristics of the study participants (n=261)

Factors	Categories	Frequency n (%)
Place of residence	City of Kigali	63(24.1)
	Northern	24(9.2)
	Southern	88(33.7)
	Eastern	51(19.5)
	Western	35(13.4)
Gender	Male	126(48.3)
	Female	135(51.7)
Age group	10-15 years old	77(29.5)
	16-20 years old	184(70.5)

Parents current marital status	Never Married	6(2.3)
	Married	203(77.8)
	Living with partner	2(0.8)
	Widowed/Divorced/Separated	50(19.2)
Highest level of formal educational attainment	No education	5(1.9)
	Primary education	115(44.1)
	Secondary education	139(53.3)
	High education (university)	2(0.8)
Employment status of the parent	Not employed	47(18)
	Employed	102(39.1)
	Self employed	112(42.9)
Income level (monthly)*	Less than 50,000Frws	40 (15.3)
	Between 50,001Frws-100,000Frws	73(28)
	100,001Frws-200,000Frws	64(24.5)
	200.001Frws-400,000Frws	72 (27.6)
	Above 400,000Frws	12(4.6)
Health insurance		260(99.6)
Dietary habits	Eating once a day	90(34.5)
	Twice a day	120(46)
	More than 2 times	13 (5)
	lack of food regularly	38(14.6)
Tobacco use	No	261(100)
Consume alcohol	Yes	16(6.1)
Engaged in any physical activity	Yes	197(75.5)

* *current rate:1USD=1450frws*

Table II: Clinical characteristics of study participants

Factors	Categories	Frequency n (%)
BMI	≤ 18.5 kg/m2	75(28.7)
	18.5-24.9 kg/m2	157(60.2)
	≥25 kg/m2	29(11.1)
High Blood Pressure		8(3.1)
Duration of follow up in the clinic in years (Time since diagnosis)	≤5 years	175(67)
	5-10 years	73(28)
	11-15 years	11(4.2)
	16-20 years	2(0.8)
Family history of diabetes		50(19.2)
Monitoring equipment		240(92)
Frequency of blood sugar control	Everyday	241(92.3)
	Twice a week	3(1.1)
	Less than 1 time/week	17(6.5)
Any incident of hypoglycemia for the last 6 months		23(8.8)
History of Hospitalization for the last 6 months		25(9.6)
Hb1Ac	≤6.5 mg/dl	29(11.1)
	>6.5 mg/dl	232(88.9)
Diabetes complications	Retinopathy	12 (4.6)
	Neuropathy	9(3.4)
	Nephropathy	13 (5)

Table III: Multiple regression analysis of significant independent variables

Risk factors	Categories	Outcome variables					
		Retinopathy		Neuropathy		Nephropathy	
		p-value	Adjusted Odds Ratio (95%CI)	p-value	Adjusted Odds Ratio (95%CI)	p-value	Adjusted Odds Ratio (95%CI)
Place of residence	City of Kigali (Ref)	0.019		0.039		0.193	
	Northern		1.76(0.03-86.19)		9.42(1.85-49.89)		2.872(0.927-8.89)
	Southern		**45.61(1.12-1863.39)**		0.57(0.032-10.18)		0.815(0.101-6.56)
	Eastern		1.63(0.009-2.807)		1.37(0261-7.00)		0.347(0.074-1.580)
	Western		2.29(0.09-55.96)		0.92(0.110-7.72)		2.025(0.528-7.73)
Sex	Male (Ref)	0.099		0.361		0.875	
	Female		1.09 (0.08-14.56)		0.524 (0.128 - 2.14)		0.914 (0.298-2.798)
Age	10-15 years old (Ref)	0.766		0.317		0.918	
	16-20 years old		0.92 (0.52-1.61)		1.96 (0.512-7.51)		1.06 (0.318-3.569)
Health Insurance	Yes (Ref)	0.826		0.850		0.819	
	No		0.15 (0.006-3.894)		0.11 (0.004- 2.97)		0.164 (0.006- 4.208)
Dietary habits	Eating 1/day (Ref)	0.469		0.388		0.361	
	Eating 2/day		1.56(0.13-19.5)		2.25 (0.59- 8.59)		0.780 (0.23- 2.60)
	More than 2		0.27(0.004-19.9)		0.88 (0.23- 3.35)		0.718 (0.22- 2.26)
	Lack of food		1.644 (0.19- 13.72)		0.93 (0.05- 16.90)		3.286 (0.65- 16.39)
	Regularly		1.56(0.13-19.5)		0.29 (0.02- 5.14)		1.005 (0.21- 4.71)
Alcohol	Yes	0.365		0.435		0.154	
	No (Ref)		0.595 (0.03-10.50)		0.754 (0.04-13.53)		3.039 (0.61-15.06)
Physical activity	Yes (Ref)	0.468		0.870		0.432	
	No		(Reference) 0.172(0.01-2.02)		1.142(0.231-5.64)		1.833 (0.39-8.49)
BMI	Normal (Ref) (18.5-24.9)	0.110		0.153		0.846	
	Below average (≤18.5)		0.69(0.45-1.04)		3.32 (0.867-12.72)		1.080 (0.33-3.71)
	Above average (≥25)		0.04(0.01-0.15)		0.04 (0.01-0.76)		1.488 (0.31-7.07)

Blood pressure	Normal (Ref)	0.701		0.481		<0.001	
	Below average (<140/90cmHg)		0.23(0.01-3.61)		0.352(0.04-2.87)		0.512 (0.11-2.37)
	Above average (>140/90cmHg)		1.136 (0.06-20.82)		1.513 (0.08-28.21)		7.111(5.83-126.13)
Duration diagnosis	≤5years (Ref)	0.853		0.670		0.134	
	5-10years		1.1(0.76-1.6)		2.121(0.55-8.13)		1.654 (0.52-5.23)
	11-15years		0.829 (0.04-14.89)		1.105 (0.06-20.18)		4.828(0.93-25.07)
	16-20years		3.96 (0.18-86.95)		5.273 (0.23-117.62)		3.651(0.16-79.89)
Family Diabetes	Yes (Ref)	0.598		0.812		0.713	
	No		0.76(0.05-11.26)		1.214 (0.24-6.03)		1.283 (0.34-4.84)
Monitoring equipment	Yes (Ref)	0.970		0.366		0.962	
	No		0.961(0.118-7.82)		1.764 (0.09-31.37)		1.052 (0.13-8.52)
Frequency Of blood Sugar control	Every day (Ref)	0.901		0.679		0.911	
	≥Twice/week		0.908 (0.11-7.42)		3.601(0.1734-4.79)		2.597(0.12-52.88)
	≤1 time/week		0.003 (0.001-0.023)		0.708 (0.04-12.68)		1.208 (0.15-9.88)
Hypogly-cemia	Yes (Ref)	**<0.001**		**0.008**		**0.004**	
	No		**26.4 (0.1-7294.3)**		**5.8 (1.35-24.96)**		**5.356 (1.5-19.02)**
Hospita-lisation	Yes (Ref)	**<0.001**		**<0.001**		**<0.001**	
	No		**3.4 (0.01-1946.1)**		**8.8 (2.19-35.28)**		**10.33 (3.15-33.84)**
Fasting Blood glucose	Normal range (Ref)	0.469		0.394		0.578	
	Below average (<110mg/dl)		0.99(0.99-1.01)		1.13 (2.29-55470471.9)		1.22 (6.57-2249571160.4)
	Above average (>130mg/dl)		1.8 (0.38-8.45)		0.425 (0.11-1.63)		0.77 (0.25-2.42)

Hb1Ac	Normal range (<6.5mg/dl) (Ref)	0.210	0.55 (0.3-1.01)	0.280	0.398 (0.02-7.03)	0.191	0.27 (0.02-4.75)
	Above average (>6.5mg/dl)						

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    - PMB: study design, data analysis, writing original draft and manuscript
    - TSA: data analysis, revision of manuscript
    - JO : critical review and revision of manuscript

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