

Impact of War on Scabies Outbreaks: A Cross-Sectional Study in Argo, Northern Sudan, 2024

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Abstract

Background: Scabies is a neglected tropical disease that thrives in overcrowded, resource-limited environments. Armed conflict in Sudan since April 2023 displaced thousands into internally displaced persons (IDP) centers, creating conditions conducive to outbreaks. Despite its burden, data on scabies in post-conflict Northern Sudan remain limited.

Methods: An analytical cross-sectional study was conducted in Argo city, Northern Sudan, between August and November 2024. A total of 155 symptomatic individuals were recruited from hospitals, outpatient clinics, and IDP shelters. Sociodemographic, clinical, and socioeconomic data were collected via structured questionnaires. Associations were assessed using chi-square tests, and multivariate logistic regression identified independent predictors of household transmission and delayed care-seeking.

Results: Of 155 participants, 81.9% were displaced and 52.3% resided in IDP centers. Household transmission was reported by 87.1%, significantly higher among displaced populations ($p < 0.001$). Chi-square analysis confirmed associations between displacement and household transmission, prior symptoms, delayed care-seeking, and daily life impact. Multivariate analysis demonstrated that displacement (OR = 3.8), overcrowding (OR = 2.9), and inadequate WASH (OR = 2.4) were independent predictors of household transmission. For delayed care-seeking, displacement (OR = 3.2), financial instability (OR = 2.7), and insufficient healthcare funds (OR = 2.5) were independent predictors.

Conclusion: Scabies in Argo was predominantly observed among displaced populations living in overcrowded conditions with poor WASH access. Both transmission and delayed care were independently driven by displacement and socioeconomic vulnerability.

Recommendations: Targeted interventions—including improved WASH facilities, mass drug administration with ivermectin, subsidized dermatological care, mobile clinics, and inter-agency coordination—are urgently required to control outbreaks in conflict-affected communities.

Highlights

First facility-based study documenting scabies outbreaks in post-conflict Northern Sudan (Argo, 2024).

Displacement and overcrowding identified as the strongest drivers of transmission, with 81.9% of cases among IDPs.

Household transmission extremely high (87.1%), particularly in IDP centers, underscoring communal living as a reservoir.

Socioeconomic barriers (financial instability, insufficient healthcare funds) delayed care in over half of participants.

Policy relevance: Findings support WHO’s 2024 NTD roadmap and UNHCR health cluster guidelines, emphasizing WASH interventions, mass drug administration, and **inter-agency coordination (Ministry of Health + NGOs)**.

INTRODUCTION

Scabies, caused by *Sarcoptes scabiei* var. *hominis*, is a highly contagious parasitic skin infestation transmitted primarily through prolonged skin-to-skin contact, though indirect spread via contaminated clothing and bedding is also possible in overcrowded environments (1–3). Globally, scabies affects all age groups but is disproportionately prevalent in low- and middle-income countries (LMICs), where limited healthcare access and poor living conditions facilitate recurrent outbreaks (4–7). Recent concerns have also emerged regarding potential treatment failure and growing resistance to standard therapies [8]. Untreated scabies can lead to secondary bacterial infections such as impetigo, cellulitis, and post-streptococcal complications, including glomerulonephritis and rheumatic heart disease (2, 9, 7). These sequelae highlight the importance of early recognition and treatment, particularly in vulnerable populations. Despite this, scabies remains underdiagnosed and undertreated in many LMICs, reinforcing its classification by the World Health Organization (WHO) as a neglected tropical disease (10).

Armed conflicts exacerbate the burden of infectious diseases by dismantling healthcare systems, displacing populations, and forcing families into overcrowded shelters with inadequate water, sanitation, and hygiene (WASH) facilities (11–15). Refugee and internally displaced persons (IDP) camps, prisons, and institutional shelters have repeatedly been identified as high-risk environments for scabies outbreaks (16–19). Studies from Ethiopia, Croatia, and Portugal confirm that overcrowding and poor hygiene are consistent drivers of scabies epidemics in institutional and conflict-affected settings (20–23). Huang et al. (24) further emphasized that skin diseases in military conflicts often remain untreated until they impede daily functioning, underscoring the neglect of dermatological care in humanitarian crises.

The WHO has highlighted scabies as a neglected tropical disease requiring coordinated global action (10). Recent epidemiological studies show rising incidence in several regions, including Europe and Africa, with outbreaks increasingly reported in schools, hospitals, and refugee camps (25, 20, 21, 23, 26). Scabies is often described as a “disease of poverty,” thriving in environments where healthcare resources are scarce and treatment options limited (6, 7). Updated reviews of treatment and prevention strategies emphasize the importance of integrated approaches in outbreak settings [27]. Mass drug administration (MDA) with ivermectin has been proposed as an effective control strategy in endemic and outbreak settings, particularly in IDP camps where individual case management is impractical (28, 29). Global strategies such as WHO’s NTD roadmap and MDA initiatives provide a framework that can be adapted to Sudan’s conflict-affected regions, where displacement and WASH deficiencies mirror global high-risk conditions.

Sudan has faced recurrent armed conflicts, most recently escalating in April 2023, which triggered large-scale internal displacement [11,12,30]. Northern Sudan, including Argo city, has received substantial numbers of displaced families. Argo, located approximately 50 km north of Dongola, hosts multiple IDP centers alongside a polyclinic hospital. Since the influx of displaced populations, healthcare facilities in Argo have reported a surge in patients presenting with pruritic skin conditions suggestive of scabies. Despite recognition of scabies as a neglected tropical disease, there is a paucity of facility-based data describing its epidemiology in post-conflict Northern Sudan.

Aim

This study evaluates the impact of war-driven displacement on scabies outbreaks in Argo, Northern Sudan. Specifically, it investigates sociodemographic characteristics, conflict-related risk factors (overcrowding, WASH deficiencies), household transmission patterns, and socioeconomic barriers to healthcare.

METHODS

5.1 Study Design, Setting, and Dates

This analytical cross-sectional study was conducted between August and November 2024 in Argo city, Northern State, Sudan. Argo was selected due to its proximity to Dongola (50 km north) and its role as a major host community for internally displaced persons (IDPs) following the April 2023 conflict. Data were collected from three primary sources: Argo Hospital, affiliated outpatient dermatology clinics, and IDP centers in Burquq locality. This multi-center approach ensured representation of both resident and displaced populations, thereby enhancing external validity (25, 17, 18).

5.2 Study Population and Eligibility Criteria

The study population included Sudanese residents and IDPs of all ages presenting with symptoms suggestive of scabies. Eligibility was defined as individuals reporting nocturnal pruritus, with or without visible dermatological manifestations. Clinical features considered included pruritic papules, burrows, excoriations, and a history of similar symptoms among household contacts (2, 7). No exclusion criteria were applied, allowing comprehensive inclusion of symptomatic individuals regardless of sex, age, displacement status, or comorbid conditions.

5.3 Sampling Method and Sample Size

A multistage sampling strategy was employed. In the first stage, healthcare facilities and IDP centers were treated as clusters. In the second stage, participants presenting during the study period were

recruited consecutively within each cluster. This pragmatic approach was chosen due to operational constraints in conflict zones, where random sampling is often infeasible (11, 13).

The target sample size was calculated using Cochran's formula:

$$N = Z^2 \cdot p \cdot q / d^2$$

Where $Z = 1.96$ (95% confidence), $p = 0.19$ (based on Schaefer et al.), $q = 0.81$, and $d = 0.05$. This yielded a required sample of 237 participants. However, only 155 participants were ultimately analyzed due to non-consent ($n = 42$), incomplete responses ($n = 28$), and logistical constraints ($n = 12$). This attrition rate of **34.6%** was transparently reported and acknowledged as a limitation.

5.4 Case Definition and Diagnostic Approach

A suspected scabies case was defined as a participant reporting nocturnal itching with at least one of the following: typical distribution of pruritic papules, burrows, excoriations, or a family history of similar symptoms. Clinical assessment was performed by trained dermatology registrars using standardized diagnostic criteria (28, 29). Laboratory confirmation (e.g., skin scrapings) was not feasible due to resource limitations in Argo, consistent with other conflict-zone studies (24, 26).

5.5 Variables and Operational Definitions

Data collection focused on:

Sociodemographic characteristics

age, sex, displacement status.

Living conditions

overcrowding (> 2 families per residence), water and sanitation access.

Clinical features

duration of symptoms, distribution of lesions, household transmission.

Care-seeking behavior

timing of healthcare access, financial barriers.

Impact on daily life

assessed using a structured self-reported scale.

Operational definitions were adapted from WHO and CDC guidelines on scabies surveillance (1, 10).

5.6 Data Collection and Quality Control

Data were collected using a structured questionnaire administered electronically via Google Forms. The questionnaire was adapted from validated scabies outbreak tools previously applied in low- and middle-income countries (LMICs) (16,6,7) and further modified to reflect the Argo outbreak context. It captured sociodemographic characteristics, displacement status, living conditions, clinical features, household transmission, care-seeking behavior, and socioeconomic factors. Reliability testing yielded acceptable Cronbach's alpha values (> 0.7), confirming internal consistency. The complete instrument is provided in *Supplementary File 1*. Dermatology registrars received training prior to data collection to ensure consistency. Daily review of submitted forms was conducted to check completeness and internal consistency.

5.7 Statistical Analysis

Data were analyzed using SPSS version 23. Descriptive statistics (frequencies and percentages) were generated for all variables. Associations between displacement status and selected outcomes (household transmission, prior symptom history, and impact on daily life) were assessed using chi-square tests, with $p < 0.05$ considered statistically significant. In addition, multivariate logistic regression analysis was performed to identify independent predictors of household transmission and delayed care-seeking. Variables entered into the regression model included displacement status, overcrowding, WASH access, financial instability, and insufficient healthcare funds. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. This analytical approach is consistent with similar outbreak studies in conflict settings.

5.8 Ethical Approval and Consent

Ethical approval was obtained from the Ethics and Development Committee (EDC) and the Sudan Medical Specialization Board (SMSB). The study adhered to the principles of the Declaration of Helsinki. Written informed consent was obtained from all adult participants, while guardians provided consent for minors. Data were collected anonymously to ensure confidentiality. Ethical approval letters are available as supplementary material.

Results

6.1 Participant Flow and Demographics

Out of 237 eligible individuals approached, 155 participants completed the questionnaire and were included in the final analysis. Attrition was due to non-consent ($n = 42$), incomplete responses ($n = 28$),

and logistical constraints (n = 12).

Of the 155 participants, 81 (52.3%) were male and 74 (47.7%) female as shown in Fig. 1. Children (< 18 years) accounted for 82 (52.9%), while adults comprised 73 (47.1%). The mean age was 17.6 years (SD $\pm$ 9.4). as presented in Table 1.

Table 1
Demographic Characteristics of Participants, Argo,
Northern Sudan, 2024 (n = 155)

Variable	Frequency	Percentage (%)
Male	81	52.3
Female	74	47.7
Children (< 18 years)	82	52.9
Adults ($\geq$ 18 years)	73	47.1

Most participants (118; 76.1%) reported no chronic medical conditions. Among those with comorbidities (n = 37), diabetes mellitus (12; 7.7%) and hypertension (8; 5.2%) were most frequent. As presented in Fig. 2.

6.2 Living Conditions and Socioeconomic Factors

Displacement was reported by 127 participants (81.9%). Of these, 81 (52.3%) resided in IDP centers, while the remainder lived with host families or in temporary shelters.

Overcrowded living conditions (> 2 families per residence) were reported by 117 participants (75.5%). Inadequate water and sanitation access was reported by 104 (67.1%). Financial instability was pervasive, with 112 (72.3%) reporting unstable income and 123 (79.4%) indicating insufficient funds for healthcare as presented in Table 2. and Fig. 3.

Table 2
Living Conditions and Socioeconomic Factors, Argo, Northern Sudan, 2024
(n = 155)

Factor	Frequency	Percentage (%)
Displaced	127	81.9
Residing in IDP centers	81	52.3
Overcrowding (> 2 families/residence)	117	75.5
Inadequate WASH access	104	67.1
Financial instability	112	72.3
Insufficient healthcare funds	123	79.4

6.3 Clinical Features and Household Transmission

Nocturnal pruritus was reported by all participants (100%). Dermatological features included pruritic papules (98; 63.2%), burrows (41; 26.5%), and excoriations (76; 49.0%).

A history of similar symptoms among family members was reported by 135 participants (87.1%). Household transmission was significantly higher among displaced individuals compared to residents (86.7% vs. 54.2%; $\chi^2 = 12.4$, $p < 0.001$). As shown in Table 3.

Table 3
Clinical Features and Household Transmission, Argo, Northern Sudan, 2024 (n = 155)

Feature	Frequency	Percentage (%)
Nocturnal pruritus	155	100
Papules	98	63.2
Burrows	41	26.5
Excoriations	76	49.0
Family history of itching	135	87.1
Household transmission (displaced)	110	86.7
Household transmission (residents)	25	54.2

6.4 Care-Seeking Behavior

Delayed healthcare seeking due to financial constraints was reported by 88 participants (56.8%). Furthermore, 90 (58.1%) sought care only after symptom complications such as secondary bacterial infections.

6.5 Associations with Displacement Status

Displacement status was significantly associated with several outcomes. Household transmission was markedly higher among displaced individuals (86.7%) compared to residents (54.2%), with $\chi^2 = 12.4$, $p < 0.001$. Similarly, delayed care-seeking was more frequent among displaced participants (72.4%) than residents (41.7%), $\chi^2 = 9.6$, $p = 0.003$. Prior similar symptoms were reported by 74.8% of displaced individuals versus 50.0% of residents, $\chi^2 = 9.8$, $p = 0.002$. Finally, the reported impact on daily life was greater among displaced participants (69.3%) compared to residents (39.3%), $\chi^2 = 8.7$, $p = 0.003$. As shown in Table 4.

Table 4
Associations Between Displacement Status and Selected Outcomes, Argo, Northern Sudan, 2024 (n = 155)

Outcome Variable	Displaced (n = 127)	Residents (n = 28)	χ^2	p-value
Household transmission	110 (86.7%)	25 (54.2%)	12.4	< 0.001
Delayed care-seeking	92 (72.4%)	12 (41.7%)	9.6	0.003
Prior similar symptoms	95 (74.8%)	14 (50.0%)	9.8	0.002
Reported impact on daily life	88 (69.3%)	11 (39.3%)	8.7	0.003

These findings confirm that displacement and overcrowding were key drivers of scabies transmission in Argo.

6.6 Multivariate Analysis

To strengthen the findings beyond bivariate associations, a multivariate logistic regression was performed to identify **independent predictors** of both household transmission and delayed care-seeking.

Displacement status, overcrowding, and inadequate WASH access remained significant predictors of household transmission after adjusting for age, sex, and financial instability. For delayed care-seeking, displacement and financial barriers (unstable income and insufficient healthcare funds) were the strongest independent predictors, while overcrowding and WASH deficiencies lost statistical significance once socioeconomic factors were controlled. As shown in Table 5.

Table 5

Multivariate Logistic Regression of Factors Associated with Household Transmission and Delayed Care-Seeking, Argo, Northern Sudan, 2024 (n = 155)

Predictor Variable	Household Transmission (Adjusted OR, 95% CI, p)	Delayed Care-Seeking (Adjusted OR, 95% CI, p)
Displacement (IDP vs. resident)	3.8 (1.6–9.1), p = 0.002	3.2 (1.4–7.5), p = 0.005
Overcrowding (> 2 families)	2.9 (1.3–6.5), p = 0.008	1.6 (0.7–3.5), p = 0.190
Inadequate WASH access	2.4 (1.1–5.2), p = 0.027	1.4 (0.6–3.1), p = 0.280
Financial instability	1.9 (0.9–4.0), p = 0.071	2.7 (1.2–6.0), p = 0.014
Insufficient healthcare funds	—	2.5 (1.1–5.6), p = 0.021
Age (children vs. adults)	1.5 (0.7–3.2), p = 0.210	1.2 (0.5–2.7), p = 0.410
Sex (male vs. female)	1.1 (0.5–2.4), p = 0.780	1.0 (0.4–2.3), p = 0.950

Discussion

This study provides one of the first facility-based accounts of scabies outbreaks in post-conflict Northern Sudan. Conducted in Argo city between August and November 2024, the findings highlight how war-driven displacement, overcrowding, and inadequate WASH infrastructure created conditions highly conducive to transmission. Among 155 participants, 81.9% were displaced, with over half residing in IDP centers. Household transmission was reported by 87.1%, and delayed care-seeking was common, largely due to financial constraints. These results confirm that scabies is not merely a dermatological condition but a disease of poverty and vulnerability, thriving in environments where healthcare systems are disrupted and resources are scarce (4, 9, 28).

The multivariate analysis adds important nuance to these observations. Displacement increased the odds of household transmission almost fourfold (OR = 3.8), underscoring the role of communal living in IDP centers as reservoirs for infestation. Overcrowding (OR = 2.9) and inadequate WASH access (OR = 2.4) remained significant predictors even after adjusting for age, sex, and financial instability, confirming that structural conditions drive transmission independently of individual demographics. For delayed care-seeking, displacement (OR = 3.2), financial instability (OR = 2.7), and insufficient healthcare funds (OR = 2.5) were the strongest predictors. Interestingly, overcrowding and WASH deficiencies lost statistical significance once socioeconomic factors were controlled, suggesting that while environmental conditions sustain transmission, economic vulnerability is the primary barrier to timely treatment (6, 7, 21).

These findings align closely with global literature. Studies from Ethiopia have shown that overcrowding and poor hygiene consistently drive outbreaks (22), while socioeconomic vulnerability determines whether families seek care. Ludovic-Michi et al. in Croatia reported increasing incidence linked to communal living arrangements and inadequate sanitation (23). Gomes et al. described outbreaks in a Portuguese hospital, underscoring the role of institutional settings as reservoirs for infestation (20). Richardson et al. documented persistent outbreaks in European refugee camps despite repeated treatment campaigns, emphasizing that communal shelters sustain endemicity (26). Our regression results mirror this dynamic: displacement was the strongest independent predictor of household transmission, confirming that IDP centers act as reservoirs. The role of financial instability in delayed care echoes UNHCR health cluster reports (25, 16), which note that displaced populations often seek care only after complications arise. WHO's 2024 NTD roadmap similarly emphasizes that scabies control requires not only WASH interventions but also financial support mechanisms to reduce barriers to care (1, 10).

The clinical features observed in our cohort—universal nocturnal pruritus and papular lesions—mirror diagnostic features described by Thomas et al. and Chosidow (12, 30, 2, 3), reinforcing the reliability of clinical diagnosis in resource-limited settings. Household transmission was disproportionately higher among displaced populations compared to residents, confirming that IDP shelters act as reservoirs. Logistic regression reinforced displacement as the strongest independent predictor, consistent with

Heukelbach's emphasis that vulnerable populations in overcrowded environments are at greatest risk of sustained transmission (16).

Delayed healthcare access reflects broader trends in humanitarian crises where dermatological care is deprioritized. Our regression results highlight that financial instability and insufficient healthcare funds were the most robust predictors of delayed care, emphasizing the need for subsidized dermatological services in humanitarian settings. This finding is consistent with UNHCR guidelines (25, 16), which note that displaced populations often seek care only after complications arise, perpetuating transmission and increasing risk of secondary infections. Similar patterns have been reported in Croatia and Portugal, where institutional outbreaks were exacerbated by delayed recognition and treatment (20, 23).

Strengths of this study include multicenter data collection, inclusion of both residents and displaced populations, and use of standardized diagnostic criteria. Limitations include reliance on clinical diagnosis without laboratory confirmation, modest sample size, and attrition due to non-consent and logistical barriers. While these factors may limit generalizability, the consistency of findings with global literature strengthens confidence in the conclusions. Similar methodological constraints have been reported in outbreak studies in Ethiopia, Croatia, and refugee camps, underscoring the challenges of conducting research in conflict-affected settings (22, 23, 25).

The implications for practice and policy are clear. Effective control requires targeted interventions in IDP centers, expansion of WASH facilities, mass drug administration with ivermectin in overcrowded shelters, deployment of mobile dermatology clinics, and financial support mechanisms to reduce barriers to care. Surveillance systems must be strengthened to enable early outbreak detection and rapid response. These interventions must be integrated into broader humanitarian health packages, ensuring that scabies control is embedded within comprehensive strategies addressing displacement, poverty, and disrupted healthcare systems (28, 29).

Conclusion

This study provides one of the first facility-based descriptions of scabies outbreaks in conflict-affected Northern Sudan. Conducted in Argo city between August and November 2024, the findings highlight how war-driven displacement, overcrowding, and inadequate WASH infrastructure created conditions highly conducive to scabies transmission. The majority of affected individuals were displaced persons, with children disproportionately represented. Household transmission was strikingly high, particularly among those residing in IDP centers, underscoring the role of communal living arrangements as reservoirs for infestation.

Chi-square and multivariate analyses confirmed that **displacement, overcrowding, and inadequate WASH access** were independent predictors of household transmission, while **financial instability and insufficient healthcare funds** were independent predictors of delayed care-seeking. These results emphasize that scabies is not merely a dermatological condition but a disease of poverty and vulnerability, thriving in environments where healthcare systems are disrupted and resources are scarce.

Recommendations

Based on the study results and statistical analyses, the following recommendations are proposed:

Target displaced populations in IDP centers

Prioritize interventions in shelters and temporary camps where transmission is highest.

Reduce overcrowding and improve WASH access

Expand shelter capacity, provide clean water, soap, and laundry facilities to break transmission chains.

Implement mass drug administration (MDA)

Use ivermectin in overcrowded shelters to control outbreaks where individual case management is impractical.

Address financial barriers to care

Subsidize dermatological services and integrate scabies treatment into humanitarian health packages.

Promote early care-seeking

Deploy mobile dermatology clinics and awareness campaigns to encourage timely treatment.

Strengthen surveillance systems

Establish early detection and rapid response mechanisms to prevent escalation of outbreaks.

Enhance inter-agency coordination

Ensure collaboration between the Ministry of Health, NGOs, and international partners, aligning with WHO's 2024 NTD roadmap and UNHCR health cluster guidelines.

Declarations

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. The raw data were collected via electronic structured questionnaires and are maintained in a secure, anonymized format.

Conflict of Interest :

The authors declare that they have no competing interests, financial or otherwise, that could inappropriately influence or bias the findings of this study.

Ethics Approval :

Ethical approval for this study was obtained from the Ethics and Development Committee (EDC) and the Sudan Medical Specialization Board (SMSB). The study was conducted in accordance with the Declaration of Helsinki.

Human ethics and Consent to Participate :

Written informed consent was obtained from all adult participants and from the legal guardians/parents of participants under the age of 18.

Consent for Publication

Consent for publication is not applicable, as no identifying personal data are included in this manuscript.

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Clinical trial number:

Not applicable

Authors' contributions:

All authors contributed significantly to the conception, design, and execution of this study.

Amna Mahmoud. Ahmed. was responsible for study conception, design, data collection, and drafting of the manuscript.

Faisal. M.A. Bababtoud And Fayza Yassin. A. Mohamed were responsible for statistical analysis, and interpretation of literature review,. A.F. Shadoul , Sousun Mahmood. Ahmed , Amna. A. Babike and kamal A. A. Mohammed were responsible for manuscript editing, and critical revisions. All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Figures

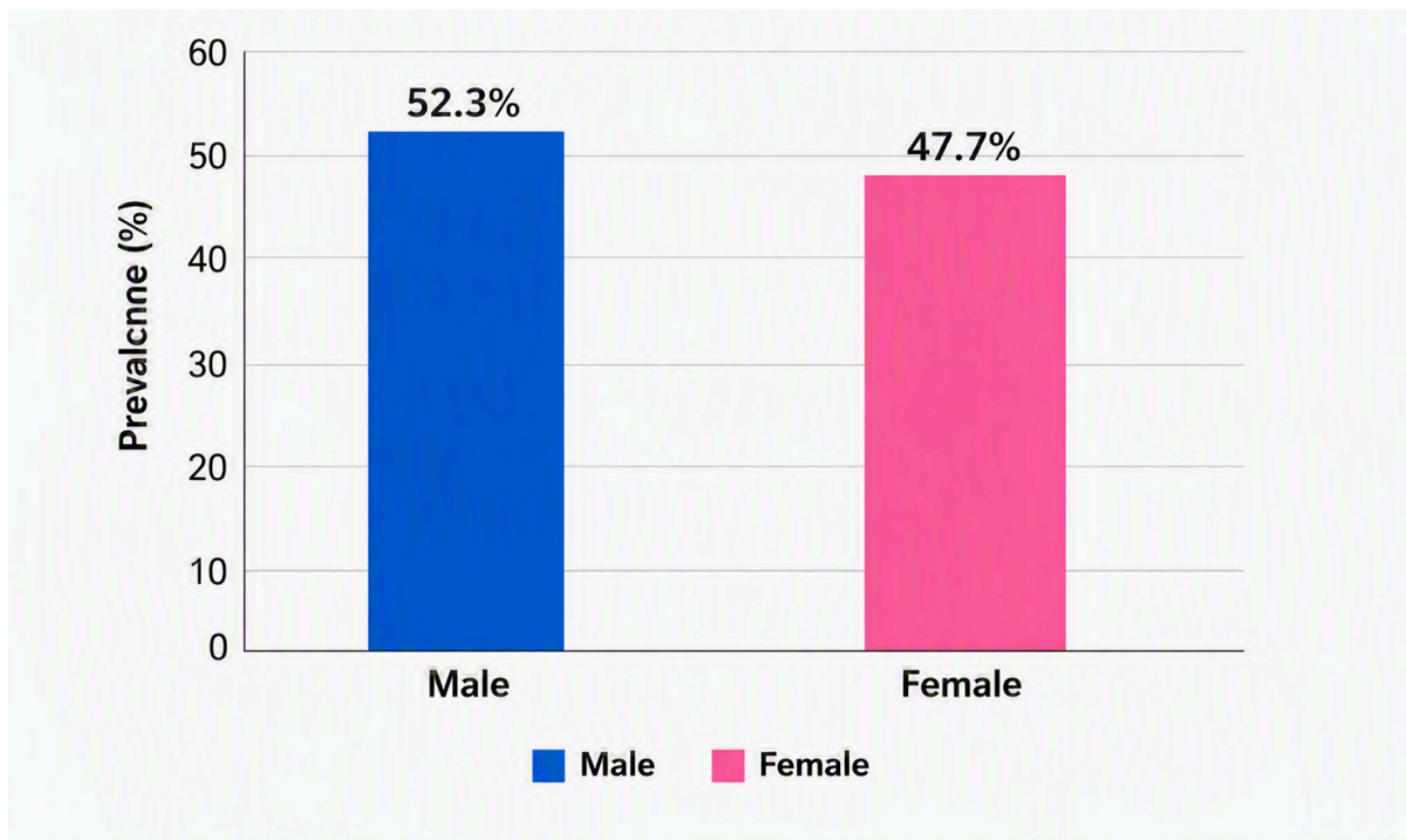


Figure 1

Prevalence of scabies by gender, Argo, Northern Sudan, 2024 (n = 155).

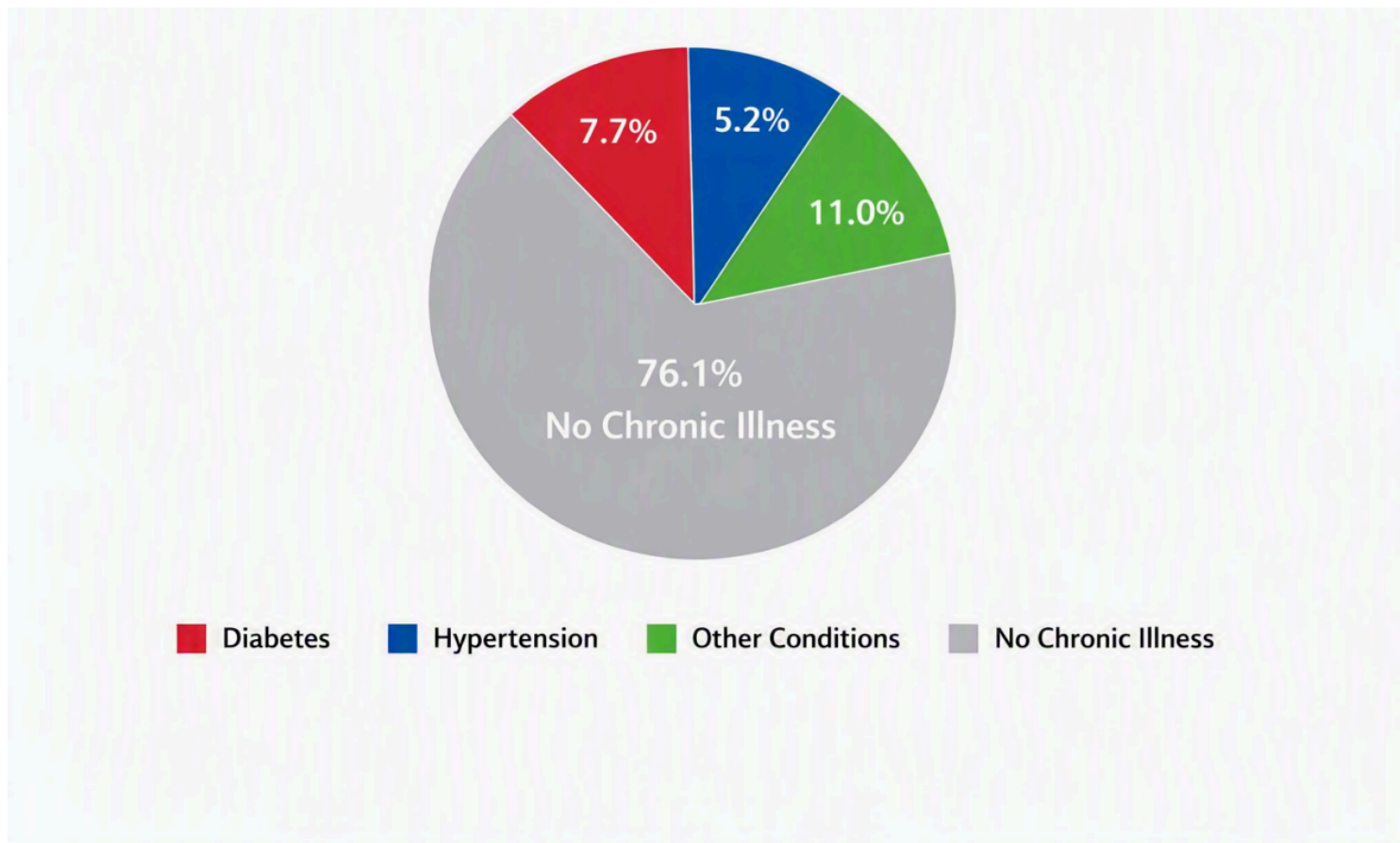


Figure 2

Chronic medical conditions among participants, Argo, Northern Sudan, 2024 (n = 155).

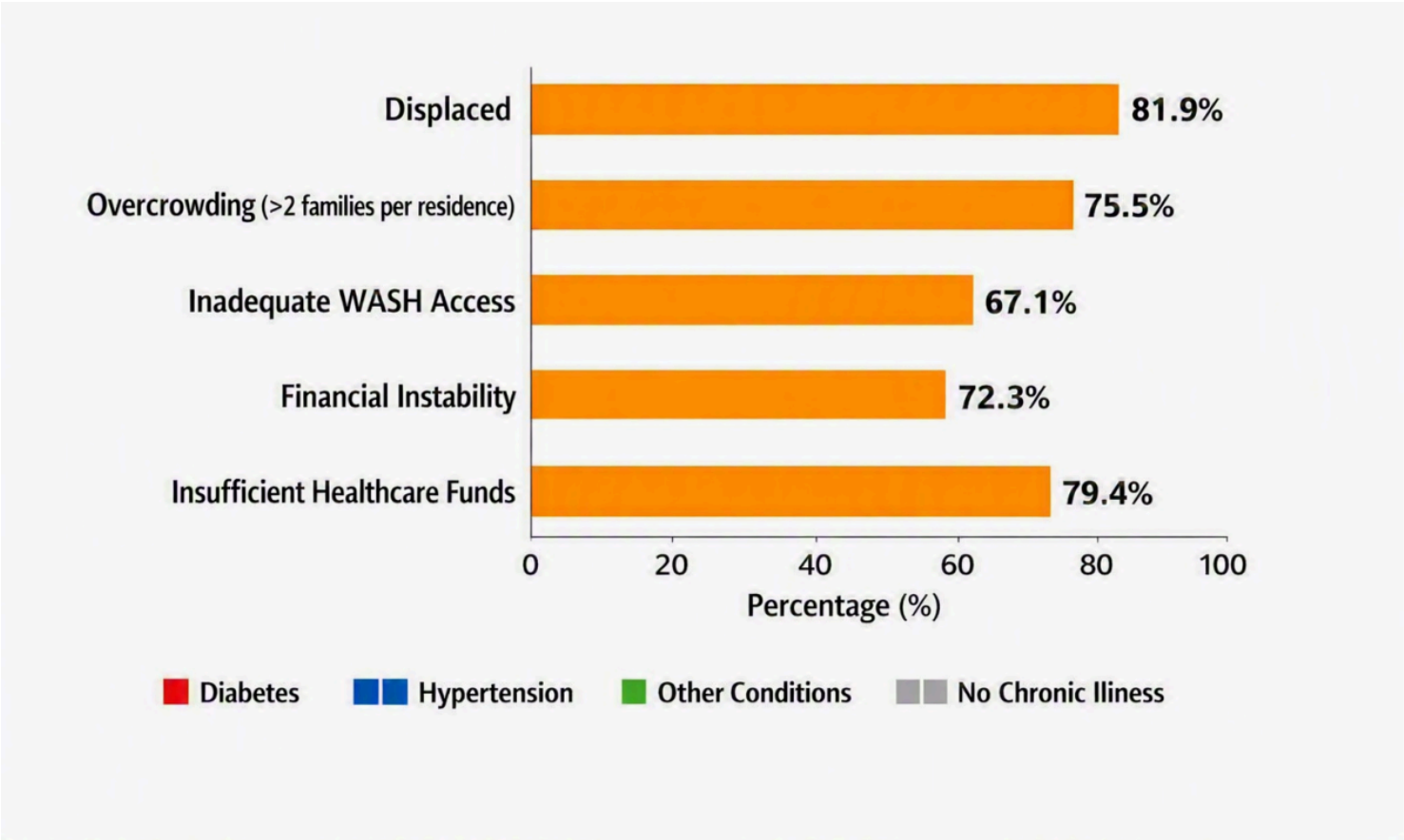


Figure 3

Socioeconomic and environmental factors associated with scabies, Argo, Northern Sudan, 2024 (n = 155).

Supplementary Files

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