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ORIGINAL RESEARCH

Prevalence and Risk Factors for Diabetes Mellitus in Nigeria: A Systematic Review and Meta-Analysis

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ABSTRACT

Introduction: There has been no nationwide health (diabetes) survey in Nigeria since 1992, when a diabetes mellitus (DM) prevalence of 2.2% was reported. We aimed to determine the prevalence of and risk factors for DM in Nigeria by performing a systematic review and meta-analysis.

Methods: We searched Medline, EMBASE, PubMed, PapersFirst, the Cochrane Library, Scopus, Bioline, African Journals Online, Institute of Scientific Information, and Google Scholar from the year 1990 to 2017. Using MeSH headings, the terms "diabetes mellitus," "risk factors," "prevalence," and "Nigeria" as well as variations thereof were searched for. The last search was performed on 26 November 2017. We only included studies that utilized the random plasma glucose test, the fasting plasma glucose test, the oral glucose tolerance test (OGTT), or HbA1c to diagnose DM. A total of 23 studies (n = 14,650 persons) were evaluated. A random effects model was used to estimate the pooled prevalence of DM. We estimated the overall pooled prevalence of DM and subgroup-specific DM prevalences while accounting for inter-study and intra-study variability/heterogeneity.

Results: The overall pooled prevalence of DM was 5.77% (95% CI 4.3–7.1). The pooled prevalences of DM in the six geopolitical zones of Nigeria were 3.0% (95% CI 1.7–4.3) in the north-west, 5.9% (95% CI 2.4–9.4) in the north-east, 3.8% (95% CI 2.9–4.7) in the north-central zone, 5.5% (95% CI 4.0–7.1) in the south-west, 4.6% (95% CI 3.4–5.9) in the south-east, and 9.8% (95% CI 7.2–12.4) in the south-south zone. Risk factors for the pooled prevalence of DM were a family history of DM (4.6%; 95% CI 3.5–5.6); urban dwelling (6.0%; 95% CI 4.3–7.8); unhealthy dietary habits (8.0%; 95% CI 5.4–10.5); cigarette smoking (4.4%; 95% CI 1.3–10.2); older age (6.6%; 95% CI 4.5–8.7); physical inactivity (4.8%; 95% CI 3.2–6.4); and obesity (5.3%; 95% CI 3.8–6.9).

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Conclusion: There has been an increase in the prevalence of DM in Nigeria. All regions of the country have been affected, with the highest prevalence seen in the south-south geopolitical zone. Urban dwelling, physical inactivity, advanced age, and unhealthy diet are important risk factors for DM among Nigerians. A national diabetes care and prevention policy is highly recommended.

Keywords: Diabetes prevalence; Meta-analysis; Nigeria; Risk factors; Systematic review

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder of chronic hyperglycemia characterized by disturbances to carbohydrate, protein, and fat metabolism resulting from absolute or relative insulin deficiency with dysfunction in organ systems [1]. This disease has shown a tremendous increase in prevalence with a demographic transition in its epidemiology in recent years. Populations previously unaffected or minimally affected by DM are now reporting soaring prevalence figures, which poses a real challenge to health financing by governments and non-governmental organizations. The latest prevalence figure published by the International Diabetes Federation (IDF) is 425 million persons living with DM worldwide, with nearly 50% of these undiagnosed [2]. The developing economies of Africa and Asia contribute a significant fraction of this figure. There is also a rising burden from the complications of DM alongside the ever-increasing prevalence of the disease [3]. We now see high rates of DM-related amputations, cerebrovascular disease, heart-related problems, and kidney disease in populations that were not previously known for these challenging health problems.

In Nigeria, the current prevalence of DM among adults aged 20–69 years is reported to be 1.7% [2]. It is widely perceived that prevalence figures reported by the IDF grossly under-report the true burden of DM in Nigeria, given that they are derived through the extrapolation of data from other countries. Various researchers have reported prevalences ranging from 2% to 12% across the country in recent years [4–7]. The last time a nationwide population estimate of DM was undertaken in Nigeria was during the 1992 Nigerian National Non-communicable Diseases (NCD) survey, where DM was said to occur in 2.2% of the population [8]. There has been no nationwide health (diabetes) survey in Nigeria since then. However, it is important to determine the actual burden of DM in Nigeria to facilitate appropriate health resource allocation, advocacy, and planning. Thus, in the work reported in the present paper, we aimed to determine the prevalence of and risk factors for DM in Nigeria using a systematic review and meta-analysis.

METHODS

Data Search

We searched Medline, EMBASE, PubMed, PapersFirst, the Cochrane Library, Scopus, Bioline, African Journals Online, the Institute of Scientific Information, and Google Scholar from the year 1990 to 2016. Using MeSH headings, the terms "diabetes mellitus," "risk factors," "prevalence," and "Nigeria" as well as variations thereof were searched for. We contacted the authors of articles in journals that were not available online. The last search was performed on 26 November 2017. Studies included in the meta-analysis were those that utilized the oral glucose tolerance test (OGTT), the random plasma glucose (RPG) test, the fasting plasma glucose (RPG) test, or glycated hemoglobin (HbA1c) to diagnose DM. In all, a total of 23 studies involving 14,650 persons were evaluated.

Inclusion Criteria

Only population-based studies that were executed between 1990 and 2017 and in which FPG, RPG, OGTT, or HbA1C was used to diagnose DM were included in the meta-analysis.

Exclusion Criteria

Clinic/hospital-based studies and those performed before 1990 or after 2017 were excluded from the meta-analysis.

Compliance with Ethics Guidelines

This review and meta-analysis is based on previously conducted studies and does not involve any study with human participants or animals performed by the authors.

Data Extraction

Various data were extracted from eligible studies, such as the prevalence of DM, risk factors for DM, method of diagnosing DM, study design, and Nigerian geopolitical zone in which the study was carried out. A summary of the data extracted is shown in Table 1. We coded the data based on the name of the first author of the study and the year that the study was published. Multiple coder agreement was assessed using Cohen's kappa [9].

Operational Definitions

DM was diagnosed based on the 1999 WHO diagnostic criteria for DM or the ADA 2010 diagnostic criteria for DM [1, 10]. According to the 1999 WHO diagnostic criteria [1], the cut-off plasma glucose values for diagnosing DM are as follows:

- Fasting plasma glucose $\geq$ 7.0 mmol/L
- Random plasma glucose $\geq$ 11.1 mmol/L
- Plasma glucose 2-h post-glucose load (75 g) $\geq$ 11.1 mmol/L

The 2010 ADA diagnostic criteria [10] for DM states that a glycated hemoglobin (HbA1c) value of $\geq$ 6.5% is diagnostic of DM if the assay technique is based on high-performance liquid chromatography (HPLC). The HPLC assay technique potentially adjusts for hemoglobinopathies and provides information on hemoglobin variants. In populations such as the Nigerian population, where there is a high prevalence of hemoglobinopathies and factors that diminish red blood cell survival, the HPLC platform adequately and accurately provides HbA1c values. In this meta-analysis, only studies that utilized the HPLC platform to evaluate HbA1c were included.

Quality of the Studies Included

Two authors separately assessed the quality of the studies included using the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies [11]. The studies were assessed with questions appropriate to the study design. We graded the quality of the study as good (G) if its rating was at least 70%, fair (F) if its rating was at least 50%, and poor (P) if its rating was less than 50%.

Statistical Analyses

The primary outcome measure was the prevalence of DM. The standard error in the prevalence was estimated using the binomial probability distribution. A random effects model based on the DerSimonian-Laird [12] method was used to estimate the pooled prevalence of DM and the confidence interval via weighted least squares (weighting was based on the reciprocal sum of the between- and within-study variances). The inter-study heterogeneity was evaluated using Cochran's Q test [13]. We defined low, medium, and high heterogeneity a priori as Cochrane Q values of 25%, 50%, and 75%, respectively. We estimated the overall pooled prevalence of DM and the subgroup-specific prevalences accounting for the inter-study and intra-study variability/heterogeneity. An assessment of risk factors was undertaken.

Publication bias was appraised using Begg's [14] rank correlation methods and Egger's [15] weighted regression test. All analyses were performed using the STATA software (version 11). A level of significance of 0.05 was adopted for Cochran's Q test.

The null hypothesis of this study assumed that all of the studies reported the same prevalence in the various populations studied.

Table 1 Studies included in the meta-analysis

S/no.	Author	Geopolitical zone	Year of publication of study	Study design	Method used to diagnose DM	Prevalence of DM (%)	Quality grading
1	Nyenwe et al. [4]	South-south	2003	Cross-sectional prospective	RBS	6.8	F
2	Puepet et al. [5]	North-central	2008	Cross-sectional prospective	OGTT	4.0	F
3	Sabir et al. [6]	North-central	2011	Cross-sectional prospective	OGTT	4.61	G
4	Gezawa et al. [7]	North-east	2015	Prospective	FBS	7.0	F
5	Kyari et al. [24]	Pan-Nigeria	2013	Cross-sectional	RBS	3.30	F
6	Omorogiuwa et al. [25]	South-south	2010	Cross-sectional	FPG and RBS	9.0	F
7	Ekpeyong et al. [26]	South-east	2012	Cross-sectional	RBS	10.0	F
8	Oyegbade et al. [27]	South-west	2007	Cross-sectional	RBS	5.0	F
9	Opeodu et al. [28]	South-west	2013	Cross-sectional	RBS	4.40	F
10	Gabriel et al. [29]	South-east	2013	Cross-sectional	FBS	5.0	F
11	Dahiru et al. [30]	Pan-Nigeria	2008	Review	RBS	2.0	F
12	Anzaku et al. [31]	North-central	2012	Cross-sectional prospective	OGTT	8.3	G
13	Adeniyi et al. [32]	North-west	2010	Cross-sectional	RBS	2.0	F
14	Etukumana et al. [33]	North-central	2014	Cross-sectional prospective	FBS	4.1	G
15	Nwafor et al. [34]	South-south	2001	Cross-sectional prospective	RBS, FBS	23.1	F
16	Sabir et al. [35]	North-west	2013	Cross-sectional prospective	RBS	0.81	F
17	Chukwunonso et al. [36]	South-east	2015	Cross-sectional	FBS	3.0	G
18	Bakari et al. [37]	North-west	1999	Cross-sectional	OGTT	8.0	G

Table 1 continued

S/no.	Author	Geopolitical zone	Year of publication of study	Study design	Method used to diagnose DM	Prevalence of DM (%)	Quality grading
19	Isara et al. [38]	South-south	2015	Cross-sectional	RBS	5.0	F
20	Enang et al. [39]	South-south	2014	Cross-sectional	OGTT	7.0	F
21	Ramalan et al. [40]	North-west	2016	Prospective	OGTT	8.0	G
22	Ramalan et al. [40]	North-west	2016	Prospective	A1C	10.0	F
23	Olamoyegun et al. [41]	South-west	2014	Prospective	FBS	7.0	F

DM diabetes mellitus, *RBS* random blood sugar, *FBS* fasting blood sugar; *OGTT* oral glucose tolerance test, *F* fair, *G* good, *A1c* glycated hemoglobin

RESULTS

The total number of records initially identified during the database searches was 149, but only 23 studies (total number of persons: 14,650) were eventually found to be eligible for inclusion in the meta-analysis, as shown in Fig. 1. The overall pooled prevalence of DM was 5.77% (95% CI 4.3–7.1). The overall prevalence and the prevalences of DM in subgroups categorized by diagnostic method are shown in Fig. 2. Figure 3 shows the pooled prevalence of DM in each of the six geopolitical zones of Nigeria, which indicates that the highest prevalence occurred in the south–south zone (9.8%; 95% CI 7.2–12.4) and the lowest in the north-west zone (3.0%; 95% CI 1.7–4.3). Assessment of the risk factors for DM (see Fig. 4) revealed that unhealthy dietary habits (8.0%; 95% CI 5.4–10.5), older age (6.6%; 95% CI 4.5–8.7), and urban dwelling (6.0%; 95% CI 4.3–7.8) were the leading risk factors for DM in Nigeria.

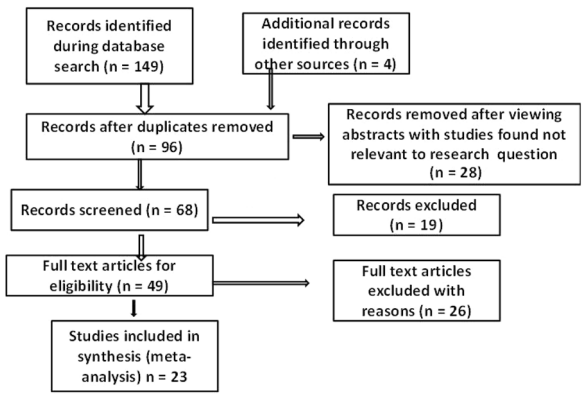

Fig. 1 Flow diagram of the studies included in the meta-analysis

DISCUSSION

The United Nation estimates that the population of Nigeria as of September 2017 was 193.3 million [16]. The pooled DM prevalence of 5.77% observed in our meta-analysis suggests that 11.2 million Nigerians (1 out of every 17 adults) are living with the disease. Regional differences in the prevalence of DM, with the highest rate observed in the south–south zone and the lowest rate seen in the north-western zone, mirror a similar finding for obesity, which is a major risk factor for type 2 diabetes [17].

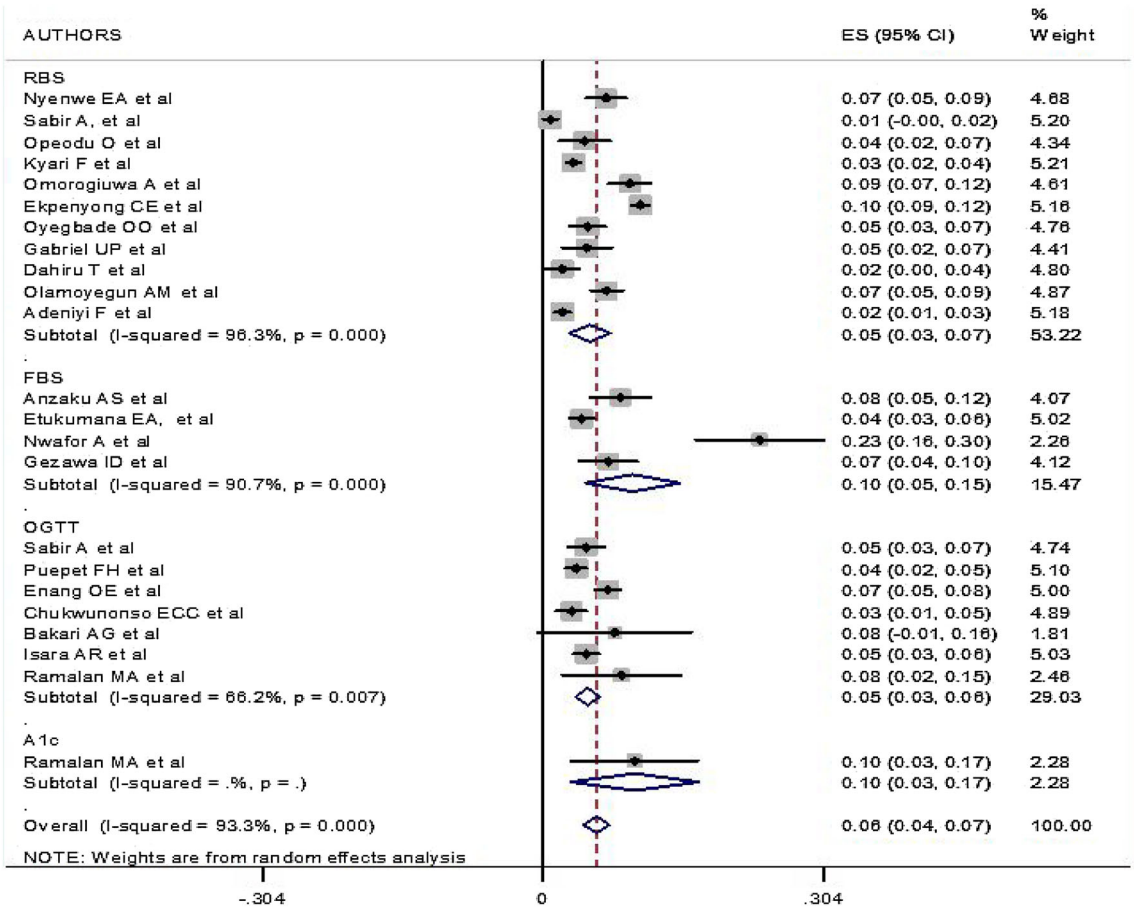

Fig. 2 Forest plot showing the overall prevalence of diabetes and the prevalences of diabetes in subgroups categorized by method of diagnosis

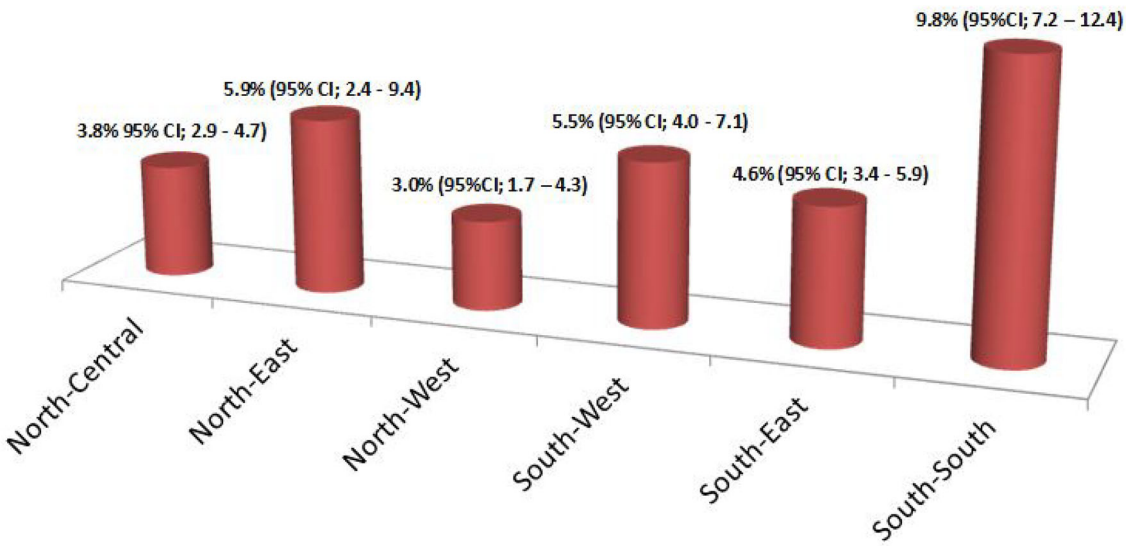

Fig. 3 Prevalence of diabetes in each geopolitical zone of Nigeria

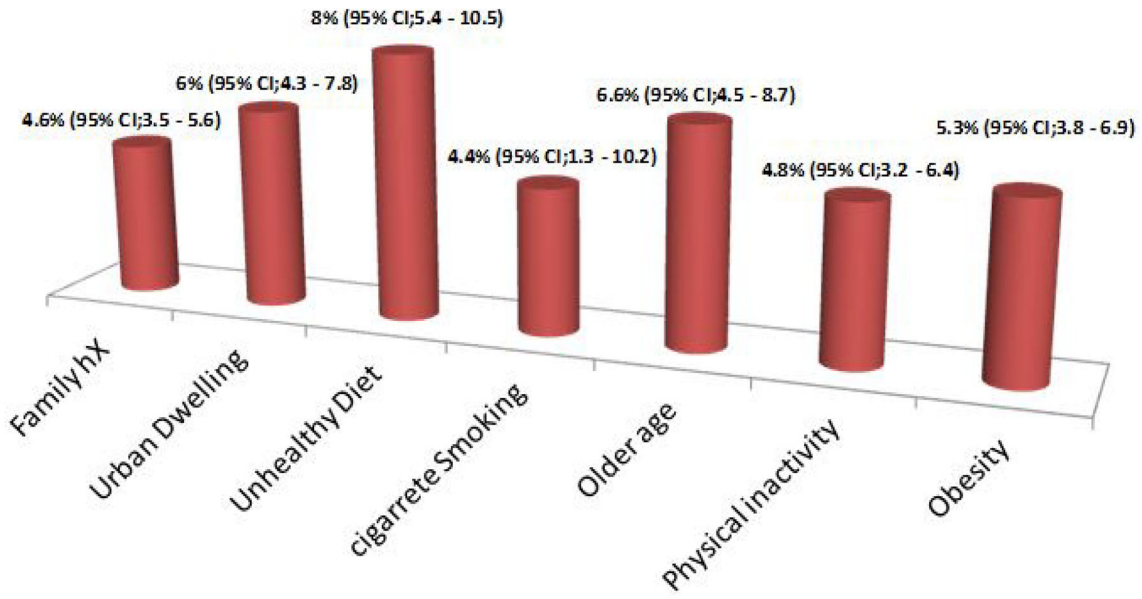

Fig. 4 Prevalences of risk factors for diabetes mellitus

To the best of our knowledge, this is the first study to determine the prevalence of and risk factors for diabetes in Nigeria using a systematic review and meta-analysis. The pooled DM prevalence of 5.77% found in our study is quite similar to the 2013 IDF estimate derived from extrapolations from populations with similar sociodemographic characteristics [18]. Our diagnostic methods also differ from those of the IDF, which mainly promotes the use of the OGTT. Although the OGTT is the gold standard for the diagnosis of DM, FPG and RPG are also good tools that are cheaper and easier to apply, even in remote settings where an OGTT may not be feasible. In 2010, the ADA recommended the use of the glycosylated hemoglobin (HbA1c) test in the diagnosis of DM [10]. We found only one study that used HbA1c measured using high-performance liquid chromatography (HPLC) to diagnose DM based on a cutoff of $\geq$ 6.5%.

Compared with the 1992 NCD population estimate of 2.2% [8], the prevalence of DM obtained in this meta-analysis suggests a 2.6-fold increase in prevalence over the past two and half decades. We found urban dwelling, physical inactivity, advancing age, and an unhealthy diet to be the leading risk factors for DM among Nigerians. It has been demonstrated that sub-Saharan Africa has one of the fastest annual rates of change in the number of urban dwellers in the world [19]. Studies have reported a two- to fivefold increase in the risk of diabetes and pre-diabetes in association with urban residence [20, 21]. Urbanization is also associated with decreased physical activity energy expenditure (PAEE), an independent risk factor for metabolic syndrome [22].

The modest improvement in living standards witnessed over the past few years in Nigeria has resulted in the aging of its populace. Insulin resistance tends to worsen with advancing age [23]. This, coupled with decreased physical activity among the aged, increases the risk of type 2 diabetes. Among the risk factors for DM found in our study, unhealthy dietary habits was the most prevalent, which is not surprising considering the proliferation of fast food outlets in many cities across the country. An unhealthy diet consisting mainly of high-fat, energy-dense foods contributes to the development of obesity and DM.

The strength of our study is that it is the first to determine the prevalence of and risk factors for diabetes in Nigeria based on a systematic review of the literature and meta-analyses. In addition, the selected studies cover the six geopolitical zones of Nigeria, making it possible

to pinpoint regional differences in the prevalence of DM.

Limitations of our study include the cross-sectional design of the selected studies, making causal associations between diabetes and the identified risk factors difficult. Our study also did not consider other potential risk factors for diabetes, such as gender and socioeconomic status. Finally, the fact that we selected studies which used different screening methods for the diagnosis of diabetes means that some people with the disease could have been missed.

CONCLUSIONS

There has been a significant increase in the prevalence of DM in Nigeria, affecting all regions of the country, with the highest prevalence noted in the south-south geopolitical zone. Urban dwelling, physical inactivity, advancing age, and unhealthy diet are important risk factors for DM among Nigerians. A national diabetes care and prevention policy is highly recommended.

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Authorship. All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

Disclosures. All authors of this article (Andrew E. Uloko, Baba M. Musa, Mansur A. Ramalan, Ibrahim D. Gezawa, Fabian H. Puepet, Ayekame T. Uloko, Musa M. Borodo, and Kabiru B. Sada) have nothing to disclose.

Compliance with Ethics Guidelines. This meta-analysis is based on previously conducted studies and does not contain any studies with human participants or animals performed by any of the authors.

Data Availability. The datasets obtained during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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