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Review Article

Prevention Strategies in Reducing the Burden of Cerebral Malaria among Children in Zaria, Kaduna State

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ABSTRACT

Cerebral malaria, a severe and often fatal manifestation of *Plasmodium falciparum* infection, poses a significant health threat to children living in malaria-endemic regions. This abstract provides a concise overview of the critical role of prevention strategies in reducing the burden of cerebral malaria among children. Prevention measures include vector control interventions, such as insecticide-treated nets and indoor residual spraying, as well as chemoprevention strategies like intermittent preventive treatment in pregnancy (IPTp), intermittent preventive treatment in infants (IPTi), and seasonal malaria chemoprevention (SMC). These strategies have profoundly impacted reducing the incidence and severity of cerebral malaria, protecting vulnerable populations, and improving overall healthcare systems. Challenges and future directions are also briefly discussed, emphasizing the importance of ongoing research and innovation in the global effort to combat cerebral malaria among children in malaria-endemic areas. This paper sets the stage for a deeper exploration of these prevention strategies, their successes, challenges, and the path forward in safeguarding the well-being of Zaria's children from the devastating impact of cerebral malaria.

Keywords: Cerebral Malaria; Prevention Strategies; Children's Health; Vector Control; Chemoprevention; Vulnerable Populations

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INTRODUCTION

Cerebral malaria, a severe and often fatal complication of *Plasmodium falciparum* infection, is a significant public health challenge in endemic regions, particularly in Zaria, Nigeria. The northern part, including Zaria, is one of the country's hotspots for malaria transmission (Wang *et al.*, 2022). Cerebral malaria is characterized by severe neurological complications, including seizures, coma, and impaired consciousness, often leading to long-term cognitive deficits or death. Children under five are the most vulnerable, making this age group the primary focus of malaria prevention efforts in Zaria. The impact of cerebral malaria on children in Zaria is severe, with high mortality rates and lifelong cognitive and neurological impairments

(Blakemore & Frith, 2020). Families often struggle to access timely and appropriate medical care, which is essential for improving the chances of survival and minimizing long-term disabilities. There is a pressing need to address the issue comprehensively. The causes of cerebral malaria in Zaria are complex and interconnected, including high malaria transmission due to Anopheles mosquitoes, parasite biology, socioeconomic factors, healthcare accessibility, and climate and environment. Effective prevention strategies must address the parasite, local context, and socioeconomic conditions (Morin, 2021).

Preventing cerebral malaria in Zaria requires a comprehensive approach that addresses both direct and underlying causes. Vector control, such

as distributing insecticide-treated bed nets and indoor residual spraying programs, can reduce mosquito populations and minimize malaria transmission. Prophylactic antimalarial drugs, such as sulfadoxine-pyrimethamine, can be administered to pregnant women and young children to prevent malaria infection during pregnancy and early childhood (Raghavendra *et al.*, 2020). Community-based education programs are essential to raise awareness about malaria prevention, promote bed net use, encourage prompt treatment-seeking behavior, and educate people on preventive measures like draining stagnant water where mosquitoes breed. Research and surveillance are crucial in understanding local disease trends, genetics, and the efficacy of prevention strategies. Investments in healthcare infrastructure, including the expansion of clinics and the training of healthcare workers, are crucial for ensuring timely diagnosis and treatment. Community engagement can increase the effectiveness and sustainability of prevention strategies (Wang *et al.*, 2022).

Cerebral malaria among children in Zaria is a pressing public health issue that demands immediate attention and comprehensive intervention. With concerted efforts from government authorities, healthcare organizations, researchers, and the community, we can reduce the burden of cerebral malaria and provide a brighter future for the children of Zaria (Tako *et al.*, 2022). Cerebral malaria, characterized by severe neurological complications arising from *Plasmodium falciparum* infection, is a life-threatening condition that disproportionately affects children in malaria-endemic regions. Prevention strategies are crucial in reducing cerebral malaria's incidence and severity, thus safeguarding vulnerable populations' health. This paper delves into the various prevention measures implemented to combat cerebral malaria among children (Coursin, 2012).

VECTOR CONTROL INTERVENTIONS

1 Insecticide-Treated Nets (ITNs)

Malaria, a deadly disease transmitted through the bites of infected mosquitoes, has been a global health concern for centuries. Insecticide-Treated Nets (ITNs) are a crucial tool in combating this disease, serving as a beacon of hope and providing protection to vulnerable populations such as young children and pregnant women. ITNs are bed nets made from durable materials like polyester or polyethylene, but they are infused with long-lasting insecticides, typically pyrethroids, which disrupt the nervous system of mosquitoes, leading to paralysis and death. ITNs are designed to be hung over

sleeping areas, creating a physical barrier between individuals and disease-carrying mosquitoes (Tavakolizadeh *et al.*, 2015). Regular maintenance, including periodic washing and re-treatment with insecticides, is essential to maintain their effectiveness. The impact of ITNs on malaria prevention is significant, as they reduce transmission by physically blocking mosquitoes and killing or repelling them. They also provide protection for vulnerable groups, such as children under five and pregnant women, who are the most vulnerable to severe malaria (de Figueiredo *et al.*, 2021).

Community-wide benefits include community-wide reductions in malaria transmission when a significant portion of the population sleeps under ITNs, creating a "herd immunity" effect. ITNs are considered one of the most cost-effective tools in the fight against malaria, as their long-lasting insecticide treatment can provide protection for several years. However, ITNs face challenges such as access and distribution, resistance, behavioral factors, and maintenance. Ensuring equitable access to ITNs, especially in remote or underserved areas, is crucial (Agu *et al.*, 2023). Continual monitoring and research into alternative insecticides are essential to combat resistance. Proper and consistent use of ITNs is crucial, and community education is vital to convey the importance of sleeping under nets. Hence, ITNs have become a cornerstone of malaria prevention efforts, offering a cost-effective and highly impactful means of reducing malaria transmission and protecting vulnerable populations. When used in conjunction with other prevention measures, ITNs bring us closer to a malaria-free world, offering hope and protection to millions of people in malaria-endemic regions worldwide (Ladhani *et al.*, 2018).

2 Indoor Residual Spraying (IRS)

Malaria, a life-threatening disease caused by *Plasmodium* parasites, is a major global health challenge, particularly in tropical and subtropical regions. Indoor Residual Spraying (IRS) is a crucial intervention in the fight against malaria, aimed at reducing mosquito populations and the risk of transmission. IRS involves the targeted application of insecticides to the inner surfaces of dwellings where mosquitoes rest after feeding. The primary components of IRS include specific insecticides approved for indoor use, application by trained personnel or community health workers, and frequency (Bennie *et al.*, 2022). IRS offers several significant benefits in the battle against malaria, including reduced malaria transmission, protection for vulnerable groups, community-wide benefits, resistance management, and cost-effectiveness.

However, IRS faces challenges such as resistance development, logistics and coverage, community engagement, and environmental impact (Hauptmann *et al.*, 2022).

Continuous use of the same insecticide can lead to mosquito populations developing resistance, necessitating rotation or combination of insecticides to maintain effectiveness. Implementing IRS programs on a large scale requires careful planning, trained personnel, and sufficient resources. Gaining community acceptance and participation in IRS campaigns is essential for their success, and education and awareness efforts are critical to overcome misconceptions and concerns. Thus, IRS plays a crucial role in malaria control efforts, offering an effective means of reducing mosquito populations and transmission. As the global community continues to work towards malaria elimination, IRS remains an indispensable tool in the fight against this deadly disease (Önder, 2018).

3 Environmental Management

Environmental management is a systematic and sustainable approach to managing natural resources and ecosystems to minimize negative environmental impacts and promote long-term ecological health and human well-being. It involves practices, policies, and strategies aimed at preserving and conserving the environment, mitigating pollution, and ensuring sustainable use of natural resources (Yildizbasi & Arioz, 2022). Key principles of environmental management include sustainability, resource conservation, pollution prevention, biodiversity conservation, sustainable land use planning, climate change mitigation, regulatory frameworks, environmental impact assessments, corporate social responsibility (CSR), international collaboration, public awareness and education, technology and innovation, monitoring and assessment, and adaptive management (Galindo *et al.*, 2022).

Sustainability is at the core of environmental management, aiming to balance human development with environmental preservation. Resource conservation involves responsible extraction and utilization of resources to prevent depletion and degradation. Pollution prevention strategies include waste reduction, recycling, pollution control technologies, and cleaner production methods (Galindo *et al.*, 2022). Biodiversity conservation involves protecting and preserving biodiversity for ecological balance. Sustainable land use planning ensures land is utilized in a way that minimizes negative environmental impacts. Climate change mitigation involves reducing greenhouse gas emissions, promoting renewable energy sources, and

implementing climate-resilient strategies. Environmental management is an interdisciplinary field that draws upon knowledge from various scientific disciplines, focusing on a harmonious relationship between humans and the natural world. Effective environmental management is crucial for the well-being of present and future generations and the planet's ecosystems and biodiversity (Osarokaka *et al.*, 2021).

BIOCONTROL MEASURES

1. **Habitat Modification:** Eliminating breeding grounds such as stagnant water to disrupt mosquito life cycles.
2. **Botanical Insecticide:** Extracts from plants like *Azadirachta indica* (Neem) and *Pyrethrum* act as natural mosquito repellents and larvicides.
3. **Biological Agents:** introducing natural predators like larvivorous fish (*Gambusia affinis*) to control mosquito larvae.
4. **Bacterial Larvicides:** Using *Bacillus thuringiensis israelensis* (Bti), a biological insecticide that targets mosquito larvae without harming non-target organisms.
5. **Fungal Pathogens:** Deploying entomopathogenic fungi such as *Metarhizium anisopliae* and *Beauveria bassiana* to infect and kill adult mosquitoes.
6. **Genetic Control Methods:** Sterile insect techniques (SIT) or genetically modified mosquitoes (e.g., Wolbachia-infected mosquitoes) to reduce malaria vector population.

CHEMOPREVENTION STRATEGIES

1 Intermittent Preventive Treatment in Pregnancy (IPTp)

Malaria is a significant global health challenge, especially in sub-Saharan Africa, where pregnant women and their unborn children are at heightened risk of infection. Intermittent Preventive Treatment in Pregnancy (IPTp) is a critical strategy to combat malaria during pregnancy, safeguard maternal health, and reduce the risks associated with malaria infection in infants (Wang *et al.*, 2022). IPTp involves administering a full therapeutic course of an antimalarial drug to pregnant women, regardless of their symptoms of malaria. Key aspects of IPTp implementation include antimalarial medication, timing and dosing, accessibility, healthcare worker training, and integration into routine prenatal care services. The impact of IPTp has been significant: reduced malaria risk, improved birth outcomes, community-

wide effects, and cost-effectiveness (Keesstra *et al.*, 2016).

However, IPTp faces challenges such as antimalarial resistance, healthcare access, and education and awareness. Resistance to Sulfadoxine-pyrimethamine (SP) and other antimalarial drugs is a growing concern, and monitoring and adjusting IPTp strategies accordingly are essential. Ensuring all pregnant women have access to regular antenatal care services can be challenging, particularly in remote or underserved areas (Brinken *et al.*, 2022). Raising awareness about the importance of IPTp and improving knowledge of pregnant women and communities is crucial for increasing its uptake. Thus, IPTp is a vital strategy in the global effort to combat malaria and safeguard the health of pregnant women and infants in malaria-endemic regions. Continued investment in IPTp programs, research into drug resistance, and efforts to improve healthcare access and education are essential for maximizing its impact in the fight against malaria (Nwankwoala, 2021).

2 Intermittent Preventive Treatment in Infants (IPTi)

Malaria, a mosquito-borne disease caused by Plasmodium parasites, poses a significant global health challenge, particularly in regions with high transmission rates. Infants, especially those living in malaria-endemic areas, are highly susceptible to severe malaria and its complications. Intermittent Preventive Treatment in Infants (IPTi) is a crucial strategy aimed at reducing malaria-related morbidity and mortality among this vulnerable population. IPTi involves the administration of a full therapeutic course of an antimalarial drug to infants, regardless of their symptoms (Nedophil *et al.*, 2021). Key aspects of IPTi implementation include antimalarial medication, timing and dosing, accessibility, and healthcare worker training. The impact of IPTi has been significant, including reduced malaria risk, lower mortality rates, improved child development, community-wide effects, and cost-effectiveness. However, it faces challenges such as antimalarial resistance, healthcare access, and raising awareness about the importance of IPTi. IPTi is a vital strategy in combating malaria and protecting the health of infants in malaria-endemic regions. By providing antimalarial drugs during routine immunization visits, IPTi reduces the burden of malaria-related morbidity and mortality among this vulnerable population. Continued investment in IPTi programs, research into drug resistance, and efforts to improve healthcare access and education are essential for maximizing its impact in the fight against malaria (Apfelbeck *et al.*, 2020).

3 Seasonal Malaria Chemoprevention (SMC)

Malaria, a life-threatening disease, is a major public health concern in tropical and subtropical regions. Seasonal Malaria Chemoprevention (SMC) is a specialized intervention designed to provide targeted protection against malaria for vulnerable populations, particularly young children in seasonal transmission areas. SMC involves the administration of a full therapeutic course of antimalarial drugs at specified intervals during the high transmission season (Osarokaka *et al.*, 2021). Key aspects of SMC implementation include the use of a combination of antimalarial drugs, such as sulfadoxine-pyrimethamine (SP) and amodiaquine (AQ), and community-based delivery. SMC has demonstrated significant benefits for child health in malaria-endemic regions, including reduced malaria incidence, prevention of severe malaria, lower mortality rates, cost-effectiveness, and community-wide effects. However, it faces challenges such as antimalarial resistance, healthcare access, and raising awareness and education. Moreover, SMC is a critical strategy in the global effort to combat malaria and protect the health of vulnerable children in seasonal transmission areas. By providing antimalarial drugs during the high transmission season, SMC significantly reduces the burden of malaria-related morbidity and mortality among this at-risk population (Apostolopoulou, 2020). Continued investment in SMC programs, research into drug resistance, and efforts to improve healthcare access and education are essential for maximizing its impact in the fight against malaria. SMC is a preventive strategy specifically designed for children in areas with highly seasonal malaria transmission. SMC significantly reduces the risk of cerebral malaria by administering antimalarial drugs during peak transmission seasons (Wang *et al.*, 2022).

IMPACT ON REDUCING CEREBRAL MALARIA BURDEN AMONG CHILDREN

The deployment of vector control programs and chemoprevention techniques has had a significant influence on the reduction of the burden of cerebral malaria among children (Al-Thani & Yasseen, 2021; Nedophil *et al.*, 2021):

1. **Reduction in Incidence:** The implementation of these preventative measures has resulted in a substantial reduction in the total incidence of malaria, particularly cerebral malaria, among children living in locations where the disease is endemic.
2. **Protection of Vulnerable Populations:** Vulnerable populations, in particular pregnant women and newborns, have

benefitted considerably from chemoprevention measures, which have reduced their vulnerability to cerebral malaria. This has allowed these groups to be protected against the disease.

3. **Community Awareness:** As a result of Prevention Campaigns, Community Awareness has been raised about the importance of early diagnosis and treatment, which has ultimately prevented uncomplicated malaria cases from progressing to cerebral malaria.
4. The execution of these strategies has forced changes in healthcare systems, including enhancing diagnostic capabilities, medication delivery networks, and healthcare infrastructure. These improvements were necessary by the implementation of these policies.

CHALLENGES AND FUTURE DIRECTIONS

Malaria, a mosquito-borne disease caused by Plasmodium parasites, remains a formidable global health challenge despite significant progress in recent decades. While substantial gains have been made in reducing malaria-related morbidity and mortality, there are still considerable challenges to overcome on the path to malaria control and eventual eradication (Wang *et al.*, 2022). This paper explores some of the key challenges facing malaria control efforts and outlines potential future directions for tackling this persistent public health threat.

Challenges in Malaria Control:

1. **Antimalarial Drug Resistance:** The emergence and spread of drug-resistant malaria parasites, particularly to frontline drugs like artemisinin-based combination therapies (ACTs), pose a significant threat. Addressing drug resistance is crucial to maintaining the effectiveness of malaria treatment (Osarokaka *et al.*, 2021).
2. **Insecticide Resistance:** Mosquitoes that transmit malaria have developed resistance to commonly used insecticides, undermining the effectiveness of vector control strategies like insecticide-treated bed nets (ITNs) and indoor residual spraying (IRS) (Brinken *et al.*, 2022).
3. **Funding and Resources:** Sustained financial and logistical support is necessary for implementing comprehensive malaria control programs, but donor fatigue and competing global health priorities can limit available resources (Evans *et al.*, 2022).

4. **Healthcare Access:** Many malaria-endemic regions lack adequate healthcare infrastructure and access to diagnostics and treatment. This hinders early detection and management of malaria cases (Nedophil *et al.*, 2021).
5. **Climate Change:** Changes in climate patterns can influence the distribution of malaria vectors and the transmission dynamics of the disease, potentially expanding the areas at risk (Gluszek *et al.*, 2021).
6. **Conflict and Instability:** Malaria control efforts are often disrupted in regions affected by conflict and instability, making it challenging to implement consistent and effective interventions.

Future Directions in Malaria Control and Eradication

1. **Research and Innovation:** Continued investment in research and development is essential to discover new antimalarial drugs, insecticides, and vaccines. Innovative approaches, such as gene-editing techniques to modify mosquito populations, show promise in reducing malaria transmission.
2. **Drug Combination Therapies:** Combining multiple drugs with different mechanisms of action can help combat drug resistance. Developing and deploying these combination therapies can extend the lifespan of existing drugs.
3. **Vector Control Strategies:** Developing novel insecticides and alternative vector control methods can help address insecticide resistance.
4. **Health Systems Strengthening:** Improving healthcare infrastructure, workforce capacity, and access to diagnostics and treatment is critical to enhancing early diagnosis and case management.
5. **Community Engagement:** Empowering communities to take an active role in malaria control, through health education and community-based interventions, can increase the effectiveness and sustainability of malaria programs.
6. **Global Collaboration:** Collaborative efforts involving governments, non-governmental organizations, research institutions, and the private sector are essential for coordinating malaria control strategies and resource mobilization.
7. **Integration with Other Health Services:** Integrating malaria control efforts with

other healthcare services, such as maternal and child health programs, can optimize resource utilization and improve overall health outcomes.

8. Surveillance and Monitoring: Enhancing surveillance and monitoring systems for malaria, including innovative technologies like remote sensing and mobile health applications, can improve the accuracy of data collection and inform timely responses.
9. Advocacy and Funding: Advocating for sustained political commitment and increased funding for malaria control and eradication is crucial to ensuring the long-term success of these efforts.

Malaria control and eradication remain complex and challenging goals, but they are attainable with continued commitment, innovation, and collaboration. By addressing drug and insecticide resistance, strengthening healthcare systems, engaging communities, and leveraging new technologies, we can move closer to a world free of malaria and its devastating impact on global health and development.

CONCLUSION

In conclusion, malaria, a centuries-old scourge, continues to pose a significant threat to global public health, particularly in tropical and subtropical regions. Over the years, substantial progress has been made in the fight against this deadly disease through a combination of strategies, including the use of insecticide-treated nets (ITNs), indoor residual spraying (IRS), intermittent preventive treatment in pregnancy (IPTp) and infants (IPTi), seasonal malaria chemoprevention (SMC), and innovative research and development efforts. Despite these advances, numerous challenges persist. The emergence of drug-resistant parasites and insecticide-resistant mosquitoes threatens the efficacy of existing tools and interventions. Healthcare access remains a concern in many malaria-endemic regions, and conflicts and climate change can disrupt control efforts. However, these challenges also serve as catalysts for innovation and collaboration.

Looking ahead, the future of malaria control and eradication holds promise. Continued investment in research and development can yield new drugs, vaccines, and vector control methods. Strengthening healthcare systems, enhancing surveillance, and empowering communities are essential steps in this journey. Global collaboration, sustained political commitment, and increased funding will be pivotal in achieving the ultimate goal of a malaria-free world. Malaria control is not

merely a health imperative but also a social, economic, and humanitarian one. The burden of this disease falls disproportionately on vulnerable populations, including children and pregnant women. By addressing the challenges and pursuing innovative solutions, we can not only save lives but also foster healthier and more prosperous communities around the globe. Together, we can write the next chapter in the fight against malaria and move closer to the day when this ancient scourge is eradicated, ensuring a brighter future for generations to come.

REFERENCES

- Agu, C. I., Ossai, E. N., Ogah, O. E., Agu, I. C., Akamike, I., Ugwu, G. O., Edwin, N., Ewenyi, B. L., & Azuogu, B. N. (2023). An appraisal of the implementation of the national school feeding programme and its effect on enrolment and attendance in public primary schools in Southeast, Nigeria: perception of heads of schools. *BMC Nutrition*, 9(1), 1–10. <https://doi.org/10.1186/s40795-023-00695-z>
- Al-Thani, R. F., & Yasseen, B. T. (2021). Perspectives of future water sources in Qatar by phytoremediation: biodiversity at ponds and modern approach. *International Journal of Phytoremediation*, 23(8), 866–889. <https://doi.org/10.1080/15226514.2020.1859986>
- Apfelbeck, B., Snep, R. P. H., Hauck, T. E., Ferguson, J., Holy, M., Jakoby, C., Scott MacIvor, J., Schär, L., Taylor, M., & Weisser, W. W. (2020). Designing wildlife-inclusive cities that support human-animal co-existence. *Landscape and Urban Planning*, 200(May), 103817. <https://doi.org/10.1016/j.landurbplan.2020.103817>
- Apostolopoulou, E. (2020). Beyond post-politics: Offsetting, depoliticisation, and contestation in a community struggle against executive housing. *Transactions of the Institute of British Geographers*, 45(2), 345–361. <https://doi.org/10.1111/tran.12354>
- Bennie, J. A., Faulkner, G., & Smith, J. J. (2022). The epidemiology of muscle-strengthening activity among adolescents from 28 European countries. *Scandinavian Journal of Public Health*, 50(2), 295–302. <https://doi.org/10.1177/14034948211031392>
- Blakemore, S. J., & Frith, C. (2020). Self-awareness and action. *Current Opinion in Neurobiology*, 13(2), 219–224. [https://doi.org/10.1016/S0959-4388\(03\)00043-6](https://doi.org/10.1016/S0959-4388(03)00043-6)
- Brinken, J., Trojahn, S., & Behrendt, F. (2022). Sufficiency, Consistency, and Efficiency as a Base for Systemizing Sustainability Measures in Food Supply Chains. *Sustainability (Switzerland)*, 14(11), 1–18. <https://doi.org/10.3390/su14116742>

- Coursin, A. M. (2012). Understanding the development of alphabet knowledge in at-risk populations: The influence of pre-literacy skills. *ProQuest Dissertations and Theses, August*, 70. https://search.proquest.com/docview/1145552120?accountid=14548%0Ahttps://julac.hosted.exlibrisgroup.com/openurl/HKU_ALMA/SERVICES_PAGE??url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Diss
- de Figueiredo, C. S., Sandre, P. C., Portugal, L. C. L., Mázala-de-Oliveira, T., da Silva Chagas, L., Raony, Í., Ferreira, E. S., Giestal-de-Araujo, E., dos Santos, A. A., & Bomfim, P. O. S. (2021). COVID-19 pandemic impact on children and adolescents' mental health: Biological, environmental, and social factors. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 106*(November 2020). <https://doi.org/10.1016/j.pnpbp.2020.110171>
- Evans, D. L., Janes-Bassett, V., Borrelli, P., Chenu, C., Ferreira, C. S. S., Griffiths, R. I., Kalantari, Z., Keesstra, S., Lal, R., Panagos, P., Robinson, D. A., Seifollahi-Aghmiuni, S., Smith, P., Steenhuis, T. S., Thomas, A., & Visser, S. M. (2022). Sustainable futures over the next decade are rooted in soil science. *European Journal of Soil Science, 73*(1), 1–16. <https://doi.org/10.1111/ejss.13145>
- Galindo, S. P., Borge-Diez, D., & Icaza, D. (2022). Energy sector in Ecuador for public lighting: Current status. *Energy Policy, 160*(March 2021), 112684. <https://doi.org/10.1016/j.enpol.2021.112684>
- Gluszek, S., Ariano-Sánchez, D., Cremona, P., Goyenechea, A., Luque Vergara, D. A., McLoughlin, L., Morales, A., Reuter Cortes, A., Rodríguez Fonseca, J., Radachowsky, J., & Knight, A. (2021). Emerging trends of the illegal wildlife trade in Mesoamerica. *Oryx, 55*(5), 708–716. <https://doi.org/10.1017/S0030605319001133>
- H. O, Nwankwoala, & D.C., O. (2021). A Review of Wetlands and Coastal Resources of the Niger Delta: Potentials, Challenges and Prospects. *Environment & Ecosystem Science, 5*(1), 37–46. <https://doi.org/10.26480/ees.01.2021.37.46>
- Hauptmann, M., Byrnes, G., Cardis, E., Bernier, M. O., Blettner, M., Dabin, J., Engels, H., Istad, T. S., Johansen, C., Kaijser, M., Kjaerheim, K., Journy, N., Meulepas, J. M., Moissonnier, M., Ronckers, C., Thierry-Chef, I., Le Cornet, L., Jahnen, A., Pokora, R., ... Kesminiene, A. (2022). Brain cancer after radiation exposure from CT examinations of children and young adults: results from the EPI-CT cohort study. *The Lancet Oncology, 2045*(22). [https://doi.org/10.1016/S1470-2045\(22\)00655-6](https://doi.org/10.1016/S1470-2045(22)00655-6)
- Keesstra, S. D., Bouma, J., Wallinga, J., Tiftonell, P., Smith, P., Cerdà, A., Montanarella, L., Quinton, J. N., Pachepsky, Y., Van Der Putten, W. H., Bardgett, R. D., Moolenaar, S., Mol, G., Jansen, B., & Fresco, L. O. (2016). The significance of soils and soil science towards realization of the United Nations sustainable development goals. *Soil, 2*(2), 111–128. <https://doi.org/10.5194/soil-2-111-2016>
- Ladhani, S. N., Collins, S., Djennad, A., Sheppard, C. L., Borrow, R., Fry, N. K., Andrews, N. J., Miller, E., & Ramsay, M. E. (2018). Rapid increase in non-vaccine serotypes causing invasive pneumococcal disease in England and Wales, 2000–17: a prospective national observational cohort study. *The Lancet Infectious Diseases, 18*(4), 441–451. [https://doi.org/10.1016/S1473-3099\(18\)30052-5](https://doi.org/10.1016/S1473-3099(18)30052-5)
- Morin, A. (2021). Self-awareness part 1: Definition, measures, effects, functions, and antecedents. *Social and Personality Psychology Compass, 5*(10), 807–823. <https://doi.org/10.1111/j.1751-9004.2011.00387.x>
- Nedophil, C., Yue, M., & Hughes, A. (2021). Scaling debt for nature swaps – which nature, how much debt and who pays? *International Institute of Green Finance, Central University of Finance and Economics, Beijing, 0–47*. <http://dx.doi.org/10.21203/rs.3.rs-1037851/v1>
- Nwankwoala H. O, (2021). A Review of Wetlands and Coastal Resources of the Niger Delta: Potentials, Challenges and Prospects. *Environment & Ecosystem Science, 5*(1), 36–46. <http://doi.org/10.26480/ees.01.2021.37.46>
- ÖNDER, M. (2018). Contribution of Plays and Toys to Children's Value Education. *Asian Journal of Education and Training, 4*(3), 146–149. <https://doi.org/10.20448/journal.522.2018.42.146.149>
- Osarokaka, A. J., Nzeako, S. O., Imafidor, H. O., & Living-Jamala, U. (2021). Soil nematodes status of crude oil polluted sites in Bodo community, Gokana Local Government Area, Rivers State, Nigeria. *African Journal of Environmental Science and Technology, 15*(2), 85–97. <https://doi.org/10.5897/ajest2020.2864>
- Raghavendra, U., Acharya, U. R., & Adeli, H. (2020). Artificial Intelligence Techniques for Automated Diagnosis of Neurological Disorders. *European Neurology, 82*(1–3), 41–64. <https://doi.org/10.1159/000504292>
- Tako, T., Ujjiga, A., & Ochi, E. B. (2022). *Infant Feeding Practice and Maternal Factors Influencing Exclusive Breast Feeding : A Cross-sectional Study in Warrap State , South Sudan Infant Feeding Practice and Maternal Factors Influencing Exclusive Breast Feeding : A Cross-sectional Study in Warrap. September.* <https://doi.org/10.21522/TIIPH.2013.10.03.Art002>
- Tavakolizadeh, J., Nejatian, M., & Soori, A. (2015). The Effectiveness of Communication Skills Training on Marital Conflicts and its Different Aspects in

Women. *Procedia - Social and Behavioral Sciences*,
171, 214–221.

<https://doi.org/10.1016/j.sbspro.2015.01.112>

Wang, D., Shi, C., Alamgir, K., Kwon, S. M., Pan, L.,
Zhu, Y., & Yang, X. (2022). Global assessment of the
distribution and conservation status of a key
medicinal plant (*Artemisia annua* L.): The roles of
climate and anthropogenic activities. *Science of the*

Total Environment, 821(January), 153378.

<https://doi.org/10.1016/j.scitotenv.2022.153378>

Yildizbasi, A., & Arioz, Y. (2022). Green supplier
selection in new era for sustainability: A novel
method for integrating big data analytics and a
hybrid fuzzy multi-criteria decision making. *Soft
Computing*, 26(1), 253–270.

<https://doi.org/10.1007/s00500-021-06477-8>