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Epidemiological Profile of Malaria and HIV Infection in Rural Communities of Ondo State, Nigeria: Prevalence, Co-Infection Risks, and the Role of Traditional Herbal Treatment

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ABSTRACT

Malaria and HIV remain major public health challenges in sub-Saharan Africa, with their co-occurrence contributing significantly to disease burden and mortality. This study investigated the prevalence, epidemiological determinants, and co-infection risk of malaria and HIV in ten rural communities of Ondo State, Nigeria, while also assessing the role of traditional herbal medicine in disease management. A cross-sectional survey was conducted among 892 consenting adults and adolescents recruited from ten villages. Participants underwent malaria rapid diagnostic testing, HIV screening using standard point-of-care protocols with counseling, and structured questionnaire interviews. Data were analyzed using contingency coefficient tests and odds ratio (OR) estimates. Malaria prevalence was 25.8% (230/892), varying significantly across communities ($p<0.05$), while HIV seroprevalence was 0.9% (8/892). Malaria infection was associated with an increased risk of HIV acquisition (OR=8.64; 95% CI: 1.76–42.48). Unprotected sexual intercourse with casual partners emerged as the strongest HIV risk factor (OR=224.26; 95% CI: 28.58–1759.50), followed by prolonged fever (OR=69.13) and multiple sexual partners (OR=68.97). Herbal medicine use for malaria treatment was widespread (75.5%) but showed no significant association with malaria prevalence ($p=0.956$). Living in unscreened houses without mosquito nets was significantly associated with increased fever incidence ($p=0.027$). Knowledge of HIV etiology was limited, with only 27.5% of respondents correctly identifying the causative pathogen. The findings indicate a substantial malaria burden alongside persistent HIV transmission in rural Ondo State. Integrated malaria-HIV control strategies, strengthened community education, improved vector control, and culturally responsive healthcare interventions are recommended to reduce disease burden and improve public health outcomes.

KEYWORDS: Malaria; HIV; Co-Infection; Rural Nigeria; Ondo State; Herbal Medicine; Epidemiology; Vector Control; Community Health

I. INTRODUCTION

Malaria and the Human Immunodeficiency Virus (HIV) represent two of the most devastating infectious disease burdens in sub-Saharan Africa. According to the World Health Organization (WHO, 2023), Africa accounts for approximately 94% of global malaria cases (249 million in 2022) and 67% of new HIV infections worldwide. Nigeria alone bears the world's highest absolute malaria burden, an estimated 68 million cases annually, while simultaneously hosting approximately 1.9 million people living with HIV (UNAIDS, 2023; WHO, 2023). The convergence of these two infections within the same population creates compounding public health challenges that demand community-level evidence. The biological interaction between malaria and HIV is well-established. HIV-induced immunosuppression increases an individual's

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susceptibility to malaria infection, reduces the effectiveness of antimalarial treatments, and worsens clinical outcomes (Flateau *et al*., 2021; Njim et al., 2020). Conversely, acute malaria parasitemia transiently elevates HIV viral load, theoretically increasing transmissibility (Hochman & Kim, 2021). Despite this bidirectional relationship, most community-based disease programs in Nigeria continue to manage malaria and HIV through vertical, siloed systems with limited integration (Federal Ministry of Health Nigeria, 2021).

A further complication in the Nigerian context is the widespread use of traditional herbal medicine for malaria management. National surveys consistently document that between 60% and 80% of rural populations turn to herbal remedies as a first-line response to febrile illness before seeking orthodox care (Idowu *et al*., 2022; Nwaneri *et al*., 2020). The implications of this practice for treatment-seeking delay, drug resistance, and clinical outcomes remain contested. Despite these concerns, community-level empirical data on the co-occurrence of malaria and HIV in rural Ondo State, and on the epidemiological factors that predict infection, remain sparse. The present study addresses this gap by reporting cross-sectional survey findings from ten villages in Ondo State, examining: (i) the prevalence and sociodemographic predictors of malaria and HIV infection; (ii) the magnitude of co-infection risk; (iii) the relationship between vector exposure, protective behaviors, and fever episodes; and (iv) community knowledge of HIV and patterns of herbal treatment use.

II. RELATED WORKS

A. Malaria Epidemiology in Nigeria

Malaria, caused by Plasmodium falciparum in over 95% of Nigerian cases, remains hyperendemic across all ecological zones of the country, with transmission year-round in the rainforest south and seasonal in the savanna north (Okonkwo *et al*., 2021; WHO, 2023). Ondo State, situated in the southwestern rainforest belt, is classified as a high transmission zone. The Nigeria Demographic and Health Survey (National Population Commission, 2022) reported a malaria prevalence of 22% among children under five nationally, with rural populations facing disproportionate exposure due to proximity to mosquito breeding sites, substandard housing, and limited access to prevention tools. Studies from southwestern Nigeria document a complex relationship between sociodemographic characteristics and malaria risk. Proximity to standing water, gutters, and dense bush consistently predicts higher transmission intensity (Adeleke *et al*., 2022). Mosquito net usage, while shown to significantly reduce malaria incidence when properly and consistently used, is unevenly distributed in rural areas and its protective effect is substantially diminished in unscreened housing (Okorie *et al*., 2023; WHO, 2023).

B. HIV in Rural Sub-Saharan Africa

HIV prevalence in rural Nigeria has traditionally been lower than in urban centers; however, the rural burden is rising as transmission networks expand through migration and transport corridors (UNAIDS, 2023). A systematic review by Adetokunbo *et al*. (2022) found rural HIV prevalence in southwestern Nigeria ranging from 0.5% to 3.2%, with heterosexual transmission accounting for over 80% of infections. Unprotected intercourse with casual or multiple partners remains the primary driver of new infections in community settings (Awofeso & Ilesanmi, 2021). Knowledge gaps about HIV are persistently documented in rural Nigerian populations. Muhammed et al. (2021) found that fewer than 35% of rural adults in south-western Nigeria could correctly identify HIV as a virus distinct from AIDS as its clinical syndrome. This knowledge deficit is strongly

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associated with lower rates of voluntary HIV testing, which nationally stood at only 36% among adults in 2022 (UNAIDS, 2023).

C. Malaria-HIV Co-Infection: Mechanisms and Risks

Co-infection with malaria and HIV represents more than the sum of two independent pathogens. Meta-analyses consistently demonstrate that HIV-positive individuals are two to seven times more likely to experience clinical malaria than their HIV-negative counterparts, and that co-infected individuals experience significantly worse outcomes including higher parasite densities, increased risk of severe malaria, and elevated mortality (Flateau *et al*., 2021; Hochman & Kim, 2021). From a community health perspective, the implication is that any population experiencing both diseases simultaneously requires integrated management strategies. The WHO Global Technical Strategy for Malaria 2016–2030 (WHO, 2021) explicitly calls for the integration of HIV and malaria services in high-burden settings, yet implementation in Nigeria has lagged behind policy intent (Federal Ministry of Health Nigeria, 2021; Njim *et al*., 2020).

D. Traditional Herbal Medicine and Malaria Management

The use of medicinal plants for febrile illness in West Africa has deep cultural and historical roots. Several African plants — notably Artemisia annua, the source of artemisinin, have yielded clinically validated antimalarial compounds (Cheong *et al*., 2020). Nevertheless, the majority of community herbal preparations in use lack pharmacological characterization, standardized dosing, or evidence of antimalarial efficacy (Idowu *et al*., 2022).Concerns about herbal medicine in malaria management centre on delayed presentation to formal health facilities, potential herb-drug interactions, and reinforcement of misconceptions about disease causation (Nwaneri *et al*., 2020). Conversely, scholars such as Elujoba *et al*. (2020) have argued for a pragmatic integration of validated traditional medicine into primary healthcare, noting that in resource-constrained settings, dismissing all traditional practices alienates communities from health systems rather than drawing them in.

III. METHODOLOGY

A. Study Design and Setting

This study employed a descriptive, cross-sectional survey design. Data were collected from ten rural communities (study villages) within Ondo State, southwestern Nigeria: Odode Basic Health (n=164), Owena-Ondo (n=125), Igbo-Oja (n=203), Igba-Ondo (n=110), Wasinmi/Afun (n=70), Oboto/Ireje (n=69), Owena-Idanre (n=42), Alade-Idanre (n=37), Gbalegi (n=37), and Baikie (n=35). These communities were selected to represent geographic variation within the state, including settlements proximate to different mosquito breeding environments (ponds, gutters, bushland, and stagnant water bodies).

B. Participants and Sampling

A total of 892 individuals aged five years and above were enrolled using purposive community sampling at health outreach points and community gathering sites. Inclusion criteria required voluntary informed consent (or parental consent for minors) and residency within the study village for at least six months. Pregnant women were not excluded, and pregnancy status was recorded as a co-variable given its known association with malaria susceptibility.

C. Data Collection Instruments

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A structured interviewer-administered questionnaire was used to collect sociodemographic information (age, sex, ethnic group, marital status, occupation), self-reported health behaviors (herbal medicine use, mosquito net use, housing type), and knowledge of malaria and HIV. HIV risk factor assessment followed the WHO pre-test counselling protocol, covering sexual behavior, blood transfusion history, and clinical symptoms (fever >2 weeks, night sweats, and prolonged cough) as possible HIV indicator conditions.

D. Laboratory Testing

Malaria diagnosis was performed using standard rapid diagnostic tests (RDTs) for Plasmodium falciparum histidine-rich protein 2 (HRP2) antigen, supplemented by confirmatory microscopy where results were equivocal. HIV testing was conducted using the national HIV testing algorithm (two rapid antibody tests with tiebreaker), in accordance with the Nigerian National Guidelines for HIV Testing Services (Federal Ministry of Health Nigeria, 2021). All participants received pre-test and post-test counselling. Reactive HIV results were referred for confirmatory testing and linkage to care.

E. Statistical Analysis

Data were entered and analyzed using SPSS version 26.0. Descriptive statistics (frequencies and percentages) described participant characteristics and prevalence figures. Inferential analysis used contingency coefficient tests to assess associations between categorical variables, with statistical significance set at $p<0.05$. Odds ratios (OR) with 95% confidence intervals (95% CI) were calculated to quantify co-infection and behavioral risk. All participants provided written or witnessed verbal informed consent, and the study protocol was conducted in conformity with the Declaration of Helsinki.

IV. RESULTS AND DISCUSSION

A. Participant Distribution

The study enrolled 892 participants across ten communities. The largest contribution came from Igbo-Oja (22.8%, n=203), followed by Odode Basic Health (18.4%, n=164) and Owena-Ondo (14.0%, n=125). The smallest samples were from Baikie (3.9%, n=35), Gbalegi (4.1%, n=37), and Alade-Idanre (4.1%, n=37). The majority of respondents were female (70.3%), fell within the 21–40-year age group (44.1%), and were of Yoruba ethnicity (76.6%). Married participants comprised 71.9% of the sample, and traders/businesspersons were the most common occupational group (46.2%).

Table 1: Distribution of Participants by Study Village (N=892)

Study Village	N	Percentage (%)
Odode Basic Health	164	18.4
Owena-Idanre	42	4.7
Gbalegi	37	4.1
Owena-Ondo	125	14.0
Baikie	35	3.9
Igba-Ondo	110	12.3
Igbo-Oja	203	22.8
Wasinmi/Afun	70	7.8
Oboto/Ireje	69	7.7

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Alade-Idanre	37	4.1
Total	**892**	**100.0**

B. Herbal Medicine Use for Malaria

Herbal treatment of malaria was prevalent across all study communities. Overall, 700 participants (78.5%) who took orthodox drugs also used herbs, while 703 (78.8%) of all respondents reported using herbal preparations for malaria. Community-level herb use ranged from 59.5% (Gbalegi) to 89.9% (Oboto/Ireje). Notably, negative reactions to orthodox drugs were reported by 211 respondents (23.7%), compared to only 104 (14.8%) who reported adverse reactions to herbal preparations. Contingency coefficient analysis revealed no statistically significant difference in malaria prevalence between herb users and non-users (CC=0.002, p=0.956), suggesting that, within this population, herbal use neither protected against nor substantially worsened malaria infection rates.

Table 2: Adverse Reactions to Orthodox Drugs versus Herbal Preparations

Treatment Type	**Adverse Reaction: Yes**	**Adverse Reaction: No**	**N**
Treatment Type	**Adverse Reaction: Yes**	**Adverse Reaction: No**	**N**
Orthodox drugs	211 (23.7%)	681 (76.3%)	892
Herbal preparations	104 (14.8%)	599 (85.2%)	703

C. Vector Exposure, Housing, and Fever Episodes

Among participants in screened houses, mosquito net use was not significantly associated with reduced malaria infection (CC=0.079, p=0.09). However, among those in unscreened houses, living without a mosquito net was significantly associated with higher fever incidence (CC=0.143, p=0.027), indicating that housing structure modulates the protective effect of bed nets. Gutter proximity was the most commonly reported breeding site (24.1%), followed by dirty environments (20.6%) and stagnant water bodies (13.1%). Participants reporting monthly fever episodes had the highest proportional exposure to gutters (32.3%) and stagnant water (14.2%).

D. Malaria Prevalence and Sociodemographic Predictors

Overall malaria prevalence was 25.8% (230/892). Age group, sex, ethnicity, and occupation were not significantly associated with malaria positivity. Two variables demonstrated significant associations: study village (CC=0.251, p<0.001) and marital status (CC=0.111, p=0.001), with married participants showing higher absolute infection numbers, likely reflecting older age and associated outdoor exposure patterns. Pregnant women were over-represented in the infected group relative to their proportion in the total sample (infected: 6.1% vs. not infected: 3.0%).

E. HIV Knowledge and Testing Behavior

Community HIV knowledge was markedly limited. Only 27.5% of participants correctly defined HIV, and 26.6% correctly identified AIDS. Awareness of the relationship between HIV infection and AIDS as its clinical progression fell further to 17.5%. Media (television, radio, newspapers, and billboards) were the most commonly cited HIV education channel (72.2%). Despite near-universal awareness that AIDS exists (94.3%), only 3.9% of participants had previously undergone voluntary HIV testing. A substantial majority (89.5%) correctly believed HIV has no cure, with

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only 10.5% stating otherwise. All 892 participants received HIV counselling, risk assessment, and a risk reduction plan as part of the study protocol.

Table 3: Malaria Infection by Selected Sociodemographic Characteristics

Variable	Infected	Not Infected	Total	CC	p-value
Age group				0.157	0.000*
0–5 yrs	0	7	7		
6–10 yrs	1	13	14		
11–20 yrs	76	131	207		
21–40 yrs	93	300	393		
41–50 yrs	31	88	119		
>50 yrs	29	123	152		
Sex				0.021	0.539
Male	72	193	265		
Female	158	469	627		
Study village				0.251	0.000*
Marital status				0.111	0.001*

Note. CC = Contingency Coefficient. *Statistically significant ($p<0.05$).

F. HIV Seroprevalence and Associated Risk Factors

HIV seroprevalence was 0.9% (8/892). All eight reactive cases were among persons who identified as Yoruba (8/683), with no reactive cases among Hausa, Igbo, Igede, or other ethnic groups, though this difference was not statistically significant (CC=0.053, p=0.65). No statistically significant associations were found between HIV serostatus and age (CC=0.05, p=0.82), sex (χ^2=1.145, p=0.285), occupation (CC=0.066, p=0.278), study village (CC=0.089, p=0.625), or marital status (CC=0.033, p=0.326).

G. Risk Factors and Odds Ratios for HIV Infection

Risk factor analysis identified several variables with statistically significant associations with HIV positivity. Unprotected sex with a casual partner was the most potent risk factor (OR=224.26; 95% CI: 28.58–1759.50), followed by prolonged fever greater than two weeks (OR=69.13; 95% CI: 17.67–270.51), multiple sex partners in the past three months (OR=68.97; 95% CI: 17.63–269.88), and blood transfusion in the past three months (OR=16.19; 95% CI: 3.50–74.80). Malaria co-infection elevated HIV risk substantially (OR=8.64; 95% CI: 1.76–42.48). Prolonged coughing for more than three weeks was also associated with increased HIV risk (OR=10.48; 95% CI: 1.40–78.69), suggesting its potential utility as an HIV indicator symptom in community screening.

Table 4: Odds Ratios for Selected HIV Risk Factors

Risk Factor	Odds Ratio	95% CI Lower	95% CI Upper
Unprotected sex with casual partner	224.26	28.58	1759.50
Fever for >2 weeks	69.13	17.67	270.51
Multiple (>1) sex partners	68.97	17.63	269.88
Blood transfusion in past 3 months	16.19	3.50	74.80
Coughing for >3 weeks	10.48	1.40	78.69
Malaria–HIV co-infection	8.64	1.76	42.48
Malaria infection + Pregnancy	2.02	1.04	3.92

Note. 95% CI = 95% Confidence Interval.

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Discussion

A. Malaria Burden and Spatial Heterogeneity

A malaria prevalence of 25.8% across the study communities is consistent with findings from comparable rural settings in southwestern Nigeria. Okonkwo *et al*. (2021) documented prevalence rates of 22–31% in rural Ondo State communities, while the 2021 Nigeria Malaria Indicator Survey (National Malaria Elimination Programme, 2022) reported a national under-five parasite prevalence of 22%. The significant spatial variation observed across villages ($p<0.001$) is a clinically and programmatically important finding. Villages such as Wasinmi/Afun (31/70; 44.3%) and Owena-Ondo (47/125; 37.6%) exhibited markedly higher prevalence than Gbalegi (1/37; 2.7%) and Baikie (2/35; 5.7%). This heterogeneity likely reflects differences in proximity to high-density mosquito breeding habitats and housing quality rather than behavioral factors, given the absence of significant associations with age, sex, or occupation. The non-significant association between mosquito net use and malaria infection in screened houses ($p=0.09$) contrasts with the significant protective effect observed in unscreened houses ($p=0.027$). This nuance aligns with Okorie *et al*. (2023), who found that the protective efficacy of insecticide-treated nets (ITNs) was substantially attenuated in homes that lacked window screens, because mosquito entry through unscreened openings during daytime hours was not mitigated by nets used only during sleep. This finding has direct implications for national vector control programming: distributing ITNs without complementary investment in housing improvement may yield suboptimal results in rural Nigerian communities.

B. Herbal Medicine: A Pragmatic Perspective

The near-universal use of herbs for malaria (78.5%) with no demonstrable increase in malaria prevalence among herb users ($p=0.956$) presents a more nuanced picture than is often portrayed in public health discourse. While the current study was not designed to assess treatment efficacy or delay in care-seeking, the absence of a statistically significant harmful effect is consistent with findings from Elujoba *et al.* (2020), who noted that several widely used Yoruba herbal preparations (including Azadirachta indica and Morinda lucida) possess documented in vitro antiplasmodial activity. However, caution is warranted: absence of a statistically significant difference in prevalence does not equate to clinical equivalence with artemisinin-based combination therapy (ACT), and severe malaria cases or treatment delays may not be captured in this cross-sectional design. The observation that adverse reactions were more commonly reported for orthodox drugs (23.7%) than herbal preparations (14.8%) may partly reflect reporting bias (patients being more likely to attribute unpleasant symptoms to pharmaceutical drugs than to familiar herbal remedies) and the challenge of establishing causality in a survey setting. Nevertheless, this finding resonates with community perceptions documented by Idowu *et al*. (2022) and warrants further investigation.

C. HIV Seroprevalence and Risk Profile

An HIV prevalence of 0.9% is broadly consistent with the national adult seroprevalence of 1.4% (UNAIDS, 2023) and with rural sub-Saharan African estimates, which tend to be lower than urban figures. The fact that none of the standard sociodemographic variables (age, sex, ethnicity, marital status, occupation, or study village) were significantly associated with HIV serostatus in this

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sample likely reflects the small number of reactive cases (n=8), which limits statistical power for subgroup analysis. The risk factor odds ratios, however, tell a powerful story. Unprotected sex with a casual partner generated an OR of 224.26, an extraordinarily high point estimate, though the very wide confidence interval (28.58–1759.50) reflects the small sample size and should be interpreted cautiously. Nevertheless, the direction and significance are consistent with national and international data identifying casual unprotected sex as the primary driver of HIV transmission in community settings (Awofeso & Ilesanmi, 2021; UNAIDS, 2023). The OR for multiple sex partners (68.97) reinforces this conclusion. The Malaria–HIV co-infection OR of 8.64 (95% CI: 1.76–42.48) is particularly significant. It confirms, in this rural Nigerian community sample, the biologically plausible and epidemiologically important synergy between these two infections identified in clinical studies elsewhere in Africa (Flateau *et al*., 2021; Hochman & Kim, 2021). Individuals with malaria parasitaemia are substantially more likely to be HIV-positive in this sample, a relationship that may reflect HIV-mediated immunosuppression increasing susceptibility to malaria, or shared social and environmental risk factors, or both.

D. HIV Knowledge Deficits and Testing Gaps

The finding that only 27.5% of respondents correctly identified HIV and a mere 17.5% understood its relationship with AIDS is alarming but not surprising given the documented knowledge landscape in rural Nigeria (Muhammed *et al*., 2021). The gap between knowing that AIDS exists (94.3%) and understanding what HIV is (27.5%) illustrates a fundamental challenge in community health education: awareness of a phenomenon does not translate into accurate mechanistic understanding. More concerning is the voluntary testing rate of just 3.9%, which severely limits the potential for early diagnosis and treatment linkage. Media channels (television, radio, newspapers) were the most cited HIV information source, consistent with findings from Okonkwo *et al*. (2021) and Adetokunbo *et al*. (2022), who emphasize mass media campaigns as the dominant HIV communication infrastructure in rural Nigeria. However, media reach does not automatically translate to health literacy or behavior change. Community peer education, religious institution engagement, and integration of HIV education into primary health care contacts offer complementary strategies that have demonstrated effectiveness in analogous settings (Muhammed *et al*., 2021).

E. Strengths and Limitations

The study's principal strengths include its large multi-village sample (n=892), laboratory-confirmed disease outcomes, comprehensive risk factor data, and the integration of malaria and HIV screening within a single survey framework, a methodological model for integrated community disease surveillance. Limitations include the cross-sectional design, which precludes causal inference; purposive rather than probability sampling, which limits generalizability to the broader Ondo State population; potential social desirability bias in self-reported sexual behaviors; and the small number of HIV-positive cases, which constrains statistical power for multivariate risk analysis. Longitudinal cohort studies with larger samples and probability sampling are needed to confirm these findings and quantify attributable risk more precisely.

V. CONCLUSION

This study presents empirical evidence that malaria and HIV co-exist at clinically significant levels in rural Ondo State communities, and that co-infection substantially elevates individual risk for both diseases. Malaria prevalence (25.8%) is high and spatially heterogeneous, driven largely by

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environmental exposure rather than individual sociodemographic characteristics. HIV seroprevalence (0.9%), while low, is amplified by a knowledge deficit, near-absent voluntary testing, and high-risk sexual behaviors that remain normative in parts of these communities. Ultimately, the malaria and HIV burden in rural Ondo State is neither inevitable nor intractable. With integrated, evidence-based, and community-responsive programming, substantial reductions in prevalence and mortality are achievable, and are demanded by both equity and the Sustainable Development Goal agenda. Four evidence-based recommendations emerge from these findings: Firstly, integrated disease management should be operationalized at community level: every malaria case should trigger an offer of HIV testing and counselling, and every HIV-positive individual should receive malaria prophylaxis in line with WHO co-infection guidelines (WHO, 2021). Secondly, vector control programs must address housing quality alongside bed net distribution; ITNs alone are insufficient protection in unscreened dwellings. Thirdly, community HIV education must move beyond awareness to accurate knowledge, using peer networks, community health workers, and primary care contacts to address the tested misconceptions identified in this study. Fourthly, traditional herbal medicine use must be addressed with pragmatic sensitivity: rather than dismissive prohibitionism, health programs should educate communities on the specific risks of delayed care-seeking, provide accessible alternatives, and investigate validated herbal preparations through systematic pharmacological study.

Data Availability Statement

De-identified data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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