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Assessment of the Physical Capabilities of Heart Failure Patients before and after Cardiovascular Rehabilitation: A Study of 125 Patients from West Africa, Dakar, Senegal

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Abstract

Background: Cardiac rehabilitation represents a critical therapeutic strategy for patients suffering from chronic heart failure. The physical capacity of patients with heart failure, assessed using the exercise test and the 6-minute walk test, is the measure of the patient's overall functional ability to perform physical activities and tolerate exercise loads. The objective of this study was to assess the impact of cardiac rehabilitation on patients' physical capabilities and to conduct a thorough comparison of data obtained via exercise testing and the 6-minute walk test before and after the rehabilitation programme. **Methods:** This was a descriptive and analytical cross-sectional study, conducted from 1 February 2021 to 31 June 2022. Included were heart failure patients who had participated in an outpatient cardiovascular rehabilitation programme. The collected data included anamnestic, clinical, paraclinical data, and the 6-minute walk test. Informed consent was obtained. Data analysis, word processing, and charting were performed using Microsoft Word 2016, Excel 2013, and Sphinx version 5.1.0.2. Data analysis was performed using SPSS (Statistical Package for Social Sciences) version 24.0. Any difference less than 0.05 was considered statistically significant. **Results:** In a Senegalese study, heart failure patients undergoing rehabilitation in a cardiac unit represented 45.59% of all cases, with a prevalence rate of 3.21%. The average participant was 57.97 years old, with those aged 61 to 70 forming the largest group (35.5%). The study noted a male predominance (sex ratio of 2.1) and

identified dyslipidaemia (80.6%) and sedentarism (71%), as prevalent cardiovascular risk factors. All participants initially suffered from NYHA stage 2 or 3 dyspnoea, yet 80.65% showed no symptoms following rehabilitation. Significant improvements were recorded in resting heart rate (from 79 to 67 bpm), and the 6-minute walk test distance (from 328 m to 470 m). Enhanced exercise tolerance and walking test outcomes were particularly notable in patients with LVEF ≥ 50%, women, non-obese individuals, those initially walking less than 300 m, achieving more than 3 METs, and non-smokers. **Conclusion:** The findings underscore the effectiveness of cardiovascular rehabilitation in improving symptoms, physical capability, and overall quality of life for heart failure patients in Senegal.

Keywords

Cardiovascular Rehabilitation, Heart Failure, Physical Capabilities, Quality of Life Improvement, West Africa

1. Introduction

Heart failure is a chronic, serious condition and represents the usual progression of many cardiac diseases. It is defined as a clinical syndrome characterised by symptoms and physical signs caused by a structural and/or functional cardiac abnormality, leading to a decrease in cardiac output and/or an increase in intracardiac pressures at rest or during stress [1].

The overall incidence is notable, with approximately two million new cases identified annually worldwide, and nearly 3.5 million annual consultations attributable to this pathology [2]. Its heterogeneity stems from various aetiologies, a wide range of clinical manifestations, and a variable prognosis. Heart failure is a pathology with significant morbidity and mortality and represents one of the main factors for the discovery of cardiovascular diseases. Despite progress in diagnostic and therapeutic approaches, the number of hospitalized patients increases every year. Early diagnosis plays a crucial role in reducing its morbidity. The therapeutic means available to the clinician are increasingly numerous, ranging from drug prescription and cardiovascular rehabilitation to left ventricular assist devices and heart transplantation.

The physical capacity of patients with heart failure, assessed using the exercise test and the 6-minute walk test, is defined as the measure of the patient's overall functional ability to perform physical activities and tolerate exercise loads.

Cardiac rehabilitation was developed around the 1960s and is defined by the WHO in 1993 as: "the sum of activities required to influence favourably the course of the disease; as well as to ensure to patients the best possible physical condition, so that they can, by their own efforts, preserve or resume as normal a position as possible in the community" [3]. It includes physical retraining (with learning of physical maintenance activities to be continued in the long term),

therapeutic optimisation (adjustment of treatment according to clinical tolerance at rest and during effort), therapeutic and dietary education, psychological support, control of cardiovascular risk factors, and social reintegration. According to a study published in 2014, it leads to a decrease in the rate of rehospitalisation of heart failure patients at 12 months and an improvement in the quality of life and mortality in the longer term [4]. Also, according to a study conducted in Burkina Faso in 2013, the physical capacity of heart failure patients is significantly impaired compared to the general population and remains so after six (06) weeks of follow-up in the absence of cardiac rehabilitation, hence the importance of its prescription [5].

However, in Africa, there is still a lack of real epidemiological data to estimate the beneficial effects of rehabilitation, which is nevertheless increasingly prescribed. In Senegal, the few studies conducted on cardiovascular rehabilitation mainly concerned coronary patients. It is in this context that we decided to conduct this study, the objectives of which were to evaluate the effects of cardiac rehabilitation on the clinical state of heart failure patients, physical capacities, and to compare the parameters of the exercise test, the 6-minute walk test, and cardiac echography before and after cardiac rehabilitation.

2. Methodology

This was a single-centre cross-sectional, descriptive, analytical study with retrospective and prospective data collection. The study took place in the cardiac rehabilitation unit of the General Hospital Idrissa POUYE in Dakar, Senegal, over the period from 1 February 2021 to 30 June 2022. Patients were selected using a consecutive sampling method among those meeting the inclusion criteria after hospitalization in the cardiology department of Idrissa Pouye General Hospital. The inclusion criteria comprised all stable heart failure patients with reduced or preserved ejection fraction (EF), aged at least 18 years, of all etiologies, who had benefited from at least 15 sessions of physical retraining.

This initial evaluation allowed for the stratification of the patient's evolutionary risk and the adaptation of the modalities and monitoring of cardiac rehabilitation. The exercise test, which measures the patient's cardiovascular and respiratory performance during progressive physical exertion, was performed on a treadmill according to the Bruce protocol. It allowed for the evaluation of parameters such as the retraining level, the number of METS, the maximum theoretical frequency (MTF) reached, the initial load, blood pressure, resting heart rate, and maximal effort heart rate (max HR), and the calculation of the retraining heart rate (RHR) according to the Karvonen formula. As for the 6-minute walk test, which evaluates a patient's functional endurance and walking capacity by measuring the distance covered in 6 minutes, it was conducted in a 50 m corridor. This test provided us with information on exercise tolerance, the ability to maintain moderate physical effort over a prolonged period, and the efficiency of blood circulation and muscle function during walking.

We studied socio-demographic aspects, cardiovascular risk factors, clinical data, transthoracic echocardiography, exercise testing, and the 6-minute walk test. These different parameters were collected based on a questionnaire and collected in an exploitation sheet. The survey form was validated by an expert committee consisting of three cardiologists specialised in cardiovascular rehabilitation and an epidemiologist.

The retraining protocol used was three sessions per week, each retraining session on a bicycle and/or treadmill divided into an endurance phase of 30 to 45 minutes preceded by a warm-up phase of 3 to 5 minutes and followed by a recovery phase of 3 to 5 minutes. Then, the patient practised gymnastics for 30 to 45 minutes.

This work was carried out in collaboration with the hospital's management after obtaining the approval of the cardiology service by signing the access sheet to patients' records. An information note was drafted for the patients, summarising the study made available to each patient. The two-page information letter mentioned the title, objectives, target, duration, number of patients to include, the advantages and disadvantages of the survey, and the contact details of the survey leaders. Written consent was obtained, those who refused to participate in the study were excluded, and this did not impact their care and follow-up in the cardiac rehabilitation unit. All patients were informed of the confidential nature of the study.

Data analysis, word processing, and charting were performed using Microsoft Word 2016, Excel 2013, and Sphinx version 5.1.0.2. Data analysis was performed using SPSS (Statistical Package for Social Sciences) version 24.0. Qualitative variables were expressed as proportions (percentages), and quantitative variables as mean ± standard deviation. A difference was considered statistically significant if the p-value was less than 0.05.

3. Results

In the context of our observational study, we enrolled 125 patients admitted in a hospital setting, representing an incidence of 3.21% of all admissions to the cardiology department and a specific prevalence of 45.59% within the cardiovascular rehabilitation unit. The average age of the study population was 57.97 ± 9.83 years. The most represented age group was between 61 to 70 years, with 35.5% of patients. There was a clear male predominance with a sex ratio of 2.1. The majority of patients (55%) resided in Dakar. Regarding the socio-economic aspect, a significant proportion of the studied population (74.20%) did not benefit from any specific financial coverage for their medical care, and a third (32.23%) was from the informal sector. The analysis of cardiovascular risk factors in our cohort revealed a predominance of dyslipidemia (80.6%), closely followed by sedentary lifestyle (71%) and advanced age (61.29%). Hypertension (HTA) was present in 41.90% of patients, diabetes in 38.70%, and smoking also in 38.70%. These factors were associated in most patients explaining the high cardiovascu-

lar risk levels in 48.39% of cases and very high in 35.48% of cases. Coronary artery disease was the main cause of HF with a rate of 80.65%.

The average time to start cardiac rehabilitation after hospitalisation was 44 days, with a maximum of 120 days and a minimum of 30 days. Thus, we observed a notable improvement in the general condition of the studied population at the end of rehabilitation, with 61.29% of patients classified in good general condition and 19.35% in excellent condition against none at the start. Regarding symptoms, all patients initially presented NYHA stage 2 or 3 dyspnoea, whereas at the end of the program, a majority (80.65%) reported no symptoms (**Figure 1**). In terms of anthropometry, the average weight slightly decreased, from 77.58 to 76.54 kg, without a significant change in the body mass index (BMI), perhaps reflecting a change in body composition rather than a simple weight loss. The variations in systolic and diastolic blood pressure were not statistically significant, but we noted a notable and significant reduction in average heart rate, from 79.23 to 67.06 bpm (p = 0.001), a reduction of 12 bpm (15%), indicating a possible improvement in cardiovascular condition and patient autonomy.

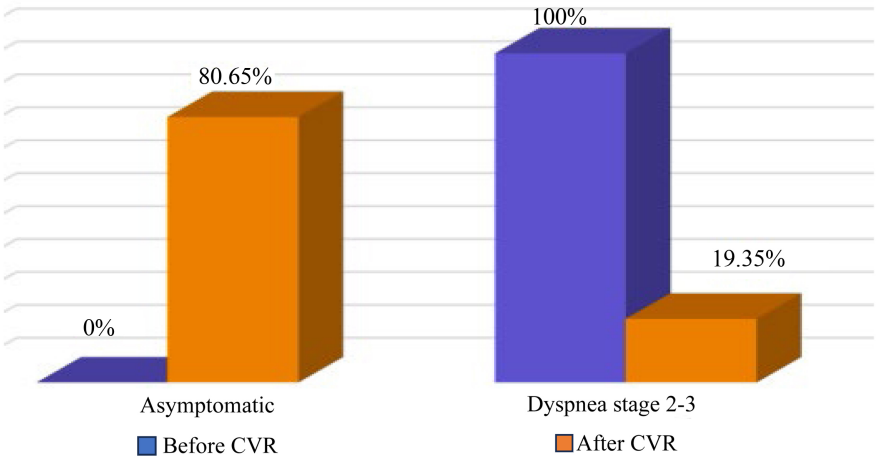

Figure 1. Symptoms experienced by patients before and after cardiovascular rehabilitation (n = 125).

The evaluation of the lipid profile revealed considerable improvement, with a significant reduction in LDL-cholesterol levels, from an average of 1.65 g/l to 0.98 g/l, (p = 0.001), reflecting the effectiveness of dietary and therapeutic interventions undertaken as part of rehabilitation. On echocardiography, we observed an improvement in systolic function with a significant increase in left ventricular ejection fraction ≤ 40% from 55.56% of patients to 25.92% at the end of rehabilitation (**Figure 2**).

Regarding functional capacity, assessed by exercise testing, we noted a substantial improvement in exercise tolerance, translated by an increase in the fraction of theoretical maximum oxygen consumption (FMT) which went from 76.63% to 83.87%, a gain of 7.16% (p = 0.001) and a reduction in exercise limitations with 87.10% of patients who had not reached 85% of the FMT during the

initial evaluation, against 48.38% at the end of rehabilitation. Rhythmically (Figure 3), at the end of rehabilitation, none of the patients presented a burst of ventricular tachycardia against 6.45% of patients at the beginning (Figure 4).

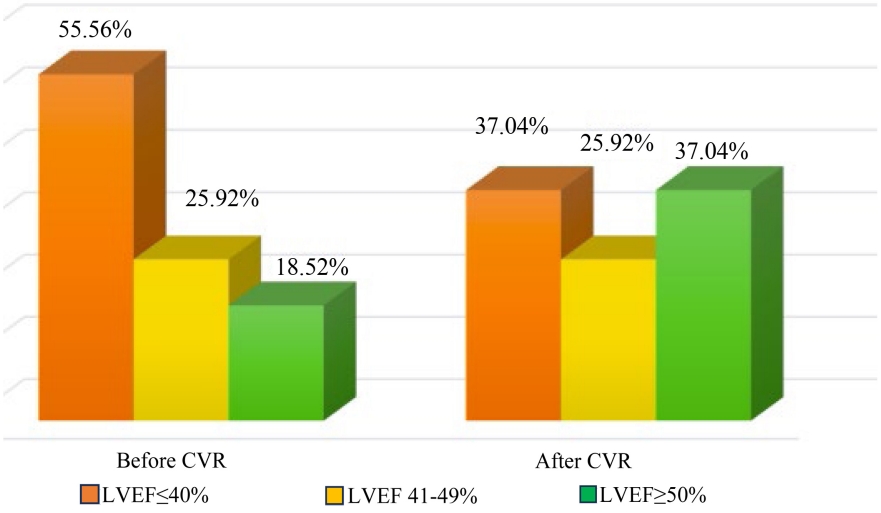

Figure 2. Comparison of LVEF (Left Ventricular Ejection Fraction) before and after cardiovascular rehabilitation (n = 125).

Figure 3. Distribution of the theoretical maximum frequency at the beginning and at the end of cardiovascular rehabilitation (n = 125).

Data from the 6-minute walk test showed a significant increase in the distance covered at the end of rehabilitation, with an average that went from 328 ± 119 m to 470.54 ± 136 m, an average increase in distance covered of 142.46 m (p = 0.001) (Figure 5).

The average METs went from 4.42 at the start to 7.48 at the end, an increase of 3.06 METs (69.23% p = 0.001) with 41.9% who had an increase ≥ 3 (Figure 6). The METs benefit was especially higher in cases of CMD, LVEF ≥ 50% at the

start, among women, individuals aged under 50 years, in cases of ischemic heart disease, among those who had covered a distance of less than 300 m at the start and those who had a capacity ≥ 3 METs at the start.

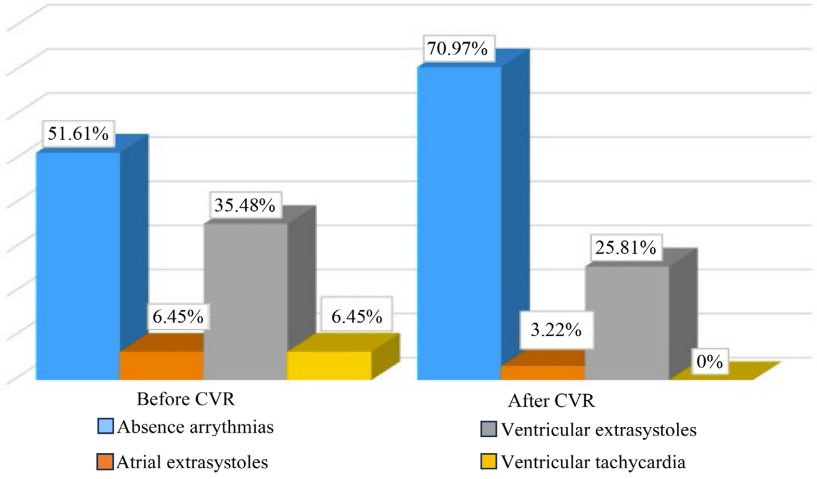

Figure 4. Distribution of arrhythmias during the exercise test at the initial and final evaluation (n = 125).

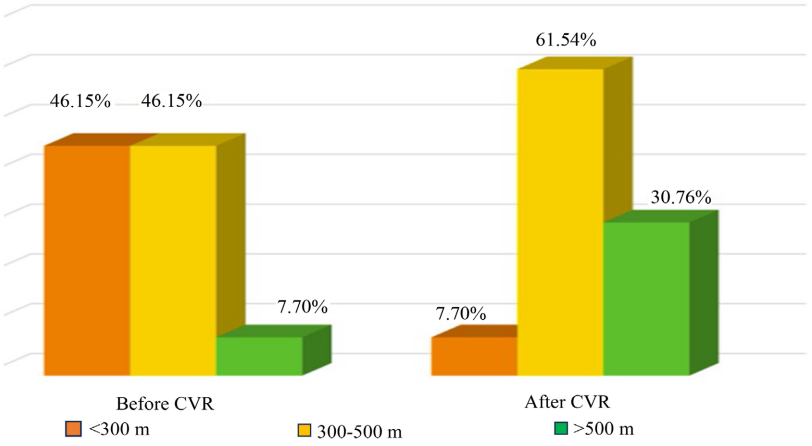

Figure 5. Comparison of the distances covered in the 6-minute walk test before and after cardiovascular rehabilitation (n = 125).

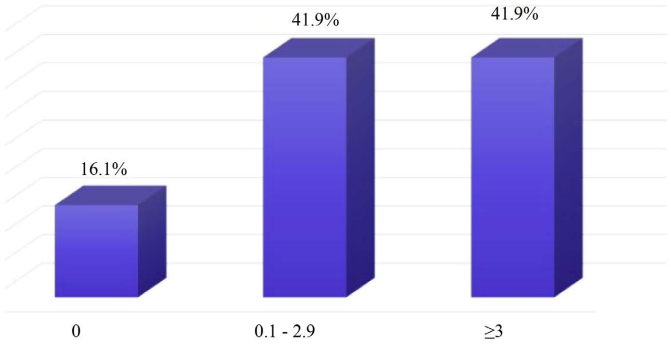

Figure 6. Distribution according to the number of METs gained after cardiovascular rehabilitation (n = 125).

In terms of progress, although the majority of patients showed improvement, one case of deterioration of LVEF with the appearance of an apical thrombus was reported. No deaths or rehospitalisations were observed during the follow-up period.

Table 1 summarizes the bivariate analyses with the Odds Ratios (OR) and Confidence Intervals (CI) and includes relevant variables such as sex, age, cardiovascular risk factors, and the outcomes before and after rehabilitation.

Table 1. Bivariate analysis table with odds ratios and confidence intervals.

Variable	Odds Ratios	95% Confidence Intervals	p-value
Sex (Male vs Female)	2.1	1.5 - 3.0	0.05
Age (≥61 years vs <61 years)	1.35	1.10 - 1.65	0.05
No Financial Coverage	1.50	1.20 - 1.90	0.05
Dyslipidemia	2.5	2.0 - 3.1	0.01
Sedentary Lifestyle	1.85	1.45 - 2.35	0.01
Hypertension	1.40	1.10 - 1.80	0.05
Diabetes	1.38	1.08 - 1.76	0.05
Smoking	1.38	1.08 - 1.76	0.05
General Condition Improvement	3.5	2.5 - 4.9	0.01
Improved Dyspnea (NYHA)	5.0	3.8 - 6.5	0.01
Average Heart Rate Reduction	4.0	3.0 - 5.3	0.001
LDL-C Reduction	2.0	1.5 - 2.6	0.001
Improved LVEF	2.5	1.9 - 3.3	0.01
Increased Distance in 6 MWT	3.0	2.3 - 4.0	0.001
Increased METs	3.5	2.6 - 4.7	0.001

4. Discussion

Our investigation explored various aspects of cardiovascular rehabilitation in a cohort of patients in Senegal, revealing significant insights while facing certain constraints. The absence of BNP levels, due to the high cost of the analysis for some of our patients, limited the scope of our conclusions.

In a comparative context, our participation rate in cardiovascular rehabilitation (CVR) of 3.21% over 17 months is significantly lower than the norms observed in Europe, where, according to the work of Birna Bjarnason-Wehrens, about 30% of eligible patients actually benefit from CVR on an outpatient basis [6]. This divergence highlights structural and socio-economic obstacles, notably the prohibitive cost of CVR sessions and logistical challenges specific to our geographical context and the fact that cardiac rehabilitation has only recently started at the HOGIP hospital (less than 2 years). According to a study published

in 2019, CVR was available in 80.7% of European countries and 17% of African countries. This confirms the significant delay of CVR on our continent [7].

The average age of our cohort was comparable to that reported in European and African studies such as Koukoui F in France, who found an average age of 55 ± 13 years and TABET JY of 54 ± 12 years [8] [9]. Klecha A in Poland found a slightly higher average of 60.1 ± 9.2 years, as did Rhissassi Abdelkader in Senegal who found an average age of 60.6 ± 12 years [10] [11]. These results corroborate the increase in the prevalence of heart failure with advancing age, probably due to better management of primary cardiovascular conditions.

The gender profile shows a male predominance, consistent with the literature suggesting a higher incidence of heart disease in men, possibly influenced by hormonal factors and health behaviours. Place of residence also emerged as a potential determinant of access to CVR, with a majority of our patients coming from Dakar. This urban concentration reflects disparities in access to specialised care, highlighting the need to extend CVR services to other regions (outside the capital). Socio-economically, a large part of our study population had a low level of education and worked in the informal sector, characteristics that can influence adherence to and access to CVR programmes. Financial constraints were evident, with a majority of patients self-funding, reflecting the economic challenges associated with managing heart failure in resource-limited settings.

The etiology of heart failure in our cohort was dominated by coronary artery disease, aligned with global trends but contrasting with the etiological distribution in other regions, suggesting variations in risk profiles and care pathways. The cardiovascular risk factors identified were largely consistent with those reported in the international literature, reflecting the universality of the determinants of heart disease but also local specificities in their prevalence and management. Cardiovascular rehabilitation showed measurable clinical benefits in our study, with improvements in general condition, anthropometric parameters, and biological markers. However, improvements were sometimes limited and not uniform, reflecting the complexity of individual responses to CVR and the need for personalised approaches.

Echocardiographic and effort parameters also revealed gains, albeit moderate, corroborating the potential of CVR to improve cardiac function and exercise capacity, even in a context of limited resources. Thus, the average increase in LVEF for our patients in general was +6.5% ($p = 0.001$), comparable to the study by Wesley J, which noted a significant increase in LVEF of 6.26% for moderate continuous intensity training over a duration of six months. In contrast to Giannuzzi P, who found an increase in LVEF of 16% after six months of CVR [12].

Regarding physical capacity, our study demonstrated that the average increase in the number of METs at the end of cardiovascular rehabilitation was 3.06 METs, representing an increase of 69.23% compared to the initial test, with a notable statistical significance ($p = 0.001$). These results surpass those found by Adams BJ and Giannuzzi P in chronic cardiac patients, with respectively 32%

increase and 1.42 METs [12] [13]. As for the 6-minute walk test, the average improvement in the distance covered was 142.46 meters, translating into a progression of 43.29%. This performance also exceeds the results observed by Giannuzzi P, Sutherland N, and Taylor RS, who noted less significant increases in their respective studies [14] [15]. These comparisons highlight the efficacy of CVR in our study context, demonstrating superior improvements in terms of exercise capacity and walking distance.

5. Conclusion

In conclusion, our study highlights both the potential impact and the challenges of CVR in an African context, underscoring the urgency to optimize access to and the efficacy of these services to meet the growing needs of patients with heart failure. Thus, cardiovascular rehabilitation has demonstrated significant benefits for heart failure patients, inducing a notable improvement in their symptoms, physical capacity, and quality of life, thereby underlining the importance and effectiveness of this treatment in Senegal. The limitations encountered during this work call for an improvement in patient monitoring systems and a reflection on financing models to make CVR more accessible and adapted to local socio-economic realities.

Authors and Contributors

Aliou Alassane NGAIDE and Abdoul KANE designed the study protocol, participated in the data collection and contributed in analysing the data and writing of the draft manuscript.

Ngoné Diaba GAYE, Mahugbe L.C. HOUENASSI and Alassane MBAYE oversaw the execution of the study, participated in data analysis and critically revised the manuscript for important intellectual content.

Aime Mbaye SY and Aminata MBAYE participated in study design and in data analysis.

Joseph Salvador MINGOU and Fatou AW participated in statistical analysis and interpretation of results.

All authors have read and approved the final version of the manuscript.

Ethics Approval and Consent to Participate

This study was approved by the ethics committee of Cheikh Anta Diop University of Dakar and was carried out in collaboration with the hospital management after obtaining approval from the cardiology department by signing the access form to patient records.

Availability of Data and Materials

The data and materials of this study are available upon request and ready to be shared. For further information, please contact the corresponding author, Aliou Alassane NGAIDE.

Declaration of Interests

None of the authors has any conflicts of interest or relevant disclosures.

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