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Ivermectin-Based Mass Drug Administration for Scabies in Northern India: A Single-Arm Community Intervention Trial

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Background. Scabies and impetigo cause direct health effects and contribute to severe infectious and immune-mediated complications. Ivermectin-based mass drug administration can reduce scabies and impetigo prevalence in island settings with high prevalence, but the effectiveness in moderate-prevalence settings is not known.

Methods. We conducted a single-arm, before–after community intervention trial. Mass drug administration was offered to the entire population of 4 villages in Uttarakhand, India. The treatment consisted of 2 doses, given 7 days apart, of oral ivermectin (~200 μg/kg), or topical 5% permethrin if ivermectin was contraindicated. The primary outcome was the prevalence of scabies at 12 months compared with baseline, as diagnosed using clinical assessment and the 2020 International Alliance for the Control of Scabies criteria. Secondary outcomes included the prevalence of impetigo at each time point. The trial was registered with the Australian and New Zealand Trials Registry (ACTRN12619001712190).

Results. In January 2020, 1211 participants were enrolled (100% of the estimated village population). Treatment coverage was high—1204 (99.4%) and 1177 (97.2%) received 1 and 2 doses, respectively. Scabies was diagnosed in 91 participants (7.5%) and impetigo in 15 (1.2%). In February 2021, 1190 (98.3% of baseline) participants re-enrolled, and of these 11 had scabies (0.9%; relative risk reduction, 87.7%; 95% CI, 77.1%–93.4%) and 5 had impetigo (0.4%; relative risk reduction, 66.1%; 95% CI, 7.0%–87.6%).

Conclusions. A single round of ivermectin-based mass drug administration substantially reduced the prevalence of scabies and impetigo in this setting with moderate scabies prevalence in northern India.

Keywords. dermatology; ivermectin; mass drug administration; neglected tropical diseases; scabies.

Scabies is an ectoparasitic skin condition caused by the mite *Sarcoptes scabiei* var. *hominis*. Infestation directly causes rash and severe itch, which can lead to stigma and absenteeism from education and employment [1]. Scabies infestation predisposes to secondary bacterial infection (impetigo) [2, 3], which in turn can lead to severe skin and soft tissue infection, septicemia, and immune-mediated conditions including rheumatic fever and poststreptococcal glomerulonephritis [4, 5]. Scabies occurs in all countries, with the highest prevalence among children in settings with increased skin-to-skin transmission, including among those living in crowded households in disadvantaged populations or within institutions such as schools, prisons, and refugee camps [6, 7].

A single round of ivermectin-based mass drug administration (MDA) has been shown to reduce the prevalence of scabies by ~90%, with concurrent reductions of impetigo prevalence of ~60%–70% and reductions in hospitalization with skin and soft tissue infections [8–10]. However, most studies to date have been conducted in settings with extremely high prevalence of scabies (≥20%), particularly on tropical islands [11, 12].

The World Health Organization (WHO) Roadmap for Neglected Tropical Diseases, 2021–2030, sets a target for 25 countries implementing MDA for scabies in all endemic districts in by 2030 [13]. A framework for scabies control was developed through a WHO informal consultation process in 2019

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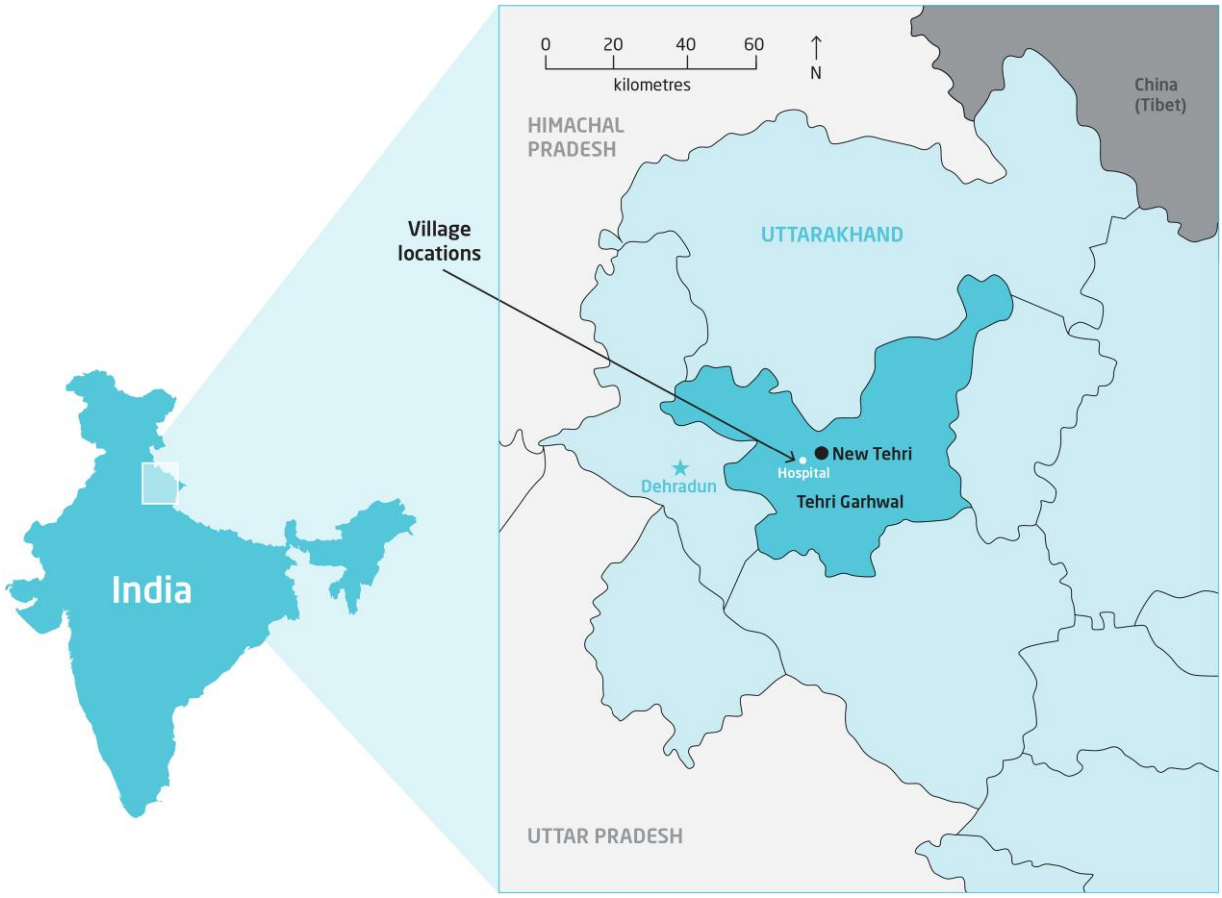

Figure 1. Map of study sites.

[14, 15]. In this framework, scabies control using 3 to 5 annual rounds of ivermectin-based MDA is recommended for settings with a community prevalence of ≥10%. However, where the prevalence is between 2% and 10%, there are few data [16], and therefore there are no recommendations for the optimal control strategy. Trials of MDA in these medium-prevalence settings, and in nonisland settings, have been identified as research priorities [4, 10].

There are few published data regarding the burden of scabies in India, with limited generalizability [17, 18]. A 2010 survey of dermatological conditions among mountainous villages in Uttarakhand estimated a scabies prevalence of 4.4% [19]. India has successfully used MDA for other diseases such as lymphatic filariasis [20]. In order to develop targeted scabies control strategies in this region, a deeper understanding of the epidemiology of scabies and impetigo is needed, along with a better understanding of the possible role of MDA for scabies in this setting.

Therefore, we aimed to assess the efficacy of ivermectin-based MDA for scabies control in a village population in northern India and to assess efficacy for impetigo. We also aimed to describe the epidemiology of scabies and impetigo in this region.

METHODS

Design and Setting

This prospective, nonrandomized, single-arm, before–after community intervention trial was conducted in Tehri-Garhwal district, in the northern Indian state of Uttarakhand (Figure 1). This region was selected in collaboration with Chamba Hospital due to its relative proximity to the hospital, geographic separation of rural villages within the region, and economically disadvantaged populations considered to be at higher risk for scabies transmission.

The population of Uttarakhand was ~10 million in 2011 [21]. Tehri Garhwal is a predominantly rural district in the foothills of the Himalayas. It has a temperate climate with cool, dry winters and warm, wet monsoons. The district's geographical isolation, along with high levels of poverty and illiteracy, contribute to poorer access to primary health care and poorer health indicators compared with other districts in Uttarakhand and other states in India [22]. Ivermectin-based MDA programs have not been used in this region previously.

Participants

Four villages were selected based on geographic location and separation and invited to participate in the study through engagement of the Pradhan (village head). A community meeting was held in each village to meet the study team, explain the importance of scabies, as well as the study design and intervention, and discuss any questions. All members of the population were invited to participate. Participation in the study was voluntary, and participants were not paid or reimbursed for their involvement.

Accredited Social Health Activist (ASHA) workers are community health workers that reside in each village and keep an updated list of village residents and housing locations. This list was updated before the study. Clinical nurses from Chamba Christian Hospital and ASHA workers went house-to-house to provide study information and enroll participants. The study team spent 3 days in each village to maximize participation. All village residents who provided informed consent were eligible to participate. Written consent was obtained from all participants and parents/guardians if the participants were aged <18 years.

Baseline Survey

Training was provided to clinical nurses and ASHA workers on study procedures, including adverse event monitoring and management. A medical doctor with experience in the diagnosis of scabies led a 2-day training on skin examinations for scabies and impetigo. The training course was based on a program developed and used previously and reviewed by a local dermatologist to ensure that it was appropriate for the local context [23]. At the baseline survey, demographic information (age, sex, household occupants) and previous treatments for itch and skin conditions were collected from all participants. Participant weight was measured using portable scales.

History and clinical examination features of scabies were collected in accordance with consensus criteria developed by the International Alliance for the Control of Scabies (IACS) [24, 25]. No diagnostic tests were used. Participants were asked about itch and whether their households and close contacts had itch or a typical scabies rash. Skin assessment in children and adults was limited to normally exposed skin (arms from above elbows to fingers, legs from above knees to feet, trunk, and chest) [26, 27]. Infants were examined in full. Examiners checked for the presence of any skin lesions, then recorded if lesions were typical, atypical, or not consistent with scabies. Examiners also noted the presence of any infected scabies lesions and infected sores (impetigo). The body location and number of typical or atypical scabies lesions and number of impetigo lesions were recorded. Data were collected using paper-based forms and imported into a password-protected Microsoft Excel spreadsheet. Data were deidentified to protect confidentiality.

Intervention

Following the examination and questionnaire, all participants were offered treatment, regardless of whether they had symptoms or signs of scabies. All participants were offered oral ivermectin except for the following groups: children weighing <15 kg, those pregnant or unsure of their pregnancy status, those breastfeeding in the first week after birth, and those diagnosed with a severe illness, taking warfarin, or allergic to ivermectin. Participants in these groups were offered topical 5% permethrin cream. Participants were excluded from MDA if they were allergic to both medication options or had taken ivermectin in the previous 7 days.

Ivermectin was dosed by weight bands at 160–250 μg/kg, rounded to the nearest 3-mg tablet. The first dose of ivermectin was administered at the household. The second dose was administered at a central village location 7 days later, and participants were followed up with home visits if they did not present for the second dose. Both doses were taken under direct observation. Information was provided on correct application of permethrin, but this was not directly observed. Participants noted to have other suspected conditions (including any cases with suspected crusted scabies) were referred to a local health facility for specialist assessment and management, or, if appropriate, managed directly by ASHA workers. Participants were educated about potential adverse events and encouraged to present with any concerning symptoms to ASHA workers residing in the villages who received specific training about safety monitoring and reporting.

Follow-up Survey

The follow-up study was conducted ~12 months later by the same study team. Refresher training was completed before the survey. The team attempted to locate all participants from the baseline survey or record their absence. The same questionnaire and skin assessment procedures were repeated. Participants were also asked whether they had participated in the study at baseline and received MDA. Household occupants who did not participate in the baseline survey were not included. Participants with scabies lesions at the follow-up survey were offered treatment with ivermectin or permethrin.

Outcomes

Clinical history and examination findings were assessed against the 2020 IACS criteria, and scabies was diagnosed when participants met 1 of 3 categories: B3 (Clinical Scabies) or C1 and C2 (Suspected Scabies) [24]. Both scabies and impetigo severity were classified by the number of lesions present as very mild (1–2 lesions), mild (3–10 lesions), moderate (11–50 lesions), or severe (>50 lesions) [24].

Sample Size and Statistical Analysis

The study aimed to recruit 1400 participants, which was the estimated population of the villages before the study [21]. Based

on previous studies [17, 19], we assumed a baseline scabies prevalence of 8%–9% and that this prevalence would fall to ~5% following ivermectin-based MDA. The recruitment target was designed to provide 90% power to detect a difference between the baseline and 12-month prevalence, assuming 80% participation in the MDA, 20% loss to follow-up, and a 0.35 correlation between paired data.

The primary analysis was the prevalence of scabies at 12 months compared with baseline (as a measure of the efficacy of ivermectin-based MDA). Additional analyses were the change in prevalence of impetigo from baseline to 12 months, participation, and coverage.

The overall prevalence of scabies and impetigo at 2 time points was calculated, and the change in prevalence was expressed as absolute difference and relative reductions in prevalence (with 95% CIs). *P* values were calculated using the chi-square test.

Descriptive statistics were used for the distribution of scabies and impetigo by demographic factors. As the 2011 census was outdated and inaccurate, baseline participation and MDA coverage for each dose wer calculated using the updated ASHA village population lists as the denominator. All data were analyzed using Stata (version 16.1; StataCorp, College Station, TX, USA).

Focus Group Discussions

A focus group discussion of 8–10 adult participants was conducted in each of the 4 villages at the time of the 12-month survey. Discussions of ~30 minutes' duration were facilitated by local investigators in Hindi. Topics included community acceptance of MDA, observed effects on skin health following the MDA, feasibility of implementation, and the effects of the COVID-19 pandemic or other external factors on social changes to village migration and populations. Deidentified quotes from participants were transcribed onto paper and translated into English. A thematic analysis was conducted using reports from discussion facilitators and participant quotes.

Ethical Approvals

The study protocol was approved by the Human Research Ethics Committee at the Royal Children's Hospital, Melbourne, and by an ethics review committee convened at Chamba Hospital. This trial was registered with the Australian and New Zealand Trials Registry (ACTRN12619001712190). An independent data safety monitoring committee oversaw the trial.

RESULTS

In January 2020, 1211 participants were enrolled, representing 100% of the estimated village population. In February 2021, 1190 (98.3% of baseline) of these were re-enrolled in a follow-up survey (Table 1).

Table 1. Participants Demographics at Baseline and 12-Month Surveys

	Baseline	12 Months[a]
Sex		
Male	465 (38.4)	456 (38.3)
Female	746 (61.6)	734 (61.7)
Age		
Median, y	28 (14–50)	29 (15–51)
≤10 y	208 (17.2)	186 (15.6)
11–20 y	229 (18.9)	230 (19.3)
21–30 y	185 (15.3)	193 (16.2)
31–40 y	145 (12.0)	144 (12.1)
41–50 y	126 (10.4)	126 (10.6)
51–60 y	131 (10.8)	133 (11.2)
>60 y	187 (15.4)	178 (15.0)
Size of household, people		
Median	4 (3–6)	5 (4–6)
1–2	140 (11.6)	107 (9.00)
3–4	483 (39.9)	416 (39.8)
5–6	379 (31.3)	415 (34.9)
≥7	209 (17.3)	252 (21.2)
Village		
A	201 (16.6)	195 (16.4)
B	506 (41.8)	496 (41.7)
C	208 (17.2)	208 (17.5)
D	296 (24.4)	291 (24.5)
Treatment for skin or itch in previous week		
Yes	37 (3.1)[b]	11 (0.9)
Total	1211	1190

Data are median (IQR) or No. (%) as a proportion.

Abbreviation: IQR, interquartile range.

[a]Twenty-one participants unavailable for follow-up: deceased (n = 11), left village (n = 10).

[b]Treatments included topical scabies treatments (permethrin, 4; and lindane, 1), topical steroids (5), topical antibiotics (2), oral antihistamines (7), oral and/or topical antifungals (6), and ayurvedic/herbal preparations (1). Seven participants received multiple treatments, and 20 participants were uncertain of the treatment received.

At baseline, the median age (interquartile range [IQR]) was 28 (14–50) years, and the median household size (IQR) was 4 (3–6) people. There was a higher proportion of females than males (61.6%). Thirty-seven participants (3.1%) reported treatment for skin disease or itch in the week before the baseline survey, including 5 treated for scabies with topical permethrin or lindane.

First-dose MDA coverage was 99.4% (ivermectin 1038, permethrin 166; total 1204). Second-dose coverage was 97.2% (ivermectin 1011, permethrin 166; total 1177). Seven participants declined treatment, and 27 were absent from the village for the second dose. No serious adverse events were reported.

Scabies and Impetigo at Baseline

Ninety-one participants met the diagnostic criteria for scabies at baseline (prevalence, 7.5%; 95% CI, 6.2%–9.2%) (Table 2). Based on the 2020 IACS criteria, 36 (39.6%) were classified as clinical scabies (subcategory B3) and 55 (60.4%) as suspected scabies (C1: 26.4%; C2: 34.1%). Of participants with scabies, 31.9% were moderate and 29.7% were severe. Six cases of

Table 2. Diagnosis and Severity of Scabies and Impetigo at Baseline

		Age, No. (%)			Sex, No. (%)	
	Total, No. (%)	0–4 years	5–34 years	≥35 years	Male	Female
Scabies						
Cases	91 (7.5)	10 (10.0)	53 (8.9)	28 (5.5)	35 (7.5)	56 (7.5)
2020 IACS category						
B3: Typical lesions in a typical distribution and 2 history features	36 (39.6)	6 (60.0)	21 (39.6)	9 (32.1)	13 (37.1)	23 (41.1)
C1: Typical lesions in a typical distribution and 1 history feature	24 (26.4)	2 (20.0)	18 (34.0)	4 (14.3)	10 (28.6)	14 (25.0)
C2: Atypical lesions or atypical distribution and 2 history features	31 (34.1)	2 (20.0)	14 (26.4)	15 (53.6)	12 (34.3)	19 (33.9)
Severity						
Very mild (1–2 lesions)	2 (2.2)	0	0	2 (7.1)	1 (2.9)	1 (1.8)
Mild (3–10 lesions)	33 (36.3)	5 (50.0)	17 (32.1)	11 (39.3)	12 (34.3)	21 (37.5)
Moderate (11–50 lesions)	29 (31.9)	4 (40.0)	16 (30.2)	9 (32.1)	12 (34.3)	17 (30.4)
Severe (>50 lesions)	27 (29.7)	1 (10.0)	20 (37.7)	6 (21.4)	10 (28.6)	17 (30.4)
Impetigo						
Cases	15 (1.2)	3 (3.0)	6 (1.0)	6 (1.2)	8 (1.7)	7 (0.9)
Severity						
Very mild (1–2 lesions)	5 (33.3)	3 (100.0)	2 (33.3)	0	3 (37.5)	2 (28.6)
Mild (3–10 lesions)	4 (26.7)	0 (0.0)	2 (33.3)	2 (33.3)	1 (12.5)	3 (42.9)
Moderate (11–50 lesions)	5 (33.3)	0 (0.0)	2 (33.3)	3 (50.0)	3 (37.5)	2 (28.6)
Severe (>50 lesions)	0	0	0	0	0	0
Missing	1 (6.7)	0	0	1 (16.7)	1 (12.5)	0
Total	1211	100	600	511	465	746

Abbreviation: IACS, International Alliance for the Control of Scabies.

suspected crusted scabies were referred for further assessment; all were ultimately diagnosed with other conditions (mostly infected scabies). Scabies prevalence was highest among children aged 2 to 9 years and was similar for males and females (Table 3). Increasing household size was associated with increased prevalence baseline. Village-level prevalence ranged from 5.8% (95% CI, 3.3%–9.9%) to 11.4% (95% CI, 7.7%–16.6%). Overall, 62 (5.1%) participants had typical scabies lesions, and 71 (5.9%) had atypical scabies lesions (Supplementary Table 1). Of participants diagnosed with scabies, 100% had itch, and most (73.6%) had a positive contact history. Fifteen participants were diagnosed with impetigo at baseline (prevalence, 1.2%; 95% CI, 0.8%–2.1%) (Table 2), and 9 (60%) of these were very mild or mild.

Scabies and Impetigo Prevalence at 12 Months

At 12 months, 11 participants had scabies (prevalence, 0.9%; 95% CI, 0.5%–1.7%) (Table 3). The absolute reduction in scabies prevalence was 6.6% (95% CI, 5.0%–8.2%), with a relative reduction of 87.7% (95% CI, 77.1%–93.4%; $P < .001$). Ten of 11 cases were from 1 village (prevalence, 2%; 95% CI, 1.1%–3.7%), and 2 villages had 0 cases. Two individuals had scabies at both baseline and 12 months.

At 12 months, 5 participants had impetigo (prevalence, 0.4%; 95% CI, 0.2%–1.0%) (Supplementary Table 2). All were from the same village where 10 scabies cases were recorded; 3 other villages had 0 cases. The absolute reduction in impetigo prevalence was 0.8% (95% CI, 0.1%–1.5%), with a relative reduction of 66.1% (95% CI, 7.0%–87.6%; $P = .027$).

Focus Groups

Thirty-nine adults contributed. Thematic findings were highly consistent across all 4 villages. Participants reported significantly improved community skin health without concerning side effects from the treatment ("After 1–2 months we have seen changes in the people who have took this MDA. They all were cured") and were consequently highly favorable about implementing further MDA for scabies control. Acceptability was considered enhanced because MDA "will help the poor people" and it would be easily accessible ("without paying money"; "We get medicine at our door"). When questioned on the effects of the COVID-19 pandemic, participants explained that many people returned to the villages from other cities for a period of 3–6 months as part of the national and regional lockdown responses. They also noted that more time was spent together in domestic homes ("Everybody stayed indoors…per the Indian Government rules and…village leader/Pradhan") with fewer opportunities for outdoor employment.

DISCUSSION

In this single-arm, before–after, community intervention trial in northern India, we found that a single round of ivermectin-based MDA substantially reduced the prevalence of scabies from 7.5% to 0.9%. The relative reduction of 88% is similar

Table 3. Diagnosis of Scabies and Impetigo at Baseline and 12-Month Follow-up

	Scabies, No. (%, 95% CI)		Impetigo, No. (%, 95% CI)	
	Baseline	12 Months	Baseline	12 Months
Sex				
Male	35 (7.5, 5.5–10.3)	1 (0.2, 0.0–1.5)	8 (1.7, 0.9–3.4)	1 (0.2, 0.0–1.5)
Female	56 (7.5, 5.8–9.6)	10 (1.4, 0.7–2.5)	7 (0.9, 0.5–2.0)	4 (0.5, 0.2–1.4)
Age				
0–1 y	2 (5.9, 1.5–20.7)	0	1 (2.9, 0.4–18.2)	0
2–9 y	22 (12.6, 8.5–18.5)	0	2 (1.2, 0.3–4.5)	0
10–19 y	18 (7.9, 5.0–12.2)	4 (1.7, 0.7–4.6)	3 (1.3, 0.4–4.0)	1 (0.4, 0.1–3.0)
20–29 y	19 (10.3, 6.6–15.6)	1 (0.5, 0.1–3.6)	3 (1.6, 0.5–4.9)	1 (0.5, 0.1–3.6)
30–39 y	6 (4.1, 1.9–8.9)	0	3 (2.1, 0.7–6.2)	0
40–49 y	6 (4.8, 2.2–10.2)	2 (1.6, 0.4–6.1)	0	0
50–59 y	6 (4.6, 2.1–9.8)	2 (1.5, 0.4–5.8)	1 (0.8, 0.1–5.2)	1 (0.8, 0.1–5.2)
≥60 y	12 (6.4, 3.7–11.0)	2 (1.1, 0.3–4.4)	2 (1.1, 0.3–4.2)	2 (1.1, 0.3–4.4)
Household size, people				
1–2	7 (5.0, 2.4–10.1)	1 (0.9, 0.1–6.3)	0	1 (0.9, 0.1–6.3)
3–4	25 (5.2, 3.5–7.6)	5 (1.2, 0.5–2.9)	4 (0.8, 0.3–2.2)	1 (0.2, 0–1.7)
5–6	31 (8.2, 5.8–11.4)	1 (0.2, 0–1.7)	5 (1.3, 0.6–3.1)	2 (0.5, 0.1–1.9)
≥7	28 (13.4, 9.4–18.7)	4 (1.6, 0.6–4.2)	6 (2.9, 1.3–6.3)	1 (0.4, 0.1–2.8)
Village				
A	23 (11.4, 7.7–16.6)	1 (0.5, 0.1–3.6)	3 (1.5, 0.5–4.5)	0
B	38 (7.5, 5.5–10.2)	10 (2.0, 1.1–3.7)	8 (1.6, 0.8–3.1)	5 (1.0, 0.4–2.4)
C	12 (5.8, 3.3–9.9)	0	1 (0.5, 0.1–3.3)	0
D	18 (6.1, 3.9–9.5)	0	3 (1.0, 0.3–3.1)	0
Total	91 (7.5, 6.2–9.2)	11 (0.9, 0.5–1.7)	15 (1.2, 0.8–2.1)	5 (0.4, 0.2–1.0)

to other trials of ivermectin-based MDA in island settings with higher baseline prevalence [9, 11, 12].

Scabies prevalence significantly declined in all 4 villages. In 2 villages, scabies appeared to be eliminated, or at least undetectable, and a third village had only 1 case. It is unclear what may have led to variation between villages. Possible factors may include undertreatment, the complex effects of the COVID-19 pandemic and the re-introduction of scabies transmission from villagers who were not present at the time of MDA. Nevertheless, this is a highly promising result from a single round of MDA and suggests that interruption of transmission may be possible with repeated rounds and mop-up of sporadic cases, as appeared to occur in a region of the Solomon Islands [28, 29].

Scabies was controlled without use of any environmental measures. Strategies such as washing clothing and bedding and cleaning of the environment are sometimes proposed but are costly and logistically difficult in resource-limited settings [30, 31]. Our results support recommendations that environmental measures are not required and should not be prioritized as part of community control of common scabies [14, 15].

The near-complete MDA coverage likely contributed to the effectiveness of the intervention. This coverage reflects the benefits of community engagement in research and public health planning and the benefits of partnering with community health workers such as ASHA workers. The focus groups also suggested that the free medication delivered to their door increased acceptability and adherence. The Chamba Hospital implementing partner is the only local hospital and is well known and trusted by the communities. This level of coverage may be difficult to achieve in other settings, particularly urban areas, which may limit the generalizability of these findings.

These results are highly significant for scabies control efforts in India and globally. They are the first evidence of MDA efficacy within the WHO Southeast Asia region and one of the few trials of MDA from nontropical, nonisland settings. The results provide evidence that MDA can be effective where community prevalence is <10%. If further studies are able to replicate this finding, there may be justification for recommending MDA as the primary control strategy for scabies in regions with similar prevalence [14, 15].

The prevalence of impetigo also declined significantly after the intervention, from 1.2% to 0.4%. Notably, the baseline impetigo prevalence was much lower than trials and surveys from the Pacific and northern Australia (range, ∼20%–50%) and lower than reports from the African continent (range, ∼5%–10%) [12, 32–34]. These differences may be partly explained by climate, as well as other unidentified factors.

Current documentation of the prevalence of scabies, impetigo, and their complications in India is inadequate for devising an appropriate public health response. Our results suggest that it is likely that scabies occurs with moderate to high prevalence,

especially in socioeconomically deprived areas with population crowding and limited access to health care. There are many potential opportunities to integrate scabies mapping with activities of other neglected tropical diseases and other health and social programs [35]. These results will help determine the most appropriate strategy for scabies control in each Indian state and region. Strengthening of primary care management, including improving access to effective treatments, should be considered alongside mass treatment approaches [14].

This study has several limitations. As a single-arm trial, we cannot be certain that the observed differences were caused by the intervention. However, there was little evidence of scabies treatment outside of the study. Exploration of sociodemographic changes during focus group discussions did not reveal any other explanation for the observed reduction. Given that the results so closely reflect previous trial findings, we conclude that the observed effects were highly likely to be due to the intervention. Scabies diagnosis was based on subjective clinical assessment by examiners with limited training and may have been inaccurate. However, survey findings were consistent with unanimous reports of reductions in itch and scabies rash during focus group discussions. Development of field-ready objective tests for scabies would add greater certainty to the results of trials and mapping efforts for scabies [36]. The observed efficacy may not translate to a public health activity conducted outside of a research environment. However, many aspects of this trial were conducted in a way that resembles what may be feasible in a real-world setting. For example, ASHA workers and nurses led the surveys and drug distribution within their local communities, and permethrin application was not directly observed.

CONCLUSIONS

A single round of ivermectin-based MDA, consisting of 2 doses a week apart, substantially reduced the prevalence of scabies in 4 villages in mountainous northern India. Impetigo was also reduced, albeit from a lower baseline. Further efforts to determine the burden of scabies in India are needed. Further studies in varying settings should evaluate MDA effectiveness where the community prevalence is <10%.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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Author contributions. D.E., A.S., and N.G. conceived the study. R.S., R.K.S., H.J.W., and N.G. led local planning and coordination of fieldwork and data collection in India. H.J.W. and M.T. conducted the training. A.C.G. led the statistical analysis with X.Z., H.O.B., and D.E. D.E. was the primary author of the manuscript. All authors contributed to revision of the manuscript and approved the final version. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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