Biomarkers and Genomic Medicine (2013) 5, 44–47

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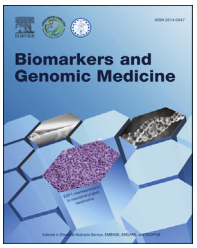

ORIGINAL ARTICLE

Intestinal parasitic infections among diabetes mellitus patients

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Received 1 April 2013; received in revised form 8 May 2013; accepted 11 May 2013
Available online 22 June 2013

KEYWORDS
diabetes mellitus;
intestinal parasites;
risk factors

Abstract Diabetes mellitus (DM) is a group of metabolic diseases in which a person has high blood glucose, either because the body does not produce enough insulin, or cells do not respond to the insulin that is produced. This study was conducted to determine the prevalence of intestinal parasitic infections among DM patients as well as the risk factors involved in the acquisition of these parasitic infections. A total of 180 individuals were included in this study. The study group consisted of 150 (41 males and 109 females) DM patients attending clinics, and 30 (7 males and 23 females) non-DM individuals served as controls. Stool and blood specimens were obtained from each participant to detect intestinal parasites and to determine hemoglobin concentration using standard techniques. An overall prevalence of 18.7% of intestinal parasitic infections among DM patients was observed in this study. DM status was significantly associated with intestinal parasitic infections (odds ratio = 14.192; 95% confidence interval = 0.842, 239.22; $p = 0.022$). Age and type of toilet significantly ($p = 0.047$ and $p < 0.0001$, respectively) affected the prevalence of intestinal parasitic infections in DM patients. *Ascaris lumbricoides*, hookworm, and *Entamoeba histolytica* were the parasites recovered from DM patients with no parasites detected among non-DM individuals. Routine diagnosis of intestinal parasites is advocated among DM patients.

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http://dx.doi.org/10.1016/j.gmbhs.2013.05.003

Introduction

Diabetes mellitus (DM) is a group of metabolic diseases in which a person has high blood glucose, either because the body does not produce enough insulin or because cells do not respond to the insulin that is produced.[1,2] This high blood sugar produces the classical symptoms of polyuria, polydipsia, and polyphagia. Diabetes is one of the most frequent metabolic diseases and is widely distributed in various populations. Its prevalence appears to be increasing rapidly.[3] The cause of diabetes depends on the type, as type-1DM is partly inherited, and then triggered by certain infections, with some evidence pointing at Coxsackie B4 virus.[4] A genetic element in individuals susceptible to some of these triggers has been traced to particular human leukocyte antigen genotypes. However, even in those who have inherited the susceptibility, type 1 DM seems to require an environmental trigger.[4] Type-2 DM is due primarily to lifestyle factors and genetics.[4] Sub-Saharan Africa faces the world's highest increase in type 2 DM occasioned by adaptation to western lifestyles and genetic predispositions.[5]

Parasitic infections are among the most widespread of all chronic human infections worldwide. They affect an estimated 3.5 billion persons and cause clinical morbidity in approximately 450 million.[6] Intestinal parasitic infections continue to be a significant health problem in both developed and developing countries.[7] Opportunistic infections vary according to the geographical location as well as the endemicity in such location.[8] There is no report on the prevalence of intestinal parasitic infections among DM patients in Ondo State. Against this background, this study was conducted to determine the prevalence of intestinal parasitic infections among diabetes as well as the risk factors involved in the acquisition of these parasitic infections in DM patients.

Materials and methods

Study area

The study area was in the southwestern part of Nigeria. Owo is one of the towns that constitutes Ondo State. It is within the low rainforest zone of Nigeria and has two seasons, dry and wet. The dry season lasts from mid-October to March or April whereas the rainy season lasts from April to September. The study was conducted at the Federal Medical Center, Owo, a tertiary hospital with a referral status.

Study population

A total of 180 participants were recruited for this study. They were 150 (41 males and 109 females) DM patients attending clinics and 30 (7 males and 23 females) non-DM volunteers. The age of the study participants ranged from 30 years to 70 years. The DM patients were controlled patients who came to the clinic for routine check up on a monthly interval; their fasting plasma glucose was $>$7.0 mM.[9] Informed consent was obtained from each participant prior to specimen collection. The protocol for this study was approved by the Ethical Committee of Federal Medical Center, Owo, Ondo State.

Specimen collection and processing

Stool and blood specimens were obtained from each participant. The stool specimen was collected in a clean wide-mouthed container. The blood specimen was dispensed into an ethylenediaminetetraacetic acid container and mixed.

Freshly voided stool specimens were processed using the formol-ether concentration method and examined microscopically for intestinal parasites as previously described.[10] Briefly, about 1 g of feces was suspended in 4 mL of formol saline and mixed. The mixture was sieved and to the filtrate, 4 mL of diethyl ether was added and agitated. The mixture was centrifuged at 3000 rpm for 1 minute. The fecal debris on the side of the tube was detached using an applicator and the supernatant discarded. From the deposit, saline and iodine mounts were prepared and examined for the presence of parasites.

Blood specimens were analyzed for CD4 count using flow cytometry (Partec, Münster, Germany) and hemoglobin concentration using an autoanalyser (KX-21; Sysmex Corporation, Kobe, Japan). Anemia was defined based on WHO criteria[10]; for males, this was hemoglobin concentration $<$130 g/L and for females it was $<$120 g/L.

Data analysis

The data obtained were analyzed using Chi-square test (χ^2) to compare the frequency data. The odds ratio (OR) was calculated for potential risk factors. The software INSTAT (GraphPad Software Inc., La Jolla, CA, USA) was used for all statistical analyses.

Results

An overall prevalence of 18.7% of intestinal parasitic infections among DM patients was observed in this study. DM status was significantly associated with the prevalence of intestinal parasitic infections [OR = 14.192; 95% confidence interval (CI) = 0.842–239.22; p = 0.022; Table 1]. Although, more females (78.6%) had intestinal parasites than males (21.4%), gender was not a risk factor for acquiring intestinal parasites in DM patients (OR = 1.475; 95% CI = 0.509–4.464; p = 0.588). Age was significantly associated with the prevalence of intestinal parasitic infections in DM patients (p = 0.047) with the age group 51–60 years having the highest prevalence. The level of education, occupation and source of water were not significantly associated with intestinal parasitic infections

Table 1 Prevalence of intestinal parasitic infections in diabetes mellitus (DM) patients and non-DM individuals.

DM Status	No. tested	No. infected (%)	OR	95% CI	p
DM patients	150	28 (18.7)	14.192	0.842–239.22	0.022
Non-DM individuals	30	0	0.070	0.004–1.188	

in DM patients ($p = 0.136$; $p = 0.095$; $p = 0.353$, respectively). Type of toilet significantly affected the infection of intestinal parasites in DM patients ($p < 0.0001$) with DM patients that use pit latrines having the highest prevalence. No DM patient had CD4 counts $<200 \times 10^6$cells/L (data not shown). Anemia was significantly associated with DM patients that had intestinal parasitic infection (OR = 3.310; 95% CI = 1.311–8.361; $p = 0.016$, Table 2).

There was no association between intestinal parasitic infections and the duration of DM ($p = 0.521$). Type of DM was not a risk factor for acquiring intestinal parasites (OR = 1.962; 95% CI = 0.393–13.199; $p = 0.528$, Table 3).

Three parasites—*Ascaris lumbricoides*, hookworm, and *Entamoeba histolytica*—were recovered from DM patients. *A. lumbricoides* was observed only among type 2 DM patients. Only one case each of hookworm and *E. histolytica* infection was observed among type 1 DM patients. Hookworm infection was the most prevalent (14/132, 10.6%) parasite followed by *A. lumbricoides* (10/132, 7.6%), while the least was *E. histolytica* (2/132, 1.5%) among type 2 DM patients.

Table 2 Risk factors for intestinal parasitic infections among diabetes mellitus (DM) patients.

Characteristic	No. tested	No. infected (%)	OR	95% CI	p
Gender (DM)					
Male	41	06 (14.6)	0.678	0.253–1.814	0.588
Female	109	22 (20.2)	1.475	0.551–3.948	
Age (DM)					
30–40 y	7	4 (57.1)			0.047
41–50 y	28	6 (21.4)			
51–60 y	40	9 (22.5)			
61–70 y	46	5 (10.9)			
>71 y	29	4 (13.8)			
Educational level					
No formal	47	13 (27.7)			0.137
Primary	40	6 (15.0)			
High school	21	5 (23.8)			
Tertiary	42	4 (9.5)			
Occupation					
Civil servant	22	4 (18.2)			0.095
Trader	62	10 (16.1)			
Farmer	15	7 (46.7)			
Artisan	4	0 (0)			
Housewife	28	4 (14.3)			
Pensioner	19	3 (15.8)			
Source of water					
Borehole	72	10 (13.9)			0.353
Well/rain water	65	15 (23.1)			
Stream/river	13	03 (23.1)			
Type of toilet					
Flush	89	7 (7.9)			<0.0001
Pit latrine	40	18 (45.0)			
Bush	21	3 (14.3)			
Hemoglobin concentration (DM)					
Anemic	79	21 (26.6)	3.310	1.311–8.361	0.016
Nonanemic	71	7 (9.9)	0.302	0.120–0.763	

Table 3 Relationship between type and duration of diabetes mellitus (DM) and intestinal parasitic infections.

Characteristic	No. tested	No. infected (%)	OR	95% CI	p
Type of DM					
I	18	02 (11.1)	0.510	0.110–2.357	0.579
II	132	26 (19.7)	1.962	0.424–9.077	
Duration of DM					
1 year	31	25 (80.6)			0.719
2 years	31	25 (80.6)			
≥3 years	88	66 (75.0)			

Discussion

Protozoa and helminthes are among the most important pathogens that can cause infections in immunocompromised individuals.[11] These microorganisms are capable of infecting individuals with impaired cellular immunity.[12] Emerging intestinal parasites have gained increasing attention as important opportunistic pathogens responsible for clinically important infections in immunocompromised patients.[8] DM patients have been reported to be immunocompromised.[13] However, no studies in Nigeria have looked at intestinal parasitic infections in DM patients. Hence this study was undertaken.

An overall prevalence of 18.7% of intestinal parasitic infection was observed among DM patients. This is lower than the 47% previously reported.[14] Geographical location may account for this difference as the Nazligul et al[14] study was conducted in Anatolia whereas our study was carried out in Nigeria. DM status was a significant risk factor for acquiring intestinal parasitic infection (OR = 14.192; 95% CI = 0.842–239.22; $p = 0.022$). This also differs from the findings of Nazligul et al[14] report where non-DM individuals had significantly higher prevalence of intestinal parasitic infections. Parasitic infection is endemic in Southeast Anatolia and a prevalence of 55.9% was observed in the non-DM individuals.[14] Among our non-DM participants, no case of intestinal parasitic infection was observed and a previous study only reported a prevalence of 3.9%.[15] The finding that gender did not affect the prevalence of intestinal parasitic infection among DM patients agrees with a previous report.[14]

In this study, age significantly affected the prevalence of intestinal parasitic infections in DM patients. The reason for this is unclear as our DM patients were asymptomatic, had controlled glucose level and were not immunocompromised as none had a CD4 count $<200 \times 10^6$cells/L.

Level of education, occupation, and source of water did not significantly affect the prevalence of intestinal parasitic infections in DM patients. The type of toilet significantly affected the prevalence of intestinal parasitic infections with patients defecating in pit latrine having the highest prevalence of 64.3%.

Anemia is a common complication of chronic kidney disease.[16] Similarly, parasitic infections are known to cause anemia,[17,18] especially among HIV patients.[19] Diminished erythropoietin production has been reported as the cause of anemia in DM patients.[20] However, this study has shown that parasitic infections among DM patients can also result in anemia. This should be borne in mind in the management of anemia in DM patients. Type and duration of DM did not significantly affect the prevalence of intestinal parasitic infections in DM patients.

With the exception of hookworm, other parasites recovered have been previously reported in DM patients.[14] More parasites were observed in type 2 than in type 1 DM patients.

In conclusion, an overall prevalence of 18.7% of intestinal parasitic infection was observed among DM patients and no case of parasitic infection was reported among the non-DM inidividuals. Age and type of toilet significantly affected the prevalence of intestinal parasitic infections among DM patients. It was observed that intestinal parasitic infections in DM patients can result in anemia. *A. lumbricoides*, *E. histolytica*, and hookworm were the only intestinal parasites recovered. Routine diagnosis of intestinal parasitic infections among DM patients is advocated.

Acknowledgment

We thank the management of Federal Medical Center, Owo, Ondo State, Nigeria for permission to carry out this study. The authors appreciate the Consultant Physicians in the Department of Internal Medicine, Federal Medical Center, Owo, Nigeria for their cooperation.

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