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# Factors influencing the use of magnesium sulphate in pre-eclampsia/eclampsia management in health facilities in Northern Nigeria: a mixed methods study

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## Abstract

**Background:** Eclampsia remains a major cause of perinatal and maternal morbidity and mortality worldwide. We examined facilitators and barriers to the use of magnesium sulphate (MgSO<sub>4</sub>) in the management of pre-eclampsia/eclampsia (PE/E) in health facilities in Bauchi and Sokoto States in Nigeria.

**Methods:** Data were collected from 80 health facilities using a cross-sectional, mixed method (quantitative and qualitative) design. We assessed health facility readiness to manage PE/E and use MgSO<sub>4</sub> as the drug of choice, through provider interviews, in-depth interviews with facility managers and an inventory of equipment and supply in facilities. Bivariate and qualitative data analyses were performed to isolate the principal enabling factors and barriers to the management of PE/E and use of MgSO<sub>4</sub>.

**Results:** The majority of health facility providers correctly mentioned MgSO<sub>4</sub> as the drug of choice for the prevention and termination of convulsions in severe PE/E (65 %). Sixty-four percent of the health facilities had service registers available. About 45 % of providers had been trained on the use of MgSO<sub>4</sub> for the management of PE/E. Regarding providers' practices, 45 % of respondents indicated that MgSO<sub>4</sub> was used to prevent and treat convulsions in severe PE/E in their facilities. Barriers to management of PE/E included inadequate numbers of skilled providers, frequent shortages of MgSO<sub>4</sub>, lack of essential equipment and supplies, irregular supply of electricity and water, and non-availability of guidelines and clinical protocols at the health facilities. Technical support to providers was inadequate.

**Conclusion:** The study revealed that a constellation of factors adversely affect the management of PE/E and especially the use of MgSO<sub>4</sub> by service providers. Efforts to improve the management of PE/E in facilities should include integrated programs that substantially improve provider and facility readiness to manage PE/E for better maternal and newborn health outcomes in Northern Nigeria.

**Keywords:** Eclampsia, Pre-eclampsia, Magnesium Sulphate, Nigeria, Health Facilities Maternal Health, Maternal Mortality, Health Systems Strengthening

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## Background

Eclampsia is a major cause of perinatal and maternal morbidity and mortality worldwide [1]. Globally, an estimated 50,000 maternal deaths, most of which occur in low and middle-income countries, have been attributed to eclampsia [2]. In Nigeria, as well as being a leading cause of maternal deaths [3–5], eclampsia is also a major cause of obstetric complications [6, 7]. Hospital-based studies in Nigeria have confirmed that eclampsia accounted for up to 32 % of all maternal deaths [8, 9]. Similarly, eclampsia has been associated with a high perinatal mortality ratio of up to 406/1,000 births that has been documented in some health facilities in Nigeria [10, 11]. Effective management of pre-eclampsia/eclampsia (PE/E) is one of the signal functions of Emergency Obstetric and Newborn Care (EmONC) to prevent and promptly treat complications, avert maternal and newborn deaths [12] and consequently contribute to the attainment of Millennium Development Goals (MDGs) 4 and 5 and to the post-2015 development agenda.

Several evidence-based strategies have over time been used in the prevention and management of PE/E [13]. Evidence has since mounted that magnesium sulphate ( $MgSO_4$ ) is accepted the drug of choice for the prevention and management of PE/E [14]. As well as being very effective, it is tolerable, safe and relatively inexpensive (US\$5 per patient) [15]. Therapeutic trials have shown that the risk of eclampsia is halved when patients with severe pre-eclampsia were treated with  $MgSO_4$  [16].

Despite evidence on its proven safety and efficacy in the management of PE/E,  $MgSO_4$  use is still uncommon and infrequent in many healthcare facilities in low-income countries [13–15]. Previous studies identified factors associated with the limited use of  $MgSO_4$  in the management of PE/E which included lack of applicable treatment guidelines, misperception that its use is restricted to highly specialised clinical settings such as intensive care units, and lack of training for health workers on its safe application. Presently, few incentives exist for local, commercial production [14, 17–20]. Whereas  $MgSO_4$  is included in Nigeria's essential drug list [21] as the first line drug in the management of PE/E [22], its use by healthcare providers in managing these conditions is low [23]. Research on factors that influence the use of  $MgSO_4$  in Nigeria health care settings is limited.

In Bauchi and Sokoto States in Northern Nigeria, the use of  $MgSO_4$  in the management of PE/E in public health facilities was supported through technical assistance provided by the Targeted States High Impact Project (TSHIP), a USAID funded six-year, Reproductive, Maternal, Newborn and Child Health (RMNCH) project (2009–2015). As part of this intervention, we implemented a study on PE/E management to assess the factors that

influence the use of  $MgSO_4$  in the management of this condition in health facilities in the two states.

## Methods

The study utilized a mixed-methods research study design. The combined use of quantitative and qualitative research methods mutually reinforce the strengths of each method and minimize their respective weaknesses [24]. It is expected that the triangulation afforded by this design will help secure a more thorough understanding of the potentially complex interplay of factors and issues related to  $MgSO_4$  use. The study utilized a descriptive cross-sectional design to survey service providers, perform in-depth interviews with facility managers, undertake structured analyses of facility documents, and conduct inventory analyses of drugs, equipment and supplies including facility guidelines and protocols for PE/E management. Combined, these methods are more likely to yield a more holistic picture of provider and health facility readiness to use  $MgSO_4$  in the management of PE/E in both Bauchi and Sokoto States.

A total of 80 health facilities were randomly sampled for the study. All primary and secondary (hospitals) health care facilities that were expected to diagnose, prevent, treat or facilitate cases of PE/E in Bauchi and Sokoto states were included in the sampling frame. The sampling frame included a total of 42 eligible hospitals (22 in Sokoto State and 20 in Bauchi State) and 800 primary health centers and maternal health centers (457 in Bauchi State and 343 in Sokoto States). Facilities that did not routinely provide delivery services to pregnant women were excluded from the sampling frame. The eligible hospitals were randomly selected from each of the three senatorial zones in each state. Ten of 22 hospitals were selected in Bauchi State, and ten of 20 were selected in Sokoto State. Primary health care facilities affiliated with the selected hospitals that supply maternal health-related referrals were retained in the sampling frame. The included PHC facilities were stratified into comprehensive PHCs and Maternal and Child Health (MCH) centers in Bauchi; in Sokoto State, delivery services were available only in PHCs and upgraded dispensaries with assigned PHC status, and so no further stratification was feasible. There were a total of 230 PHC facilities in Bauchi State and a total of 180 eligible facilities in Sokoto State. From this list, a total of 30 PHCs per state were randomly selected. Thus, we selected 10 PHCs and 20 MCHs in Bauchi and 30 PHCs in Sokoto state. For each facility, a complete list of service providers who rendered obstetric services was generated and using a table of random numbers, one service provider per health facility was randomly sampled for an interview. In addition, we purposively selected 30 health facility managers to further explore the mix of system

factors that influenced the management of PE/E and the use of MgSO<sub>4</sub> in these facilities (15 managers per state) in both states. Managers were purposively selected from a mix of urban and rural hospitals and PHC facilities.

Eight resident postgraduate medical doctors, were recruited as research assistants in each state, and were trained for three days on study methods and instruments. Data were collected in June and July 2013. The research assistants administered structured questionnaires to the 80 service providers; data were collected on service providers' socio-demographic characteristics, training and experience in prevention and management of PE/E and factors influencing management of PE/E in their health facilities. Equipment and medical supplies including protocols and guidelines available for PE/E managements in sampled health facilities were similarly assessed using a checklist (Table 1). Epi Info™ version 7 (CDC, Atlanta, GA, USA) was utilized for data entry, univariate and bivariate analyses. Chi-square tests were used to perform tests of statistical significance.

In-depth interviews with 30 health managers were conducted in English. Four pairs of research assistants, who had previously been trained on qualitative research, conducted the interviews and were overseen by the first author, who is also an experienced qualitative researcher. A qualitative descriptive approach was used as the overall framework for the in-depth interview analysis. A semi-structured interview guide, with inputs from all members of the research team, was used to guide the interviews with each interview lasting an average of one hour. Field notes generated during the interview as well as transcripts from audio recordings were analysed using AtlasTi®. Initial coding of responses was done simultaneously by two coders (first and second authors) and coded responses were refined as further analyses yielded newer insights. Furthermore, the analyses systematically identified recurring themes on enabling factors and barriers to MgSO<sub>4</sub>, which were consolidated into thematic groupings [25]. Illustrative quotes from respondents were provided in each thematic area to further provide clarity.

Ethical approval for the study was obtained each from Bauchi and Sokoto States' Health Research Ethics Committees, and from the Health Media Laboratory in Washington DC, USA. Written informed consent was also collected from each respondent before data collection and after providing adequate information about the study including the study objectives.

## Results

Findings from this study are presented along thematic areas. Quantitative and qualitative findings are further triangulated to provide a clearer understanding for each thematic area.

### Study participants

A total of 80 service providers were interviewed (see Table 2). Of these, 55 % were community health extension workers (CHEWs) and fewer than 2 % were environmental health assistants. The mean age of service providers was 35.6 years old (range = 21-56 years, SD = 8.6) and the majority were female (97 %), married (75 %) and practised Islam (64 %).

### Facilitators and barriers to use of MgSO<sub>4</sub> in the management of PE/E in health facilities

#### Provider training and experience

The mean number of years of direct work experience in EmONC services by service providers was 9.6 (SD = 8.2) years. Of the 80 providers interviewed, two thirds (65 %) named MgSO<sub>4</sub> as the recommended drug of choice for prevention and treatment of convulsions in severe PE/E; nearly 60 % of all the providers reported that MgSO<sub>4</sub> was used for this purpose in their facilities. One in three providers said they did not know when and how to initiate treatment with MgSO<sub>4</sub> and only 39 % of the providers correctly described the correct administration of the drug.

Forty-five percent of providers reported that they have ever participated in training on prevention and management of PE/E. There was no significant difference in the

**Table 1** Data collection methods, respondents and thematic areas

Data Collection Instrument	Respondents	Thematic area
Quantitative		
SP questionnaire	80 SPs, 40 in each state	To obtain information on knowledge of PE/E and its management as well as current practices about PE/E management in the health facilities
Observational checklist	80 facilities, 40 in each state	To assess the infrastructure and equipment that are available for management of PE/E at the health facilities; To explore availability of adequate manpower, drugs, equipment and infrastructure that are required to provide prompt and adequate treatment to patients with PE/E
Qualitative		
In-depth interviews with facility managers	30, 15 in each state	To obtain information from the managers of the health facilities in order to explore individual, organizational and community factors that are associated with the use of magnesium sulphate in the management of PE/E in the health facilities

**Table 2** Characteristics of study participants and health facilities

Characteristic	%
<i>Service Provider (n = 80)</i>	
CHEWs	55
Nurse Midwife	40
CHO	4
Environmental Health Assistant	1.3
<i>Facility Manager (n = 30)</i>	
Nurse/Midwife	53.3
CHEW	40
CHO	6.7
<i>Health Facility (n = 80)</i>	
General Hospitals	25
Primary Health Centers (PHC)	50
MCH <sup>a</sup>	25

<sup>a</sup>Facilities render mainly maternal and child health services unlike PHCs that provide complete set of primary health care services

number of providers who had ever attended training by facility type (Table 3). Facility managers reported that whereas providers who were previously trained on the management of PE/E did conduct step-down trainings for their co-workers, such training was still inadequate to assure the requisite capabilities of trainees. A majority of the providers (96 %) indicated a desire to receive

**Table 3** Facilitators and barriers to the management of PE/E using MgSO<sub>4</sub> by type of facility

Item	Hospitals (n = 20), %	Health centers (n = 60), %	Total (n = 80), %
<i>Facilitators</i>			
Attendance of a training on PE/E by SP	60	38.3	43.8
Identification of MgSO <sub>4</sub> as first line drug by SP <sup>†</sup>	85	58	65
Availability of service registers in the facility	80	58.3	63.7
<i>Barriers</i>			
Non-availability of MgSO <sub>4</sub>			
Reported by SP <sup>†</sup>	15	46.7	38.8
Facility inventory	35	63.4	56.2
MgSO <sub>4</sub> stockout <sup>§</sup> in the facility <sup>a</sup>	46	33	40
Non-availability of clinical guidelines/protocols in the facility <sup>†</sup>	50	90	80
No supportive supervision <sup>¶</sup> received by SP <sup>†</sup>	55	90	81.2

<sup>a</sup>Among those that had MgSO<sub>4</sub> on the day of survey, N = 35

<sup>†</sup>p-value < 0.05

<sup>§</sup>Events where supplies were completely exhausted before re-supply

<sup>¶</sup>Routine supervisory visits by States' Ministry of Health officials during which service providers are mentored and provided with technical assistance to improve on their work

either new training or refresher training on the management of PE/E.

### Supportive supervision

The majority (82 %) of providers reported that they had not received any supportive supervision visits (i.e. routine supervisory visits by States' Ministry of Health officials during which service providers are mentored and provided with technical assistance to improve on their work) on prevention and treatment of PE/E in the 12 months preceding the survey. Of the 14 providers that received supportive supervision, the visits were made at least quarterly for 10 service providers and less frequently (6 monthly) for another four. Among those who received it, supportive supervision was much more frequently performed in general hospital settings (45 %) than at other health facility types (10 %) ( $p < 0.0001$ ) (Table 3).

### Availability of clinical protocols and guidelines

On the day of the survey, 80 % of all the health facilities visited did not have observable, written clinical protocols and guidelines for the management of PE/E, as required by the State Ministries of Health. Only 14 % of health facilities were able to present written clinical protocol and guidelines that were also observed to be in use by data collectors, while the remaining 6 % retrieved such guidelines and protocols from safekeeping for sighting. Hospitals were far more likely to have verifiable written protocols than all other types of facilities combined ( $p < 0.0001$ ) (Table 3).

### Availability of MgSO<sub>4</sub>

Three in five providers (61 %) reported that MgSO<sub>4</sub> was available for the treatment of PE/E in their facilities. However, while 38.8 % reported non-availability of MgSO<sub>4</sub>, about 56 % of the surveyed facilities were unable to produce samples of MgSO<sub>4</sub> on demand. Nearly 30 % of facilities had never received a supply of MgSO<sub>4</sub>. Hospitals were significantly more likely to have MgSO<sub>4</sub> available than any other type of facility ( $p = 0.01$ ) (Table 3). Of the 44 % (N = 35) that had some supplies of MgSO<sub>4</sub> in stock on the day of the survey, more than half (54 %) reported they had experienced at least one stock-out in the preceding 12 months. Furthermore, 9 % of providers reported an ongoing stock-out at the time of the survey; another 8 % of providers reported stock-out that had occurred within three months of the study. Non-availability of MgSO<sub>4</sub> due to stock-out was reported by 49 % of providers, and was an important barrier to the management of PE/E. During stock-out, most providers asked clients to buy the medicine from private pharmacies. According to facility managers, clients' access

to MgSO<sub>4</sub> was worsened by its high, unaffordable price in retail outlets.

#### **Patient referrals**

The majority of service providers (77 %) reported referring patients they could not handle to other health facilities. Among these, almost a third of providers (33 %) reported inadequate equipment in numbers and functionality as a main reason for patient referral. Other frequently cited reasons for referral were non-availability of drugs (61 %) and shortage of human resources (62 %).

#### **Human resources**

Inadequate staffing in health facilities to provide clinical services to pregnant women was a prominent recurring theme. Inadequate trained staff (51 %) and shortages of human resources (44 %) were two major barriers reported by service providers in the prevention and treatment of PE/E. Two facility managers commented thus:

*"We are only two midwives (in this facility and) we have no resting time. You (we) work for 24 hrs (round the clock, and), at night they [patients relatives] (still) come and call us (to attend to pregnant women in labour) too."* Sokoto HF manager

*"...The staffing is not sufficient, because it is good for us to have sufficient staff that will run shifts and as we are now, we cannot run shifts. Like in the evening, if patients present (themselves), they have to come and call us [from home] to come and render services"*  
Bauchi HF manager

#### **Availability of equipment and supplies**

Inventories of basic essential equipment and supplies essential for the management of PE/E were non-functional or unavailable. Blood pressure cuffs, intravenous fluid infusion sets and urine test strips were unavailable in 16 %, 68 % and 66 % of facilities respectively. Stethoscopes were unavailable in 6 % of facilities.

#### **Availability of adequate infrastructure at health facility**

The study examined other organizational factors such as the overall infrastructure that affect the provision of quality services by providers. Nearly 60 % of providers reported that their facilities had sufficient lighting during the day to render adequate care to patients with PE/E. However, during the night, only 30 % of service providers reported having adequate lighting. In-depth interviews with the facility managers revealed that most of the providers relied on sunlight to perform clinical tasks during the day; torchlight or a bush lamp was used at night, as facilities were often beset with the frequent electricity outages. Infrequent and inconsistent supply of

electricity was named as a significant barrier for providing maternal health services at night by majority of service providers.

While some managers reported that their facilities had non-functioning electricity generators, most facilities that had functioning generators did not have a constant supply of fuel. Health facility managers stated:

*"In the day we do not have any problem [with lighting]. We use the God-given (sun)light (laughing)."*  
Sokoto HF manager

*"One thing I don't like ... if we are having midnight delivery, we don't have generator [to provide electricity]. So we normally use our rechargeable lamp or our (mobile) phone [light] to conduct delivery."*  
Sokoto HF manager

On the availability of water, respondents reported that 44 % of facilities did not have running water. Two respondents said:

*"(We have) No water. We are using rainfall water... when the rainfall water dries, so we must move (to another source) and fetch water almost 1–2 km"*  
Sokoto HF manager

*"We don't have conveniences [bathroom and toilet facilities] for our patients and also no water supply. The pumping machine uses (an electricity) generator and we don't have [diesel fuel...]"* Bauchi HF manager

#### **Community perception about eclampsia and health seeking behavior**

The study examined community level factors such as beliefs that influence demand for health services. In-depth interviews with facility managers revealed that it was commonly held by communities that convulsions in general were caused by evil spirits or by witchcraft, which in turn prevented patients with eclampsia from presenting early at health facility or not even assessing healthcare at all. The following quotes exemplify facility managers' description of the social belief:

*"... it is just that the people are not really aware of the eclampsia. They call it 'iska' They feel (that) witches disturb the patient."* Sokoto HF manager  
*"Patients present (very) late (to the facility). They believe eclampsia is jinn (evil spirits) not a health problem"* Bauchi HF manager

#### **Discussion**

Successful management of patients with PE/E and other obstetric complications requires quality emergency

obstetric services that involve a mix of sufficiently equipped health facility and adequately trained staff [14, 26]. The predictable availability of quality services at the health facility is therefore essential to mitigate obstetric complications and maternal mortality. It is vital that providers possess the applicable know-how to promptly diagnose and manage obstetric complications.

This study assessed the enabling factors and barriers to the management of PE/E in health facilities in Bauchi and Sokoto states, to support the implementation of the national strategy to reduce maternal mortality. The study also sought qualitative information to learn of the factors that affected the use of MgSO<sub>4</sub> by service providers in the management of PE/E.

Less than half of providers had ever been trained on the correct use of MgSO<sub>4</sub>. This finding on the inadequate number and capabilities of service providers being a significant barrier to proper management of PE/E as part of EmONC services, and is consistent with similar studies from low and middle-income countries [14, 17, 18]. These findings suggest the need for a system to routinely train and re-train service providers on the use of MgSO<sub>4</sub> in the management of PE/E. Similarly, improved decision making on the management of severe PE/E associated with service providers training has been previously reported [12]. It is essential that programmes focus on training, refresher trainings and post-training supportive supervision of providers that might create an enabling environment for the provision of quality services in health facilities and especially the use of MgSO<sub>4</sub> as the preferred drug for managing convulsions in severe PE/E.

It is noteworthy that the facilities assessed in this study lacked basic and essential equipment and supplies, all of which were required for the successful management of PE/E. As a consequence, these facilities were functionally incapable of detecting, preventing or treating PE/E. Also, almost half of facilities did not have MgSO<sub>4</sub> in stock. Continuous availability of MgSO<sub>4</sub> is critical to arrest convulsions in eclampsia and to prevent progression from severe pre-eclampsia to eclampsia with more fatal outcomes for mothers and newborns [14, 18, 20, 27]. The predictable availability of adequate equipment, supplies and drugs has been suggested as important factors for the effectiveness of the management of obstetric complications [12]. Ensuring availability of essential equipment and supplies including MgSO<sub>4</sub> will contribute to reducing maternal mortality in the country.

Our study showed that few providers had received technical support or supportive supervision on prevention and treatment of PE/E. Lack of supportive supervision might partly explain the inadequate knowledge among respondent providers on how to identify, prevent and promptly treat PE/E. Similar findings related to lack

of supportive supervision were reported by other studies [28]. The study results underscore the need to strengthen supportive supervision including frequent supervisory visits to facilities to promote on-the-job training, provide support towards continuous quality improvement, and more importantly to serve as a tool to strengthen the local health system.

Infrastructure-related factors such as lack of electricity and water were reported as significant barriers to service provision in the management of PE/E. Such structural barriers to care account in large part for health workers' inability to provide quality care [29]. Similar findings were reported in a recent systematic review of the causes of the "third delay" (i.e. delay in receiving adequate and appropriate care once the patient is in a facility) in maternal health [30]. Therefore, strategies to address infrastructure in rural health systems must be aggressively pursued.

In Nigeria, the policy environment already promotes providers' use of MgSO<sub>4</sub> in the management of severe PE/E with up-to-date clinical protocols and national guidelines in place; MgSO<sub>4</sub> is included in the national MNCH essential drug list [18, 19]. However, this study showed that the majority of the surveyed health facilities did not have clinical protocols and guidelines in place. Studies have shown that inappropriate policies or lack of clinical protocols contribute to providers' lack of competence and confidence in the use of MgSO<sub>4</sub> in the management of severe PE/E [31]. Access to treatment protocols and guidelines will increase the likelihood that PE/E is effectively and efficiently managed as long as care providers use them appropriately. There is also the added advantage that clinical protocols and national guidelines can be used to guide the provision of technical and/or supportive supervision.

While this study identified several service provider and facility level barriers to the use of MgSO<sub>4</sub> in the management of PE/E, the goal of reducing maternal morbidity and mortality also requires intervention beyond health facilities. Similar to previous findings in Nigeria [9], the study identified community factors related to health seeking behaviour preventing early management of PE/E such as women presenting with complicated cases belatedly at facilities as a result of the belief that bad spirits caused convulsions. Community education through mass media and community-based health workers can improve community awareness of the warning symptoms and signs of eclampsia, such as headache, visual disturbances, and epigastric pain and can weaken beliefs that PE/E signs are caused by witchcraft or bad spirit. Moreover, these communication channels can be used to improve health-seeking behaviors including ANC attendance and facility-based child delivery, as well as promptly seeking for care when women experience symptoms suggestive

of PE/E [32–34]. The health promotion and counseling roles of frontline health workers in Bauchi and Sokoto States, who are well placed to engender community trust, should be strengthened through re-training, the provision of appropriate kits, and the provision of supportive supervision.

The strengths of this study include the use of mixed methods and data triangulation techniques for better understanding of enabling factors and barriers on the use of MgSO<sub>4</sub>. This study has some limitations. It is cross-sectional in design and is unable to deduce causality between the variables of interest. The community perceptions of the barriers to accessing pre-eclampsia care were supplied by facility managers and not from the women in the communities, albeit that the former tended to be well-informed about such perceptions.

## Conclusions

The study demonstrated the presence of multifactorial challenges faced by facilities in Northern Nigeria in the provision of quality and essential services for the management of PE/E. Furthermore, the analyses showed that a whole system approach that focuses on key building blocks of the health system elements is likely to contribute more effectively and efficiently to improvements in the management of complicated obstetric cases. Therefore, interventions proposed to improve the management of PE/E in facilities should consider the administrative and structural context in which health workers operate. Future programs ought to include training of service providers on PE/E management and ensure regular post-training supportive supervision, assure the continuous availability of MgSO<sub>4</sub> and functioning equipment needed for the management of PE/E in all facilities. Such programmes should also ensure the availability and correct use of protocols for management of eclampsia, address other organizational barriers for the provision of quality health services such as shortage of staff, inadequate power and water supply and sensitize religious and village leaders on the advantages of facility-based child delivery to women, children, and communities.

## Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

OO, ZC, MC, WS contributed to the research design, analysis and drafting of the paper. OO, NL, SED contributed to study implementation and review of the paper. HS, KS, AK contributed to research design and review of the paper. NO contributed to drafting and critical review of the paper. All authors read and approved the final manuscript.

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