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Prevalence survey of dermatological conditions in mountainous north India

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Conflicts of interest: Drs. N. Grills and C. Grills and Dr. Rajesh all work in this area with community health charities, which are dependent on outside sources of funding for their activities. The results of this study will inform grant applications for their work.

Abstract

Background Dermatological conditions account for a substantial proportion of the global burden of disease in low and middle income countries (Bickers D, Lim H, Margolis D, *et al*. The burden of skin diseases: 2004. A joint project of the American Academy of Dermatology Association and the Society for Investigative Dermatology. *J Am Acad Dermatol* 2006; **55**: 490–500) and place major pressures on primary healthcare centers (Satimia F, McBride S, Leppard B. Prevalence of skin disease in rural Tanzania and factors influencing the choice of health care, modern or traditional. *Arch Dermatol* 1998; **134**: 1363–1366). In mountainous North India, where limited resources are available for skin care, no dermatological data exists on prevalence, treatment patterns, or associations. The study aimed to measure prevalence and treatment of dermatological conditions and associated factors in Uttarakhand so to inform delivery of dermatological care and prevention programs in India.

Methods Single stage cluster randomized sampling generated seven cluster units or villages. Household members (n = 1275) from each cluster were interviewed, and where possible, examined and offered treatment.

Results Dermatological conditions were prevalent (45.3%), with 33% being of infectious etiology. Atopic dermatitis (9.2%), scabies (4.4%), tinea corporis (4.1%), and pityriasis alba (3.6%) were most prevalent. Multivariate analysis showed that cohabitation with animals (OR = 1.62, 95% CI-1.35, 1.95) was a predictor of any skin diseases. A health practitioner was not consulted in 64.7% of dermatological conditions, and where consulted, approximately 69% received inappropriate or ineffective treatments. Excessive spending on dermatological care was commonplace. Limitations associated with cross-sectional cluster methodology included the underrepresentation of seasonal conditions and conditions of short duration. Caste proved difficult to randomize across clusters given villages were often composed according to caste.

Conclusion These results demonstrate a high prevalence of dermatological conditions and a pattern of conditions somewhat distinctive to this mountainous area of North India. These findings will assist development of appropriate and cost-effective dermatological services in these mountainous regions.

Introduction

Dermatological conditions account for a significant proportion of the global burden of disease in low and middle income countries (LMICs)[1] and place significant pressure on primary healthcare centers.[2] Community cross-sectional surveys have shown high prevalence of skin conditions in Tanzania (34.7%),[3] Mexico (50%),[4] Ethiopia (47% and 59%),[5] and Egypt (87%).[6]

There is heterogeneity in the frequency of diverse skin conditions between different areas.[4–8], The dermatological prevalence studies in the literature were completed in tropical African, Latin American, and Southeast Asian areas. It is uncertain if frequencies of particular skin conditions can be generalized to mountainous and cold regions in LMICs.[5]

Although the Global Burden of Disease documents skin disease as a cause of substantial morbidity and mortality in South Asia, there is paucity of specific information from the isolated and impoverished regions of the mountainous Himalayan areas of North India. A Nepalese study reported meaningful prevalence of a range of skin conditions (e.g., dermatophyte infections 11.4%, pityriasis versicolor 8.9%); however, even these data were collected from the tropical plains of the Terai. This lack of monitoring and surveillance restricts strategic health planning in an area where access to conventional dermatological health services is limited.

Findings from various studies in LMICs demonstrate that dermatological skin diseases are associated with poverty, overcrowding, and nutritional status.[2,10] Furthermore, it is unknown if associations found in other LMICs can be generalized to mountainous South Asia where we might expect a unique pattern of associations given the distinctive mixture of nutritional disorders, caste profile, income poverty, animal cohabitation, and employment.

In regards to treatment of dermatological conditions in LMIC, research findings have shown significant waste on often inappropriate treatment of skin conditions.[5,10] In India, the breakdown of costs associated with allopathic/non-allopathic and evidence-based/non-evidence-based treatments is unknown. However, such information is important in India given that 240 million people live in poverty and 69.4% of health expenditure is an out-of-pocket expense.[11]

Given that no data have been published from Uttarakhand, North India, on the prevalence, associations, and management of dermatological conditions, a cross-sectional prevalence study was conducted. This study sought to document the burden of dermatological disease, associated factors, and current therapeutic practices so to inform planning of preventive and treatment interventions and limit wastage associated with inappropriate treatment.

Methods

A cross-sectional cluster randomized epidemiological prevalence survey was developed, piloted, and implemented in conjunction with local co-investigators.

Population and sampling procedure

The survey was conducted in the Tehri district of Uttarakhand, an impoverished and isolated region of the northern Indian Himalayas with poor access to healthcare (Fig. 1). Uttarakhand is one of eight states in India identified by the Government as having particularly "high levels of child mortality, low life expectancy, and other challenges." The Jaunpur block with a population of 54,565 was selected, as it is one of the poorest blocks in Tehri (population 605,000).[12]

A single-stage cluster sampling methodology was utilized whereby a cluster unit was a single village. From among 110 villages in the Jaunpur block, eight villages were randomly selected using a standard formula for probability proportionate to the size.[13] All household members residing in each cluster were interviewed, and where possible, examined and offered treatment. Absent family members were excluded from the survey unless their mother (or a caregiver) was present and willing to provide information. Visitors and household members who had spent more than 50% of their time away from the house in the last month were excluded to ensure prevalence data reflected specific geographical and climatic conditions.

Statistical power was assessed using sample size calculations appropriate for a cluster randomized design.[14] After adjustment for anticipated intra-cluster variation, an overall sample size of 1000 was estimated to be sufficient to detect a minimum disease prevalence of 2% with 80% power at the 5% significance level. As this project aims to inform the management of common skin conditions, >2% was considered appropriate. Furthermore, this

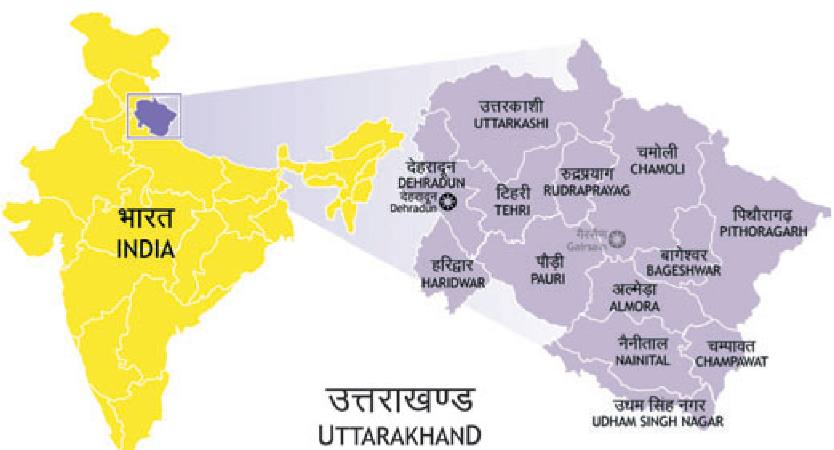

Figure 1 Map of the Tehri district of Uttarakhand

sample size was sufficient to permit multivariate regression modeling of the predictors of disease.

Methods of measurement: survey and skin examination

A brief survey, adapted from a format used by Hay *et al.*, was piloted on 144 people to estimate the duration of the interview and examination, as well as the clarity and face validity of the survey.[10] Questions relating to potential barriers to dermatological health that had been observed in the pilot were incorporated into the final survey.

Researchers and translators were trained and provided with a code book to help administer a household survey to ensure consistency. The data were recorded on paper forms by the dermatologist and research assistants, aggregated onto a de-identified data sheet in Epinfo, and accessed in a Microsoft Access database.

The survey was undertaken in the winter/dry season (March 2010), and basic demographic data on the participants, including name, village, age, sex, and occupation, were collected. The survey also gathered data on potential risk factors for dermatological disease, including number of people per household (overcrowding), expenditure on food (surrogate for income), days going hungry (nutritional status), smoking status, and animal cohabitation.

The data on the outcome variable, skin condition, were determined by two medical practitioners, including a trained dermatologist, through a dermatological history and examination of the present family members. All persons with skin infections received free treatment or were referred as required for other conditions. They were followed up through the community health workers resident in the village to ensure that treatment was completed as required, after the survey had finished. Hospital care, when required, was arranged at the local not-for-profit hospital.

Self-report data from the survey were used to determine treatment that had been received for skin conditions, route of treatment, class of treatment, type of practitioner consulted, and cost.

Data management and analysis

Summaries of the prevalence of various dermatological diseases were tabulated and graphed in a frequency chart. The prevalence of different dermatological conditions was analyzed by income, occupation, age, and numbers cohabiting using Stata Version 10.1.

Clustered logistic regression was used to investigate predictors of dermatological disease. Clustering the model by village, univariate clustered logistic regression was used to identify candidate predictors for inclusion in the multivariate analysis. Predictors with a $P < 0.1$ were included in the initial multivariate models. Final multivariate models of associations with dermatological disease were derived through backwards elimination, with non-significant predictors sequentially removed from the model until a subset of significant predictors remained, alongside potential confounders identified beforehand. Overall, model fit was assessed using the Hosmer and Lemeshow goodness of fit test.[15] The design effect of clustering was quantified through calculation of intra-village correlation coefficients (ICCs).

All reported *P*-values are two-tailed and for each analysis, $P = 0.05$ was considered significant. All analyses were performed using Stata version 11.0 (StataCorp, College Station, TX, USA).

Ethics

This project was approved by a locally convened ethics committee consisting of an *ad hoc* committee of local experts from the project area (local leaders, community representatives, government health officials, and local health staff). In addition, ethics approval was obtained from the Alfred Hospital Ethics Committee.

Results

The overall number of participants was 1250. There were no non-consenters, although an estimated one-fifth of families were absent and therefore not included. Almost one-third of households had nine or more people living in them. Two households described 10 people in one room (see Table 1).

The ICC for the primary outcome of any dermatological disease was 0.0048 (95% CI: 0.0000, 0.0171), suggesting little to no correlation between dermatological disease and the village clusters. This translates into a variation inflation factor of 1.8049. The ICCs were low for age (0.0053, 95% CI: 0.0000, 0.0182) and sex (0.0000, 95% CI: 0.0000, 0.0069). ICC was similarly small for other potential risk factors; however, over-representation of Rajput castes within three of the village clusters led to a higher ICC for a caste of 0.4783 (95% CI: 0.1849, 0.7718).

The overall prevalence of any dermatological condition in this prevalence study was 45.3% (95% CI 40.9–50.5) (see Table 2). When dermatological conditions were grouped into categories (see Fig. 2), "infections and infestations" (14.6%, 95% CI 10.91, 18.3) were the most prevalent dermatological category representing 33% of all skin conditions diagnosed. When exploring specific diseases, eczema had the highest prevalence (10%), followed by tinea (4.0%), scabies (4.4%), acne (3.9%), and pityriasis alba (3.6%) (see Table 2).

Treatment analysis

For 64% of the dermatological conditions, no health practitioner was consulted. Where a health practitioner was consulted ($n = 185$), the majority (66.7%) consulted

Table 1 Summary sample demographics and those with any dermatological disease

Variable	Level	Total	% of sample	Any dermatological disease (% of total in category)
Age group (years)[a]	<5	121	10.3	47 (38.8)
	6–18	368	31.4	193 (52.5)
	19–35	305	26.0	137 (44.9)
	36–50	173	14.8	64 (37.0)
	51–65	122	10.4	44 (36.1)
	>65	83	7.1	34 (41.0)
Sex	Female	646	55.1	289 (44.7)
	Male	526	44.9	230 (43.7)
Caste	Brahmin	249	21.2	128 (51.4)
	Rajput caste	295	25.2	295 (39.8)
	Scheduled caste	92	7.8	92 (52.3)
Animals	No	768	65.5	308 (40.1)
	Yes	404	34.5	211 (52.2)
Smoking status	Current	171	14.6	51 (29.8)
	Ex-smoker	32	2.7	12 (37.5)
	Never	456	38.9	456 (47.1)
Education	Higher secondary	201	17.2	101 (50.3)
	Higher studies	37	3.2	14 (37.8)
	Primary	817	69.7	349 (42.7)
	Secondary	1	0.1	1 (100.0)
	Upper primary	116	9.9	54 (46.6)
Occupation[b]	Manual labor	22	1.9	8 (36.4)
	Service worker	15	1.3	6 (40.0)
	Government	20	1.7	5 (25.0)
	Farm/house	559	47.7	219 (39.2)
	Retired	19	1.6	9 (47.4)
	Student	417	35.6	223 (53.5)
Food expenditure per month[c,d]	1001–3000	280	23.9	127 (45.4)
	3001–5000	646	55.1	274 (42.4)
	5001–7000	164	14.0	72 (43.9)
	7001–9000	27	2.3	15 (55.6)
	9000+	22	1.9	10 (45.5)
Village	1	98	8.4	54 (55.1)
	2	127	10.8	59 (46.5)
	3	187	16.0	88 (47.1)
	4	250	21.3	98 (39.2)
	5	164	14.0	78 (47.6)
	6	192	16.4	82 (42.7)
	7	154	13.1	60 (39.0)

[a]Median age in years was 18, interquartile range (10, 35).
[b]Children who were not students were excluded from this category.
[c]Data were missing from 33 individuals as this was a sensitive question.
[d]Median income per person per month was Rs.600, interquartile range (454.5, 833.3).

a Western medical doctor, 13.7% a non-Western doctor, 16.9% a chemist, 1.6% a community health worker, and 1.1% a spiritual healer. Relevant treatments are summarized in Table 3. The treatment analysis also revealed that 27 cases were treated with multiple classes of medications.

Few predictors maintained a significant association after multivariate analysis (Table 4). Among those that did, female sex (OR 1.4, 1.17 to 1.65, $P < 0.001$) was predictive of pigmentary lesions, whereas the Rajput caste (OR 0.55, 0.33–0.91, $P < 0.02$) was protective compared with the scheduled caste.

Animal cohabitation (OR 1.56, 1.05–2.33, $P = 0.029$) and increasing persons per room (5–6 PPP = 1.52 (1.16, 1.99) $P = 0.002$ and 9–10 PPP = 2.59 (1.77, 3.78) $P < 0.001$) were predictive of atopic dermatitis after multivariate analysis. However, as might be expected, atopic dermatitis was negatively associated with increasing age beyond 18 years of age (0.24 [0.08, 0.71] $P < 0.010$).

Table 2 Prevalence of dermatological conditions in Tehri Gahrwal, Uttarakhand State

Diagnosis	Total	Corrected intradiagnosis total	95% CI
Allergic contact dermatitis	4	0.39	−0.16, 0.93
Irritant contact dermatitis	5	0.52	0.02, 1.02
Varicella zoster	4	0.51	−0.54, 1.57
Acne	47	3.93	0.00, 7.85
Angular stomatitis	3	0.27	−0.16, 0.69
Carbuncle	3	0.31	−0.07, 0.70
Cracked heels	34	3.19	1.21, 5.18
Atopic dermatitis	111	9.18	5.04, 13.32
Head lice	7	0.49	−0.13, 1.11
Keloid scar-burn	4	0.39	−0.10, 0.87
Keratosis pilaris	3	0.28	−0.09, 0.64
Lichen simplex chronicus	5	0.43	−0.02, 0.88
Melasma	5	2.42	1.32, 3.52
Pityriasis alba	41	3.64	2.01, 5.27
Pityriasis versicolor	5	0.37	0.00, 0.75
Pruritus	4	0.31	−0.12, 0.73
Psoriasis	4	0.29	−0.27, 0.84
Scabies	54	4.41	0.97, 7.86
Seborrheic dermatitis	3	0.33	−0.07, 0.72
Tinea corporis	51	4.01	2.52, 7.41
Tinea cruris	3	0.22	−0.16, 0.60
Tinea facei	3	1.2	−0.50, 2.91
Tinea pedis	11	1.2	−0.19, 2.60
Urticaria	8	0.67	−0.16, 1.49
Warts	9	0.9	−0.03, 1.83
Xanthelasma	4	0.46	−0.23, 1.15
Other dermatological diagnosis	53	4.97	2.33, 7.61
Total diagnoses	519	45.29	
Total no. diagnoses	653	54.71	49.51, 59.91
Total survey	1172		

Multivariate analysis suggests female sex (3.16 [1.36, 7.34] $P = 0.007$) was predictive of irritant contact dermatitis and dry skin, while increasing income was protective (0.25 [0.09, 0.65] $P = 0.004$) when increasing from Rs.1000–3000 to Rs. 5000–7000.

Animal cohabitation, although not significant (1.33 [0.94, 1.87] $P = 0.105$) had higher odds of infectious disease. Increasing education was protective [0.29 (0.12, 0.70) $P = 0.006$] from no education to higher secondary but it did not remain significant after controlling for other factors in the multivariate model. Increasing people per room showed no consistent relationship.

Discussion

Findings

The 45.3% prevalence of dermatological skin disorders is consistent with other South Asian prevalence studies. The prevalence was 47.6%[16] in a Sri Lankan suburban population, 62% in a study of Nepali villages in the plain areas.[17] Infections and infestations, although prevalent in this study, were less prevalent than in studies in other LMICs (Nepal 53.5%, Sumatra 49.5%, and Tanzania 57.6%).[3,17,18] This difference could be accounted for by the cooler and less tropical climate of mountainous Himalayan north India. However, scabies prevalence was similar to that found in other studies conducted in rural Tanzania (4.5%), Egypt (5.4%), and Mexico (10.3%).[2–4,19]

Atopic conditions (including eczema) were significantly more prevalent than in other similar studies.[2,5,6] The Williams analysis of the international study of asthma and allergies in childhood has demonstrated eczema prevalence rates in the Indian Subcontinent of 2.4%.[20] The 10% prevalence of eczema in this study may be a result of the climatic cold and dry setting of this mountainous Himalayan area.

Pigmentary conditions (prevalence = 6.8%) may seem relatively trivial compared with other more serious prevalent conditions, but in India they have a social impact. Skin color and appearance are associated with social and

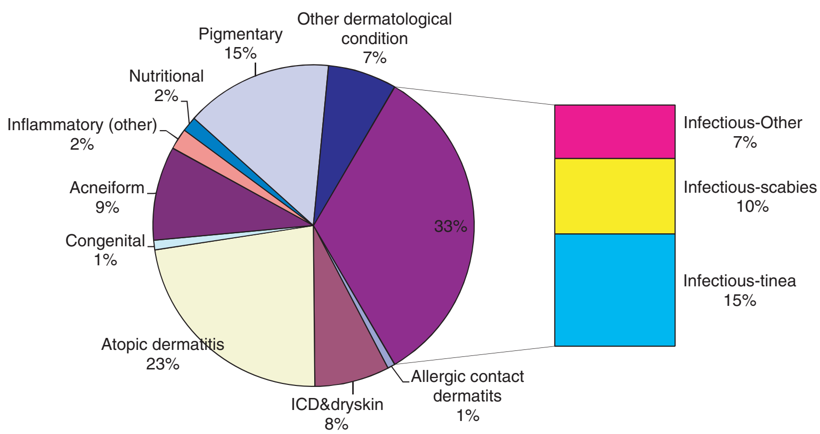

Figure 2 Prevalence by category of dermatological conditions

spiritual stigma in part of rural India and so affect marriageability and employability. For example, in the free-listing exercise described above, pigmentary skin conditions, whatever their taxonomy, were referred to as "leprosy," a term that remains extremely socially stigmatizing in India.

Lack of accessibility to quality and affordable dermatological care

Despite a rapidly growing Indian economy, access to healthcare in the rural Himalayas remains limited, and of 600,000 doctors in India, only 26,000 serve the rural population.[12,21] The low percentage (35.3%) who consulted health practitioners for their dermatological condition perhaps reflects the fact that there are few allopathic medical practitioners, and no known fully qualified dermatologist, in the entire district of 605,000 people. For villagers from six of the seven villages surveyed, visiting the primary healthcare center, which may or may not be staffed by a doctor, would be at least a day trip on foot. In this study, non-allopathic practitioners and chemists (16.9%) filled the breach, who in rural India are often undertrained.[22] Perhaps in part also reflecting inferior access to healthcare was the finding of a higher prevalence of skin conditions in scheduled (low caste) as compared with those from the Rajput caste, when controlling for other factors such as education and overcrowding. However, as caste has wide-ranging impacts on various social determinants of health, it is difficult to isolate the casual pathway between caste and prevalence of skin conditions.

Table 3 Route and class of treatment by condition

Diagnosis	Injection (unknown class)	Steroid (oral or topical)	Antimicrobial	Antifungal
Eczema	14	2	4	3
Scabies	12	1	5	1
X-linked ichthyosis	2			
Acne	1	3	2	3
Congenital melanocytic nevus	1		1	
Eryrthromelalgia	1			
Lichen simplex chronicus	1	1	1	
Seborrheic dermatitis	1			
Tinea (any type)	6	6	5	7
Warts	1			1
Melasma		2	1	1
Perioral dermatitis		1		
Irritant contact dermatitis		1	1	2
Pityriasis alba		1	1	1
Pityriasis versicolor		2	1	2
Xanthelasma			1	
Urticaria			1	1
Ingrown toenail			1	
Carbuncle			2	
Herpes simplex			1	
Other			1	2
Numbers of these likely to have received inappropriate treatment	40	15	13	12
Total	40	23	29	24

In this study, the median money spent on food was Rs.600 per person per month, indicating substantial poverty. Given the low income, it is likely that the cost of medical care remains a major barrier to prevention, diagnosis, and treatment of dermatological conditions. Without government assistance, treatment remains inaccessible or impoverishing for many individuals, yet 78% of outpatient services are provided by non-government sources,[21] and 66.3% of health expenditure is an out-of-pocket expense.[11] As a result, spending on healthcare is responsible for reducing 37 million Indians to below the poverty threshold each year,[23] which indicates the gravity of this study's findings on the cost of dermatological treatment. Twelve percent of those with dermatological conditions spent more than Rs.950 ($25USD) on treatment, and in three cases, over 15,000 rupees had been spent in the previous three months.

Given that healthcare can reduce those people with dermatological conditions, and possibly their families, to poverty, it was alarming to find that many of the treatments recorded were classified as unnecessary and potentially harmful. Fifteen of 23 conditions treated with steroids, 11 of 24 treated with antifungals, and 13 of 29 treated with antibacterials were judged to be inappropriate given the condition diagnosed (see Table 3). In addition to the cost, the condition may have been worsened by the treatment, such as the use of topical steroids for tinea and acne and the widespread use of injections. It would be difficult to justify injections for any of the dermatological conditions noted. Nevertheless, 40 participants had received injections for their dermatological condition, which included eczema (n = 14), scabies (n = 12), and tinea (n = 5). In addition to their potential adverse effects, injections tend to be expensive and could lead to abscesses and septicemia. The actual medicine given by injection was usually unknown to the patients.

The results also demonstrated usage of multiple treatment classes and seeking consultations from multiple practitioners. There were 27 instances where the conditions diagnosed in this survey were treated with more than one treatment. Polypharmacy and advice from multiple practitioners (mostly an out-of-pocket expense) can contribute to iatrogenic conditions and contribute to financial burden. Few individuals in India, according to Jha and Laxminarayan[23], can assess whether the pluralis-

Table 4 Predictors of "any dermatological disease"

Predictor	Level	*n* (% of level)	Univariate (unadjusted) OR (95% CI)	Multivariate (adjusted)[d] OR (95% CI)
Age	<5	47 (38.8)	1.00	
	6–18	193 (52.5)	1.74 (0.93, 3.25)	
	19–35	137 (44.9)	1.28 (0.60, 2.75)	
	36–50	64 (37.0)	0.92 (0.57, 1.51)	
	51–65	44 (36.1)	0.89 (0.50, 1.57)	
	66+	34 (41.0)	1.09 (0.48, 2.47)	
Sex	Female	289 (44.7)	1.00	
	Male	230 (43.7)	0.96 (0.78, 1.18)	
Caste[a]	Brahmin	128 (51.4)	0.97 (0.67, 1.39)	1.01 (0.73, 1.40)
	Rajput	295 (39.8)	0.60 (0.43, 0.84)	0.68 (0.48, 0.96)
	Scheduled caste	92 (52.3)	1.00	1.00
Occupation[b]	Manual labor	8 (36.4)	0.89 (0.50, 1.57)	
	Service worker	6 (40.0	1.04 (0.56, 1.90)	
	Government	5 (25.0)	0.52 (0.13, 2.02)	
	Farmhouse	219 (39.2)	1.00	
	Retired	9 (47.4)	1.40 (0.25, 7.82)	
Education level	Primary	349 (42.7)	1.00	
	Upper primary	54 (46.6)	1.17 (0.71, 1.93)	
	Secondary	1 (100.0)	[c]	
	Higher secondary	101 (50.3)	1.35 (0.81, 2.26)	
	Higher studies	14 (37.8)	0.82 (0.43, 1.56)	
Tobacco user	Current	17 (34.7)	1.00	
	Ex-user	6 (60.0)	2.82 (0.43, 18.37)	
	Never	496 (44.6)	1.51 (0.79, 2.89)	
Persons per room	1–2	266 (46.2)	1.00	
	3–4	172 (41.5)	0.82 (0.62, 1.11)	
	5–6	65 (48.9)	1.11 (0.88, 1.41)	
	7–8	13 (32.5)	0.56 (0.24, 1.30)	
	9–10	3 (37.5)	0.70 (0.58, 0.84)	
Food expenditure	1001–3000	127 (45.4)	1.00	
	3001–5000	274 (42.4)	0.89 (0.60, 1.31)	
	5001–7000	72 (43.9)	0.94 (0.69, 1.29)	
	7001–9000	15 (55.6)	1.51 (0.58, 3.91)	
	9000+	10 (45.5)	1.00 (0.63, 1.59)	
	Missing	21 (63.6)	2.11 (0.79, 5.65)	
Income/person	100Rs increment		1.03 (1.00, 1.06)	
Animals	No	308 (40.1)	1.00	1.00
	Yes	211 (52.2)	1.62 (1.35, 1.95)	1.53 (1.26, 1.86)

[a]Caste is ranked from highest to lowest.
[b]Excludes students and children <5.
[c]Insufficient numbers.
[d]Hosmer and Lemeshow goodness of fit test = 0.4060.

tic healthcare offered is appropriate, which makes them vulnerable to being offered expensive, unnecessary, or inappropriate services. Incompetent or exploitative treatment is difficult to regulate given that only 63.6% of private health practitioners are registered in India.[24]

Other risk factors

Animal cohabitation was a predictor of "any dermatological disease" (OR 1.53, (1.26, 1.86) $P < 0.001$) when controlling for other risk factors. However, the higher prevalence of fungal and other infectious conditions among families who cohabited with animals was not statistically significant. Although the association remained significant for atopic dermatitis (OR 1.55 (1.04, 2.32) $P = 0.033$), it did not remain significant for tinea or other infectious conditions when applying the multivariate model. This may have been due to inadequate power. Although not measured, a lack of access to clean water and poor hygiene was recorded in a number of individuals with infectious skin disorders.

Limitations

Cross-sectional surveys are useful for rapidly and cheaply exploring hypotheses but are limited in their generalizability and have limited value in the determination of causation. Low intra-cluster coefficients for the primary outcome and key predictors (with the exception of caste) confirm that random sampling mostly worked and as such, the associations demonstrated are less likely to be due to within-cluster correlation. As villages are constructed along caste lines, it is difficult to completely randomly sample caste across villages.

Furthermore, cross-sectional surveys do not account for diseases of short duration, such as those that occur seasonally. We recorded skin conditions over a three-month period in the winter season, which may limit generalizability beyond the winter season. Although we can extrapolate, the prevalence of certain conditions may well vary from season to season. Furthermore, the extent to which this study is generalizable to other South Asian mountain contexts and beyond is unclear. Additionally, a cross-sectional study can exclude those absent at the time, which may explain why there were more women than men in the sample. Men are often away on business or form migratory labor. To limit such bias, data were gathered on absent family members, even though the diagnosis category, based on history alone, was likely to be less accurate.

Diagnostic validity in the survey depended largely on the diagnostic capability of the consultant dermatologist. Trained in Australia, Dr. Grills had previous dermatological experience in India. Initially, diagnoses were validated by an experienced local doctor to increase cross-validity. Additionally, before commencement of the survey, a free-listing exercise was undertaken where village health workers and local leaders clarified local terminology for describing common skin conditions.

Despite comprehensive training of enumerators, research assistants and translators were hesitant to directly question about sensitive areas, such as smoking status, household income, and about going hungry. To limit this observer bias, continual coaching and supervision was required. Additionally, the study was susceptible to responder bias where people who had skin conditions may have been more likely to participate in return for treatment. However, this was diminished by surveying everyone in each village.

Conclusions

Dermatological conditions were common in the rural mountains of the Indian Himalayas with an overall prevalence of 45.3%. Thirty-three percent of these were of infectious etiology. Atopic dermatitis (9.2%), scabies (4.4%), tinea corporis (4.1%), acne (3.9%), pityriasis alba (3.6%), and cracked heels (3.2%) were especially prevalent. Money and access were limiting factors to achieving good dermatological care, with much money being wasted on expensive but ineffective treatments. A number of predictors were examined, but greater power is required to better explore these predictors using multivariate models.

To our knowledge, no other dermatological mapping surveys have been undertaken in this Himalayan region. These results should:

- Ensure that treatment and health resources are targeted towards the dermatological conditions and their predictors specific to this geographical and climatic area.
- Educate the health service providers on rational prescribing for skin conditions.
- Inform the training of community health workers to address common dermatological conditions. The high prevalence of skin conditions, inaccessibility of medical practitioners and dermatological services, and expenses incurred suggests the importance of training and equipping rural community health workers or "barefoot doctors" to diagnose and competently treat common dermatological conditions *in situ*.
- Facilitate integration of appropriate dermatological services into existing primary and community health structures and systems. The survey was developed, piloted, and implemented in conjunction with local co-investigators. This collaborative research approach assists in dissemination and adoption of the findings.
- These data will assist in the development of quality, integrated, and cost-effective dermatological services to improve the skin health of disadvantaged people in the rural mountainous regions of north India. A proposal for a dermatological treatment and referral center is currently being considered.

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