Original Research Article

Young Health Professional Perception of Training and Capacity Building for Improved Utilization of Phytomedicinal Antimalarial: A Cross-sectional Survey

.

ABSTRACT

|  |
| --- |
| **Aims:** To assess the perceptions of young health professionals regarding training and capacity building for the improved use of phytomedicinal antimalarials and enhancing research in Nigeria.  **Study design:** A descriptive cross-sectional survey.  **Place and Duration of Study:** Conducted in NIPRD between January to March 2025.  **Methodology:** A simple random sampling technique was used to recruit participants. Data were collected through a self-administered questionnaire. Responses from 203 participants were analysed using SPSS version 26. Descriptive statistics summarised demographic characteristics. The association between socio-demographic factors was assessed using multivariate binary logistic regression  **Results:** Most respondents were female, and nearly half were aged between 22 and 25 years. Over two-thirds came from non-medical but health-related disciplines. More than two-thirds had received formal training in antimalarial drug development or natural medicine research. Almost all participants (98.5%) agreed that training enhances understanding of phytomedicinal antimalarials. Internships at research institutions were rated the most valuable opportunity for gaining practical experience (52.7%). A majority showed strong interest in phytomedicinal research, driven by a desire to make a difference (64.0%) and by career aspirations (58.1%). Workshops were identified as the most convenient training format (73.4%). Research grants (68.5%) and mentorship programmes (61.3%) were the most cited support needs. Logistic regression revealed that individuals with research backgrounds were significantly more likely to value participation in fieldwork (p < 0.05).  **Conclusion:** There is a strong interest among young health professionals in phytomedicinal antimalarial research, accompanied by a recognised need for structured training and hands-on experience to support malaria control strategies. |

*Keywords: Antimalarial drugs, Capacity building, Malaria control, Natural product research, Phytomedicine, Training programmes, Young health professionals*

1. INTRODUCTION

Malaria accounts for morbidity and death in numerous tropical regions, including Nigeria, where transmission persists throughout the year (Omojuyigbe et al., 2023). This burden is particularly concerning giving that is a preventable and curable infection (Banks, 2022). However, the global community continues to face the challenge of drug-resistant *Plasmodium* strains, aggravated by a complex interplay of factors such as improper drug use, practice, pharmacokinetics, transmission intensity, multiplicity of infection, parasite density, host immunity, intra-host dynamics, and genetic adaptations (Phillips et al., 2017). These are further compounded by insecticide-resistant mosquito vectors, the absence of licensed malaria vaccines with long-term efficacy (Tuteja, 2007), and the circulation of counterfeit antimalarial drugs (Beargie et al., 2019). Whilst there have been targeted efforts to curtail the prevalence of malaria, the disease continues to rage on thereby posing significant public health concerns (Gao et al., 2023; Garrido-Cardenas et al., 2023).

Available data from extant literature has shown that natural products, particularly those sourced from plants, have played a critical role in the development of effective antimalarial treatments (Pan et al., 2018; Tajuddeen & Van Heerden, 2019). Notable instances include drug development of quinolines following the discovery of quinine from the bark of the *Cinchona* tree, and artemisinin from *Artemisia annua*, a plant indigenous to China (An et al., 2017; Fernández-Álvaro et al., 2016; Su & Miller, 2015; Suraj S. Raut et al., 2025). These phyto-active compounds serve as a base for recent therapies and demonstrate the potential of phytomedicines in combating malaria (Anibogwu et al., 2021). Their proven efficacy also inspires the development of analogues and affordable herbal antimalaria formulations (Wright, 2010).

Despite their potential, researchers and healthcare systems face challenges in utilizing and integrating plant-based resources for the development of antimalarials of plant origin in modern healthcare (Habibi et al., 2022). A recent study by (Almech et al., 2024) reinforces this concern, unveiling a level of misinformation among future health professionals: approximately one in five medical students believed that herbal remedies have no side effects, and a similar one in five assumed they could be safely used alongside pharmaceutical drugs without clinical guidance. It revealed the gap in the perception of young health professionals and suggests that the integration of these therapies is often hindered by scepticism.

Whilst several studies examine general awareness, knowledge and attitudes towards Complementary and Alternative Medicine (CAM) which includes herbal medicine (Ameade et al., 2016; Ben-Arye et al., 2008), there remains a clear gap in the literature as few have focused on how young health professionals perceive the adequacy of training and capacity development related to phytomedicinal antimalarials. Young professionals form the backbone of the conventional healthcare workforce and represent a key demographic for implementing new health initiatives (Ameade et al., 2016; Jonassen et al., 1999). Equipping them with essential competencies is critical, as their perceptions significantly influence the adoption of alternative therapies like phytomedicines in clinical practice (Deng & Cassileth, 2013). Therefore, this study aims to address this gap by evaluating how future healthcare providers perceive training and capacity building for the improved utilisation of phytomedicinal antimalarials. It is anticipated that the findings of this study will guide the development of culturally appropriate, evidence-based training strategies that enable young professionals to play a meaningful role in enhancing medicine security and supporting sustainable malaria intervention efforts.

2. material and methods

This study employed a cross-sectional survey design to assess the young health professionals’ perception of training and capacity building for improved utilisation of phytomedicinal antimalarials. A quantitative approach was adopted to ensure objectivity, reliability, and statistical generalisation of the findings. The questionnaire was designed in English. The items in the instrument were basically sectioned into demographic characteristics and questions aimed to evaluate the perception of training and capacity building for the utilisation of phytomedicinal antimalarials. The study population consisted of young health professionals, graduates and undergraduates from science-related fields that have had the opportunity to train at the National Institute for Pharmaceutical Research and Development (NIPRD). A simple random sampling technique was employed for participant selection. From an estimated population of 420 individuals, the minimum required sample size was calculated using Epi Info Software version 7, based on a 95% confidence level and a 5% margin of error, yielding a sample size of 201. To account for potential non-response, a total of 250 questionnaires were distributed. The inclusion criteria for participants in this study include young professional in healthcare, research, and related scientific fields, as well as a willingness to participate. Participants who did not meet these criteria were excluded from the study. Participation in this study was completely voluntary as the Google form questionnaire, disseminated via WhatsApp featured a consent section that determined access to the rest of the survey questions. Participants who provided consent were able to proceed and complete the questionnaire, whilst those who did not were restricted from continuing beyond that section. Based on their preference, participants could choose to fill the hard copy of the questionnaire. The responses provided by participants were anonymised and handled with absolute strict confidentiality to protect their privacy. Responses were exported to Microsoft excel and later coded and analysed using the Statistical Package for Social Sciences (SPSS) version 25. Multivariate Binary Logistic Regression Analysis was done to assess the views of young health professionals on ‘participation in field work’ as an opportunity crucial for gaining practical experience.

3. results and discussion

**3.1. Demography**

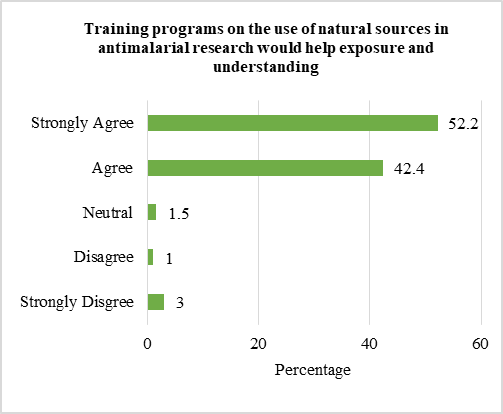
A total of 203 questionnaires were retrieved and analysed, yielding a response rate of 81.2%. Males were 34.5% of the sample and females comprised 65.5%. More than two-thirds of the respondents (68.5%) had professional backgrounds in other health-related fields whilst 22.7% were healthcare practitioners and only 8.9% were researchers. Similarly, about two-thirds of the participants (67.5%) indicated that they had formal training on antimalarial drug development or natural medicine research whilst one-third (32.5%) had no training in this regard. Further details on the participants' demography are presented in Table 1.

**Table 1: Sociodemographic Characteristics of the Participants**

|  |  |
| --- | --- |
| **Demography** | **Frequency (%)** |
| **Gender** |  |
| Male | 70 (34.5) |
| Female | 133 (65.5) |
| **Age** |  |
| 18 – 21 | 46 (22.7) |
| 22 – 25 | 101 (49.8) |
| 26 – 35 | 56 (27.6) |
| **Profession** |  |
| Healthcare practitioner | 46 (22.7) |
| Researcher | 18 (8.9) |
| Other health related fields | 139 (68.5) |
| **Level of Education Completed** |  |
| Undergraduate | 77 (37.9) |
| Graduate | 126 (62.1) |
| **Years of Work Experience** |  |
| < 1 | 108 (53.2) |
| 1 - 3 | 69 (34.0) |
| 4 and above | 26 (12.8) |
| **Formal Training in Antimalarial Drug Development or Natural Medicine Research** |  |
| Yes | 137 (67.5) |
| No | 66 (32.5) |
| **Geopolitical Zone of Educational Institution** |  |
| North-West | 21 (10.3) |
| North-East | 17 (8.4) |
| North-Central | 86 (42.4) |
| South-West | 24 (11.8) |
| South-East | 22 (10.8) |
| South-South | 33 (16.3) |

**3.2 Participants’ Perception of Training on Phytomedicinal Antimalarial Research**

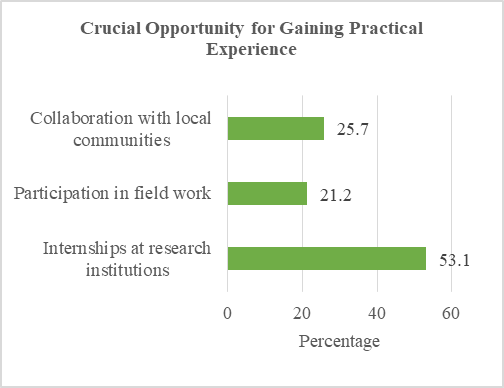
As presented in Figure 1, an assessment of the participants’ perception of training on the utilisation of phytomedicinal antimalarials showed that majority (94.6%) of the participants agreed that such a program on its implementation for research would help exposure and understanding.



**Fig. 1. Perception of training on phytomedicinal antimalarial research**

**3.3 Opportunities for Practical Exposure**

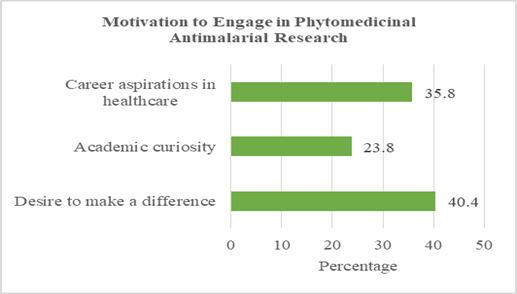
Participants’ responses to the question on what opportunities they considered crucial for gaining practical experience in the field of natural antimalarials are summarised in Figure 2. More than half (53.1%) of the respondents indicated that internships at research institutions were critical for operational experience. Also, one-quarter of the study cohort opined that collaboration with local communities is essential whilst only 21.2% were of the opinion that participation in fieldwork was a determinant for gaining real-world experience on phytomedicinal antimalarials.



**Fig. 2. *Crucial opportunity for practical experience in phytomedicinal antimalarial research***

**3.4. Interest in Phytomedicinal Antimalarial Research**

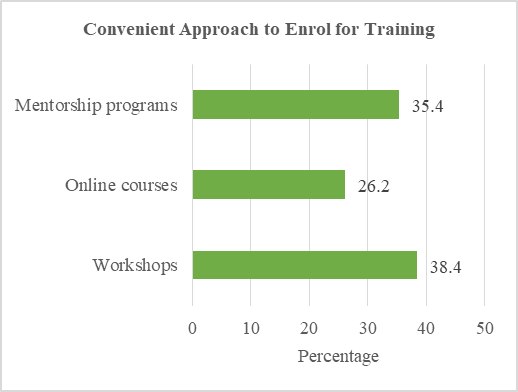
Findings from this study demonstrate that a strong majority of the young health professionals (95.1%) were interested in phytomedicinal antimalarial research however, 4.9% of the respondents stated that they were not interested. Furthermore, the motivation to engage in the research amongst participants who indicated interest as presented in Figure 3, shows that more of the participants were motivated because of the desire to make a difference. Participants whose motivation was due to academic curiosity were 23.8% of the sample. About two-thirds of the survey respondents (35.8%) revealed that they were passionate in engaging in phytomedicinal antimalarial research because of their career aspirations in healthcare.



**Fig. 3. Motivation to engage in phytomedicinal antimalarial research**

**3.5. Methods for Enrolling in Phytomedicinal Training**

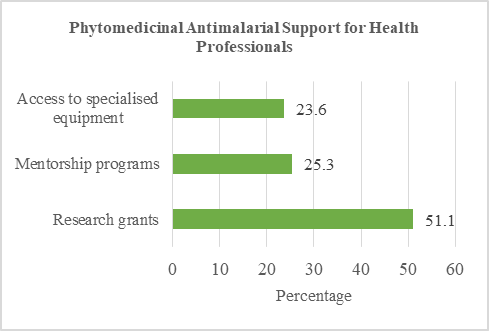
Participants’ views regarding methods for enrolling in training on phytomedicinal antimalarials are depicted in Figure 4. More than one-third of the young health professionals (38.4%) were inclined to workshops as the most convenient way for enrolling in the phytomedicinal training. One-quarter of the study participants (26.2%) were of the view that online courses were effective methods for enrolling in phytomedicinal training for antimalarials. Additionally, about one-third of the respondents perceived those mentorship programmes are convenient strategies for enrolling in the training.



**Fig. 4. Convenient Approach to Enrol for Training**

**3.6. Relevant Support for Health Professionals**

Respondents' perspective regarding the support that should be provided for health professionals interested in pursuing research on phytomedicinal antimalarials is presented in Figure 5. About half of the participants (51.1%) opined that research grants should be provided to interested persons. About one-quarter of the young professionals (23.6%) indicated that access to specialised equipment should be made available. A similar proportion of the sample population (25.3%) had the view that mentorship programme should be the support provided. 1.7 Association between Demographic Characteristics and Outcome Variables.



**Fig. 5. Phytomedicinal Antimalarial Support for Health Professionals**

**3.7. Association between Demographic Characteristics and Outcome Variables**

The relationship between the socio-demographic characteristics and views that participating in fieldwork presents a crucial opportunity for gaining practical experience on phytomedicinal antimalarials was determined using multivariate binary logistic regression analysis. The crude- and adjusted odds ratios (COR and AOR) are presented in Table 2. Only the participants' professional background was a significant factor influencing this view. Compared to those in other health-related fields, researchers were 5.21 times more likely to affirm that participating in fieldwork is critical for hands-on experience regarding plant-based antimalarial (AOR = 5.21; 95% CI = 1.65 – 16.43; p = 0.005). Other sociodemographic characteristics of the young health professionals did not significantly influence the outcome variable in Table 2. However, in comparison with those in the South-South geopolitical zone, the odds of acknowledging that fieldwork participation is essential for practical experience were higher in the North-West (AOR = 1.82) and North-East (AOR = 2.08) but increasingly lower in the North-Central (AOR = 0.69), South-West (AOR = 0.55) and South-East (AOR = 0.48). Also, participants’ highest levels of education show that undergraduates were less likely to agree with participating in fieldwork (AOR = 0.72) than graduates.

**Table 2. Relationship between sociodemographics and views on fieldwork participation**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Demography** | **Participation in Field Work** | | **COR (95% CI)** | ***p*-value** | **AOR (95% CI)** | ***p*-value** |
|  | **Yes** | **No** |  |  |  |  |
|  |  |  |  |  |  |  |
| **Gender** |  |  |  |  |  |  |
| Male | 16 (22.9) | 54 (77.1) | - 0.78 (0.41 – 1.57) | 0.514 | - 0.68 (0.32 – 1.46) | 0.321 |
| Female | 36 (27.1) | 97 (72.9) | Ref | Ref | Ref | Ref |
| **Age** |  |  |  |  |  |  |
| 18 – 21 | 7 (15.2) | 39 (84.8) | - 0.38 (0.14 – 1.01) | 0.052 | - 0.47 (0.14 – 1.56) | 0.219 |
| 22 – 25 | 27 (26.7) | 74 (73.3) | - 0.77 (0.38 – 1.57) | 0.473 | - 0.94 (0.41 – 2.16) | 0.885 |
| 26 – 35 | 18 (32.1) | 38 (67.9) | Ref | Ref | Ref | Ref |
| **Profession** |  |  |  |  |  |  |
| Healthcare practitioner | 8 (17.4) | 38 (82.6) | - 0.65 (0.28 – 1.53) | 0.324 | - 0.79 (0.31 – 1.97) | 0.605 |
| Researcher | 10 (55.6) | 8 (44.4) | + 3.86 (1.41 – 10.57) | 0.009\* | + 5.21 (1.65 – 16.43) | 0.005\* |
| Other health related field | 34 (24.5) | 105 (75.5) | Ref | Ref | Ref | Ref |
| **Level of Education Completed** |  |  |  |  |  |  |
| Undergraduate | 16 (20.8) | 61 (79.2) | - 0.66 (0.34 – 1.29) | 0.219 | - 0.72 (0.33 – 1.57) | 0.407 |
| Graduate | 36 (28.6) | 90 (71.4) | Ref | Ref | Ref | Ref |
| **Years of Work Experience** |  |  |  |  |  |  |
| < 1 | 23 (21.3) | 85 (78.7) | - 0.61 (0.24 – 1.58) | 0.307 | - 0.88 (0.30 – 2.54) | 0.809 |
| 1 - 3 | 21 (30.4) | 48 (69.6) | - 0.98 (0.37 – 2.62) | 0.975 | - .91 (-.3- - 2.73) | 0.869 |
| 4 and above | 8 (30.8) | 18 (69.2) | Ref | Ref | Ref | Ref |
| **Formal Training in Antimalaria Drug Development or Natural Medicine Research** |  |  |  |  |  |  |
| Yes | 30 (21.9) | 107 (78.1) | - 0.56 (0.29 – 1.08) | 0.082 | - 0.54 (0.26 – 1.13) | 0.100 |
| No | 22 (33.3) | 44 (66.7) | Ref | Ref | Ref | Ref |
| **Geopolitical Zone of Educational Institution** |  |  |  |  |  |  |
| North-West | 8 (38.1) | 13 (61.9) | + 1.08 (0.35 – 3.34) | 0.898 | + 1.82 (0.52 – 6.36) | 0.348 |
| North-East | 6 (35.3) | 11 (64.7) | - 0.96 (0.28 – 3.24) | 0.941 | + 2.08 (0.54 – 8.06) | 0.290 |
| North-Central | 18 (20.9) | 68 (79.1) | - 0.46 (0.19 – 1.12) | 0.086 | - 0.69 (0.26 – 1.84) | 0.458 |
| South-West | 4 (16.7) | 20 (83.3) | - 0.35 (0.10 – 1.27) | 0.110 | - 0.55 (0.13 – 2.37) | 0.421 |
| South-East | 4 (18.2) | 18 (81.8) | - 0.39 (0.11 – 1.42) | 0.153 | - 0.48 (0.12 – 1.96) | 0.307 |
| South-South | 12 (36.4) | 21 (63.6) | Ref | Ref | Ref | Ref |

Note: ‘COR’ stands for Crude Odds Ratio. ‘AOR’ is Adjusted Odds Ratio ‘+’ indicates that the odds increase. ‘–’ implies that the odds decrease. ‘Ref’ means reference category. ‘\*’ signifies that p < 0.05

**5. DISCUSSION**

Approximately nineteen out of every twenty respondents (94.6%) agreed that training programmes on the use of natural sources in the research for phytomedicinal antimalarials would improve their exposure and understanding of this field when implemented. About one in twenty (4%) participants disagreed, whilst 1.5% remained neutral. This study demonstrates a broadly positive attitude toward phytomedicine training, underscoring the awareness and readiness among young professionals to engage in phytomedicinal research if the appropriate platforms and opportunities are made available. Similarly, (Ani et al., 2024) and (Igbokwe et al., 2022) revealed that individuals in the medical field show very positive attitude to research but are not very keen to practically apply their knowledge. The endorsement for formal training mirrors findings in educational context. A study among Turkish medical students reported that 85.5% of respondents believed physicians should have adequate knowledge of Complementary and Alternative Medicine (CAM), and most supported the inclusion of CAM in the medical school curriculum (Clement et al., 2005). Similarly, (Chez et al., 2001) and (Lie & Boker, 2006) also documented support for the formal integration of CAM training among healthcare professionals. Given that phytomedicinal antimalarials is a subset of CAM; these findings consolidates the importance of structured capacity building programs as a strategic interface for advancing the role of plant medicine in health innovation. However, it is important to note that whilst enthusiasm for training is strong, opinions’ regarding the clinical integration of CAM remains mixed. A study showed that only 33.1% of students supported combining CAM with conventional medicine. This suggests that although health professionals may value CAM-related knowledge and training, their support for its integration into standard clinical practice may be influenced by cultural beliefs, professional norms, and the availability of scientific evidence. As such, capacity-building initiatives should aim not only to deliver technical content but also to promote critical engagement with the evolving role of phytomedicine in healthcare systems.

Over half of the respondents (53.1%) identified internships at research institutions as crucial for gaining practical experience, whilst 25.6% of the participants highlighted collaboration with local communities, and 21.2% emphasized fieldwork participation. It is important to acknowledge that the background of the study population drawn from individuals affiliated with the National Institute for Pharmaceutical Research and Development (NIPRD) may have influenced their responses. Many of the participants had previously undertaken internships or bench work training at NIPRD, which could have shaped their perspectives on phytomedicinal research and training.

More than nineteen out of twenty participants (95.1%) expressed interest in phytomedicinal antimalarial research. Among them, the largest share roughly two out of five (40.3%) were driven by the desire to make a difference. Just over one-third (35.8%) cited career aspirations, and nearly one-quarter (23.8%) were motivated by academic curiosity. This suggests that whilst curiosity plays a role, intrinsic values and professional goals are the key motivators for most participants. (Ommering et al., 2018) reported that first-year medical students scored highly on both intrinsic (5.49) and extrinsic (5.66) motivation for research. (Amida et al., 2021) found intrinsic motivation to be the strongest predictor of perceived success for graduate students.

When asked about convenient approaches to enrol in training, just over one-third (38.4%) highlighted workshops, about one-third favored mentorship programs, and roughly one-quarter (26.2%) found online courses most suitable. Considering that the study population was sourced from NIPRD, the strong selection of workshops likely reflects the institution’s established role in delivering hands-on, experiential training. Additionally, the preferred training modalities which included workshops, mentorship, and online learning tip to a demand for a more flexible blended learning approach. Notably, (Rowe et al., 2021), also showed that workshops where interactive and showed higher effectiveness in knowledge transfer.

About half of the respondents (51.1%) indicated that access to research grants would be the most supportive measure to be provided for health professionals interested in pursuing research on antimalarials of plant origin. Roughly one-quarter supported the provision of specialized equipment (23.6%), whilst a similar proportion (25.3%) prioritized mentorship. These responses suggest that financial and technical resources are just as critical as guidance and training in enabling early-career professionals to pursue phytomedicinal research effectively. The high inclination of respondents on research grants evidently reflects how the paucity of funds truncates the advancement of plant based antimalarial research.

Only professional background significantly influenced the view that fieldwork is crucial, with researcher’s times more likely to hold this view. This suggests that individuals already embedded in research contexts appreciate skills acquisition through community engagement and direct field observations. Geopolitical zone and education level also showed variations, with North-West and North-East participants more likely to see fieldwork as essential compared to South-South, and undergraduates less likely than graduates. This regional variation might reflect differing educational exposures, necessitating tailored regional policies to support phytomedicinal research development. However it’s important to note that some geopolitical zones were sparingly represented in the study population, thus conclusions cannot be made. Finally, this study vehemently affirms that adequately equipping early career professionals with relevant, practical, and research-oriented skills is central to enhancing the uptake of phytomedicinal antimalarials. Bridging professional and structural gaps through targeted training and support will be vital in strengthening local capacity for sustainable malaria control.

**5. CONCLUSION**

This study reveals that young health professionals recognise the importance of training programmes and express interest in phytomedicinal antimalarial research, whilst also identifying significant gaps in training, infrastructure, and exposure to practical. Participants emphasised the value of fieldwork, suggesting that professional orientation may have a greater influence on their engagement than demographic traits. To support the integration of phytomedicinal approaches into malaria control efforts, targeted capacity-building initiatives highly grounded in experiential learning, equitable resource distribution, and structured mentorship are urgently required. These insights underscore key areas for intervention that would empower young professionals to become active contributors to evidence-based sustainable healthcare solutions.

**6. LIMITATIONS**

The cohort for this cross-sectional study was drawn strictly from young professionals affiliated with the National Institute for Pharmaceutical Research and Development (NIPRD). Thus the findings as regards this study may not be fully generalizable to the wider population of similar sample or other low resource settings, most especially those without prior exposure to research environments. Additionally, the over representation of respondents from North-Central zone and individuals from allied fields other than those solely inclined to clinical practice or research, may introduce response bias, thus limiting the ability to draw strong comparative conclusions across regions and disciplines.

**7. RECOMMENDATIONS**

We highly recommend that research and tertiary institutions should be empowered to offer training in phytomedicinal antimalarial research. This includes providing academic and research centers across all regions with relevant amenities to aid equal access to learning opportunities. With respect to participants' preference for more flexible training formats such as mentorship, and online courses, institutions should incorporate a learning model that accommodates individual learning needs while expanding reach. More so, the reported need for research grants and specialized equipment must be prioritized. Stakeholders, not limited to government bodies and fund providing agencies, should allocate resources to support individuals in the bud of their research career in plant medicine.

ETHICAL APPROVAL

The ethical approval for this study was obtained from the National Institute from Pharmaceutical Research and Development (NIPRD) Health Research Ethics Committee, Abuja, Nigeria before the commencement of data collection.

**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 the writing or editing of this manuscript.

References

Almech, Majd, Abdulrahim Alissa, Ragad Baghdadi, Jakleen Abujamai, Waleed Hafiz, Hassan Alwafi, Mohammed Shaikhomer, Asim Alshanberi, Maram Alshareef, and Safaa Alsanosi. 2024. “Medical Students’ Knowledge and Perceptions of Herbal Medicine in Saudi Arabia: Should Medical Schools Take Immediate Action?” *Advances in Medical Education and Practice* Volume 15:1243–53. doi: 10.2147/AMEP.S497642.

Ameade, Evans Paul Kwame, Anthony Amalba, Gideon Kofi Helegbe, and Baba Sulemana Mohammed. 2016. “Medical Students’ Knowledge and Attitude towards Complementary and Alternative Medicine – A Survey in Ghana.” *Journal of Traditional and Complementary Medicine* 6(3):230–36. doi: 10.1016/j.jtcme.2015.03.004.

Amida, Ademola, Sameera Algarni, and Robert Stupnisky. 2021. “Testing the Relationships of Motivation, Time Management and Career Aspirations on Graduate Students’ Academic Success.” *Journal of Applied Research in Higher Education* 13(5):1305–22. doi: 10.1108/JARHE-04-2020-0106.

An, Jie, Mark Minie, Tomikazu Sasaki, Joshua J. Woodward, and Keith B. Elkon. 2017. “Antimalarial Drugs as Immune Modulators: New Mechanisms for Old Drugs.” *Annual Review of Medicine* 68(1):317–30. doi: 10.1146/annurev-med-043015-123453.

Ani, Chidiebere Kingsley, Aniekeme Sunday Bassey, Osahon Joseph Osaghae, and Miriam Uzezi Eroh. 2024. “Medical Research Engagement among Resident Doctors in Nigeria: Assessing Knowledge, Attitudes, and Barriers in a Public and Private Tertiary Hospital in Nigeria.” *BMC Medical Education* 24(1):1521. doi: 10.1186/s12909-024-06548-y.

Anibogwu, Rosemary, Karl De Jesus, Samjhana Pradhan, Srinath Pashikanti, Sameena Mateen, and Kavita Sharma. 2021. “Extraction, Isolation and Characterization of Bioactive Compounds from Artemisia and Their Biological Significance: A Review.” *Molecules* 26(22):6995. doi: 10.3390/molecules26226995.

Banks, Jim. 2022. “Is the End of Malaria in Sight?” *IEEE Pulse* 13(1):22–24. doi: 10.1109/MPULS.2022.3145625.

Beargie, Sarah M., Colleen R. Higgins, Daniel R. Evans, Sarah K. Laing, Daniel Erim, and Sachiko Ozawa. 2019. “The Economic Impact of Substandard and Falsified Antimalarial Medications in Nigeria.” *PLOS ONE* 14(8):e0217910. doi: 10.1371/journal.pone.0217910.

Ben-Arye, Eran, Moshe Frenkel, Anat Klein, and Moshe Scharf. 2008. “Attitudes toward Integration of Complementary and Alternative Medicine in Primary Care: Perspectives of Patients, Physicians and Complementary Practitioners.” *Patient Education and Counseling* 70(3):395–402. doi: 10.1016/j.pec.2007.11.019.

Chez, Ronald A., Wayne B. Jonas, and Cindy Crawford. 2001. “A Survey of Medical Students’ Opinions about Complementary and Alternative Medicine.” *American Journal of Obstetrics and Gynecology* 185(3):754–57. doi: 10.1067/mob.2001.117484.

Clement, Yuri N., Arlene F. Williams, Kristi Khan, Tricia Bernard, Savrina Bhola, Maurice Fortuné, Oneil Medupe, Kerry Nagee, and Compton E. Seaforth. 2005. “A Gap between Acceptance and Knowledge of Herbal Remedies by Physicians: The Need for Educational Intervention.” *BMC Complementary and Alternative Medicine* 5(1):20. doi: 10.1186/1472-6882-5-20.

Deng, Gary, and Barrie Cassileth. 2013. “Complementary or Alternative Medicine in Cancer Care—Myths and Realities.” *Nature Reviews Clinical Oncology* 10(11):656–64. doi: 10.1038/nrclinonc.2013.125.

Fernández-Álvaro, Elena, W. David Hong, Gemma L. Nixon, Paul M. O’Neill, and Félix Calderón. 2016. “Antimalarial Chemotherapy: Natural Product Inspired Development of Preclinical and Clinical Candidates with Diverse Mechanisms of Action.” *Journal of Medicinal Chemistry* 59(12):5587–5603. doi: 10.1021/acs.jmedchem.5b01485.

Gao, Liping, Qi Shi, Zhiguo Liu, Zhenjun Li, and Xiaoping Dong. 2023. “Impact of the COVID-19 Pandemic on Malaria Control in Africa: A Preliminary Analysis.” *Tropical Medicine and Infectious Disease* 8(1):67. doi: 10.3390/tropicalmed8010067.

Garrido-Cardenas, Jose A., Lilia González-Cerón, Federico García-Maroto, José Cebrián-Carmona, Francisco Manzano-Agugliaro, and Concepción M. Mesa-Valle. 2023. “Analysis of Fifty Years of Severe Malaria Worldwide Research.” *Pathogens* 12(3):373. doi: 10.3390/pathogens12030373.

Habibi, Peyman, Yao Shi, Maria Fatima Grossi-de-Sa, and Imran Khan. 2022. “Plants as Sources of Natural and Recombinant Antimalaria Agents.” *Molecular Biotechnology* 64(11):1177–97. doi: 10.1007/s12033-022-00499-9.

Igbokwe, Martin, Oladimeji Adebayo, Oluwaseyi Ogunsuji, Gbenga Popoola, Rereloluwa Babalola, Sebastine Oseghae Oiwoh, Anuoluwapo Mojisola Makinde, Adebayo Makinde Adeniyi, Kehinde Kanmodi, Wasinda Francis Umar, Ayanfe Omololu, Ibiyemi Oduyemi, Abdulmajid Ibrahim Yahya, and Aliyu Sokomba. 2022. “An Exploration of Profile, Perceptions, Barriers, and Predictors of Research Engagement among Resident Doctors.” *Perspectives in Clinical Research* 13(2):106–13. doi: 10.4103/picr.PICR\_152\_20.

Jonassen, J. A., M. P. Pugnaire, K. Mazor, M. B. Regan, E. W. Jacobson, W. Gammon, D. G. Doepel, and A. J. Cohen. 1999. “The Effect of a Domestic Violence Interclerkship on the Knowledge, Attitudes, and Skills of Third-Year Medical Students.” *Academic Medicine* 74(7):821–28. doi: 10.1097/00001888-199907000-00017.

Lie, Désirée A., and John Boker. 2006. “Comparative Survey of Complementary and Alternative Medicine (CAM) Attitudes, Use, and Information-Seeking Behaviour among Medical Students, Residents &amp; Faculty.” *BMC Medical Education* 6(1):58. doi: 10.1186/1472-6920-6-58.

Ommering, Belinda W. C., Floris M. Van Blankenstein, Cathelijn J. F. Waaijer, and Friedo W. Dekker. 2018. “Future Physician-Scientists: Could We Catch Them Young? Factors Influencing Intrinsic and Extrinsic Motivation for Research among First-Year Medical Students.” *Perspectives on Medical Education* 7(4):248–55. doi: 10.1007/S40037-018-0440-Y.

Omojuyigbe, Jeremiah Oluwamayowa, Adedoyin John-Joy Owolade, Taiwo Oluwaseun Sokunbi, Habib Ademola Bakenne, Blessing Abraham Ogungbe, Habeebullah Jayeola Oladipo, and Prosper Ifunanya Agughalam. 2023. “Malaria Eradication in Nigeria: State of the Nation and Priorities for Action.” *Journal of Medicine, Surgery, and Public Health* 1:100024. doi: 10.1016/j.glmedi.2023.100024.

Pan, Wen-Hui, Xin-Ya Xu, Ni Shi, Siu Wai Tsang, and Hong-Jie Zhang. 2018. “Antimalarial Activity of Plant Metabolites.” *International Journal of Molecular Sciences* 19(5):1382. doi: 10.3390/ijms19051382.

Phillips, Margaret A., Jeremy N. Burrows, Christine Manyando, Rob Hooft van Huijsduijnen, Wesley C. Van Voorhis, and Timothy N. C. Wells. 2017. “Malaria.” *Nature Reviews Disease Primers* 3(1):17050. doi: 10.1038/nrdp.2017.50.

Rowe, Alexander K., Samantha Y. Rowe, David H. Peters, Kathleen A. Holloway, and Dennis Ross-Degnan. 2021. “The Effectiveness of Training Strategies to Improve Healthcare Provider Practices in Low-Income and Middle-Income Countries.” *BMJ Global Health* 6(1):e003229. doi: 10.1136/bmjgh-2020-003229.

Su, Xin-Zhuan, and Louis H. Miller. 2015. “The Discovery of Artemisinin and the Nobel Prize in Physiology or Medicine.” *Science China Life Sciences* 58(11):1175–79. doi: 10.1007/s11427-015-4948-7.

Suraj S. Raut, Yashkumar R. Dhole, and Swati P. Deshmukh. 2025. “Role of Medicinal Plant in Treatment of Malaria.” *GSC Biological and Pharmaceutical Sciences* 30(1):178–85. doi: 10.30574/gscbps.2025.30.1.0499.

Tajuddeen, Nasir, and Fanie R. Van Heerden. 2019. “Antiplasmodial Natural Products: An Update.” *Malaria Journal* 18(1):404. doi: 10.1186/s12936-019-3026-1.

Tuteja, Renu. 2007. “Malaria − an Overview.” *The FEBS Journal* 274(18):4670–79. doi: 10.1111/j.1742-4658.2007.05997.x.

Wright, Colin W. 2010. “Recent Developments in Research on Terrestrial Plants Used for the Treatment of Malaria.” *Natural Product Reports* 27(7):961. doi: 10.1039/c002196m.