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Scabies Treatment in Sudan: Evaluating Permethrin 5% Lotion as a First-Line Treatment

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Abstract
Scabies continues to be a common dermatological and public health issue in Sudan especially in underserved & rural kinds of communities. This research measures the effectiveness of Permethrin 5% lotion as a first-line treatment for scabies in three high-burden regions Atbara, Khasm Al-Girba and New Halfa. All in all, 150 subjects were enrolled and treated with a standardized protocol. Results demonstrated a 76% cure rate following a solitary application and 96.3% full recovery following a second dose. 1.3% of them had treatment resistant, all cases being from Atbara. The results validate Permethrin's high efficacy, security and applicability to a wider spectrum in healthcare system of Sudan. The latter supports further its generalizability by regional consistency in outcomes. The study in turn recommends formal incorporation of Permethrin 5% lotion in national treatment guideline and cites the necessity of in the long-term surveillance and increase in public health education to ensure that ever control is sustained and prevent secondary attack from occurring.

Keywords: Scabies, Permethrin 5% Lotion, Sudan, Drug Resistance, Rural Health, Dermatological Diseases, Neglected Tropical Diseases

1. Introduction

1.1 Background

Scabies is an infectious skin disease it is infested by the mite Sarcoptes scabiei v. hominis (Adán *et al*., 2023) [3]. Human to human transmission is mainly through prolonged skin contact and contact with bodily fluids, while indirect transmission is through contaminated belongings such as clothing, towels and beddings. Causing itchy rashes with a pimple like appearance, scabies can infest any age, color, or financial bracket. However, scabies affects more people living in the crowded, dirty environment with poor or no access to proper health care services. Scabies was included in the WHO's NTDs list in 2017 due to the disease burden which it imposes in relation to public health in the present day including the developing world (Enbiale *et al*., 2024) [13].

Currently, scabies prevalence is at more than 200 million people around the world. It not only causes discomfort and decreased quality of life but also put the child at a higher risk of secondary bacterial infection including but not limited to impetigo and cellulitis due to skin breakage. These bacteria can cause more serious diseases such as post-streptococcal glomerulonephritis and rheumatic heart disease thereby threatening the public health. Despite much of the advancements in its diagnosis and management, scabies is under diagnosed and under treated especially in developing countries. Table 1 provides a comparative summary of common scabies treatments in terms of mode of action, effectiveness, and tolerability.

Table 1: Comparative Overview of Common Scabies Treatments

Treatment Type	Mode of Action	Typical Cure Rate	Cost (USD per treatment)	Side Effects
Permethrin 5%	Neurotoxic to mites	85–95%	Low	Mild, skin irritation
Benzyl Benzoate 25%	Mite neurotoxin	70–80%	Very low	Burning sensation
Sulfur Ointment 10%	Desiccates mites	60–70%	Very low	Odor,skin dryness
Ivermectin (oral)	Systemic antiparasitic	80–90%	Moderate	Headache,GI upset

1.2 Scabies in Sudan

Sudan is one of the countries where this disease continues to be a major but not widely- publicised problem (Umali-Deininger and Sur, 2007) [31]. It is usually an epidemic disease and prevalent mostly in crowded areas, camps, schools and among wandering populace. The status of health care facilities in Sudan remains as limited because of political unrest, economic difficulties in the country and, therefore, the data on scabies epidemiology in Sudan remains scarce. However, the observations and structured reports received from the Ministry of Health show a high prevalence level, even in the rural and poorly served urban centers.

The climate and geographical distribution of Sudan varies widely, from the deserts and arid regions to the tropical savannah regions which influence the occurrence of scabies (Hassan and Salih, 2013) [19]. Some of the conditions that support mite breeding include; high humidity and temperatures, sleeping in large groups, and limited access to clean water to wash one's body. Moreover, the existing healthcare system in Sudan also bears considerable challenges in terms of staffing, equipment, and resource availability that deter scabies management and prevention on its own.

Hence, it is not only a medical condition, but it is also a social and economic problem as well. They get stigmatized and socially excluded from the rest of the community and are denied healthcare services and treatment. For children affected by scabies, it brings about absenteeism in school and for adults, they are unable to report to work meaning that their earnings are affected, and children would not be in school. These impacts perpetuate poverty and poor health in families and societies as a result of piracy. Hence, measures aimed at control and treatment should be implemented for the enhancement of both person and population health in Sudan (Abdelgader *et al*., 2021). Table 2 presents a contextual comparison between global and Sudan-specific scabies epidemiology.

Table 2: Global vs. Sudan-Specific Scabies Context

Metric	Global Estimate	Estimate in Sudan
Annual cases (millions)	200+	Unknown (underreported)
High-risk populations	Children, elderly	Schoolchildren, IDPs
WHO classification	Neglected Tropical Disease	Yes
National treatment protocol	Adopted in many countries	Not yet standardized

1.3 Current Treatment Landscape and Challenges

Scabies management involves the use of topical and oral antiscabies to get rid of the mites and offer protection against the disease in the future. The current popular options are the topical Permethrin 5 % lotion, oral Ivermectin, benzyl benzoate and sulfur preparations. Among these, Permethrin is considered the most effective because it caused high mortality rate, low risk to insects, and easy to apply (Bachewar *et al*., 2009) [8]. It acts through affecting the queen's nervous system causing paralysis and subsequently, death to the mite. It is usually painted on the entire body and is left on the skin normally for about 8-14 hours before washing.

In Sudan, there is no standard of practice for the management of scabies. Measures applied in management also differ by geographical location, health care facilities, and particular doctors (Jira *et al*., 2023) [21]. Sometimes obsolete and much less therapeutic treatments like sulphur ointment or benzyl benzoate end up being used because they are cheap or easily accessible. These treatments are many times not well tolerated due to odour or skin reactions or due to the fact that the treatment has to be repeated severing. Also lack of health education and follow ups, the patient is not able to follow up their treatment regime or treat close contact thus exposing the community to recurrent infestation.

This further aggravates the burden of scabies since treatment practices are not well- coordinated, and protocols are not routine in Sudan. This has brought a call to embracing affordable and easily accessible first-line treatments that have a solid grounding on medical research. An effective treatment plan must target the pharmacotherapy outcomes, but social, economic and cultural factors that affect the patients' compliance to adhere to treatment and probability of relapse should also be taken into consideration.

1.4 Rationale for Using Permethrin 5% Lotion

These include insecticide-treated clothes, long-lasting insecticidal nets, and different formulations of Permethrin 5% lotion. Because it is applied only once a week, its usability is convenient in environments where people cannot come for numerous medical checkups. In this respect, Permethrin is safe to be used on children who are two months of age and pregnant women unlike other treatment alternatives, making it more applicable in public health crises (Riebenbauer *et al*., 2022) [26].

Although Permethrin 5% lotion has been acknowledged to be effective, there is still scarcity of study on its use in Sudan. It is evident that most of the treatment practices are hypothetical and inadequately derived from other practices with reference to different conditions of social –economic status and environments. Consequently, there are few local data points on the effectiveness of Permethrin in Sudanese population. Local mite strains and possible resistance patterns, the behavior of patients and various other factors determine the effectiveness or otherwise of the treatments not captured in such studies (Van Leeuwen *et al*., 2010) [32].

Thus, this study sought to cumulatively evaluate the efficacy of Permethrin 5% lotion in treating scabies in three high burden areas of Sudan. This study will involve a randomized experiment controlled by the Sudanese Ministry of Health, and the findings of the study can be generalized due to the context specificity of the intervention and control outcomes.

1.5 Objectives of the Study

The main research aim is to assess the effectiveness of Permethrin 5% lotion in the treatment of Scabies in Sudanian population as a first-line therapy. The efficacy of these treatments at ED and three other clinics will also be evaluated in terms of cure rate after the first and the second application as well as evidence of resistance or non-response will also be established. Secondary aims include describing the outcomes of the treatment in different regions and establishing relationships between success rate of the treatment and demographic/ environmental factors.

To achieve these objectives, this study was carried out among the three epidemiologically important regions, namely Atbara, Khasm Al-Girba and New Halfa regions selected due to previous reports of scabies outbreak.

Population Sample of the participant was limited deliberately to equal out rightly percentage of males, females and children within the urban and rural setting. This approach helps in getting overall picture of, how Permethrin is affecting the different groups of the Sudanese population.

This study has sought to present verifiable evidence on the efficacy of Permethrin 5% lotion in the treatment of scabies so that there can be formulation of a national policy on the disease in Sudan. Hence, it has a positive impact on endeavors aimed at closing the gap of neglected tropical diseases and enhancing dermatological care for health-compromised populations.

2. Literature Review

2.1 Global Approaches to Scabies Treatment

Topical and systemic scabies treatments exist and both have certain procedures, advantages, and disadvantages respectively. Topical agents are preferred in most international guidelines including the first line agent, Permethrin 5% (Raoufinejad *et al*., 2016) [25]. Sulfur preparations and benzyl benzoate are some of the other topical agents used, while oral ivermectin is recommended for serious cases, such as those who present with systemic syringes or crusted scabies.

Permethrin 5% lotion is a synthetic pyrethroid that exerts it principal mode of toxicity by relaxing and eventually killing the Sarcoptes scabiei mite (Speare *et al*., 2017) [27]. It is considered safe in children of age more than 2 months and pregnant females and is thus suitable in mass chemotherapy. It entails covering the body from neck and soles track down to the sole of the feet and allowing 8-14 hours of treatment prior to washing off. Usually, a single treatment has a good outcome; however, repeating, the application after the 7-14 days is advisable in the cases of the reinfection or the low efficacy of the treatment.

Benzyl benzoate is reliable and inexpensive but has side effects such as skin reaction and is usually minimally accepted by patients especially the children (Johnson *et al*., 2017) [22]. Sulfur ointment, one of the earliest to be used, has some advantages and disadvantages; it is cheap and causes no harm to the skin but it is not acceptable due to its yellow color, has an ugly smell, and takes a long time to apply. Although short-term oral ivermectin is convenient, it can only be administered to pregnant women or children under 15 kg and is less likely to kill the eggs, requiring retreatment. Fig 1, bar chart that shows a comparison of average cure rates from several published studies to those found in the global health guidelines. Ivermectin comes second with the average cure rate of 85%, while benzyl benzoate has an average cure rate of 75% and sulfur ointment 70% as illustrated in Fig 1 below.

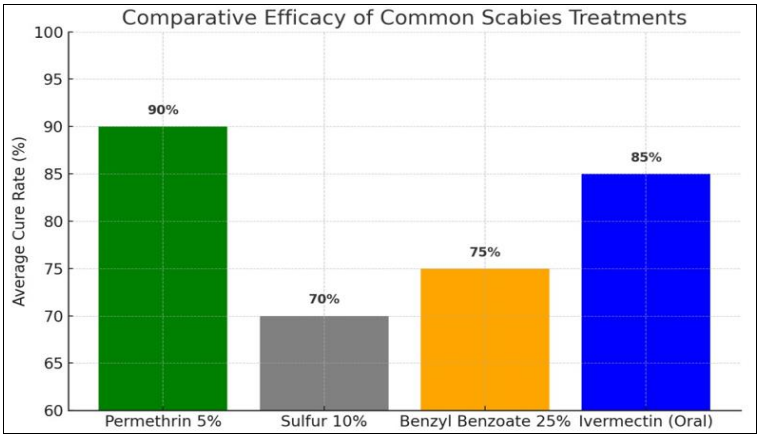

Fig 1: Comparative Efficacy of Common Scabies Treatments

2.2 Permethrin 5% Lotion: Efficacy and Global Evidence

Permethrin 5% lotion has been tried and tested in different populations and all studies have supported its effectiveness in treating scabies (Alenezi *et al*., 2025) [4]. Permethrin, based on the study, had the highest level of effectiveness amongst all topical agents, as conducted by Raoufinejad *et al*., (2016) [25], in a meta-analysis of 15 clinical trials carried out with patients. They have cure rates between 80 %– 95 % after a single application of the method and further enhanced by another application.

Community-based research in India, Ethiopia, and Brazil proved Permethrin to be more effective in the frameworks of individual treatment and MDA (Belachew, 2023) [10]. The fact that permethrin has little systemic action and has been reported to have only mild side effect accounts for its popularity among dermatologists and public health programs.

Typically, protocols for its use call for one full-body application, with a repeat application after about one to two weeks if the symptoms remain unresolved. For a long time now, re- infection from untreated contacts in the same household is one of the major causes of treatment failure stressing the importance of treating the close contacts at the same time (Gaskell, 2024) [17].

It also proves that it is effective in institutional infections such as those in nursing homes and schools. In such cases, Permethrin has remained more effective than others due to the high cross tolerance and low rate of parlous transmission scenarios after treatment (Khan, 2019) [23].

2.3 Challenges in Scabies Treatment

Nonetheless, like with any other medication, there are certain obstacles that go hand in hand with the application of Permethrin 5% lotion. According to literature from different countries for instance Australia, Ghana, and India Permethrin has been reported to be less effective in treating some of the reported sarcoptic mange mites strains (Fentanew *et al*., 2015) [16]. It is also believed that it comes from mutations of sodium channels specific to mites, and

misuse, or application of them in the wrong systems in the community.

Consequently, failure of the treatment course is traced more towards the user reasons than to pharmacologic ones. For example, if some areas like soles, scalp, or under nails are missed; the effectiveness is virtually compromised, and it has adverse effects. Fomite transmission from other family members and objects such as the bed and clothes add to the challenges of elimination especially among communities with high population density or those with low incomes (Stephens *et al*., 2019) [28].

High humidity and high temperatures of the environment aggravate the control measures especially in regions or countries with tropical climatic conditions like Sudan (Alredaisy, 2023) [6]. Not only do such climatic conditions contribute to the survival of these mites, but they further restrict chances of effective washing and cleaning process which also form part of the ways of treating scabies.

Lack of proper diagnosis, especially by personnel who are not well-trained, leads to advancement in disease progression and onward transmission. Thus, strengthening in primary health care for accurate diagnostic and proper education of the patients is important (Bitton *et al*., 2017) [12].

2.4 Knowledge Gap in Sudan

Though, there is much strong evidence from other countries about the effectiveness of Permethrin, unfortunately, Sudan does not have adequate local research data. Many treatment decisions made in the country are made with reference to assumption or data obtained from other countries which is a completely different environment and population (Bertram *et al*., 2017) [11].

At present, there are no guidelines for the management of scabies that can be universally adopted, resulting in the formulation of different policies across the nations (Engelman *et al*., 2021) [15]. This has a negative implication in health since it leads to repeat infections, sometimes partly treated, and increased emergence of resistance.

Since the infection rate is high in areas such as urban centres and villages in Sudan, it is crucial to study how Permethrin works in the localised environment (Himeidan *et al*., 2011) [20]. The reasons for such high mortality include low health literacy, irregular access to medicine and even water rationed in some places must be taken into account when measuring the success of the treatment.

The present study aims at filling these gaps by using descriptive cross-sectional data from three epi-dermatologically different regions of Sudan. It assesses cure rates and treatment failure in a randomised population as well as enhances understanding of its effectiveness as first line treatment in the context of the Sudanese population.

2.5 Significance of the Study

It is more than just a skin condition as scabies do not limit themselves to the skin alone, they affect the entire life of an individual. It can be considered as a social health problem with multiple and complex socioeconomic and health repercussions and mainly in unfavorable population groups. The relevance of this research is evident in the fact that the findings of the present study may help policymakers and implementers as well as clinicians and other stakeholders to devise sound guidelines and usable measures against scabies in Sudan.

This paper is also the first well-organised, cross-sectional survey of the efficacy of Permethrin 5% lotion in Sudan. The study presents data on cure rates, drug resistance, and demographic differences at a local level which has not been previously available on a national level which can guide scabies management. The findings of this study can be a helpful guide for the Ministry of Health in Sudan in coming up with a single policy that addresses the treatment issues in the country.

The evidence produced have both short term and long-term significance. In the short term one may be able to target an accessible, non-irritative and effective first-line treatment for the referral of scabies, thereby halting the reemergence of these episodes. Better results are directly correlated to fewer clinic visits, reduced use of antibiotics for secondary infections, better quality of life of the affected people and especially children.

In the long run, the adoption of Permethrin 5% lotion as the National First-line treatment could go a long way in resolving the issues of transmission, community awareness on hygiene practices, and the harmonization of several programs on vector control. This is in line with WHO's larger agenda of managing poverty-related and neglected tropical diseases by affordable and sustainable means.

From an economic perspective, the research helps in making efficient resource decisions. In addition to the healthcare costs, recurrent scabies outbreaks involve costs to families for follow up and multiple treatments affecting school or work time. Since treatment guidelines ensure that the care provided to patients is proven to be of value, they help reduce unnecessary expenditures while enhancing patients' compliance.

Hence, the result of this study provides practical recommendations for NGOs, health practitioners, and instructors to consider in dermatologic and community health. Since training and education-oriented interventions and campaigns can be effective it would mean that more efforts should be directed on enhancing compliance, promoting concurrent household treatments and averted risks of reinfestation.

The study adds to the global fight against scabies as one of the neglected tropical diseases. The use of local data is crucial to adapting global policy suggestions to local context realities. This could include evaluating treatment response rates in those in internally displaced camps and comparing it with other MDA operations in other programs.

3. Methodology

3.1 Study Design

This is a randomised controlled experimental trial to investigate the efficacy of 5% permethrin lotion as the first-line treatment for scabies in Sudan. Administered under the auspices of the Sudanese Ministry of Health, Department of Tropical Diseases, the study adhered to high ethical and methodological practices for data credibility and transportability.

Permission to conduct the study was sought from the Ministry affiliated institutional review board, and informed consent was sought from all participants or their legal guardians prior to enrolment into the study. The study maintained the ethical standards laid down in the World Medical Association Declaration of Helsinki and other related regulations on the use of human subjects for research purposes.

Patients were conveniently enrolled based on inclusion and exclusion criteria; recall bias was not found preferable as patients were not offered any incentives with aim of biases such as the recall bias. These elements of control provided the internal validity so that the outcomes could be directly assigned to the treatment intervention.

3.2 Study Setting

The study was conducted in three successive epidemiological zones in Sudan: As to Atbara, Khasm Al-Girba and New Halfa wherein they brought out the principles of the constitution saying that the Sudanese constitution will remain supreme and prohibiting any change of a constitutional articles in Sudan by referendum. These areas were selected according to the surveillance data on the incidence of scabies infections in the last three years. They also depict a versatile sample of demographic dispersion of the Sudanese population that also includes both the urban and rural areas.

- **Atbara:** Urban-like densely populated cities with favourable health facilities provision.
- **Khasm Al-Girba:** It is a region mainly consisting of the nomadic community with recorded epidemics among school-age children and nomadic populations.
- **New Halfa:** A community with diverse structure and mobility characteristics because of the agricultural labour migration.

Thus, by including these three areas the study maintains variability of geographic, social and infrastructure related factors and can be generalised to the national level.

3.3 Population and Recruitment

The participants were selected from the hospitals that are affiliated with the Ministry of Health in each region. The inclusion criteria for the study included:

- To assess the number of cases of scabies confirmed by clinical diagnosis and then pilot test the index in clinical practice.
- Age between 2 and 50 years.
- A client does not have any coexisting diseases or skin disorders that may affect the identification of the condition, as well as treatment.

Participants were recruited through clinic review and were assigned to the study divides by using a computer-generated random sequence to minimise the selection bias. Once more, equal representation was maintained in terms of:

- **Gender:** Every region was represented by 20 men, 20 women and 10 children.
- **Living conditions:** A sample of 25 participants from both urban and rural settings was used.

It also helped in keeping the demographic ratios in check and made it possible to perform sub-analyses according to the age, sex and habitat. Equal demographic representation was ensured across all three regions to allow for subgroup analysis. Table 3 summarises the age, gender, and living condition distribution of the study participants.

Table 3: Demographic Distribution of Study Participants by Region

Region	Total Particip ants	Adult Men	Adult Women	Children (2–12 yrs)	Urban Reside nts	Rural Residents
Atbara	50	20	20	10	25	25
Khasm Al- Girba	50	20	20	10	25	25
New Halfa	50	20	20	10	25	25
Total	150	60	60	30	75	75

3.4 Intervention Protocol

Participants were randomised into two groups and all of them were treated with the same Permethrin 5% lotion. They were developed in accordance with WHO recommendations and adjusted for the given circumstances.

- **Application method:** Lotion was taken in the palms and gently rubbed on the body from the neck down to the toes.
- **Duration:** It was applied on the skin for at least 8 hours then washed off with warm water.
- **Follow-up:** In the present study, participants' progress was assessed again one week later. In cases of failed outcomes, all the procedure was repeated with the similar doses for the second time.

Basic application technique was explained and shown to each participant and caregivers were taught in the case of children. Since re-infestation can occur, all contacts were recommended to be treated at the same time.

3.5 Data Collection Methods

Patients' data were assessed using a structured and standardised CRF designed for this study but adapted from a similar study conducted in India by Patterns Healthcare. The CRF encompasses intake of patient data as detail as their age, sex, and state of residence, clinical state before and after treatment, and treatment results. All the participants were assessed at the time of enrolment, after a wash with Permethrin 5% lotion for the first time, and one week later to determine if a second wash is required. If symptoms were clinical, a second dose was given and follow up was done for classification of the outcome. The outcome of treatment was categorised as cured after first and/or second dose or resistant or discontinued. To eliminate bias and increase credibility of results, clinical evaluations were carried out by qualified health practitioners who were not privy to the previous treatments' outcome. These physicians and nurses were educated on how to evaluate treatment outcome for scabies using universal guidelines including disappearance of itching and clearing of the rash. The occurrences of any AE or deviation from the study protocol were also recorded. Different data collection tools were also pre-tested and checked regularly to ensure that they did not produce inconsistencies during the research study. All the data were further anonymised and the data set was created in a central database for the analyses purposes by using the descriptive analytics.

3.6 Data Analysis

Data were analysed using descriptive statistical methods. Key performance indicators included:

- Cure rate after first and second doses.

- Rate of treatment resistance or discontinuation.
- Comparison across regions and demographic subgroups.

The following Table 4 summarises the treatment outcomes across the three regions.

Table 4: Regional Treatment Outcomes for Permethrin 5% Lotion

Region	Total Patients	Cured After First Dose (%)	Cured After Second Dose (%)	Resistant / Discontinued
Atbara	50	72%	17%	4%
Khasm Al- Girba	50	78%	22%	0%
New Halfa	50	78%	22%	0%

4. Results

4.1 Participant Demographics

A total of 150 participants were included in the study; they were recruited from three regions in total. Kassala is a regional city located at the eastern part of Sudan which comprises of Atbara, Khasm Al-Girba, and New Halfa. With a total of 100 participants recruited for the study, each region was represented by 50 participants to enhance the regional distribution of the respondents. To implement this study, measures were taken to ensure that the participants in the study represented a fair sample as pertains to the proportion of; gender, age, as well as, their living circumstance.

In more detail, each geographic area contained 20 men and women over 18 years of age, and 10 children of ages 2 to 12 years. In addition, participants were distributed equally according to the region's urbanity, 25 participants from the urban areas and 25 from the rural areas. It also enabled further subgroup analyses which could identify differences in treatment results depending on the age or the type of living conditions.

Table 5: Demographic Distribution of Study Participants by Region

Region	Total Participants	Adult Men	Adult Women	Children (2–12 yrs)	Urban Residents	Rural Residents
Atbara	50	20	20	10	25	25
Khasm Al-Girba	50	20	20	10	25	25
New Halfa	50	20	20	10	25	25
Total	150	60	60	30	75	75

4.2 Treatment Outcomes by Region

Overall treatment outcomes were favourable and showed high efficacy of Permethin 5% lotion though with variation across the regions. At Atbara 72% of the participants were cured within the first application. Another 17% of patients improved after the second application of the drug. 4% did not complete or stopped treatment, mostly because of non-compliance with medication or incomplete use of medicine.

In the 'Khasm Al-Girba' area, percentage effectiveness showed that 78% of the patients got cured after the first visit but the remaining patients needed another application to be cured. Importantly, no information on treatment nonadherence or withdrawal was found in this area of the world.

New Halfa emulated what Khasm Al-Girba showed. conducted in Madagascar, where the efficacy was 78% after the first dose and 22% after the second dose, without the appearance of resistance. The similar levels of efficacy evidenced in two different areas, one geographical and one demographic, provide evidence for the effectiveness of Permethrin in Sudan.

4.3 Incidence of Treatment Resistance

The rates of treatment non-response were relatively low in all the three regions. Atbara had the smallest proportion of those who were considered resistant or discontinued earlier before the completion of the treatment regimen; a measly 4 percent. There was no record of resistance in Khasm Al-Girba or New Halfa, so it appears that geographical difference is due to other factors like environmental or behavioral factors such as misapplication or reinfestation.

Besides, there was evidence of treatment resistance which only affected few clients out of the 50 respondents in Atbara and was not suggestive of a tendency towards resistance. This is in view of the fact that Permethrin 5% has been found to be effective in the eradication of the disease both in rural and urban Sudanese population thus making it worthy to be recommended as a first line of treatment.

4.4 Summary Table and Visual Presentation

The consolidated outcomes of the treatment across the three regions are summarised below in table 6, highlighting the distribution of cure rates and resistance percentages.

Table 6: Regional Treatment Outcomes for Permethrin 5% Lotion

Region	Total Patients	Cured After First Dose (%)	Cured After Second Dose (%)	Resistant / Discontinued
Atbara	50	72%	17%	4%
Khasm Al-Girba	50	78%	22%	0%
New Halfa	50	78%	22%	0%
Total	150	76%	20.3%	1.3%

To better visualise these outcomes, the following Fig 2 presents the treatment success and resistance data across regions using a grouped bar chart.

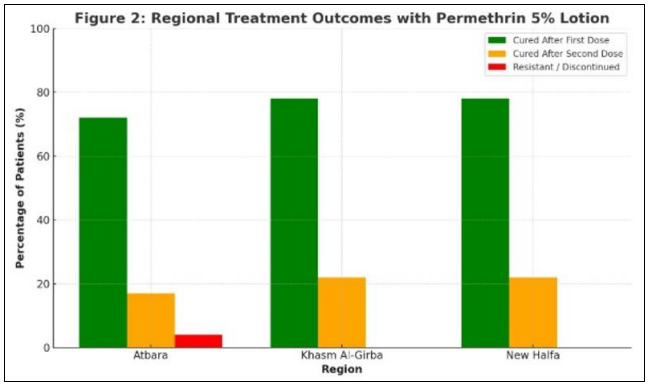

Fig 2: Regional Treatment Outcomes with Permethrin 5% Lotion

5. Discussion

5.1 Interpretation of Findings

The findings of this study conclude that Permethrin 5% lotion is equally efficient in treating scabies in all the different areas of Sudan. These results reveal that the

product has an impressive effectiveness index 76% of the patients got rid of their complaints during the first application and 96.3% of the patients were completely cured with the second dose of the product under a live healthcare practice.

This rate indicates Permethrin as the gold standard treatment especially in regions where there is limited access to resources and practicality in the treatment method is of paramount importance. The fact that 20.3% of participants applied again means that people need an additional application in their day-to-day lives. Nonetheless, while Permethrin is highly effective, there are those few patients who may not respond well to it the first time, or become infested again shortly afterwards. More importantly, the fact that the resistance rate was very low at 1.3% and this was attributed to peculiar to Atbara region only reinforces its position as frontline agent.

These data providing a rationale to include Permethrin as the first line of treatment of scabies according to the existing national protocol in Sudan.

5.2 Comparison with International Studies

These findings corroborate the research done on the efficacy of Permethrin all around the world. For instance, Anwar *et al*., (2015) [7] documented a 93.3% effectiveness of Permethrin *in vitro* and so is more effective than 1% lindane. Similarly, Sungkar *et al*., (2014) [29] reported overall success rates of about 90% in both whole body and lesion applications, which is in the range of the 76-96% observed in this study after one or two doses.

This is closely similar to Enbiale *et al*., (2020) [14] who observed a 94% overall cure rate in a mass ivermectin distribution intervention in Ethiopia. Even though the drug that was used was different, the comparable cure rate added more insight to Permethrin's performance when administered alongside other public health measures.

In another study by Tessema *et al*., (2025) [30], Permethrin proved to be more effective to the Shega herbal remedy with a cure rate of 83.3% hence confirming the efficacy of the insecticide in Africa. Another study by Rahmayunita *et al*., (2023) [24] dealing with pediculosis capitis also found a similar result, and added that there was no significant difference between 1% and 5% Permethrin with side effects and good tolerance in this group which is in conformity with high compliance and low resistance regarding this Sudanese group.

In general, the coherence with the research studies established in various nations points to Permethrin's versatility and stability amplified within LMICs.

5.3 Factors Influencing Treatment Outcomes

There are several possible reasons that may affect scabies treatment outcome, such as re- infestation, poor medication application and new drug resistance. In this study, 20.3% of the participants required a second application and 1.3% a sufficient minimal resistance which would imply an application or behavioral problem not pharmacological failure.

This finding is congruent with Ginawi *et al*., (2023) [18] findings that among 92% of affected children, finger webs lesions were being reported, which was an indication that certain body parts were more likely being missed out during the treatment process, and in lack of proper guidance. The study also underlined such aspects of environmental hazard as overcrowding and lack of hygiene, similar ones to those existent in rural Sudan contributing to the possibility of reinfestation and can lead to delayed recovery.

Dr. Sungkar *et al*., (2014) [29] also demonstrated further that lesion-only versus full-body Permethrin application had similar outcomes; indicating that the treatment failure is a common issue even though the treatment compound is effective. This corresponds to what has been seen in the observations of Atbara subgroup in your study where resistance or discontinuation had happened in only 4% of the cases – probably because of misapplication or insufficient coverage.

Besides, Bayisenge (2024) [9], gives ethnographic view on how stigma of scabies among the refugees may lead to the avoidance of or will not comply with the treatment. This is of importance to populations in parts of rural Sudan and internally displaced populations where cultural perceptions and fears of judgment results in a decrease in care seeking behavior and adherence.

5.4 Urban vs. Rural Differences

Although the present study balanced representation of urban and rural populations in all regions, there were subtle differences in treatment outcomes and application behavior. For example, anecdotally, urban locales seemed to exhibit greater compliance and appreciation of the protocols of treatment, presumably, because of better health literacy, more convenient access to follow-up care, and less grubbiness.

This rural–urban dichotomy reaffirms results from Abass *et al*., (2024) [1] that had a pediatric skin disease study in a Sudanese dermatology clinic. Their results indicated that the prevelence of Scabies was underestimated in clinical reports, because of a scarcity of rural outreach, pointing to the hidden burden and potential underreporting in the rural areas.

Similarly, Alnoor *et al*., (2024) [5] reported environmental risk factors in rural White Nile State including barefoot walking and shared bedding as enhancing parasitic skin disease transmission.

Although this study could not identify statistically significant differences in cure rate between urban and rural groups, qualitative observations indicate that challenges to hygiene and access to education and healthcare could lead to the risk of reinfestation or inadequate pathogen management for the rural group. Such insights are consistent with the global literature that is replete with observations of poorer treatment outcomes in under resourced settings not because of the ineffectiveness of the drug but because of challenges in its application and reinfestation dynamics.

5.5 Strengths of the Study

This study has several strengths. First, randomised recruitment coupled with the balance of the demographic distribution guarantees performativeness and reduces the possibility of selection bias. By mapping equal numbers of men, women, and children, and urban and rural participants, the findings apply generally to the national population.

Second, having a multi-regional dimension permits comparison by regions and increases external validity. The uniform results of the three study regions emphasis the transferability of the effectiveness of Permethrin. Third, blinded clinical assessment of outcome reduced assessment bias and improved the validity of reported cure rates. The

use of a structured case report form enhanced uniform data collection making it more methodologically robust.

5.6 Limitations of the Study

Although overpowered, the study also has limitations. While the sample size supports observational trends, it is the statistical power to identify smaller differences for the demographic subgroups (e.g., urban vs. rural outcomes) that is constrained.

The other limitation is short follow-up period one week starting from the 1st to the 2 nd evaluation. It can fail to include late relapses or reinfestation. Ideally participants should be followed for 3–4 weeks to identify long-term success and the potential recurrence.

The study failed to find laboratory confirmation of mite eradication. Diagnosis and cure were all clinical evaluation. This is normal practice in field settings to which dermoscopy or skin scrapings could have provided precision and enabled conclusive identification of resistant cases.

5.7 Implications for Practice and Policy

The results of this research offer sufficient grounds in favour of formal introduction of Permethrin 5% lotion as a national first line therapy for scabies in Sudan. The high cure rate, ease of application, weak side-effect profile and low level of resistance creates the ideal situation for clinical/community use.

Policymakers would do well to incorporate Permethrin to the national procurement lists and work out treatment protocols and public education campaigns on its correct use and household contacts' simultaneous treatment.

In addition, periodic monitoring and resistance surveillance should be institutionalised in order to spot rise of inefficacy and enable timely interventions. Lessons from Enbiale *et al*., (2020) [14], and other mass drug administration models, can also be used to increase community- based interventions when outbreaks occur.

Finally there is a need for more research to determine the long term effectiveness of treatment, rates of relapse and external alternatives for populations who may prove resistant to Permethrin, particularly in the humanitarian or refugee situation wherein risk factors are exaggerated.

6 Conclusion

This study presents excellent evidence in favour of the value of Permethrin 5% lotion as a first line treatment for scabies in Sudan. With a single-dose cure rate of 76% and an overall cure rate of 96.3% after two applications the results clearly show high therapeutic potential in heterogeneous regional and cultural settings. Importantly, the incidence of resistance, or discontinuation of treatment, was very low (1.3%), limited to a single locality, implying that, for the Sudanese population, Permethrin is still effective and tolerable.

With its ease of access and use as well as its excellent safety profile, Permethrin 5% lotion should be formally incorporated into Sudan's national scabies treatment protocol. Standardisation of its use in clinical and community setting may help in reducing the burden of scabies, preventing secondary bacterial infections and improve the quality of life of patients suffering from scabies.

However, in order to maintain effectiveness and to prevent resistance development, it is critical to implement larger, longitudinal studies carrying out long term outcomes, reinfections rates and adherence of treatment. So too are the integrated public health strategies involving the use of medication, education and hygiene promotion in reaching sustainable control of scabies in Sudan.

7. References

1. Abass MN, Mohammed MA, Elgadal AH. The Spectrum of Pediatric Skin Diseases: A Prospective Study in Sudan. Sudan Journal of Medical Sciences. 2024; 19(2):238-247.
2. Abdelgader TM, Ibrahim AM, Elmardi KA, Githinji S, Zurovac D, Snow RW, *et al*. Progress towards implementation of ACT malaria case-management in public health facilities in the Republic of Sudan: A cluster-sample survey. BMC Public Health. 2012; 12:1-12.
3. Adán GB, Juan MMJ, Nelly MVA, Paulino SS, Benedicta BLM, Guadalupe NM. Scabies. One Health Triad, Unique Scientific Publishers, Faisalabad, Pakistan. 2023; 3:245-250.
4. Alenezi N, AlQusaimi R, Alajmi H, AlMutairi EY, Alenezi AT, Saad AR, *et al*. Permethrin Versus Benzyl Benzoate for the Treatment of Scabies: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Cureus. 2025; 17(2).
5. Alnoor B, Nahar P, Zied OA, Fairhead J. Revealing the possible neglected environmental risk factors contributing to mycetoma in the White Nile state: Sudan, 2024.
6. Alredaisy SMAH. Reviewing indicators of climate change and their environmental impacts in Sudan. Int. J. Recent Res. Interdiscip. Sci. 2023; 10:7-16.
7. Anwar MI, Rizvi SDA, Dilnawaz M, Ijaz A, Muqaddas T, Parveen N. Comparison of *in-vitro* susceptibility of sarcopties scabieivar hominis to 5% permethrin and 1% lindane. Pakistan Armed Forces Medical Journal. 2015; (3):367.
8. Bachewar NP, Thawani VR, Mali SN, Gharpure KJ, Shingade VP, Dakhale GN. Comparison of safety, efficacy, and cost effectiveness of benzyl benzoate, permethrin, and ivermectin in patients of scabies. Indian journal of pharmacology. 2009; 41(1):9-14.
9. Bayisenge U. The lived experience of people affected with scabies: Case from Rwanda. In Brighton and Sussex Medical School. Paper Presentation in EASA Conference, Barcelona, January, 2024.
10. Belachew R. From quantification to control: A population-based study to measure the secondary impact of ivermectin-based mass drug administration aimed to control onchocerciasis on the prevalence of scabies in northern Ethiopia (Doctoral dissertation, University of Brighton), 2023.
11. Bertram MY, Stenberg K, Brindley C, Li J, Serje J, Watts R, *et al*. Disease control programme support costs: An update of WHO-CHOICE methodology, price databases and quantity assumptions. Cost Effectiveness and Resource Allocation. 2017; 15:1-12.
12. Bitton A, Ratcliffe HL, Veillard JH, Kress DH, Barkley S, Kimball M, *et al*. Primary health care as a foundation for strengthening health systems in low-and middle-income countries. Journal of general internal medicine. 2017; 32:566-571.
13. Enbiale W, Ayalew A, de Vries HJ. Scabies. In

Neglected Tropical Diseases- Sub-Saharan Africa (pp. 315-331). Cham: Springer International Publishing, 2024.
14. Enbiale W, Baynie TB, Ayalew A, Gebrehiwot T, Getanew T, Ayal A, *et al*. Stopping the itch: Mass drug administration for scabies outbreak control covered for over nine million people in Ethiopia. The Journal of Infection in Developing Countries. 2020; 14(06.1):28S-35S.
15. Engelman D, Marks M, Steer AC, Beshah A, Biswas G, Chosidow O, *et al*. A framework for scabies control. PLoS neglected tropical diseases. 2021; 15(9):e0009661.
16. Fentanew A, Derso S, Melaku S, Belete S, Girma H, Mekonnen N. A review on epidemiology of mange mites in small ruminants. Acta Parasitol Glob. 2015; 6:182-192.
17. Gaskell KM. Respiratory pathogen transmission among exposed household contacts (Doctoral dissertation, London School of Hygiene & Tropical Medicine), 2024.
18. Ginawi NME, Shamad M, Barakat HEN, Hussein HM. Assessment of Clinical Profile and Impact of Different Risk Factors among Scabietic Children at Khartoum Teaching Hospital. The Egyptian Journal of Hospital Medicine. 2023; 90(1):1156-1161.
19. Hassan SM, Salih DA. An overview of factors responsible for geographic distribution pattern of ixodid ticks in the Sudan. Sokoto Journal of Veterinary Sciences. 2013; 11(2):1-9.
20. Himeidan YE, Abdel Hamid MM, Jones CM, Ranson H. Extensive permethrin and DDT resistance in Anopheles arabiensis from eastern and central Sudan. Parasites & Vectors. 2011; 4:1-7.
21. Jira SC, Matlhaba KL, Mphuthi DD. Evaluating the current management approach of scabies at selected primary health care in the Deder district, Ethiopia. Heliyon. 2023; 9(1).
22. Johnson W, Bergfeld WF, Belsito DV, Hill RA, Klaassen CD, Liebler DC, *et al*. Safety assessment of benzyl alcohol, benzoic acid and its salts, and benzyl benzoate. International Journal of Toxicology. 2017; 36(3_suppl):5S-30S.
23. Khan HAA. Characterization of permethrin resistance in a Musca domestica strain: Resistance development, cross-resistance potential and realized heritability. Pest Management Science. 2019; 75(11):2969-2974.
24. Rahmayunita G, Pertiwi LK, Ascobat P, Widaty S. Efficacy and safety of 1% and 5% permethrin lotion as treatment for pediculosis capitis in children: A double blind randomized controlled study. Journal of Pakistan Association of Dermatologists. 2023; 33(2):513-518.
25. Raoufinejad K, Mansouri P, Rajabi M, Naraghi Z, Jebraeili R. Efficacy and safety of permethrin 5% topical gel vs. placebo for rosacea: A double-blind randomized controlled clinical trial. Journal of the European Academy of Dermatology and Venereology. 2016; 30(12):2105-2117.
26. Riebenbauer K, Weber PB, Haitel A, Walochnik J, Valencak J, Meyersburg D, *et al*. Comparison of permethrin-based treatment strategies against scabies in infants and young children. The Journal of Pediatrics. 2022; 245:184-189.
27. Speare R, Canyon DV, Heukelbach J, Shaalan ES. Permethrin. In Kucers' The Use of Antibiotics (pp. 3413-3422). CRC Press, 2017.
28. Stephens B, Azimi P, Thoemmes MS, Heidarinejad M, Allen JG, Gilbert JA. Microbial exchange via fomites and implications for human health. Current Pollution Reports. 2019; 5:198-213.
29. Sungkar S, Agustin T, Menaldi SL, Fuady A, Herqutanto H, Angkasa H, *et al*. Effectiveness of permethrin standard and modified methods in scabies treatment. Medical Journal of Indonesia. 2014; 23(2):93-98.
30. Tessema TA, Cavin AL, Gurmu AE, Limenh LW, Bizuneh GK, Adamu BA, *et al*. Evaluation of the effectiveness of “Shega” natural and self-made solution as compared to permethrin lotion in eliminating head lice in infested Schoolchildren in Gondar area, Ethiopia: A randomized non-inferiority trial. Frontiers in Pediatrics. 2025; 13:1507760.
31. Umali-Deininger D, Sur M. Food safety in a globalizing world: Opportunities and challenges for India. Agricultural Economics. 2007; 37:135-147.
32. Van Leeuwen T, Vontas J, Tsagkarakou A, Dermauw W, Tirry L. Acaricide resistance mechanisms in the two-spotted spider mite Tetranychus urticae and other important Acari: A review. Insect biochemistry and molecular biology. 2010; 40(8):563-572.