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Enhancing Energy Security in Nigeria: An Analysis of International Efforts (2015-2024)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The paper examines the international efforts and attempts to improve energy security in Nigeria between 2015 to 2024, the paper focuses more on the interplay between foreign collaborations and local energy challenges. Nigeria possess abundant of fossil fuel resources and is the Africa's largest producer of oil, but unfortunately Nigeria is marked with limited energy supply and connectivity to the wider population, corruption. Etc. The study examines dependency theory, it analyses how Nigeria relied on foreign collaboration and foreign technology which perpetuate systematic vulnerabilities in Nigeria's Energy sector. The methodology the study realized that while international collaborations and partnership is a big step towards having energy security and offer critical support, achieving long term energy security requires a comprehensive and independent energy strategy focused on investment in renewable energy, infrastructure development and good governance.

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1. INTRODUCTION

Nigeria, Africa's most populous nation, faces significant energy security problems, apart from being a major oil producer, the country struggles with lack electricity supply, the country also relies on fossil fuels to source Energy, and is experiencing energy poverty. This article analyzes the key initiatives and international collaborations between 2015 to 2024 aimed at enhancing energy security in Nigeria. Energy is very important for socioeconomic development and has positive impacts on poverty eradication, quality of life, and national security. Some scholars have relate the importance of energy to climate, public health, and security, emphasizing its advantage to an economy. “Energy affects various aspects of human life, such as nutrition, health, education, technology, transportation, and communication recognize energy as the mainstay of great economies, highlighting the growth of an economy's function of reliable, affordable, and adequate energy supply. Most advanced economies depend ponderously on energy efficiency and availability. According to IEA, 80% of primary energy consumption worldwide is from fossil fuels and hydrocarbons like coal, natural gas, and petroleum” (IEA, 2024). The World Energy Assessment highlights substantial progress in global development over the past five decades, stressing that energy security defined as the consistent, affordable, and adequate supply of energy is essential for sustaining this growth. “This piece highlights that energy insecurity can easily distract production and negatively impact consumer welfare. Energy resources are classified into renewable and non-renewable, and Nigeria possess both the two. The country's economy has long depended on its oil and gas sector, but this over reliance has caused current and future threats to the nation. Despite its rich energy resources, Nigeria faces issues such as power supply problems, corruption, environmental degradation, and fuel supply issues, leading to energy insecurity and problems like social crises and communal clashes” (Abdallah & Odetukun, 2023). It should however be noted that the Energy sector in Nigeria has the prospectiveness of bringing technological innovation for the nation. In Nigeria, the issue of energy security has been the subject of research aimed at advancing sustainable development, because mismanagement in this particular area can have profound and adverse impacts on the nation's economy. For years, energy security has remained an important aspect in Nigeria, driven by the country's struggle to deliver dependable and sustainable energy to its expanding population.

2. THEORETICAL FRAMEWORK

This work relies on dependency theory, dependency theory revolves around the idea that resources flow from a periphery to a core states. This theory is a critical response to modernization theory, an earlier development theory that posits all societies progress through similar stages of development. Modernization theory suggests that underdeveloped regions are in a historical stage once experienced by today's developed areas, and thus, overcoming poverty requires accelerating their development through measures like investment, technology transfer, and deeper integration into the global market. According to Sonntag Dependency theory is a school of thought in modern social science which seeks to contribute immensely in understanding of underdevelopment, an analysis of its causes, and to a smaller level, leads toward overshadowing it (Sonntag, 2001).

Core states herein refers to developed state of the west while periphery herein refers to the poor countries of Africa, Asia and Latin America. Poor nations supply natural resources, cheap labor, a market for outdated technology, and a consumer base that supports the high living standards of developed nations. Wealthy nations encourage the dependency through various mechanisms, such as economic policies, media dominance, political influence, financial systems, education, cultural exchanges, and sports. Adherents of dependency theories are Hans Singer, Raul Prebisch, Walter Rodney, Paul A. Baran, Paul Sweezy, and Andre Gunder Frank.

Dependency theory could be used to explain Nigeria's reliance on foreign investment and imported technology for energy projects often leads to uneven power dynamics. Dependency theory can explore how these dependencies limit Nigeria's capacity to develop a self-sustaining energy infrastructure. Also, the theory highlights how Nigeria's natural resources, such as oil and gas, are extracted and exported by international corporations, leaving limited value addition or reinvestment within the country.

3. LITERATURE REVIEW

The topic has drawn so much interest from researchers, policymakers, and stakeholders, all striving to identify its underlying causes and develop practical strategies to resolve it. As Oyedepo noted that Nigeria's energy security is threatened by so some element, including things like lack of infrastructure, policy inconsistency, corruption, and a lack of investment in renewable energy. Also, in an attempt by Akinyemi, Osabuohien, Alege and Ogundipe to highlight the significant role of renewable energy in enhancing energy sufficiency in Nigeria, The authors highlighted that renewable energy offers a viable means to decrease reliance on fossil fuels, enhance electricity access in rural regions, and lessen the effects of climate change Akinyemi, etal, 2017). However, they highlights that the development of renewable energy in Nigeria is still at an early stage and requires more investment and policy support. Also, some scholars contend that energy security in Nigeria extends beyond mere energy availability to include ensuring its affordability for the general population". Moreover, a study by Ekeocha et al (2018) "explains that the high cost of energy in Nigeria is the main obstacle to energy access for poor salary earners and households, thereby worsening energy poverty in the nation". "Moreover, a study by Amadi, argued that Nigeria's energy security is hugely dependent on the political will of the national government to implement effective policies and ensure sustainable energy development" (Amadi, 2019). "The author noted that the lack of political will was the main thing that hindered the growth of the energy sector in Nigeria and at the end it resulted in the country's overdependence on fossil fuels. Moreover, a study by Adeleke and Oyebisi emphasize the role of public-private agreements in improving energy security in Nigeria, the authors argument is that such partnerships could leverage the strengths of both sectors to address the challenges facing the energy sector and improve access to energy for the masses" (Adeleke & Oyebisi, 2021). In addition, another valuable book is the book authored by Raffaelo Cervigni, Riccardo Valantini and Monia Santini titled Towards climate resilient Development in Nigeria, the book was published by World Bank, it touches various important genres in Nigeria from food security, Agricultural sector, Environment and Energy.

At last, the literatures reviewed herein highlighted the main arguments on energy security in Nigeria. The energy sector in Nigeria faces complex and interconnected challenges that demand a comprehensive approach to effectively address them. Predecessor literature explained the importance of energy security as a critical issue, emphasizing the need for further research to develop practical solutions that enhance energy access for the population.

Energy in Nigeria: Nigeria has the largest in Africa, with estimate of the population of about 234 million as at 2024 (Worldometer, 2024). Abuja is the capital of Nigeria. Nigeria shares borders with Benin, Cameroon, Niger, and Chad to the west, east, and north respectively. Nigeria is globally recognized for its abundant of natural resources and large population, the country faces various socioeconomic challenges, many of which are linked to the under-performance of its energy sector.

According to NERC (2017), Nigeria's grid supply capacity is approximately 12,522 MW, but other issues like poor infrastructure maintenance and irregular primary fuel supply hinder operational efficiency. Even though the grid reached a peak generation of 5,375 MW in February 2019 (Mbah, 2019), this aspect still remains insufficient to meet the nation's growing energy demand.

According to Business day (2016) reports that less than 58% of Nigeria's population is connected to the grid, with 86% urban access contrasted by just 41.1% in rural areas. Furthermore, only about 4% of Nigerians have access to clean energy for domestic use, despite an urban population nearing 49.6%. This growing demand is an indicator itself that shows urgent need for trans formative policies and investments in Nigeria's energy sector.

The Table 1 shows Nigeria's conventional energy resources which include crude oil, natural gas, Coal, Tar sands and hydropower. Their respective reserves and unit in billion tonnes are also shown, with Tar sand representing the largest percentage of conventional energy in Nigeria at 28.4% and as expected, crude oil and natural gas has a 21% and 24% total conventional energy respectively while the Hydropower has 13.1% and Coal and lignite has 12.7% of the total conventional energy in Nigeria.

Table 1. Nigeria's conventional energy

Resources	Reserve	Reserve in Energy units (billion tonnes)	%Total of coventional Energies
Crude Oil	23 billion barrels	3.128	21.0
Natural Gas	4293 billion m	3.679	24.8
Coal & Lignite	2.7 billion tonnes	1.882	12.7
Tar Sands	31 billion barrels of oil equivalent	4.216	28.4
Hydropower	10,000MW	1.954 (100yrs)	13.1
Total	Coventional/Commercial Energy resources	14.859	100%

Source Abdallah & Odetukun

Table 2. Nigeria's non-conventional energy resources

Resources	Reserve	Reserve (Billion tonnes)
Fuel wood	43.3 million tonnes	1.6645 (over 100 years)
Animal Waste and |Crop residue	144 million tonnes	3.024 (over 100 years)
Small scale hydropower	734.2 MW	0.143 (over 100 years)
Solar radiation	1.0 KWm Land Area (Peak)	-
Wind	2.0-4.0 ms	-

Source Abdullah & Odetukun

The second table shows Nigeria's non-conventional energy resources which include fuel wood, animal wastes, crop residue, small scale hydro power, solar radiation and wind with their respective reserves with the majority of them having a lifespan of over 100 years. Nigeria is one of the biggest powerhouse in Africa, blessed with so much solid and liquid resources such as LNG, crude oil, lignite, bitumen, tar sands, biomass, and hydropower. These resources have made the country to generate substantial revenue through energy exports and also supporting domestic industrial growth. The nation's crude oil reserves rank among the largest globally, with approximately 36.2 billion barrels of oil and 5,000 billion cubic meters of natural gas, primarily located in the Niger Delta, Gulf of Guinea, and other regions. Despite this wealth of energy resources, Nigeria faces some challenges in the area of resource management and energy distribution, leading to a persistent mismatch between supply and demand. Inadequate development and inefficiencies in the energy sector have resulted in an low energy supply over the years. The situation is particularly more dire in the rural areas, where over 70% of residents rely on firewood as their main energy source. This heavy dependence has contributed to deforestation, desertification in the arid regions, and soil erosion in southern Nigeria, where firewood is widely used for domestic and commercial purposes. The country loses an estimated 350,000 hectares of forest annually, equivalent to 3.6% of its total forest and woodland area, exacerbating environmental degradation (Report of the Inter-Ministerial Committee on Combating Deforestation and Desertification).

The lack of access to electricity and petroleum products in rural areas exacerbates the problem, with the prices of petroleum products like kerosene and petrol often exceeding 200% of the official pump price in the country. The bad road network in rural areas also makes it difficult to transport and distribute energy resources to these areas. As a result, many rural dwellers are forced to rely on firewood for their energy needs, further exacerbating the environmental challenges. While Nigeria is a leading energy giant in Africa with abundant natural resources, the country needs to address the challenges in the management and distribution of energy resources to ensure sustainable development, especially in rural areas where access to energy is limited.

In Nigeria, the NNPC is the government company that controlled gas and petroleum prices. Subsidies on energy resources have been reduced and removed in order to improve efficiency, resulting in higher prices. Privatization of the electricity sector was implemented to increase effectiveness, efficiency and rural

electrification according to the Nigerian government. It should however be noted that, electricity supply is paramount as it helps the development of primary things like education, health services, pipe-borne water, communication, etc. and its absence and inconsistency has affected the economic potentials of the nation as the nation is highly blessed with energy resources which include wind, biomass, solar, hydro power, etc.

Energy consumption in Nigeria can be divided into five categories: transport, commercial, agriculture, household, and industrial sectors. Most importantly, the household is responsible for the largest share of energy consumption in Nigeria, at around 65%, due to the low level of development in other sectors. Energy as far as the household is concern is mainly used for cooking, lighting, heating, and powering of electrical appliances, with cooking accounting for 91% of household energy usage, lighting for 6%, and other uses for 3%. However, the electricity sector in Nigeria has been plagued with inefficiencies, these issues include frequent breakdowns due to outdated and overloaded equipment, equipment vandalization, inefficient billing and collection systems, inadequate funding, and a lack of routine maintenance, among others.

4. ENERGY SECURITY CHALLENGES IN NIGERIA

Nigeria is worldwide player in the global oil industry, Nigeria's energy sector is plagued with inefficiencies and setbacks, these issues affect the energy security of the nation, some of the various challenges are as follows:

The individual challenges faced by different energy resources in Nigeria. One of these resources is diesel, due to the inability of Nigerian government to provide constant electricity supply to it citizens, it makes rich individuals and companies to look for diesel powered engines to get electricity, though the high demand for diesel has made its availability and pricing a major issue in Nigeria. Petrol, Nigeria's most controversial energy resource, is also marred by inefficiencies and corruption. The security of petrol as a resource is in the hands of a small group of elites who make decisions regarding its distribution in their own interests, rather than the interests of the general public. Then natural gas, this resource was affected by availability and affordability issues which discourage average citizens from using Liquefied Natural Gas. Then regarding Kerosene, the supply of kerosene has been monopolized by key intermediaries and unlicensed operators within the petroleum industry, leading to higher prices for consumers.

“Other challenges include corruption tendencies that hinder the implementation of effective policies, insecurity, and external forces that negatively impact energy security. Nigeria's mono-cultural system has encouraged a heavy dependency on oil and gas, with the country's budget tied closely to fluctuations in oil prices. Environmental pollution in the energy zone has also led to social unrest in the oil regions, with political effects manifesting in the form of vandalism, kidnapping, trade unionism, and cartels in oil and gas” (University of Reading, 2022).

The inefficiency of the nation's refinery capacity has further compounded these issues, the refineries available are underutilized, which means there is a looming threat of resource importation, even for Nigeria's own resources. This situation has led to fuel shortages, parallel market activities, and increased prices. All this has put the nation in a state of economic dis-equilibrium, with the energy sector being a significant contributor to the overall instability of the Nigerian economy.

Inadequate electricity supply: This is one of the major energy security challenges in Nigeria. Nigeria's power grid struggles to meet the country's growing energy demands, resulting in frequent blackouts and reliance on generators. The issue of inadequate electricity supply in Nigeria has been a major concern not just to the citizen but to the Federal Government and companies under various industries. Every Nigerian greatly believes that the current rate of electricity supply is not regular and in a low state. The inadequate electricity supply in Nigeria can be attributed to several factors, including ineffective policy initiatives, lack of asset protection mechanisms, poor maintenance practices, insufficient gas supply, pipeline vandalism, inadequate urban planning complicating power distribution, staffing shortages, mismanagement of water resources impacting the national grid, and weak transmission infrastructure. To address these challenges, various solutions have been proposed, such as integrating renewable energy technologies into the grid, banning the use of

energy-wasting devices, adhering to the expected lifespan of plant components, employing skilled and qualified personnel in energy companies, and improving transmission systems.

When all the proposed solutions are fully implemented, it will help to check the poor nature of electricity supply in Nigeria. Poor electricity supply in Nigeria has been a major barrier to the growth of our economy. Power outages can have devastating consequences for businesses. Essential services such as quality healthcare, reliable water supply, and telecommunications become severely limited or even inaccessible during prolonged power failures. The effects of such disruptions include significant revenue losses, business interruptions, layoffs in affected industries, loss of critical data at data centers, spoilage of perishable goods, and damage to home appliances. Despite efforts by both current and previous governments to address this issue, the measures in place have proven ineffective. A more effective approach is needed to identify and address the underlying causes.

5. NIGERIA'S OVER RELIANCE ON FOSSIL FUELS

Nigeria's energy mix is heavily reliant on fossil fuels, contributing to greenhouse gas emissions and environmental degradation. The United Nations' seventh Sustainable Development Goal (SDG 7), "Ensure access to affordable, reliable, sustainable, and modern energy for all," aims to be achieved by 2030. The realization of other SDGs, such as SDG 1 – No Poverty and SDG 13 – Climate Action, depends significantly on achieving SDG 7 – Affordable and Clean Energy . This underscores the need to provide universal electricity access without exacerbating poverty or environmental harm. While global access to electricity increased by 7% from 2015 to 2019, the IEA (2021) reports that 770 million people still lack electricity, with 75% residing in sub-Saharan Africa. As Africa's largest economy and most populous nation, Nigeria had a population of 206.1 million in 2020 (World Bank Group, 2021). Over the past decade, Nigeria's electricity access rate has risen by 7%, aligning with the global average, reaching 61% (IEA, 2021). In 2020, Nigeria's installed electricity generation capacity was 12.5 GW (World Bank Group, 2021), about 5% of Africa's total installed capacity. However, due to constraints such as insufficient gas supply, a weak grid infrastructure, and other limitations, only 4.4 GW of electricity was generated, and 29,000 GWh was transmitted.

Mesagan, Isola, and Alimi (2017) highlight that legislative challenges and rapid population growth have hindered the expansion of Nigeria's power supply. As a result, urban and rural areas experience frequent power outages, often lasting for several hours, disrupting residential life and threatening businesses. e stable power supply to operate efficiently, reduce costs, and attract investments. The unreliable power infrastructure undermines investor confidence, hindering economic growth and development (Okafor et al., 2020). To cope with these energy shortages, Nigerians rely heavily on backup generators, contributing to one of the largest national generator fleets globally. Nigeria is the largest importer of backup generators in Africa, but no official data exists on the installed capacity of these generators, as off-grid power generation under 1 MW is unregulated (NESP, 2015). Although large-scale generator imports were restricted in 2015 due to environmental concerns, they remain widely available in the market (jacal et al, 2022). Consequently, fleet estimations are based on surveys and import-export data. The most recent estimate places Nigeria's generator installed capacity at 13 GW, with 2.8 million units used in households and 210,000 in commercial sectors (IFC, 2019). This capacity exceeds Nigeria's national grid generation and adds an additional 5% to Africa's total installed capacity. Gasoline generators, commonly used by households and small businesses, have a capacity ranging from three to five kilovolt-amperes (kVA) and are perceived as more affordable, despite being less durable and requiring frequent replacement compared to diesel generators favored by larger industries. While backup gasoline generators are critical for electricity access in urban Nigeria, limited research exists on the economic and environmental costs for both users and society. The increasing reliance on backup generators in Nigeria raises concerns about their impact on the achievement of several SDGs in sub-Saharan Africa.

6. NIGERIAS ENERGY POVERTY

Energy poverty has recently emerged as a significant issue in development and energy literature, gaining attention in various policy documents in major organizations such as the World Bank, the United Nations Development Program (UNDP), the World Energy Council. The

link between energy and poverty is undeniable. For instance, a reliable energy supply is crucial for industrialization which Nigeria lack, and the availability of Energy will surely foster economic growth, create job opportunities, and reduce poverty. However, energy poverty can both cause and result other dimensions of poverty.
Although Africa is rich in both renewable and non-renewable energy resources, many African nations suffer from energy poverty due to low incomes and economic underdevelopment. This paradox energy poverty amidst abundant resources has sparked debates among African scholars and policymakers, seeking effective solutions. For sustainable development to be achieved, access to modern and environmentally friendly energy sources is essential. Unfortunately, in Africa, the majority of people still rely on traditional energy sources, with only a few having access to modern energy.

In Nigeria, often regarded as the "giant of Africa," energy poverty is widespread, with over two-thirds of households relying on firewood for cooking (Cervigni et al., 2013). This signifies a severe energy poverty problem, which has significant implications for sustainable development. Access to modern energy is critical for addressing issues like climate change, food security, health, education, poverty, and inequality. This raises essential questions about the extent, causes, and impacts of energy poverty in Nigeria.

To address these questions, a multidimensional energy poverty index (MEPI) should be used, covering key energy needs to estimate the scope of energy poverty and facilitate detailed analysis. Unfortunately, no comprehensive study using a robust MEPI and nationally representative data currently exists in Nigeria. Some experts view energy poverty as synonymous with fuel poverty, while others distinguish the two. Energy poverty is often defined as the lack of access to modern energy services or products, leaving households reliant on traditional energy sources. Factors such as physical unavailability of energy, low income, and high energy costs contribute to energy poverty (Pachauri & Spreng, 2011).

There is no universally accepted definition of energy poverty, but common conceptualizations are based on minimum energy needs, necessary energy expenditure, access to modern energy, and the proportion of income spent on energy. Given Nigeria's high levels of energy poverty, it is critical to implement measures to provide access to modern energy sources, particularly in regions with the highest energy poverty rates (Muller-Kraenner, 2018). Addressing energy poverty will require improving employment opportunities, education, and population control.

For Nigeria to become one of the world's 20 most developed economies, energy poverty must be tackled. Achieving this goal is impossible without addressing the widespread energy poverty that hampers development. The government should create incentives for households to transition to modern energy sources, breaking the cycle of energy poverty.

7. INTERNATIONAL EFFORTS (2015-2024)

There are various international efforts made in conjuction with the nigeriam nitional governments to solve to issue of energy in Nigeria, below are some of the attemps:

1. United States-Nigeria Bi-national Commission (2015): The US-Nigeria Bi-National Commission (BNC) met on March 30, 2016, in Washington, D.C. The BNC was co-chaired by Geoffrey Onyeama, Honorable Minister of Foreign Affairs, Federal Republic of Nigeria and Antony Blinken, Deputy Secretary of State, United States of America. U.S. National Security Advisor Susan Rice provided opening remarks, and Secretary of State John Kerry met the group and hosted a working lunch (US Embassy, 2016). It was established to strengthen cooperation in energy, trade, and investment, the commission facilitated the development of Nigeria's power sector.

2. World Bank's Nigeria Energy Sector Recovery Program (2017): This is a support from the world Bank group to Nigeria’s ailing power sector.The Power Sector Recovery Program focuses on supporting implementation of power sector reform, reducing losses in the distribution companies, enhancing the sector’s financial viability, increasing access to electricity services, and mobilizing private

3. sector investment (World Bank Group, 2017).

4. German-Nigerian Energy agreement (2023): This was an agreement signed between President Bola Ahmed Tinubu and German Chancellor Olaf Scholz in Dubai, United Arab Emirates, the agreement was signed in the sidelines of the COP28 climate summit. Though prior to this an agreement was signed in 2019

between Nigeria and Germany to enhance electricity supply. The agreement signed will see to the end-to-end modernization and expansion of Nigeria's electric power transmission grid with the full supply, delivery and installation of Siemens-manufactured equipment under the time line of 18 to 24 months (The African Courier, 2012).

8. SUMMARY OF KEY FINDINGS

i. Energy challenge: One of the challenges bedevilling Nigeria is the issue of Energy particularly due to inadequate of electricity supply, aging infrastructure which need to be renewed. Nigeria is one of the countries experiencing Energy poverty. And the reason for that is the issue of corruption, policy inconsistencies and inefficient energy management
ii. International Effort: There are various international efforts which Nigeria attempt through collaborations and partnership such as US-Nigeria Bi-National Commission in 2015, World Bank Energy sector Recovery Program (2017) and German-Nigeria Energy partnership (2023)
iii. Overrelience on Fossil fuel: This could also be seen as one of the challenges facing Nigeria as heavy dependence on Oil and Gas has made the country to be vulnerable to market fluctuations and whatnot.

9. RECOMMENDATIONS

i. Diversify of Energy Sources: Nigeria as a matter of urgency should accelerate investment in renewable energy such as Solar, Wind and Biomass so as to reduce reliance on fossil fuels.
ii. Strengthen local capacity: Nigeria should invest in local technologies so as to reduce the reliance on imported technology.
iii. Reform of Governance and Policies: Nigeria should create consistent and transparent energy policies so as to attract more foreign investors.

10. CONCLUSION

In conclusion, enhancing energy security in Nigeria needs policymakers to adopt a multidimensional approach that will systematically solve the issues of the lack of infrastructure, policy inconsistencies, and overreliance on fossil fuels, so as to have a more cleaner and sustainable Energy in the country. Furthermore, there are various International efforts between 2015 and 2024 that Nigeria partnered with other countries, this includes things like investments, technology transfers, and partnerships like the German-Nigerian Energy Partnership, this is an example of one particular agreement that provided critical support but also highlight persistent structural dependencies. To achieve sustainable energy security, Nigeria must as a matter of urgency make some priorities such as building local capacity, diversifying energy sources, and fostering regional collaboration, because this will reduce reliance on external actors while in the process ensuring that international engagements align with its long-term developmental goals. This balance is essential for Nigeria as it makes Nigeria to transit from being a resource-dependent economy to an energy-secure and sustainable nation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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