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Perceived Barriers to Malaria and Dengue Diagnosis, Treatment, and Prevention in Conflict-Affected Sudan: An Exploratory Web-Based Cross-Sectional Survey

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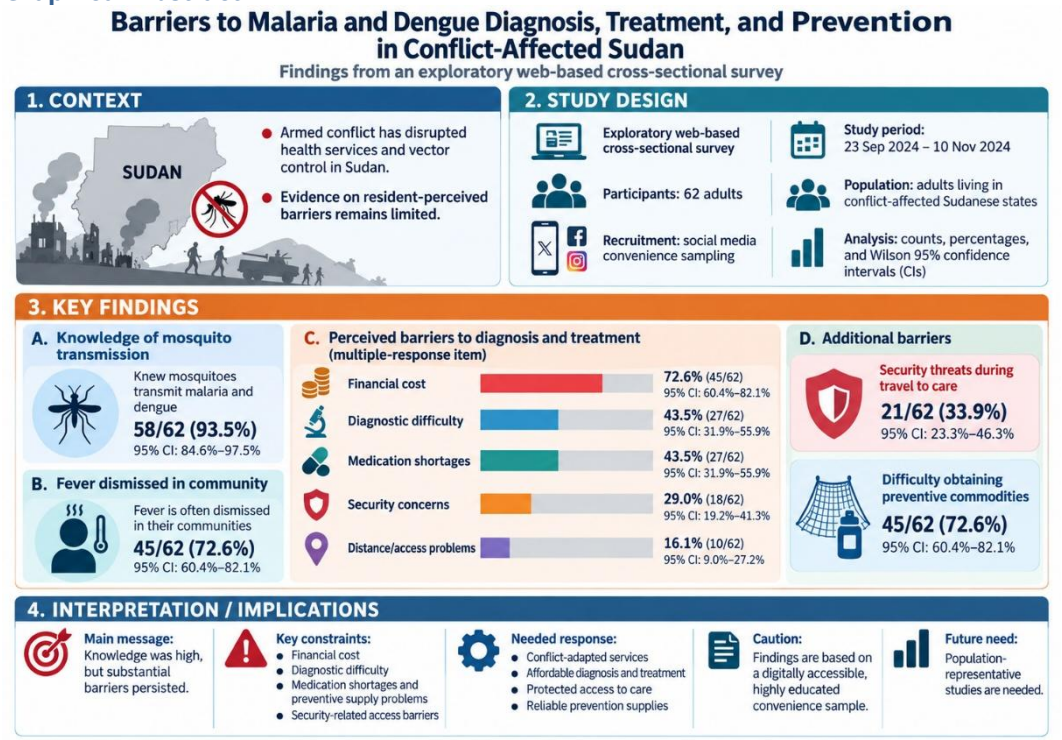
Graphical Abstract



Abstract: Armed conflict has disrupted health services and vector control in Sudan, but evidence on barriers perceived by affected residents remains limited. We conducted an exploratory web-based cross-sectional survey from September 23 to November 10, 2024. Sixty-two adults living in conflict-affected Sudanese states were recruited through social media using convenience sampling. Categorical responses were summarized as counts and percentages, and Wilson 95% confidence intervals (CIs) were calculated for key proportions. Most respondents knew that mosquitoes transmit malaria and dengue (58/62, 93.5%; 95% CI, 84.6%-97.5%), yet 45/62 (72.6%; 95% CI, 60.4%-82.1%) reported that fever is often dismissed in their communities. In a multiple-response item, financial cost

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was selected by 45/62 participants (72.6%; 95% CI, 60.4%-82.1%), diagnostic difficulty and medication shortages by 27/62 each (43.5%; 95% CI, 31.9%-55.9%), security concerns by 18/62 (29.0%; 95% CI, 19.2%-41.3%), and distance or access problems by 10/62 (16.1%; 95% CI, 9.0%-27.2%). Security threats during travel to care were reported by 21/62 (33.9%; 95% CI, 23.3%-46.3%), and 45/62 (72.6%; 95% CI, 60.4%-82.1%) reported difficulty obtaining preventive commodities. Among this digitally accessible, highly educated convenience sample, knowledge was high but respondents reported substantial financial, diagnostic, supply, and security constraints. The findings support conflict-adapted services that combine affordable diagnosis and treatment, protected access, and reliable prevention supplies. Population-representative studies are needed.

Keywords: armed conflict; dengue; health services accessibility; malaria; Sudan; vector-borne diseases; web-based survey.

INTRODUCTION

The armed conflict that began in Sudan in April 2023 has damaged facilities, displaced health workers and patients, interrupted supply chains, and reduced access to routine and emergency care. Published analyses describe extensive disruption to the health system and warn that reduced donor capacity compounds the effects of violence on service delivery.[1-4] Systematic evidence from other conflicts shows that population displacement, damaged water and sanitation systems, interrupted surveillance, and reduced access to diagnosis and treatment create linked pathways for infectious-disease transmission.[5]

Malaria and dengue are especially important in this setting because they share an acute febrile presentation while requiring different clinical and public-health responses. Dengue outbreaks and malaria-dengue coinfection have been documented in Darfur, Kassala, and other parts of Sudan, including among internally displaced populations.[6-11] Malaria transmission also remains heterogeneous within Sudan, and recent economic evaluation shows that sustaining vector control requires deliberate resource allocation.[12-13] Clinical overlap and limited laboratory capacity increase the risk of delayed or incorrect management, particularly where rapid diagnostic tests, microscopy, trained staff, or referral pathways are unavailable.[6-8,36-37]

Conflict affects vector-borne disease control through more than health-facility damage. It changes population movement, housing, exposure to mosquito breeding sites, access to insecticide-treated nets, and the feasibility of indoor residual spraying and environmental management. Historical and contemporary reviews link malaria and other vector-borne diseases with war, displacement, and weakened surveillance.[14-18] Evidence from fragile and conflict-affected settings further shows that resilient responses depend on maintaining essential services, local coordination, and adaptable delivery mechanisms.[19-20,38-40]

Health-seeking behavior in humanitarian settings is shaped by perceived severity, cost, insecurity, displacement status, and the availability of trusted services. These factors can move care away from facilities or delay it altogether.[21-24] Community engagement can improve uptake, but awareness alone cannot compensate for unaffordable care, medicine shortages, or unsafe travel.[25] Studies of malaria rapid diagnostic tests and treatment seeking similarly show that access, provider practice, and retail pathways influence whether febrile illness is tested and treated appropriately.[26-27]

Most published reports on Sudan's current health emergency describe system-level damage, outbreak occurrence, or service readiness. Less is known about how digitally reachable residents in affected states perceive the combined barriers to malaria and dengue diagnosis, treatment, and prevention. This exploratory study therefore aimed to describe awareness, reported access constraints, prevention barriers, and community-proposed responses among adults living in conflict-affected areas of Sudan. The analysis was designed to generate cautious, sample-specific estimates rather than population prevalence.

MATERIALS AND METHOD

Study design and setting

We conducted an exploratory descriptive cross-sectional survey between September 23 and November 10, 2024. The survey was administered online to residents of Sudanese states affected by the ongoing conflict, including Khartoum, Al Jazeera, Gadarif, Kassala, Nile River, Northern, Sennar, and White Nile. Reporting was guided by the Strengthening the Reporting of Observational Studies in Epidemiology recommendations.[30-31]

Participants and recruitment

Eligible participants were adults aged 18 years or older who lived in a conflict-affected area of Sudan and reported personal or household experience with malaria or dengue. People living outside Sudan or in areas not affected by the conflict were excluded. The survey link was distributed through Facebook, Telegram, and WhatsApp. Recruitment used nonprobability convenience sampling, and 62 respondents were included in the analysis. No claim of representativeness was made.

Questionnaire development and measurement

A structured self-administered questionnaire was prepared in Arabic and translated into English for analysis. It covered demographics, disease awareness, barriers to diagnosis and treatment, healthcare access and security, perceived quality of care, prevention, effects of the war, community roles, and proposed solutions. The Arabic questionnaire underwent a limited pre-deployment review for clarity and comprehension. The number and characteristics of pretest participants and the resulting revisions were not formally documented. Because the instrument consisted principally of single categorical items rather than a multi-item psychometric scale, no composite score was created and internal consistency was not calculated.

Data collection and variables

Electronic consent was obtained before the questionnaire opened. Closed questions captured participant characteristics and reported experiences. Some questions allowed more than one selection. For these items, each option was summarized using the number of participants selecting it and the total sample of 62 as the denominator; percentages therefore may sum to more than 100%. Open-text responses were grouped into recurring descriptive themes. No identifying information was included in the analytic file.

Statistical analysis

Data were cleaned, coded, and summarized in Microsoft Excel 365. Categorical variables are presented as counts and percentages. Wilson score 95% CIs were calculated for key proportions because the sample was small and several estimates were close to the boundaries of the binomial distribution.[32] The CIs quantify precision within the observed sample and do not correct for selection bias from convenience sampling. Urban-rural and sex-stratified hypothesis tests were not performed because subgroup cells were small and the nonprobability sample was not designed for stable between-group inference. The analysis was therefore exploratory and descriptive; no causal associations were estimated.

Ethical considerations

Ethical approval was granted by the Institutional Review Board of Sudan University of Science and Technology (reference No. MLS-02-04-2025). Participation was voluntary and anonymous, electronic informed consent was required, and study data were used only for research purposes.

RESULTS

Participant characteristics

Of the 62 participants, 39 (62.9%) lived in Khartoum State and 23 (37.1%) lived in the other included states. Urban and rural residents were equally represented. Most respondents were women (49/62, 79.0%), 51/62 (82.3%) were aged 35 years or younger, and 54/62 (87.1%) had university-level or higher education (Table 1).

Table 1. Sociodemographic characteristics of participants (n = 62)

Characteristic	Category	Participants (n)	Percentage (%)

State	Khartoum	39	62.9
	Other included states*	23	37.1
Residence	Urban	31	50.0
	Rural	31	50.0
Age group	18-25 years	28	45.2
	26-35 years	23	37.1
	>35 years	11	17.7
Sex	Female	49	79.0
	Male	13	21.0
Education	University or higher	54	87.1
	Secondary or lower	8	12.9

**Al Jazeera, Gadarif, Kassala, Nile River, Northern, Sennar, and White Nile.*

Awareness and reported care seeking

All participants were aware of both malaria and dengue (62/62, 100.0%; 95% CI, 94.2%-100.0%). Fifty-eight participants (93.5%; 95% CI, 84.6%-97.5%) knew that mosquitoes transmit the diseases, and 54 (87.1%; 95% CI, 76.6%-93.3%) reported that they could distinguish their symptoms. However, 45 participants (72.6%; 95% CI, 60.4%-82.1%) said that early symptoms such as fever were often dismissed in their communities as "just a fever." Among mentions of prevention methods, mosquito nets accounted for 27.8%, removal of stagnant water for 25.3%, indoor insecticide spraying for 23.7%, and repellents for 22.2%.

Barriers to diagnosis and treatment

The diagnosis and treatment barrier item allowed multiple selections. Financial cost was selected by 45/62 participants (72.6%; 95% CI, 60.4%-82.1%). Diagnostic difficulty and medication shortage were each selected by 27/62 (43.5%; 95% CI, 31.9%-55.9%), security concerns by 18/62 (29.0%; 95% CI, 19.2%-41.3%), and distance or access problems by 10/62 (16.1%; 95% CI, 9.0%-27.2%) (Figure 1).

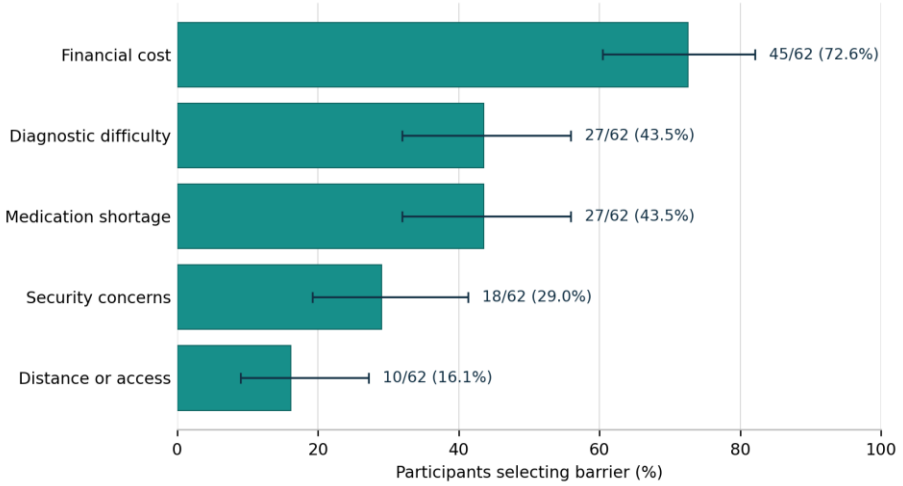

Figure 1. Reported barriers to malaria and dengue diagnosis and treatment.
Multiple selections were allowed; percentages use all 62 participants as the denominator. Error bars show Wilson 95% confidence intervals.

Healthcare access and perceived quality

Fifty-four participants (87.1%) reported that they could reach a health facility within 1 hour. Walking (41.9%) and public transport (32.3%) were the most frequently reported travel modes. Twenty-one participants (33.9%; 95% CI, 23.3%-46.3%) reported a security threat during travel to care: 12 (19.4%) sometimes and 9 (14.5%) often. Among reported effects of the war on healthcare and prevention, rising drug prices accounted for 29.0% of mentions, destruction or closure of facilities for 22.0%, and health-worker shortages for 18.0%. In addition, 44.1% of respondents rated healthcare quality as much worse than before the war.

Prevention barriers and community proposals

Forty-five participants (72.6%; 95% CI, 60.4%-82.1%) reported difficulty obtaining preventive commodities such as insecticide-treated nets or repellents. Disrupted humanitarian distribution accounted for 28.7% of cited reasons, cost for 26.4%, and unavailability in local markets for 21.8%. Among proposed solutions, free medication represented 26% of solution mentions, health-awareness activities 22%,

sanitation and environmental management 21%, mobile clinics 19%, and safe passage to health facilities 12%.

Table 2. Key sample proportions with Wilson 95% confidence intervals

Outcome	Participants n/N	Percentage %	Confidance Interval (CI 95%)
Aware of malaria and dengue	62/62	100.0	94.2-100.0
Knew mosquito-borne transmission	58/62	93.5	84.6-97.5
Reported ability to distinguish symptoms	54/62	87.1	76.6-93.3
Reported fever often dismissed	45/62	72.6	60.4-82.1
Reported security threat while traveling	21/62	33.9	23.3-46.3
Reported difficulty accessing prevention commodities	45/62	72.6	60.4-82.1
Selected financial cost as a barrier*	45/62	72.6	60.4-82.1
Selected diagnostic difficulty*	27/62	43.5	31.9-55.9
Selected medication shortage*	27/62	43.5	31.9-55.9
Selected security concerns as a barrier*	18/62	29.0	19.2-41.3
Selected distance or access problems*	10/62	16.1	9.0-27.2

*CI indicates confidence interval. *Multiple-response item; percentages do not sum to 100%.*

DISCUSSION

Principal findings

This exploratory survey found a marked difference between reported awareness and the practical ability to act on that knowledge. Although 93.5% of respondents knew that mosquitoes transmit malaria and dengue, 72.6% reported that fever is often dismissed in their communities. Financial cost was the most frequently selected barrier to diagnosis and treatment, followed by diagnostic difficulty and medication shortage. Security threats affected approximately one-third of respondents traveling for care, and nearly three-quarters reported difficulty obtaining prevention commodities. These findings describe the experiences of the respondents; they should not be interpreted as national prevalence estimates.

Health system disruption and diagnostic constraints

The reported diagnostic and medicine barriers are consistent with published accounts of facility damage, supply interruption, and reduced service capacity during the Sudan conflict.[1-4] They are also clinically important because malaria and dengue can present with overlapping febrile syndromes, and coinfection has been documented in Sudan.[6-8] Outbreak investigations in Darfur and assessments of Sudan's dengue response have identified surveillance limitations, inadequate laboratory confirmation, and constrained response capacity.[9-11] In this context, restoring basic microscopy, quality-assured malaria rapid diagnostic tests, specimen referral, and medicine supply may reduce empiric treatment and delayed recognition of severe illness.[26,36-37]

Financial and security barriers to care

Financial cost was selected by 45 participants. Cost may operate through consultation fees, transport, diagnostic charges, and medicine prices. Evidence from conflict-affected populations shows that perceived illness severity, displacement conditions, and access to recognized services influence whether people use formal care.[21-24] Treatment-seeking studies in malaria-endemic settings likewise demonstrate the importance of pharmacies and other nonfacility sources when formal services are difficult to reach.[27] The security finding adds a separate constraint: a service can be geographically close yet functionally inaccessible when travel exposes patients to violence or checkpoints.

Awareness and preventive capacity

High awareness did not translate into reliable access to preventive commodities. This distinction is important because knowledge-attitude-practice studies show that knowledge does not consistently predict sustained preventive behavior when material or environmental constraints remain.[28-29] Malaria and dengue also require partly different control measures. Insecticide-treated nets and indoor residual spraying can reduce malaria transmission, whereas dengue prevention relies heavily on Aedes source reduction, daytime bite prevention, community environmental management, and responsive surveillance.[33-36] Conflict-adapted communication should therefore explain danger signs and when to seek care, while distribution systems ensure that recommended actions are feasible.

Implications for response

In the short term, mobile or temporary clinics should combine syndromic triage with malaria testing, referral for severe febrile illness, and free or subsidized essential medicines. Service locations and schedules should be planned with communities to reduce travel risk. Community health workers and trusted local networks may support referral, surveillance, and risk communication when fixed facilities are inaccessible, but they require supplies and supervision.[23,25] Prevention packages should include malaria-appropriate vector control, dengue source-reduction materials, and locally practical environmental measures rather than a single undifferentiated mosquito-control message.

Longer-term recovery requires laboratory rehabilitation, dependable procurement, workforce retention, and surveillance that can detect multiple febrile diseases. Reviews of fragile and conflict-affected health systems emphasize adaptable service delivery, coordination, and locally grounded resilience rather than restoring infrastructure alone.[19-20,38-40] Sudan's malaria vector-control planning and regional experience in integrated vector management provide relevant operational foundations.[12-15]

Strengths and limitations

The study captured timely perceptions from adults living in several conflict-affected states and included healthcare access, prevention, security, and community-proposed responses in one instrument. Multiple-response barriers were reported using the participant denominator, and Wilson CIs show the imprecision expected with n = 62.

Several limitations are substantial. Convenience recruitment through social media selected a digitally accessible subgroup and overrepresented women, younger adults, university-educated respondents, and residents of Khartoum. People without internet access, older adults, and displaced populations in remote camps may face different or greater barriers. The small sample limits precision and does not support stable urban-rural or sex-stratified comparisons. Responses were self-reported and may be affected by recall or social-desirability bias. The cross-sectional design cannot establish temporal or causal relationships. The questionnaire received only limited clarity review; the pilot sample, revision process, and formal content validity were not documented, and no internal-consistency coefficient was calculated. Several items were recorded as shares of mentions rather than participant-level prevalence, which restricts interpretation. Finally, the open-text analysis was descriptive and did not use a formal qualitative coding framework. Future studies should use probability-based or venue-assisted recruitment, retain item-level data, prespecify subgroup analyses, and conduct formal instrument validation.

CONCLUSION

Among 62 digitally accessible respondents in conflict-affected Sudan, awareness of malaria and dengue transmission was high, but financial cost, limited diagnostic and medicine access, insecurity, and difficulty obtaining prevention commodities were frequently reported. The findings support integrated, conflict-adapted services that make diagnosis and treatment affordable, reduce travel risk, restore essential supplies, and distinguish malaria from dengue prevention needs. Because the sample was small and nonprobability based, larger representative studies are required before national or subgroup estimates can be made.

AUTHORS CONTRIBUTIONS

Ahmed Bakheet Abd Alla and Wahag Moawia conceived the study and prepared the initial manuscript. Anfal Hashim Nasir Eltayib, Ezaldin Abdelbagi Yahia Elhadi, Hagir Masaad Albushra Altayeb, and Saja Abu Algasem Mohmmed Hassan contributed to data collection, preparation, and analysis. All authors reviewed the revised manuscript and approved the final version.

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DATA AVAILABILITY STATEMENT

The deidentified data supporting this study are available from the corresponding author on reasonable request, subject to ethical and confidentiality requirements.

DISCLOSURE STATEMENT

The authors declare no relevant financial or nonfinancial competing interests.

ETHICS APPROVAL

The Institutional Review Board of Sudan University of Science and Technology approved the study (reference No. MLS-02-04-2025). All participants provided electronic informed consent.

AI-ASSISTED STATEMENT

A generative AI assistant was used for language editing. The authors reviewed and take responsibility for the final scientific content and references.

REFERENCES

1. Khogali A, Homeida A. Impact of the 2023 armed conflict on Sudan's healthcare system. Public Health Challenges. 2023;2(4):e134. doi:10.1002/puh2.134
2. Dafallah A, Elmahi OKO, Ibrahim ME, Elsheikh REF, Blanchet K. Destruction, disruption and disaster: Sudan's health system amidst armed conflict. Conflict Health. 2023;17(1):43. doi:10.1186/s13031-023-00542-9
3. Musa MK, Eshun G, Modber MAA, et al. Public health consequences of armed conflict in Sudan in the face of global donor fatigue. Public Health Challenges. 2024;3(1):e156. doi:10.1002/puh2.156
4. Venkatesan P. Burden of infectious diseases in Sudan. Lancet Microbe. 2025;6(1):101035. doi:10.1016/j.lanmic.2024.101035
5. Marou V, Vardavas CI, Aslanoglou K, et al. The impact of conflict on infectious disease: a systematic literature review. Conflict Health. 2024;18(1):27. doi:10.1186/s13031-023-00568-z
6. Ahmed A, Eldigail M, Elduma A, et al. First report of epidemic dengue fever and malaria co-infections among internally displaced persons in humanitarian camps of North Darfur, Sudan. Int J Infect Dis. 2021;108:513-516. doi:10.1016/j.ijid.2021.05.052
7. Alsedig K, Eldigail MH, Elduma AH, et al. Prevalence of malaria and dengue co-infections among febrile patients during dengue transmission season in Kassala, eastern Sudan. PLoS Negl Trop Dis. 2023;17(10):e0011660. doi:10.1371/journal.pntd.0011660
8. Elduma AH, LaBeaud AD, Plante JA, Plante KS, Ahmed A. High seroprevalence of dengue virus infection in Sudan: systematic review and meta-analysis. Trop Med Infect Dis. 2020;5(3):120. doi:10.3390/tropicalmed5030120
9. Ahmed A, Elduma A, Magboul B, Higazi T, Ali Y. The first outbreak of dengue fever in Greater Darfur, Western Sudan. Trop Med Infect Dis. 2019;4(1):43. doi:10.3390/tropicalmed4010043
10. Bagahizel AM, Elkhatim HS. Assessment of the readiness and response toward the dengue fever outbreak (2019) in Sudan: a qualitative exploration. BMC Public Health. 2023;23(1):2122. doi:10.1186/s12889-023-17020-9
11. Aljaily SM, Hamed IAY, Mustafa KS, et al. Challenges and epidemiological implications of the first outbreak of dengue and chikungunya in Sudan. East Mediterr Health J. 2024;30(1):53-59. doi:10.26719/emhj.24.007
12. HasapAla SM, Azrag RS, Awad OM. Cost effectiveness of malaria vector control activities in Sudan. Malar J. 2024;23(1):80. doi:10.1186/s12936-024-04900-7

13. Bashier H, Malik E, Khader Y, Shaheen MA. Epidemiology of malaria in Khartoum, Sudan: a teaching case-study. Pan Afr Med J. 2019;33(suppl 1). doi:10.11604/pamj.supp.2019.33.1.18624
14. Chanda E, Govere JM, Macdonald MB, et al. Integrated vector management: a critical strategy for combating vector-borne diseases in South Sudan. Malar J. 2013;12(1):369. doi:10.1186/1475-2875-12-369
15. Chanda E, Doggale C, Pasquale H, et al. Addressing malaria vector control challenges in South Sudan: proposed recommendations. Malar J. 2013;12(1):59. doi:10.1186/1475-2875-12-59
16. Mertens JE. A history of malaria and conflict. Parasitol Res. 2024;123(3):165. doi:10.1007/s00436-024-08167-4
17. Carew J, Simpson R, Pillay TD, et al. Vector-borne diseases and the Syrian conflict: a systematic review of literature from Syria and neighbouring, refugee-hosting countries. PLoS Negl Trop Dis. 2025;19(11):e0013721. doi:10.1371/journal.pntd.0013721
18. Bruckner C, Checchi F. Detection of infectious disease outbreaks in twenty-two fragile states, 2000-2010: a systematic review. Conflict Health. 2011;5(1):13. doi:10.1186/1752-1505-5-13
19. Thu KM, Bernays S, Abimbola S. A literature review exploring how health systems respond to acute shocks in fragile and conflict-affected countries. Conflict Health. 2022;16(1):60. doi:10.1186/s13031-022-00484-8
20. Truppa C, Yaacoub S, Valente M, et al. Health systems resilience in fragile and conflict-affected settings: a systematic scoping review. Conflict Health. 2024;18(1):2. doi:10.1186/s13031-023-00560-7
21. Munezero E, Manoukian S. The social determinants of health and health seeking behaviour in populations affected by armed conflict: a qualitative systematic review. Med Confl Surviv. 2021;37(4):293-318. doi:10.1080/13623699.2021.1971824
22. Gidado S, Musa M, Ba'aba AI, et al. Factors associated with health-seeking patterns among internally displaced persons in complex humanitarian emergency, Northeast Nigeria: a cross-sectional study. Conflict Health. 2023;17(1):54. doi:10.1186/s13031-023-00552-7
23. Cantor D, Swartz J, Roberts B, et al. Understanding the health needs of internally displaced persons: a scoping review. J Migr Health. 2021;4:100071. doi:10.1016/j.jmh.2021.100071
24. Hammer CC, Brainard J, Hunter PR. Risk factors and risk factor cascades for communicable disease outbreaks in complex humanitarian emergencies: a qualitative systematic review. BMJ Glob Health. 2018;3(4):e000647. doi:10.1136/bmjgh-2017-000647
25. O'Mara-Eves A, Brunton G, Oliver S, et al. The effectiveness of community engagement in public health interventions for disadvantaged groups: a meta-analysis. BMC Public Health. 2015;15(1):129. doi:10.1186/s12889-015-1352-y
26. Boyce MR, O'Meara WP. Use of malaria RDTs in various health contexts across sub-Saharan Africa: a systematic review. BMC Public Health. 2017;17(1):470. doi:10.1186/s12889-017-4398-1
27. Ladner J, Davis B, Audureau E, Saba J. Treatment-seeking patterns for malaria in pharmacies in five sub-Saharan African countries. Malar J. 2017;16(1):353. doi:10.1186/s12936-017-1997-3
28. Chng JWQ, Parvathi T, Pang J. Knowledge, attitudes and practices of dengue prevention between dengue sustained hotspots and non-sustained hotspots in Singapore: a cross-sectional study. Sci Rep. 2022;12(1):18426. doi:10.1038/s41598-022-22776-y
29. Jahromi AS, Jokar M, Abdous A, et al. Global systematic review and meta-analysis of knowledge, attitudes, and practices towards dengue fever among

the general population. Asian Pac J Trop Med. 2024;17(5):191-207. doi:10.4103/apjtm.apjtm_925_23
30. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. PLoS Med. 2007;4(10):e296. doi:10.1371/journal.pmed.0040296
31. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. PLoS Med. 2007;4(10):e297. doi:10.1371/journal.pmed.0040297
32. Brown LD, Cai TT, DasGupta A. Interval estimation for a binomial proportion. Stat Sci. 2001;16(2):101-133. doi:10.1214/ss/1009213286
33. Pryce J, Richardson M, Lengeler C. Insecticide-treated nets for preventing malaria. Cochrane Database Syst Rev. 2018;11(11):CD000363. doi:10.1002/14651858.CD000363.pub3
34. Pluess B, Tanser FC, Lengeler C, Sharp BL. Indoor residual spraying for preventing malaria. Cochrane Database Syst Rev. 2010;(4):CD006657. doi:10.1002/14651858.CD006657.pub2
35. Bhatt S, Gething PW, Brady OJ, et al. The global distribution and burden of dengue. Nature. 2013;496(7446):504-507. doi:10.1038/nature12060
36. Simmons CP, Farrar JJ, Nguyen vV, Wills B. Dengue. N Engl J Med. 2012;366(15):1423-1432. doi:10.1056/NEJMra1110265
37. White NJ, Pukrittayakamee S, Hien TT, et al. Malaria. Lancet. 2014;383(9918):723-735. doi:10.1016/S0140-6736(13)60024-0
38. Haar RJ, Rubenstein LS. Health in fragile and post-conflict states: a review of current understanding and challenges ahead. Med Confl Surviv. 2012;28(4):289-316. doi:10.1080/13623699.2012.743311
39. Woodward A, Sondorp E, Witter S, Martineau T. Health systems research in fragile and conflict-affected states: a research agenda-setting exercise. Health Res Policy Syst. 2016;14(1):51. doi:10.1186/s12961-016-0124-1
40. Woodward A, Sheahan K, Martineau T, Sondorp E. Health systems research in fragile and conflict affected states: a qualitative study of associated challenges. Health Res Policy Syst. 2017;15(1):44. doi:10.1186/s12961-017-0204-x