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Estimating the global burden of scabies: what else do we need?

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Summary

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Scabies is one of the most common disorders identified in any estimate of global skin disease prevalence. Furthermore, quantifying its impact on individuals and societies has been problematic. There has been a lack of clear case definitions and laboratory tests. There have been few epidemiological studies, particularly those focusing on low-income countries, variation in prevalence within high-income countries, or estimates of the effect of scabies on health beyond the skin, such as renal disease or mental wellbeing. Economic studies are also lacking. However, the new strategy of integrating surveillance for skin Neglected Tropical Diseases may well produce advancements on these issues, in addition to providing an overarching structure for health improvement and disease control.

What is already known about this topic?

- There is a dearth of information on the global impact of scabies.
- This review article reviews the current literature and details missing data.
- The designation of scabies as a Neglected Tropical Disease has added urgency to the need to carry out further research on the epidemiology and impact of this infection.

What does this study add?

- This study provides an up-to-date critique of the current state of our understanding of the global impact of scabies and addresses how to fill the gaps in our knowledge.

Scabies is one of the most common skin conditions found across the world. It is caused by infection owing to the human ectoparasite *Sarcoptes scabiei* var. *hominis*, transmitted primarily through direct skin-to-skin contact.¹ In response to increasing recognition of its public health importance, the International Alliance for the Control of Scabies (IACS) was formed in 2012, leading to an increased global focus on advocacy, policy and disease mapping.² Scabies was subsequently added to the World Health Organization (WHO) list of Neglected Tropical Diseases (NTDs) in 2017³ and is the most common of the NTDs with recognized skin manifestations,

also known as 'skin NTDs'. Its public health burden results from huge case numbers, disease complications and containment costs. Yet, these current estimates of the global disease burden are likely to be an underestimate.

Scabies often causes severe itching, which can last for months in untreated patients. While the diagnosis of scabies is largely based on clinical assessment and medication is relatively affordable, diagnosis is frequently delayed and treatment, if actually provided, is often wrongly applied. Complications of scabies are frequent, and there is a considerable public health burden associated with these complications.

Scabies causes significant morbidity owing to sleep disruption, concentration difficulties and impaired productivity.⁴ Additionally, bacterial skin infections caused by *Staphylococcus aureus* and *Streptococcus pyogenes* commonly complicate scabies.⁵ These include more severe soft-tissue infections such as abscess, cellulitis and necrotizing fasciitis, and invasive bacterial infections including bacteraemia leading to death through sepsis, particularly at the extremes of age.^{6,7} Streptococcal skin disease can lead to serious immune-mediated conditions such as glomerulonephritis and potentially acute rheumatic fever.⁸

Scabies disproportionately affects children in disadvantaged settings and has important health equity implications. However, despite a high burden of disease and significant morbidity across the world, there is a dearth of supporting data, in particular on sequelae, which are needed to guide diagnostic, preventative and treatment strategies.^{9–11}

Case definition and diagnosis

A founding principle of the IACS was to identify key priorities and promote operational research on scabies. Underlying this strategy is the need for advocacy to promote prevention and control of scabies on global public health and research agendas.¹ The group recognized that a standardized methodological approach was essential to determine the global disease burden, economic impact and direction for future research.

Diagnostic criteria

Unlike some other skin NTDs, there is no simple diagnostic test for scabies, rather the diagnosis is based on a clinical assessment using a combination of history and visual examination techniques.^{12,13} There are relatively few prevalence surveys for scabies, and of those, many have been conducted in low-income settings with no access to appropriate or affordable diagnostic devices to aid the clinical recognition of scabies.^{9–11}

There have been several attempts to develop and validate clinical diagnostic methodologies for scabies. A study in Mali compared diagnoses made by nonspecialist doctors and nurses trained in the use of a diagnostic algorithm focusing on the five most common skin conditions (including scabies) with diagnoses made by expert dermatologists.¹⁴ The algorithm had moderate specificity, although the intention of the scheme was primarily to ensure treatment of patients and it was not promoted as a definitive diagnostic test. A study in Fiji aimed to validate an algorithm for diagnosis of common skin conditions by primary healthcare workers in low-resource settings as part of the WHO Integrated Management of Childhood Illness strategy.¹⁵ Similarly, there was a moderate-to-excellent level of agreement between different diagnosticians for scabies. This algorithm performed reasonably well overall when diagnosis of skin conditions by nurse practitioners trained in the algorithm was compared with diagnosis made by experts, but there was variation in diagnostic accuracy across skin conditions, ranging from high sensitivity for infected scabies

(89.1%) to lower sensitivity for noninfected scabies (58.3%). A systematic review of diagnosis for scabies in clinical trials found that only half of the studies provided any specification of the diagnostic criteria that had been used.⁵ These studies emphasize the need for clear diagnostic standards for scabies. In addition, delayed and missed diagnoses of scabies are common in both clinical and outbreak settings.^{5,9}

To address this, the IACS led a formal Delphi study to develop consensus criteria for the diagnosis of scabies. The 2020 IACS criteria include different levels of diagnostic certainty to suit a variety of settings, from field diagnosis in scabies research programmes to disease surveillance and global mapping programmes, in addition to clinic-based environments.¹² The criteria are not designed for clinical variants such as crusted scabies.¹⁶

Other diagnostic tools

The standard technique for identification of mites by microscopic examination of skin scrapings is time-consuming, operator-dependent, requires access to a microscope, is poorly tolerated in children and has low sensitivity.¹⁷ Dermoscopy, while helpful, requires training and can be costly.

There are a number of diagnostic approaches in development that may assist diagnosis in low-resources settings and atypical cases. These range from training packages for frontline workers in resource-limited settings as outlined above, to low-cost magnification techniques and rapid antigen detection tests.^{17–20}

Epidemiological data

Limitations in current diagnostic methods and accuracy pose a challenge to determining the disease burden of scabies. The true global prevalence of scabies is probably considerably higher than current estimates because (i) high-quality data are lacking from many areas where scabies is likely to have a high prevalence – disease modelling techniques often assume relatively low prevalence for these areas and (ii) use of routine clinical data almost always underestimates disease burden because people in poor areas often live with scabies rather than seek treatment, which may be expensive and futile. Another less likely scenario is that current global figures may be an overestimate because the most accurate prevalence studies are often conducted in geographically limited endemic areas where scabies is identified as a public health issue. Estimating ‘true’ prevalence may prove challenging because of the large numbers of cases and variations in prevalence within different communities in the same region.

The Global Burden of Disease Study

Scabies is one of 15 skin conditions included in the Global Burden of Disease (GBD) Study, which analysed 20 years of data across 187 different countries in 2010.²¹ The global prevalence of scabies was estimated to be 100 625 000 people

worldwide in 2010, but a subsequent GBD analysis based on more recent data for 2013 estimated the global prevalence to be over 204 151 000.²⁰ The estimated prevalence for 2017 was 175 406 000.²² A limitation of the GBD Study for scabies burden estimates has been the lack of good-quality epidemiological data sources. In particular, there were few studies that reported epidemiological data on the prevalence of scabies in North America and Latin America. The GBD Study draws from multiple sources, ranging from peer-reviewed scientific papers to hospital data sources. The use of extrapolation methodology, based on Bayesian techniques, to estimate missing data attempts to fill the data gap for the many countries and regions with no relevant data sources. Using potential covariants such as poverty and climate to estimate missing data, although an important start, may not encompass all the determinants of scabies prevalence.

A global systematic review of population-based surveys of scabies found a wide range of prevalence, with the highest prevalence observed in Papua New Guinea (71%), Panama (32%) and Fiji (32%).⁹ Prevalence was generally much lower in developed countries,^{9–11} with very few estimates exceeding 2–4%. However, authors have noted that many of the published studies were of low quality, were predominantly conducted in low-resource settings and often only included children.^{9,23}

In addition to the lack of epidemiological data to allow comparison between different countries, there are also limited available data to allow comparison of scabies between distinct communities within countries. For example, disadvantaged populations within high-income countries may have high prevalence that country-level prevalence estimates would fail to represent.²⁴ Similarly, prevalence studies conducted in high-risk populations may not accurately reflect the nationwide burden of disease. For instance, remote Indigenous communities in Australia continue to experience a very high burden of scabies.^{25,26} Understanding the burden of scabies in Australia should encompass these very high-prevalence areas in addition to the low prevalence in urban populations.^{27–30} A recent large outbreak of scabies in the Amhara region of Ethiopia is a further example of variation of scabies prevalence within a single country, largely brought about by population displacement.³¹ A priority for future research is to capture these subnational variations in prevalence.^{21,23,32}

Other gaps in the estimation of disease burden

Estimating the true global burden of scabies also requires consideration of secondary medical, psychosocial and economic factors that relate to burden of disease.

Medical consequences of scabies

Disruption of the skin barrier through scratching promotes secondary bacterial infection.³³ The attributable risk of bacterial impetigo from scabies infestation varies across studies (up

to as high as 94% in a study in Fiji).⁸ Other studies, particularly those from sub-Saharan Africa have observed a lower rate of secondary bacterial infection.²¹ *S. pyogenes* and *S. aureus* are the most common bacterial pathogens isolated from skin swabs. Acute rheumatic fever, rheumatic heart disease, post-streptococcal glomerulonephritis and invasive bacterial infections are important complications caused by *S. pyogenes*, which lead to poor health outcomes and significant public health burdens; however, there is a lack of epidemiological data and limited disease mapping of invasive and immune-mediated group A *Streptococcus* (GAS) diseases.⁶ One study estimated that there are 18.1 million people living with serious GAS diseases and approximately 1.78 million new cases each year.⁶

It is unclear what proportion of GAS disease may be secondary to scabies infestation, and how this may vary regionally. While traditional teaching suggested that acute rheumatic fever occurred only after GAS pharyngitis, and not impetigo, there is emerging epidemiological and microbiological evidence to suggest that GAS impetigo plays some role in the development of acute rheumatic fever. Indigenous Australians have a very high rate of rheumatic heart disease but a low rate of GAS pharyngitis.^{34,35} In contrast, they have high rates of GAS skin disease, largely related to secondarily infected scabies.^{9,11} Poststreptococcal glomerulonephritis is known to be caused by either throat or skin infection, and signs of renal damage, such as proteinuria, often persist long after initial infection of the skin.³⁴ In tropical low-resource settings, a significant proportion of poststreptococcal glomerulonephritis could be attributed to skin infection.³⁵ It follows that the mortality and morbidity associated with chronic kidney disease is an important late complication of scabies that should be recognized. Finally, in calculating the proportion of glomerulonephritis that is scabies-associated, an additional factor is the fact that the burden of secondary complications of GAS is greater in areas of high endemicity of scabies.³⁶

To date, the proportions of the total global disease burden of glomerulonephritis, chronic kidney disease or rheumatic heart disease attributable to scabies have not been formally estimated. Even research that is focused on identifying global prevalence estimates, such as the GBD Study, have methodological limitations that make these estimations challenging.²¹ The disability weight methodology for scabies and other skin diseases in GBD only assesses the direct effect of these conditions, such as itch and disfigurement on the skin itself, and not the complications from secondary bacterial infections.²³ The systemic complications from secondary bacterial infections do not form part of the GBD methodology. Therefore, most of the more significant secondary complications that occur after scabies infection are not included in the reported levels of morbidity, such as disability-adjusted life years. Skin diseases commonly affect multiple body systems and similarly the complications of scabies are frequently multifocal. Therefore, it is important that future research includes estimates of the complications of scabies, rather than focusing exclusively on one body system or disease process.

Psychosocial burden of scabies

In addition to the physical manifestations of disease, skin NTDs, including scabies, cause a considerable burden of stigma, discrimination and distress,³⁷ and can have profound effects on quality of life.³⁸ To date, these issues have not been adequately explored in relation to scabies.

Children and adults with scabies suffer emotional distress as a result of severe itch, discomfort, disfigurement and social isolation.³⁸ Adults with skin NTDs also suffer from social isolation and report exclusion from engaging in family duties and community activities, along with impediments to normal societal engagements.³⁹ School absenteeism is also a potential problem in many societies. Unfortunately, the emotional burden and stigma of scabies may dissuade affected individuals from seeking treatment, which can further promote transmission and indeed exacerbate the physical and emotional burden.^{40,41}

Economic burden of scabies

Scabies has economic implications for patients and communities affected by the disease, in addition to implications for the healthcare system. There are few data to estimate this economic burden, but available data suggest that the direct economic cost for people affected by scabies can be profound. A study in Mexico surveyed the economic cost associated with ineffective treatment of skin diseases.⁴² Scabies was the second most common skin disease in this community study and the treatment cost was substantial, which was equivalent to 1 week of household cash earnings. In this study, children spent an average of 8 days away from school. Several studies of skin NTDs describe a negative impact on employment, but this has not been considered for scabies specifically.^{21,40} More research is needed to understand the economic impact of skin NTDs on the productivity of women. Limited data suggest that the cost and impact is likely to be considerable because scabies can have an impact on the ability of women to conduct unpaid work in rural communities, a key element in the structure of traditional economies.⁴²

Historically, large-scale funding has been allocated to disease-specific programmes with disease-specific outcomes.^{43–45} However, there is a growing body of evidence highlighting the potential economic savings of integrating NTD surveillance, diagnosis and treatment of multiple skin NTDs.⁴³ For instance, an analysis determined that in the context of sub-Saharan Africa, up to USD \$100 million could be saved using a combined programme treating five skin NTDs together compared with the cost of individual programmes.⁴⁴

Scabies in closed communities

Alongside regional differences, there are other important variations in the clinical presentation, disease burden and

complications associated with skin disease in closed communities, especially institutional settings. This is particularly important to consider for scabies, where the prevalence in institutions or displacement camps has been reported to be as high as 70% and outbreaks are common.^{46,47} Communal settings and closed residential environments that may be at higher risk of an outbreak of scabies include orphanages, nursing homes, aged care facilities, homeless shelters, prisons, displacement camps and some school settings.⁴⁸

Recent research on outbreaks of scabies in nursing homes and residential care facilities in the UK identified some important diagnostic considerations for scabies in these settings.⁴⁹ Clinical presentation can be variable, diagnostic criteria for scabies in older persons are not standardized and there can be a significant delay in diagnosis, resulting in inappropriate management and significant morbidity in this vulnerable patient group.^{49,50} In turn, there may be unforeseen psychological and economic effects, especially if infected residents are transferred between care facilities prior to effective treatment.^{51,52}

Management of scabies in these settings is often challenging. A specific focus on the education of allied healthcare practitioners and family members is imperative to ensure timely diagnosis and appropriate treatment.⁵³ More high-quality research exploring the diagnosis and management of scabies in special care facilities and in outbreak situations is needed.^{8,52}

Integration of skin Neglected Tropical Disease programmes and their potential impact on the burden of scabies

A shift from disease-specific programmes to integrated management strategies for all skin NTDs has dominated recent discussions between researchers, clinicians, funding bodies and policy stakeholders.^{54–58} Strategic partnerships and an integrated approach for all skin NTDs could lead to significant financial savings and logistic improvements through common diagnostic pathways, shared approaches to mapping, compatible drug regimens and overlapping nonpharmacological management.^{54,55,59} These initiatives may have an impact on our understanding of the scabies disease burden. Integrated programmes may allow for expanded understanding of disability and stigma associated with skin NTDs. Finally, integrated programmes for multiple skin NTDs may also lead to improved patient health outcomes over and above what can be achieved in disease-specific programmes, through deeper engagement of local populations in line with universal health coverage.⁵⁹ Scabies has already been integrated into NTD programmes in the Solomon Islands, where epidemiological mapping and scabies treatment programmes have been conducted with programmes for trachoma and yaws,⁶⁰ and mass drug administration of ivermectin used to control other diseases such as onchocerciasis and lymphatic filariasis has been observed to reduce scabies in Africa.⁶¹

Conclusion

Our review highlights the challenges of establishing accurate assessments of scabies burden. Routine health data, dedicated prevalence surveys, systematic reviews and the GBD Study have all contributed to provide a picture of disease impact. An increased research focus on key areas, including the psychological impact of scabies, the long-term renal and cardiac consequences of untreated disease, economic impact and the cost–benefit of control programmes, particularly where these form part of an integrated skin-NTD initiative, will provide much needed new information. This knowledge will bolster efforts to argue the case for more widespread implementation and funding of much needed control programmes to reduce the global impact of scabies.

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References

- Engelman D, Steer AC. Control strategies for scabies. *Trop Med Infect Dis* 2018; **3**:98.
- Engelman D, Kiang K, Chosidow O *et al.* Toward the global control of human scabies: introducing the international alliance for the control of scabies. *PLOS Negl Trop Dis* 2013; **7**:e2167.
- World Health Organization. Report of the Tenth Meeting of the WHO Strategic and Technical Advisory Group for Neglected Tropical Diseases. Available at: https://www.who.int/neglected_diseases/NTD_STAG_report_2017.pdf (last accessed 4 November 2020).
- Heukelbach J, Wilcke T, Winter B, Feldmeier H. Epidemiology and morbidity of scabies and pediculosis capitis in resource-poor communities in Brazil. *Br J Dermatol* 2005; **153**:150–6.
- Thompson MJ, Engelman D, Gholam K *et al.* Systematic review of the diagnosis of scabies in therapeutic trials. *Clin Exp Dermatol* 2017; **42**:481–7.
- Carapetis JR, Steer AC, Mulholland EK, Weber M. The global burden of group A streptococcal diseases. *Lancet Infect Dis* 2005; **5**:685–94.
- Lawrence G, Leafasia J, Sheridan J *et al.* Control of scabies, skin sores and haematuria in children in the Solomon Islands: another role for ivermectin. *Bull World Health Organ* 2005; **83**:34–42.
- Engelman D, Cantej PT, Marks M *et al.* The public health control of scabies: priorities for research and action. *Lancet* 2019; **394**:81–92.
- Romani L, Steer AC, Whitfield M, Kaldor J. Prevalence of scabies and impetigo worldwide: a systematic review. *Lancet Infect Dis* 2015; **15**:960–7.
- Zhang W, Zhang Y, Luo L *et al.* Trends in prevalence and incidence of scabies from 1990 to 2017: findings from the Global Burden of Disease Study 2017. *Emerg Microbes Infect* 2020; **9**:813–16.
- Bowen AC, Mahé A, Hay RJ *et al.* The global epidemiology of impetigo: a systematic review of the population prevalence of impetigo and pyoderma. *PLOS ONE* 2015; **10**:e0136789.
- Engelman D, Yoshizumi J, Hay RJ *et al.* The 2020 International Alliance for the Control of Scabies Consensus Criteria for the Diagnosis of Scabies. *Br J Dermatol* 2020; <https://doi.org/10.1111/bjd.18943>.
- Hay RJ, Denning DW, Bonifaz A *et al.* The diagnosis of fungal neglected tropical diseases (fungal NTDs) and the role of investigation and laboratory tests: an expert consensus report. *Trop Med Infect Disease* 2019; **4**:122.
- Mahé A, Faye O, N'Diaye HT *et al.* Definition of an algorithm for the management of common skin diseases at primary health care level in sub-Saharan Africa. *Trans R Soc Trop Med Hyg* 2005; **99**:39–47.
- Steer AC, Tikoduadua LV, Manalac EM *et al.* Validation of an Integrated Management of Childhood Illness algorithm for managing common skin conditions in Fiji. *Bull World Health Org* 2009; **87**:173–9.
- Davis JS, McGloughlin S, Tong SYC *et al.* A novel clinical grading scale to guide the management of crusted scabies. *PLOS Negl Trop Dis* 2013; **7**:e2387.
- Micali G, Lacarrubba F, Verzi AE *et al.* Scabies: advances in non-invasive diagnosis. *PLOS Negl Trop Dis* 2016; **10**:e0004691.
- Arlian LG, Feldmeier H, Morgan MS. The potential for a blood test for scabies. *PLOS Negl Trop Dis* 2015; **9**:e0004188.
- Scanni G. The mite-gallery unit: a new concept for describing scabies through entodermoscopy. *Trop Med Infect Dis* 2019; **4**:48.
- Hollman M, Julian TT, Hermann F. In situ diagnosis of scabies using a handheld digital microscope in resource-poor settings—a proof-of-principle study in the amazon lowland of Colombia. *Trop Med Infect Dis* 2018; **3**:116.
- Hay RJ, Johns NE, Williams HC *et al.* The global burden of skin disease in 2010: an analysis of the prevalence and impact of skin conditions. *J Invest Dermatol* 2013; **134**:1527–34.
- GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018; **392**:1789–858.
- Karimkhani C, Colombara DV, Drucker AM *et al.* The global burden of scabies: a cross-sectional analysis from the Global Burden of Disease Study 2015. *Lancet Infect Dis* 2017; **17**:1247–54.
- Hay RJ, Steer AC, Engelman D, Walton S. Scabies in the developing world—its prevalence, complications, and management. *Clin Microbiol Infect* 2012; **18**:313–23.
- Australian Council of Social Service/University of New South Wales. Poverty in Australia 2018. Available at: https://www.acoss.org.au/wp-content/uploads/2018/10/ACOSS_Poverty-in-Australia-Report_Web-Final.pdf (last accessed 31 May 2020).
- Australian Child Rights Taskforce/UNICEF Australia. CRC25: Australian Child Rights Progress Report. Available at: <https://www.unicef.org.au/Upload/UNICEF/Media/Documents/CRC25-Australian-Progress-Report.pdf> (last accessed 31 May 2020).
- Kearns TM, Speare R, Cheng AC *et al.* Impact of an ivermectin mass drug administration on scabies prevalence in a remote Australian Aboriginal community. *PLOS Negl Trop Dis* 2015; **9**:e0004151.
- Andrews R, Kearns T. East Arnhem Regional Healthy Skin Project: Final Report 2008. Available at: <https://www.lowitja.org.au/content/Document/PDF/Healthy-Skin-Report-2009.pdf> (last accessed 31 May 2020).
- Thomas L, Bowen AC, Ly M *et al.* Burden of skin disease in two remote primary healthcare centres in northern and central Australia. *Intern Med J* 2019; **49**:396–9.
- Yeoh DK, Anderson A, Cleland G, Bowen AC. Are scabies and impetigo “normalised”? A cross-sectional comparative study of hospitalised children in northern Australia assessing clinical recognition and treatment of skin infections. *PLOS Negl Trop Dis* 2017; **11**:e0005726.

- 31 Wendemagegn E, Ashenafi A. Investigation of a scabies outbreak in drought-affected areas in Ethiopia. *Trop Med Infect Dis* 2018; **3**:114.
- 32 Hagstrom EL, Patel S, Karimkhani C *et al.* Comparing cutaneous research funded by the US National Institutes of Health (NIH) with the US skin disease burden. *J Am Acad Dermatol* 2015; **73**:383–91.e1.
- 33 Chandler DJ, Fuller LC. A review of scabies: an infestation more than skin deep. *Dermatology* 2019; **235**:79–90.
- 34 Bessen DE, Carapetis JR, Beall B *et al.* Contrasting molecular epidemiology of group A streptococci causing tropical and nontropical infections of the skin and throat. *J Infect Dis* 2000; **182**:1109–16.
- 35 Steer AC, Jenney AWJ, Kado J *et al.* High burden of impetigo and scabies in a tropical country. *PLOS Negl Trop Dis* 2009; **3**:e467.
- 36 Chosidow O. Clinical practices. Scabies. *New Eng J Med* 2006; **354**:1718–27.
- 37 White AV, Hoy WE, McCredie DA. Childhood post-streptococcal glomerulonephritis as a risk factor for chronic renal disease later in life. *Med J Aust* 2001; **174**:492–6.
- 38 Walker SL, Lebas E, De Sario V *et al.* The prevalence and association with health-related quality of life of tungiasis and scabies in schoolchildren in southern Ethiopia. *PLOS Negl Trop Dis* 2017; **11**:e0005808.
- 39 Reithinger R, Aadil K, Kolaczinski J *et al.* Social impact of leishmaniasis Afghanistan. *Emerg Infect Dis* 2005; **11**:634–6.
- 40 Mitja O, Marks M, Bertran L *et al.* Integrated control and management of neglected tropical skin diseases. *PLOS Negl Trop Dis* 2017; **11**:e0005136.
- 41 Estrada-Chávez G, Estrada R, Engelman D *et al.* Cushing syndrome due to inappropriate corticosteroid topical treatment of undiagnosed scabies. *Trop Med Infect Dis* 2018; **3**:82.
- 42 Hay RJ, Castanon RE, Hernandez HA *et al.* Wastage of family income on skin disease in Mexico. *BMJ* 1994; **309**:848.
- 43 Lammie PJ, Fenwick A, Utzinger J. A blueprint for success: integration of neglected tropical disease control programmes. *Trends Parasitol* 2006; **22**:313–21.
- 44 Brady MA, Hooper PJ, Ottesen EA. Projected benefits from integrating NTD programs in sub-Saharan Africa. *Trends Parasitol* 2006; **22**:285–91.
- 45 Ramaiah KD, Das PK, Michael E, Guyatt HL. The economic burden of lymphatic filariasis in India. *Parasitol Today* 2000; **16**:251–3.
- 46 Stanton B, Khanam S, Nazrul H *et al.* Scabies in urban Bangladesh. *J Trop Med Hyg* 1987; **90**:219–26.
- 47 Terry B, Kanjah F, Sahr F *et al.* *Sarcoptes scabiei* infestation among children in a displacement camp in Sierra Leone. *Public Health* 2001; **115**:208–11.
- 48 Talukder K, Talukder MQK, Farooque MG *et al.* Controlling scabies in madrasahs (Islamic religious schools) in Bangladesh. *Public Health* 2013; **127**:83–91.
- 49 Cassell JA, Middleton J, Nalabanda A *et al.* Scabies outbreaks in ten care homes for elderly people: a prospective study of clinical features, epidemiology, and treatment outcomes. *Lancet Infect Dis* 2018; **18**:894–902.
- 50 Millership S, Kapadia S. Scabies outbreaks in care homes for the elderly. *Lancet Infect Dis* 2018; **18**:1308–9.
- 51 Jung J, Lee WJ, Chang SE, Kim SH. Scabies outbreaks in care homes for the elderly. *Lancet Infect Dis* 2018; **18**:1309–10.
- 52 Morrison EJ, Middleton J, Lanza S *et al.* Do we know how scabies outbreaks in residential and nursing care homes for the elderly should be managed? A systematic review of interventions using a novel approach to assess evidence quality. *Epidemiol Infect* 2019; **147**:e250.
- 53 Chong YO, Vasanwala FF. Infected with scabies again? Focus in management in long-term care facilities. *Diseases* 2018; **7**:3.
- 54 Engelman D, Fuller LC, Solomon AW *et al.* Opportunities for integrated control of neglected tropical diseases that affect the skin. *Trends Parasitol* 2016; **32**:843–54.
- 55 Yotsu RR. Integrated management of skin NTDs—lessons learned from existing practice and field research. *Trop Med Infect Dis* 2018; **3**:120.
- 56 World Health Organization. *Accelerating Work to Overcome the Global Impact of Neglected Tropical Diseases: A Roadmap for Implementation*. Available at: https://apps.who.int/iris/bitstream/handle/10665/70809/WHO_HTM_NTD_2012.1_eng.pdf;jsessionid=DB1FF1C1FA27F1ADA2EEFB307B05F300?sequence=1 (last accessed 4 November 2019).
- 57 Malaria Consortium. The London declaration on NTDs: one year on. Available at: <https://www.malariaconsortium.org/news-centre/the-london-declaration-on-ntds-one-year-on.htm> (last accessed 4 November 2019).
- 58 Solomon AW, Kurylo E. The global trachoma mapping project. *Community Eye Health* 2014; **27**:18.
- 59 Hay RJ, Asiedu K. Skin-related neglected tropical diseases (skin NTDs) – a new challenge. *Trop Med Infect Dis* 2018; **4**:4.
- 60 Mason DS, Marks M, Sokana O *et al.* The prevalence of scabies and impetigo in the Solomon Islands: a population-based survey. *PLOS Negl Trop Dis* 2016; **10**:e0004803.
- 61 Krotneva SP, Coffeng LE, Noma M *et al.* African Program for Onchocerciasis Control 1995–2010: impact of annual ivermectin mass treatment on off-target infectious diseases. *PLOS Negl Trop Dis* 2015; **9**:e0004051.