Pulmonary rehabilitation across Africa: A continental evaluation of healthcare providers' awareness, availability and utilisation, and barriers to access

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Background. In Africa, with a high burden of chronic obstructive pulmonary disease (COPD), access to medication and availability and use of pulmonary rehabilitation (PR) intervention, including awareness of its effectiveness, remain limited.
Objectives. To evaluate the extent of clinical awareness and knowledge of and support for PR among healthcare providers, and to identify barriers to PR in Africa.
Methods. A comprehensive electronic survey was conducted to assess healthcare providers (HCPs)' beliefs about, knowledge, awareness and utilisation of, and access to PR in Africa, to inform strategies and policies for improved COPD prevention. The survey was adapted and validated for the African context through expert review and pilot testing with regional practitioners. It was then distributed to HCPs in clinical practice through the networks of the South African Thoracic Society and the Pan African Thoracic Society across Africa.
Results. Data were received from 108 HCPs representing diverse disciplines across rural and urban locations in 23 African countries (response rate 56%). The median (interquartile range) age was 41.0 (37.0 - 48.5) years, with no significant differences between the locations. Almost all the HCPs (98%) acknowledged the necessity of PR for severe pulmonary disease, and 58% expressed the need to improve their knowledge and skills in this area. Significant barriers such as under-reporting of symptoms by patients (74%) and a lack of easy access to spirometry (53%) were reported, hindering access to and diagnosis and rehabilitation of patients with COPD.
Conclusion. The substantial awareness and recognition of PR as an effective intervention for COPD and other chronic lung diseases across Africa is remarkable. It could indicate the feasible benefits that HCPs attach to implementing comprehensive PR in African settings. Equipping all HCPs with the requisite skills to implement an effective, locally acceptable PR programme will mitigate the burden of COPD in Africa.
Keywords. Pulmonary rehabilitation, Africa, COPD.

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Study synopsis
What the study adds. There is a paucity of recent studies in Africa that have addressed healthcare providers (HCPs)' knowledge of, attitudes to and beliefs about pulmonary rehabilitation (PR) or PR-related care activities. This study addresses that lack.
Implications of the findings. The increasing recognition and acknowledgment of PR as a highly effective intervention for chronic obstructive respiratory disease and other chronic lung diseases across Africa is truly notable. It reflects the potential benefits that HCPs associate with implementing a comprehensive PR programme in African settings. Equipping all HCPs with the necessary skills to set up effective, locally accepted PR programmes will alleviate the burden of COPD in Africa.

It is important to recognise the rising concern of pulmonary diseases, which are widespread causes of morbidity and mortality globally.[1] Chronic respiratory diseases, both obstructive and restrictive, including asthma, post-tuberculosis lung disease, bronchiectasis and pulmonary fibrosis, are on the rise and have a significant impact on public health. Chronic obstructive pulmonary disease (COPD) is the most common chronic respiratory disease, with an exponentially increasing global prevalence of 12.2%.[1] COPD currently affects ~65 million people, resulting in ~3 million deaths annually.[2] The burden of COPD is high, and the World Health Organization estimated a rise in COPD mortality from the fourth leading cause of death in 2004 to the third leading cause by 2030, with ~90% of the morbidity and mortality related to COPD occurring in low- to middle-income countries (LMICs).[1,3] Unfortunately there are significant gaps in COPD prevention and management in LMIC settings, including understanding of its diagnosis, treatment and prevention.[3,4]

COPD remains underdiagnosed and untreated in most countries, particularly LMICs, partly owing to low diagnostic capacity and inadequate therapy compared with high-income countries,[4] and causes respiratory morbidity in addition to that from historically prevalent infectious diseases such as pneumonia and tuberculosis.[5] The burden of non-communicable diseases, particularly COPD and post-tuberculosis lung disease, has increased in LMICs, including those in Africa.[5,6] Management efforts to contend with this increased burden on LMICs are mainly directed towards pharmacological treatment, but some patients may require hospitalisation for various reasons, including severity of symptoms, failure to respond to initial treatment, poor or low-resourced home-based care, and the presence of comorbidities, which are long-term conditions associated with disabilities.[5,7] This situation highlights the need to address the rising burden of pulmonary diseases in LMICs, including improved access to diagnostic tools and effective therapy.

It is imperative that healthcare providers (HCPs) explore the optimal combination of pharmacological and non-pharmacological treatment strategies, including lifestyle changes, to manage COPD effectively. While clinical guidelines for managing COPD provide evidence-based recommendations, significant gaps still exist in their implementation.[8] For instance, pulmonary rehabilitation (PR) has emerged as a general standard of care for patients with chronic lung disease, based on a growing body of scientific evidence.[9] However, there are some known barriers to implementing PR in low-resource settings, such as limited resources, lack of awareness, and patient-related costs.[10-12]

PR, as defined by the American Thoracic Society and the European Respiratory Society, encompasses a 'comprehensive intervention tailored to the individual patient, including exercise training, education, and behavior change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence of health-enhancing behaviors'.[12] PR has been shown to have physiological, symptom-reducing, psychosocial and health-economic benefits for patients with chronic respiratory diseases.[13] As such, it is recommended as a standard of care alongside other well-established non-pharmacological interventions such as smoking cessation, reduction of other risk factors (e.g. exposure to open cooking fires), and influenza vaccination.[14-17]

PR is considered a critical and integral component of integrated patient management and usually involves a range of HCPs to ensure optimal outcomes.[17,18] The multidisciplinary team commonly consists of pulmonologists, physical medicine specialists, social workers, psychologists, nurses, respiratory therapists, occupational therapists, physiotherapists, general practitioners, pharmacists and dieticians.[17] Even with the existing level of evidence, PR needs to be more utilised worldwide.[17] A lack of resources, funding and reimbursement coupled with a lack of HCPs, payer and patient awareness and knowledge has contributed to the gap between understanding and delivery to suitable patients.[13,17,19]

In Africa, there is very limited empirical evidence of the utility and availability of PR. A systematic review that synthesised the evidence and efficacy of PR in sub-Saharan Africa between 1997 and 2019 only obtained data from three countries in the region,[20] underscoring the need for more evidence-based research and an understanding of Africa's barriers to PR implementation. The present study aimed to explore clinical awareness, knowledge and utilisation of PR implementation among HCPs actively involved in respiratory care across Africa, and barriers to implementation experienced by them.

Methods

An electronic survey was developed for distribution to African clinicians within the networks of the Pan African Thoracic Society (PATS) and the South African Thoracic Society (SATS), prior to the COVID-19 outbreak in 2020. The survey was adapted from a previous questionnaire by Yawn *et al.*,[21] validated in the USA and tailored to an African context. Terminology specific to the USA was adapted; for example, a term such as 'pulmonologists' was replaced by 'chest physicians' or 'respiratory specialists', more commonly used across Africa. We also added specific questions relating to resource constraints, such as access to spirometry. Prior to deployment of the questionnaire, content review was conducted by colleagues from across Africa (Uganda, South Africa (SA), Malawi) and the questionnaire was piloted with eight HCPs from four different countries (SA, Malawi, Uganda and Nigeria). Minor changes were made to questions that were perceived to be unclear. The survey was conducted as a qualitative/descriptive study, with no answer scores etc. applied.

An email invitation was distributed through the channels of the PATS, the SATS and allied networks. This email outlined the background and aims of the study, and the hypothesis, research questions and potential implications. If the HCPs decided to take part, their participation would be anonymous, with only age and country of practice being discernible personal identifiers. The University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee (ref. no. HREC 863/2019) approved the study. Two reminder emails were sent at 2-week intervals, and inclusion was finally closed off after 8 weeks. The inclusion criteria were active membership in PATS and/or SATS, with current involvement in respiratory care and working in an African healthcare setting. The primary hypothesis tested was that the value of PR would be well recognised, but knowledge about and implementation of effective PR would be variable and limited by specialty.

The questionnaire included demographic information: specialty, age, gender, and additional practice-related information, including practice site (urban, suburban/rural) and practice location (country). Specific questions about PR included whether the HCPs had access to PR and whether they had access to PR guidelines. It further queried

whether they utilised spirometry in their respective practices and whether lack of PR knowledge was a barrier.

A second set of questions interrogated participants' knowledge of COPD treatments, including whether treatments were effective for symptom improvement, decreased exacerbations, and improved longevity in patients with pulmonary disease. A third set of questions interrogated the tests and factors that respondents deemed essential in making a diagnosis of COPD. These included having access to chest radiographs, a trial of corticosteroids coupled with whether patients had ready access to a trial of bronchodilators, and whether the clinician had the means to screen for alpha-1 antitrypsin deficiency. A fourth and last set of questions interrogated respondents' perceived barriers, attitudes and beliefs. Barriers related to pulmonary diseases and their treatment included differentiation in symptoms, the effectiveness of treatment, and the impact of making a diagnosis. In addition, we interrogated ease of accessing spirometry to ascertain whether limited access hampers the ability to diagnose and rehabilitate patients.

Data analysis

We conducted a comprehensive statistical analysis using Statistica 14.0.0 (Tibco Software, USA). While the sample size of 108 respondents imposes some limitations, power calculations indicated adequate power (80%) to detect minimum effect sizes (Cohen's $d \geq 0.5$) for primary outcomes. The analysis included descriptive statistics with 95% confidence intervals, χ^2 tests with Fisher's exact test for small cell counts, non-parametric tests for continuous variables, and multivariate analysis to adjust for key confounders. To address the sample size limitations, we used conservative statistical approaches focused on effect sizes alongside *p*-values and applied appropriate corrections for multiple comparisons. This process facilitated reliable conclusions despite the sample size constraints, while acknowledging the limitations outlined in the discussion section below.

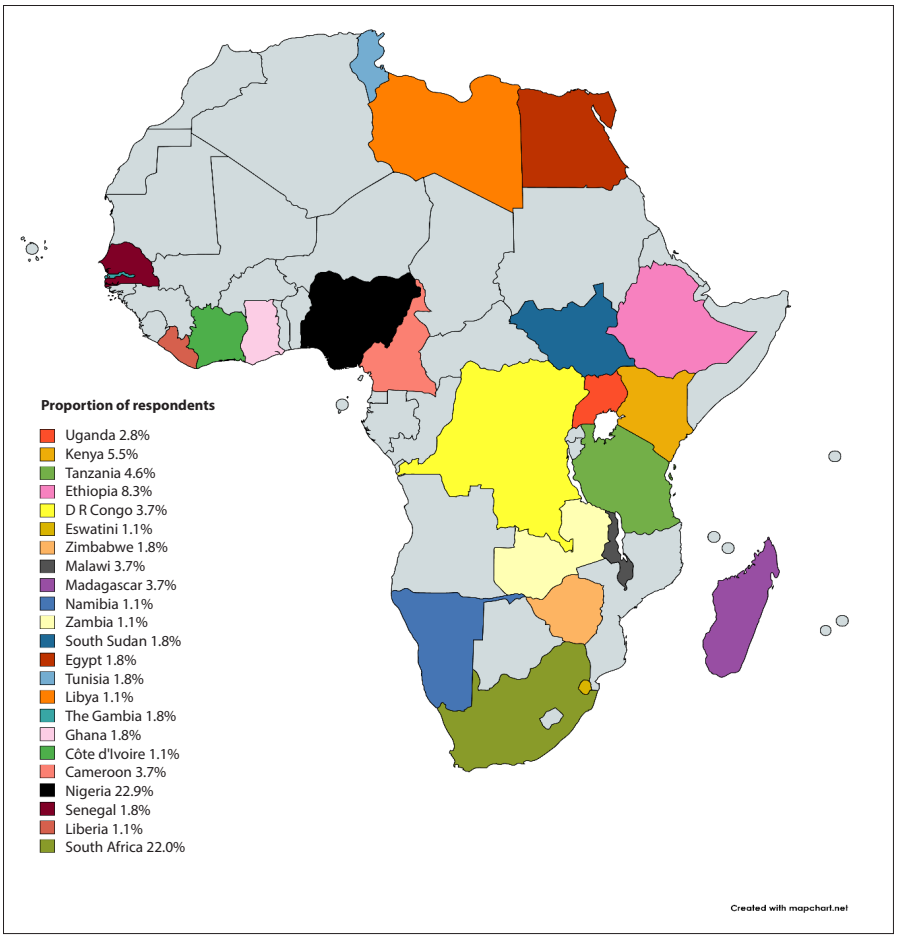

Fig. 1. Distribution of respondents across countries in Africa (created with MapChart.net).

Table 1. Healthcare providers' characteristics and access to resources

Variable	Combined (*N*=108), *n* (%)*	Urban (*n*=94), *n* (%)*	Suburban/rural (*n*=14), *n* (%)*	*p*-value
Age (years), median (IQR)	41.0 (37.0 - 48.5)	41.0 (37.0 - 48.5)	45.0 (36.0 - 48.0)	0.706
Access to PR resources				
Practice guidelines	85 (78.7)	72 (76.6)	13 (92.9)	0.166
Equipment and facilities	51 (47.2)	43 (45.7)	8 (57.1)	0.425
Spirometry usage	83 (76.9)	72 (76.6)	11 (78.6)	0.870
Knowledge gap reported	63 (58.3)	55 (58.5)	8 (57.1)	0.923

*Except where otherwise indicated.

Table 2. Healthcare providers' professional categories (*N*=108)

Professional category	*n* (%)	Profession
Clinical specialists	42 (38.9)	Pulmonology, internal medicine, primary care
Allied health	38 (35.2)	Physiotherapy, respiratory therapy, rehabilitation
Public health/research	28 (25.9)	Public health, research, medical education

Table 3. Professions of the healthcare providers distributed across the Africa region

Profession	*n*
Allergist	1
Allied health worker	1
Cardiothoracic surgeon	3
Chest physician	1
Clinical exercise physiologist	1
Clinician	1
Clinician and public health practitioner	1
Consultant physician	1
Consultant pulmonologist	1
Medical doctor	24
General practitioner	1
Health expert and advocate	1
Internal medicine doctor	1
Internist, pulmonary and critical care subspecialist	1
Medical doctor (paediatrician)	1
Medical educator (paediatrician and lecturer)	1
Medical practitioner	1
Medical public health physician	1
Nurse	4
Nurse specialist in anaesthesia and critical care	1
Occupational medicine specialist	2
Paediatrician	1
Paediatric pulmonologist	2
Paediatric pulmonologist and critical care	1
Person-centred care management	1
Pharmacist	1
Physician	7
Physiatrist (physical medicine and rehab)	1
Physician: physiology and functional explorations	1
Physiotherapist	10
Pneumonologist	1
Private respiratory nurse practitioner	1
Public health	1
Public health clinical specialist	1
Public health epidemiologist	1
Public health physician	1
Public health specialist	2
Pulmonary and critical care physician	2
Pulmonologist	17
Research assistant	1
Research and clinician	1
Researcher	1
Respiratory physiotherapist	1
Respiratory therapist/respiratory physiotherapist	1
University professor	1
Total	108

Results

The survey received 110 responses from 196 PATS and SATS practitioners (response rate 56%). After excluding two incomplete responses, we analysed data from 108 HCPs across 23 African countries.

HCP characteristics and resource access

The median (interquartile range) age of the participants was 41.0 (37.0 - 48.5) years, with no significant differences between the urban and suburban/rural locations. The data presented in Table 1 reveal significant disparities in access to PR resources across Africa. While over two-thirds of HCPs (79%) had access to PR guidelines, less than half (47%) had access to PR equipment and facilities. The disparity between theoretical knowledge and practical resources was consistent across both the urban and rural settings, with no statistically significant differences noted ($p>0.05$). A noteworthy finding was that despite resource constraints, the majority of the HCPs (77%) reported utilising spirometry and maintaining its use in their practice, demonstrating a resilience and commitment to diagnostic standards on the continent. Furthermore, the prevalence of reporting knowledge gaps (58%) underscores a clear need for additional professional development in PR implementation in the region.

HCP distribution by professional category

The 108 HCPs were distributed across 23 African countries and represented more than 30 professions (Fig. 1 and Tables 2 and 3).

The professional distribution of the respondents highlights a balanced representation across HCP disciplines. Clinical specialists comprised the largest group at 39%, followed closely by allied health professionals at 35% and public health/research at 26%. The distribution shows the multidisciplinary nature of PR delivery in African settings. The balanced representation across the categories strengthens the study findings by incorporating diverse professional perspectives and expertise levels. The high proportion of specialists suggests that PR knowledge is concentrated among highly trained practitioners, potentially limiting its broader implementation across the healthcare tiers.

The geographical distribution is summarised as follows: southern Africa 45%, East Africa 25%, West Africa 20%, and North Africa 10%.

Treatment perceptions and practice barriers

Treatment perceptions (Table 4) indicate remarkably high confidence in PR effectiveness, with almost universal agreement (99%) on its role in reducing exacerbations. However, there are significant implementation barriers, including symptom under-reporting by patients (74%). The rural-urban comparisons reveal unique and interesting patterns, with rural practitioners reporting higher access to trials of bronchodilators (100% v. 78% in urban settings; $p=0.049$), although facing similar barriers in resource constraints. The data reveal and suggest that while healthcare providers strongly believe in PR benefits, practical implementation challenges remain substantial across all settings, with resource limitations affecting rural and urban practices similarly. Furthermore, most HCPs emphasised the necessity for PR for patients with pulmonary diseases (97%), with 87% sharing the belief that these treatments contribute to reduced patient mortality.

Discussion

The survey results reveal substantial awareness and recognition of the value of PR among HCPs from 23 African countries. This awareness highlights the potential for PR implementation if HCPs are provided with appropriate capacity development.

Table 4. Treatment perceptions and practice barriers

Aspect	Overall agreement (%)	Urban (%)	Suburban/rural (%)	*p*-value
Treatment effectiveness				
Symptom improvement	87	86	92	0.594
Exacerbation reduction	99	99	100	0.695
Mortality benefit	87	87	83	0.702
Implementation barriers				
Resource limitations	53	54	43	0.460
Symptom under-reporting	74	74	71	0.852
Multiple comorbidities	71	74	50	0.062

The HCPs indicated strong confidence in the clinical benefits of PR, with 87% reporting and affirming its effectiveness for symptom management and 99% reporting reduction of exacerbations. These positive perceptions align with international evidence supporting PR effectiveness.[22,23]

Implementation challenges

Our study identified barriers of which the removal is key to PR implementation in African healthcare settings. Resource constraints present the major challenge, with 53% of respondents having limited access to essential medical equipment, medications and trained personnel. This situation contrasts with higher-resourced settings such as the USA, where infrastructure availability typically exceeds 80%.[23] These disparities underscore the need for context-specific solutions in African healthcare systems. While mirroring the challenges reported in other developing regions, they require Africa-centric solutions that consider local healthcare infrastructure and resources. [10,20,24,25]

Clinical practice implications

Key findings have direct implications for clinical practice improvement. They include:

- **Provider education.** Despite a high awareness of the value of PR, 59% of the HCPs identified gaps in the implementation of PR and expressed the need to improve their knowledge and skills. This finding underscores the crucial need for targeted HCP programmes, empowering HCPs with the knowledge and skills necessary for effective PR implementation.
- **Patient engagement.** The high rate of symptom under-reporting (74%) highlights the need for enhanced education and communication strategies for patients. This finding underscores the importance of empathy in healthcare, especially on a diverse continent such as Africa that has more than 2 500 langauages, where cultural and linguistic considerations should inform these efforts.
- **Resource optimisation.** Limited PR equipment and access suggest a need for innovative approaches to maximise the few available resources. This finding presents an opportunity to co-create and co-design culturally appropriate PR interventions through citizen science, paving the way for a more resource-efficient healthcare system.

Study limitations and strengths

This survey, like all surveys, has its limitations. It was primarily distributed to the HCPs within the SATS and PATS network, potentially missing perspectives from more isolated healthcare settings. The survey content was focused on the medical aspects of diagnosis and treatment, overlooking important barriers to utilisation and accessibility. These include the lack of knowledge or access to evaluation tools that allow for a comprehensive patient assessment. To address this deficiency, we need to ask more comprehensive questions that delve into the specifics of HCPs' lack of access to or ability to provide PR. This information will help us to avoid broad generalisations and provide more nuanced insights.

The survey also did not query information about practices regarding taking an exacerbation history, evaluating the disease-specific symptom burden, evaluating symptoms of anxiety and depression, evaluating components of physical fitness (muscle function, exercise capacity), and capturing (impairments in) participation in daily physical activity.

The study has several limitations that should be considered when interpreting the findings. First, the response rate of 56% (n=108/196), while reasonable for survey research, means that a substantial portion of potential participants did not respond. We were unable to conduct a formal analysis comparing characteristics of responders and non-responders owing to limited access to comprehensive non-responder data, which introduces the possibility of response bias, particularly as we suspect that HCPs from rural settings may be under-represented in our sample. Rural practitioners constituted only 13% of respondents, despite the known high proportion of rural healthcare facilities across Africa. This potential under-representation is significant, because rural practitioners are likely to face unique challenges in implementing PR programmes that may not be fully captured in our results.

The rural-urban disparity in representation may have important implications for our findings on barriers to PR implementation. Rural healthcare settings typically have more limited resources, fewer specialist providers, and greater logistical challenges in programme implementation. Without adequate representation of these perspectives, our understanding of the full spectrum of implementation barriers across different African healthcare contexts remains incomplete. Future studies should employ stratified sampling approaches with targeted recruitment strategies to ensure adequate representation of practitioners across all practice settings, particularly those in rural and remote areas.

Additionally, our sample primarily comprised members of professional organisations (PATS and SATS), who may have different knowledge levels, resources and attitudes towards PR compared with non-member HCPs. The nature of the sample limits generalisability of our findings to the broader healthcare workforce across Africa.

Future research would benefit from including practitioners from diverse professional backgrounds and affiliations to provide a more comprehensive picture of PR awareness and implementation across the continent.

A notable limitation of our study is our analytical approach to examining the differences between rural and urban healthcare settings. While we presented findings based on geographical distinctions (rural v. urban), the small rural sample size (n=14) relative to urban practitioners (n=94) restricts our ability to draw definitive conclusions regarding disparities in PR knowledge and implementation.

Furthermore, limitations in our dataset hindered robust statistical comparisons across professional categories. In attempts to stratify the data by both professional category and geographical location, the rural sample sizes often became so small, sometimes just one or two practitioners per category, that meaningful comparisons were not feasible. This constraint limits our understanding of which professional groups face the most significant challenges in rural settings and impedes the development of targeted interventions.

Although we present the data by geographical setting (urban, suburban/rural) in Table 1, a more nuanced analysis that incorporates professional categorisation would yield deeper insights. Future studies should utilise purposive sampling strategies to ensure adequate representation across both professional categories and geographical contexts. This approach will enable researchers to identify specific groups requiring tailored support, ultimately guiding the development of effective interventions to address disparities in PR across diverse African healthcare environments.

Additional limitations, despite our response rate of 56%, include self-reporting bias. These biases are inherent in survey-type research, and especially across an entire continent. We were encouraged that our responders provided both positive and negative responses. However, it is not possible to determine the reasons for non-response, be they positive or negative towards PR.

The goal of this study was to understand the context of those engaged actively in the pulmonology community, who would therefore be likely to be up to date and enthusiastic about novel interventions. It is probable that those who did not respond would have less knowledge and less access, and hence have limited interest in completing the survey. The picture may therefore be worse than we describe. We consider it unlikely that those who are enthusiastic with limited obstacles would not respond, given their positive attitude. For more detailed understanding, future studies could employ stratified sampling approaches with targeted recruitment strategies. Given the large variation in self-described professional categories, subgroup analysis by profession was not possible owing to small numbers.

Despite these limitations, the positive enthusiasm for PR among the surveyed HCPs is encouraging. With some support and investment, PR could become a reality in many settings. It is also important to acknowledge the diversity and nuances across the African continent, which has 54 countries, and to interpret the data cautiously without generalising or relying solely on the 'mean data'.

Conclusion

The substantial awareness and recognition of PR as an effective intervention for COPD and other chronic lung diseases across Africa is remarkable. The wide and diverse range of respondents from 23 African countries could indicate the feasibility of implementing a multidisciplinary approach to deliver PR for equitable access to COPD management in Africa. Despite the existing barriers, equipping all HCPs with the requisite skills to implement an effective, locally acceptable PR programme will significantly impact on patients with COPD and mitigate the high burden of COPD in Africa.

Data availability. The datasets generated and analysed during the present study are available from the corresponding author (MI) on reasonable request.
Declaration. None.
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Author contributions. Study design was undertaken by MI, RNvZ-S and KJO. Data collection was conducted by JG, KD, RNvZ-S, MI, FMB, JR and EA, while data analysis was performed by MI, JG, RNvZ-S, KJO, EA and KD. All authors played integral roles in the preparation and review of the manuscript.
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