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Blood Pressure and Plasma Levels of Blood Glucose among Subjects Screening by Malaria Rapid Diagnostic Test in Indigenous Area, Ondo State

Adedeji David Atere[1*], David Bolaji Akinbo[2], Olaiya Paul Abiodun[3] and Henry Chijindu Okpoli[4]

[1]Department of Medical Laboratory Science, Achievers University, Owo, Ondo State, Nigeria.
[2]Department of Medical Laboratory Science, Afe Babalola University, Ado Ekiti, Ekiti State, Nigeria.
[3]Department of Public Health, University of Nicaragua, Guyana, South America.
[4]Department of Chemical Pathology, University of Benin Teaching Hospital, Benin city, Edo State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Authors ADA and DBA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OPA and HCO managed the analyses of the study. Authors ADA and OPA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Plasmodium falciparum malaria is one of the most devastating diseases and causes an estimated one million deaths, mostly children living in sub-Saharan Africa. There is evidence that higher glucose level increases the attractiveness for Anopheles feeding. This study was initiated to ascertain the reliability of rapid diagnostic test (RDT) for malaria in managing plasma blood glucose and blood pressure among people living in indigenous areas with resource-limited

**Corresponding author: E-mail: ateread@gmail.com;*

settings. This is a cross sectional study and it was conducted between February to April, 2017. A total number of 150 subjects aged between 18 – 80 years, who were sub-divided into subjects with diabetic mellitus only (Subjects with DM only), subjects with neither DM nor malaria parasite (NDM or MP), subjects with both DM and MP and subjects with MP only attending the clinic were randomly selected for the study. Blood pressure was taken using a sphygmomanometer. Blood levels of fasting blood glucose were determined using standard spectrophotometric method and RDT based on antigens was carried out on aliquots of whole blood. Data obtained were statistically analyzed appropriately. $P<0.05$ was considered significant. The mean blood level of FBG was significantly lower while the mean level of SBP was significantly higher in subjects with MP positive compared with subjects with MP negative. FBG showed positive significant correlation with SBP in subjects with MP only. In conclusion, this study confirmed that malaria contributes to the development of hypertension and low blood levels of glucose among subjects living in indigenous area.

Keywords: Hypertension; rapid diagnostic test; diabetes mellitus; malaria; indigenous area.

1. INTRODUCTION

Malaria infection remains the most devastating disease and predominant of illness and death every year in Nigeria, which is one of the countries in tropics. About 500 million cases of *Plasmodium falciparum* malaria was reported in 2010 and caused an estimated one million deaths, mostly among children living in sub-Saharan Africa [1,2]. According to the report, there was impressive reduction in global malaria burden. Between 2010 and 2015, the new cases of malaria incidence fell by 21% globally and in the African Region (212 million new cases of malaria worldwide). During this same period, malaria mortality rates also declined by an estimated 29% globally and by 31% in the African Region [15]. Glucose is vital for *Plasmodium* because the basic characteristic of mosquito life is sustained by feeding on glucose as a nutrient. It is the only nutrient consumed by males and probably the more common one for females, even if they need vertebrate blood to produce eggs [3]. *Plasmodium* relies entirely on an exogenous supply of glucose because it has no capacity to store energy in the form of glycogen. There is evidence that higher glucose level increases the attractiveness for Anopheles feeding [4]. Thus the infected erythrocyte exhibits a substantial increase in its permeability to low molecular weight sugar. The metabolism of the parasite utilizes up to 75 times more glucose than uninfected erythrocytes [5].

Arterial hypertension, which is known as a global public health challenge, has also been reported as a complex multifactorial disease. It results to at least 45% of deaths due to heart disease and 51% of deaths due to stroke, adding up the tremendous number of 9.4 million deaths every year [6,7]. Recent work has shown Malaria as the cause of low birth weight, inflammation as well as stunting. All these factors have been separately associated with the development of high blood pressure in high-income countries [8]. Therefore this study is conducted to confirm whether malaria contributes to the development of high blood pressure in indigenous area.

The conventional method of microscopic identification of parasite in staining of peripheral blood smears however still remains the gold standard in laboratory diagnosis of malaria [9,10], even though there are a lot of challenges facing its use in rural area. Use of microscopy in Nigeria is somehow limited to secondary or tertiary health clinics. Use of microscopic identification of parasite is not only daunting in resource-limited or poor power settings, but also time consuming and requiring a skilled personnel. Rapid diagnostic tests (RDTs) for malaria could be considered as alternative for most patients in endemic regions, especially in indigenous area with poor power settings. However, there is very little evidence, especially from malaria endemic areas to guide decision makers on the sensitivity and specificity of these RDTs. Rapid diagnostic test (RDT) is a device that detects malaria antigen in a small amount of blood, usually 5–15 μL, by immuno-chromatographic assay with monoclonal antibodies directed against the target parasite antigen impregnated on a test strip [10]. The result, usually a colored test line, is obtained within 5–20 min. Besides RDTs are simple to perform and are easy to interpret, they require no capital cost or electricity. Thus it will be a very useful diagnostic malaria tools in remote area in endemic region. This study was initiated to ascertain the reliability of rapid diagnostic test for

malaria in managing plasma blood glucose and blood pressure among people living in indigenous areas with resource-limited settings.

2. MATERIALS AND METHODS

2.1 Study Design

This is a cross sectional study and it was conducted at General Hospital, Oka Akoko, which serve as secondary health institution within the community. The research was conducted between February to April, 2017. A total number of one hundred and fifty (150) subjects (both males and females) aged between 18 – 80 years, which were sub-divided into subjects with diabetic mellitus only (Subjects with DM only), subjects with neither DM nor malaria parasite (NDM or MP), subjects with both DM and MP and subjects with MP only attending the clinic were randomly selected for the study. Type 2 diabetes mellitus subjects in this study were diagnosed according to guideline of WHO [11]. Their medical history and personal data was obtained via short structured questionnaire after due approval from the ethical committee of the hospital.

2.2 Ethical Clearance and Consent

Subjects participating in this study were fully briefed on the research protocols in the clinic after which they were required to sign a written consent. After that, a pre-designed structural questionnaire was utilized to collect bio-data, and socio-demographic characteristics of the patients. Approval for this study was obtained from the General Hospital, Oka Akoko and Ethical Clearance was issued by Ethical Committee of this health Centre.

2.3 Collection and Storage of Samples

Blood samples were obtained from each subject by applying a tourniquet around the arm above elbow. The ante-cubital forsa was disinfected with a 70% alcohol soaked swab. Four milliliters (4 ml) of venous blood was collected from each subject using aseptic procedure after 12 hours fast. Two milliliters (2 ml) of venous blood was dispensed into 3 ml sterile vacutainer bottle containing EDTA anticoagulant and gently mixed by inverting the container severally for the examination of malaria using RDT. The remaining 2mls of the venous blood was dispensed into 3mls vacutainer bottle containing fluoride oxalate anticoagulant which was also mixed gently by inverting the container several times for the determination of plasma glucose. Plasma was separated from the blood by centrifugation for 5 minutes at 4000 rpm, into plain bottles and stored at -20°C until time of analysis.

2.4 Analytical Methods

Blood pressure was taken using a sphygmomanometer. Blood levels of fasting blood sugar (FBS) was determined using standard spectrophotometric method [12,13] and CareStart™, Access Bio, Inc., USA in vitro rapid diagnostic kit based on antigens was carried out on aliquots of whole blood in duplicates as described by Azikiwe et al. [10].

2.5 Statistical Analysis of Data

A statistical package for social sciences (SPSS) 21.0 was used for the analysis of the data appropriately. All values were expressed as Mean ± Standard deviation (SD). Analysis of variance (ANOVA) was used to determine significant differences among groups while Spearman correlation was used to test the association between variables. The level of significance was taken at 95% confidence interval and P value less than 0.05 was considered significant.

3. RESULTS AND DISCUSSION

3.1 Results

In Table 1, the mean blood level of FBG was significantly lower while the mean level of SBP was significantly higher in subjects with MP positive compared with subjects with MP negative. Table 2 shows that mean of Age, SBP, DBP and FBG were significantly lower in subjects with neither DM nor MP. Also the significantly higher mean of Age, SBP, DBP and FBG were observed in subjects with both DM and MP while significantly different in mean of SBP, DBP and FBG were recorded in subjects with MP only. Correlation of FBG with systolic and diastolic blood pressure in subjects with DM only, subjects with neither DM nor MP, subjects with both DM and MP and subjects with MP only was shown in Figs. 1 to 4 respectively. FBG showed positive significant correlation with SBP in both subjects with neither DM nor MP and MP only.

Table 1. Comparison of blood pressure and fasting blood glucose among the subjects according to result of malaria investigation using RDT

Parameters	Subjects with MP positive (n=73) Mean ± SD	Subjects with MP negative (n=77) Mean ± SD	P Value
Age (Years)	49.21±17.06	44.43±15.95	0.078
SBP (mmHg)	139.22±24.29	127.58±15.93	0.001*
DBP (mmHg)	83.89±14.98	79.51±12.82	0.056
FBG (mg/dl)	92.48±14.77	101.40±31.59	0.030*

** Significant at p≤0.05*

Key: SBP= Systolic blood pressure, DBP= Diastolic blood pressure, FBG= Fasting blood glucose, n=Sample size, SD=Standard deviation

Table 2. Comparison of blood pressure and fasting blood glucose among the subjects according to grouped Investigative conditions

Parameters	Subjects with DM only (n=25) Mean ± SD	Subjects with neither DM nor MP (n=52) Mean ± SD	Subjects with both DM and MP (n=09) Mean ± SD	Subjects with MP only n=64) Mean ± SD	P-value
Age (Years)	52.36±14.14 [a]	40.62±15.48 [b, c]	61.11±7.51 [a, c]	47.53±17.38 [a, b]	0.001*
SBP (mmHg)	137.56±19.23 [a]	122.79±11.49 [b, c]	146.89±21.13 [a]	138.14±24.66 [a]	0.000*
DBP (mmHg)	88.20±15.16 [a]	75.33±9.06 [b, c]	90.22±15.73 [a]	83.00±14.78 [a]	0.000*
FBG (mg/dl)	129.68±42.05 [a, c]	87.81±8.63 [b]	120.67±21.84 [a, c]	88.52±7.70 [b]	0.000*

**Significant at P ≤ 0.001*

a = significantly different from Subjects with neither DM nor MP, b = significantly different from Subjects with both DM and MP, c = significantly different from Subjects with MP only

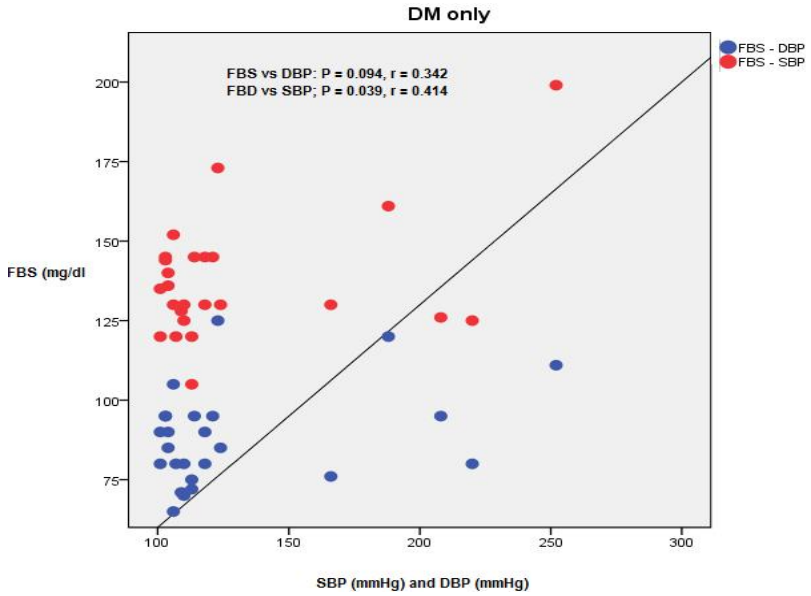

Fig. 1. Graphical representation of the correlation between fasting blood sugar (FBS) with blood pressure (SBP and DBP) in subjects with DM only

3.2 Discussion

Microscopic identification of malaria parasite is the universal gold standard used to diagnose malaria at peripheral levels because it can give important information to the physician like species, parasites stages and parasite density provided it is handled by skilled personnel. Besides that use of microscopy is difficult to maintain in resource-limited or poor power

settings, it is labor intensive and requires highly skilled personnel. However, the use of malaria RDTs is recommended by WHO when reliable microscopy is not available [9,10]. It was observed in this study that the mean blood level of FBG was significantly lower while the mean level of SBP was significantly higher in subjects with MP positive compared with subjects with MP negative. Glucose is vital for Plasmodium because the basic characteristic of mosquito life is sustained by feeding on glucose as a nutrient [3]. There is evidence that the metabolism of the parasite utilizes up to 75 times more glucose than uninfected erythrocytes [5]. Thus decrease in blood levels of glucose might be as a result of feeding on glucose as a source of nutrient by the parasites. Furthermore, significantly increased in mean SBP among subjects with MP positive corroborated recent report that showed malaria as a condition associated with the development of high blood pressure in high-income countries [8], but it contradicted Anigbogu and Olubowale's report [14] that says malaria may lower blood pressure.

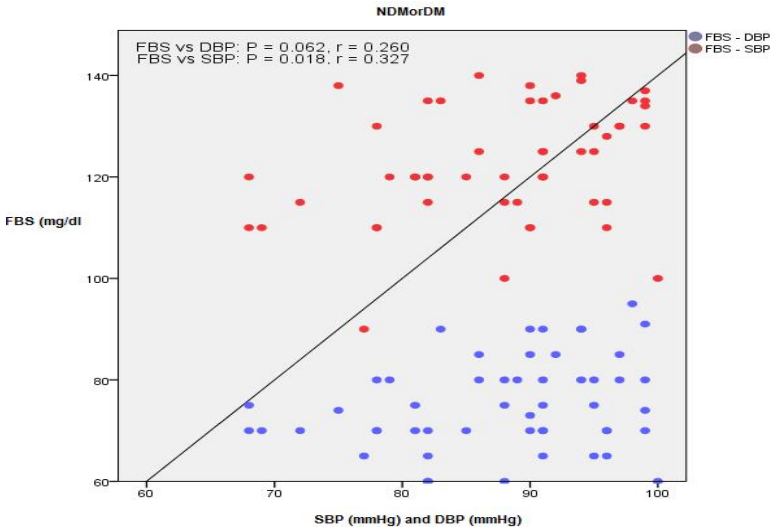

Fig. 2. Graphical representation of the correlation between FBS and blood pressure (SBP and DBP) in subjects with neither DM nor MP

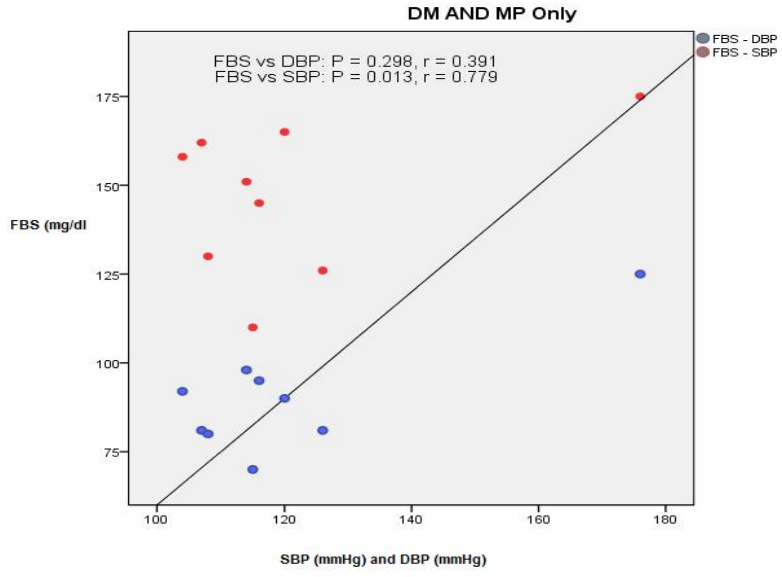

Fig. 3. Graphical representation of the correlation between FBS and blood pressure (SBP and DBP) in subjects with both DM and MP

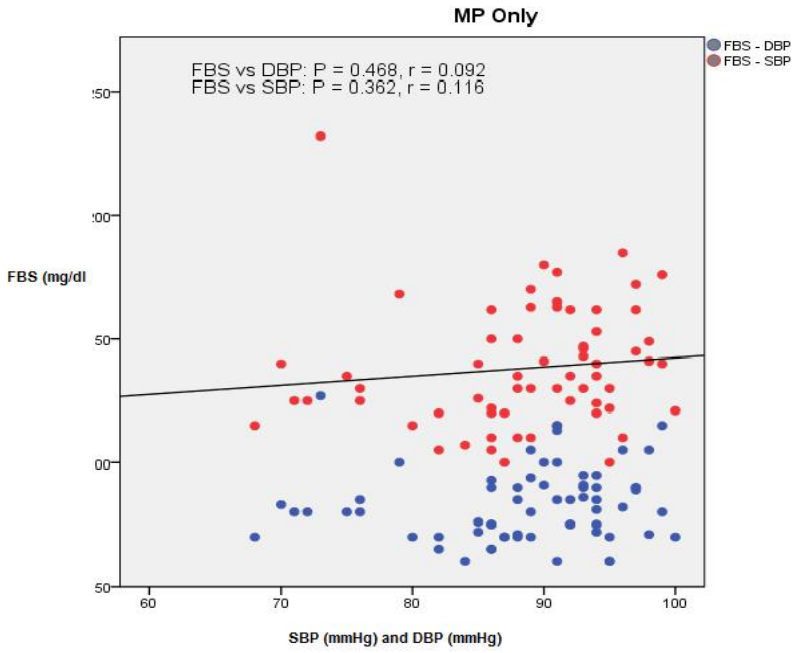

Fig. 4. Graphical representation of the correlation between FBS and blood pressure (SBP and DBP) in subjects with MP only

Similarly, the significantly increased mean of SBP, DBP and FBG from subjects with neither DM nor MP, MP only and both DM and MP respectively in this research work further showed possible effect of malaria to cause hypertension. The available data in this work are still scanty and could not address scientific basis behind it. Thus additional genetic studies are necessary in malaria endemic regions to determine whether malaria could have been a driving evolutionary force for hypertension. This study also obviously reported significant positive correlation of FBG with SBP in MP only. This association suggests that hyperglycemia per se is greatly involved in hypertension, especially among subjects with malaria infection.

4. CONCLUSION AND RECOMMENDATION

Therefore this study confirmed that malaria contributes to the development of high blood pressure and low blood levels of glucose among subjects living in indigenous area. However, the use of malaria RDT is recommended as reliable diagnostic malaria tools in endemic region, where microscopy is not available, in managing plasma blood glucose and blood pressure among people living in resource-limited settings.

CONSENT

All authors declare that written informed consent was obtained from each subject before being enrolled into the study.

ETHICAL APPROVAL

Approval for this study was obtained from the Ethical Committee of General Hospital, Oka Akoko and also, written informed consent (approved by the Ethical Committee of this health Centre) was obtained from each subject.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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