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EPIDEMIOLOGY (R DELLAVALLE, SECTION EDITOR)

Global Burden of Skin Disease: Inequities and Innovations

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Abstract

Purpose of Review We review the current understanding of the burden of dermatological disease through the lens of the Global Burden of Disease project, evaluate the impact of skin disease on quality of life in a global context, explore socioeconomic implications, and finally summarize interventions towards improving quality of dermatologic care in resource-poor settings.

Recent Findings The Global Burden of Disease project has shown that skin diseases continue to be the 4th leading cause of non-fatal disease burden worldwide. However, research efforts and funding do not match with the relative disability of skin diseases. International and national efforts, such as the WHO List of Essential Medicines, are critical towards reducing the socioeconomic burden of skin diseases and increasing access to care. Recent innovations such as teledermatology, point-of-care diagnostic tools, and task shifting help to provide dermatological care to underserved regions in a cost-effective manner.

Summary Skin diseases cause significant non-fatal disability worldwide, especially in resource-poor regions. Greater impetus to study the burden of skin disease in low-resource settings and policy efforts towards delivering high-quality care are essential in improving the burden of skin diseases.

Keywords Global health · Dermatology · Dermatoepidemiology · Health equity · Task shifting · Point-of-care diagnostics

Introduction

Understanding the impact of dermatological diseases in resource-poor areas of the world is critical in developing a concerted and sustained global response towards reducing this burden [1]. Skin conditions are often the presenting face of more severe systemic illnesses, including HIV and neglected tropical diseases (NTDs), such as elephantiasis and other lymphedema-causing diseases [2, 3]. Furthermore, skin and subcutaneous disorders were the 4th leading cause of non-fatal disease burden worldwide in 2010 and 2013, emphasizing the role of dermatology in the ever-expanding field of global health [4•].

Recent recognition of skin disease at the global stage reaffirms the need for developing dermatologic guidelines. The World Health Organization's "Guidelines on Skin and Oral HIV-Associated Conditions in Children and Adults" [5], the first such guideline on the dermatologic manifestations of HIV, illustrates a new wave of interest in ensuring that skin disease is included in the global public health agenda. Additionally, scabies was added to the list of neglected tropical diseases and psoriasis was recognized as a priority for health care quality improvement by the 67th World Health Assembly [1]. Yet, these conditions only represent a fraction of the dermatological burden in resource-poor settings that demands better support.

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This article reviews our current understanding of the burden of dermatological disease from an epidemiological and socioeconomic standpoint, with recommendations for interventions to improve quality of care. A global health perspective of dermatology will help to provide a better framework for delivering resources and care.

Burden of Skin Disease

One method of understanding the epidemiological burden of skin disease is through the Global Burden of Disease (GBD). The GBD project is based at the Institutes of Health Metrics and supported by the Bill and Melinda Gates Foundation. It provides disability and mortality estimates for a broad range of diseases, injuries, and risk factors. Disability burden is calculated using disability-adjusted life years (DALYs) and years lived with disability (YLD), which both account for life years lost due to disease and allow for comparison across conditions. Each revision of the GBD incorporates new studies, novel methodologies, and existing uncertainties. This allows for a dynamic data source for informing future policy and research. The 2013 and recently published 2015 iterations of GBD provide an overview of the burden of skin disease globally and allow for comparison of disease across time [6••].

In 2013, skin conditions contributed 1.79% to the total global burden of disease measured in DALYs across 306 diseases and injuries. When comparing absolute DALYs/YLDs, skin and subcutaneous disorders were the 4th leading cause of non-fatal disease burden, directly following iron-deficiency anemia, tuberculosis, and sense organ diseases. Fifteen skin disease categories were assessed: dermatitis, psoriasis, cellulitis, pyoderma, scabies, fungal skin diseases, viral skin diseases, acne vulgaris, alopecia areata, pruritus, urticaria, decubitus ulcer, malignant skin melanoma, and keratinocyte carcinoma (including basal and squamous cell carcinomas), and other skin conditions. Dermatitis (encompassing atopic, seborrheic, and contact types) resulted in the greatest burden of the skin conditions, costing 9.3 million DALYs [6••].

As expected, the burden of skin disease shows both geographic and age-related variations. Melanoma causes the greatest burden in resource-rich regions such as Australia and North America, while dermatitis has the highest DALY rate in Sub-Saharan Africa. Mortality due to melanoma was found to be 4.7 times higher in resource-rich countries compared to resource-poor in 2010, while mortality due to measles was found to be 197 times greater in resource-poor nations compared to resource rich [7]. Additionally, GBD reveals variation by age, with infectious causes of skin conditions, such as viral warts, pyoderma, cellulitis, and scabies, causing greater burden among children. Persons of older age suffer disability burden from psoriasis, alopecia areata, urticaria, fungal skin diseases, and decubitus ulcers. These variations emphasize the need for region- and population-specific studies to truly understand the dermatologic needs of a community [6••].

However, epidemiological estimates of the burden of skin disease are likely to be underestimated due to a variety of factors. First, the GBD is based on the ICD classification system, which leads to categorization of certain skin conditions under other entities, for example, melanoma is classified under “cancer.” Furthermore, the dermatological manifestations of systemic illnesses are not necessarily individually categorized; the burden of lupus erythematosus is therefore entirely included under that of musculoskeletal disease [4•]. Second, the stigma associated with dermatological diseases, such as psoriasis, leads to underreporting by patients, leading to global underestimation [8]. Third, available data is often limited in geographic coverage and collected in ways difficult for inclusion into larger studies. For example, the GBD estimates for skin and subcutaneous diseases in Sub-Saharan Africa, a designation that encompasses 46 independent nations, are based on only 53 studies, while estimates for the USA alone, with a population of approximately 1/3 the size, are based on 62 studies. This underscores the need for strengthening of a global dermatologic research infrastructure towards finer granularity of dermatologic disease burden in both resource-poor and resource-rich regions.

Impact of Skin Disease on Quality of Life

Skin conditions pose significant threat to patients’ well-being, mental health, ability to function, and social participation, a measure of disability defined broadly by the WHO as a person’s ability to be involved and engaged in relations with others. Quality of life (QoL) tools help to estimate the impact of medical conditions on these determinants of health. Multiple QoL measurement tools, such as the Dermatology Life Quality Index (DLQI) and the Skindex, exist and can be adapted to different settings [9–11].

The effects of skin conditions on QoL in resource-replete settings are profound and well-documented [4•, 10, 12]. Far fewer studies exist examining the QoL of patients with skin conditions in the resource-poor world [9, 13]. Fewer still directly compare QoL in resource-poor to resource-replete settings [13]. Conditions that constitute the highest disability burden are often characterized by disabling symptoms like pruritus. These conditions include dermatitis, prurigo, and papular urticaria [9, 13]. A study of QoL in South African patients with skin complaints found that patients with these diseases had significantly poorer QoL compared to controls in realms such as depression, anxiety, effect on work or study, clothing choice, and looking after one’s home [9].

Dermatologic QoL is also more impaired for members of vulnerable groups: people of advanced age, women, and children. Women reported greater impact on self-esteem, clothing choice, treatment problems, and clothing choice in the South African study. Seniors were much more likely to experience disability due to a skin condition. Brazilian children with scabies reported high rates of teasing (26%) and social exclusion (17%) secondary to their disease [14]. In addition to its detrimental effects on current QoL, teasing can have devastating long-term effects on mental health, predisposing children to anxiety disorders and social phobias [15].

Assessing risk factors for decreased QoL in resource-poor and resource-replete settings is challenging. Increased clinical severity was an independent predictor of decreased QoL in a study of skin conditions among South Africans [9]. However, clinical severity has not been uniformly associated with decreased QoL [16]. This is because clinical severity, as measured by clinicians using formal grading scales, does not always correlate with patients' perceptions of their condition's severity. The discrepancy appears to be disease specific. Some dermatologic diseases have their most salient impact on appearance, which is closely connected to self-worth for many patients, but is a difficult quality for clinicians to assess. Clinical severity of acne, for example, has not been shown to correlate with the patient's perception of its severity. In contrast, diseases that impact more quantifiable domains, such as physical ability, have a higher correlation with patient perception. The clinical severity of psoriasis correlates more to patient perception due to the presence of comorbid psoriatic arthritis [16–18].

The most salient symptoms of a skin condition have a considerable impact on quality of life. For example, a study of QoL in Ugandan patients found a significant burden of depressed mood and poor self-image secondary to pruritus [13]. Approximately 8% of participants reported suicidal ideation. Pruritus had an adverse effect on QoL in both primary dermatoses and systemic disorders, though primary dermatoses were more commonly associated with poor self-image. Ugandan patients with itch were younger, more likely to have HIV, and less impacted by itch when compared to German patients. German patients were older, more likely to have end-stage renal disease, and more impacted by itch. These results suggest that demographic, socioeconomic, and cultural factors may play a role in QoL perception.

Socioeconomic Implications of Skin Disease

Socioeconomic factors contribute greatly to the epidemiology of skin disease in resource-poor settings. High household density, for example, is especially associated with transmissible skin disease—this factor was more important than salary, literacy, the use of shoes, distance to a water source, and quality of home construction in a Tanzanian study [19]. These findings are perhaps unsurprising. We know that living in close quarters predisposes one to infection; this knowledge is the underpinning of such public policy measures as meningococcal vaccination for American college students living in dormitories [20]. Infectious skin conditions are prevalent among disenfranchised people. The homeless, prisoners, and victims of violence are disproportionately affected in these settings [14, 21]. Skin conditions are the primary reason for members of the homeless population seek medical care [21]. Etiologies are diverse. Cellulitis and tinea pedis occur from inappropriate footwear; skin infections are sequelae of burns and physical trauma; mite infestations such as scabies are common in people with poor hygiene living in close quarters [21].

The definition of socioeconomic burden includes functional impairment with subsequent lost opportunities in professional life (indirect cost) and healthcare expenses (direct cost) [8]. In the USA, the direct and indirect costs of skin disease in 2013 were $75 billion and $11 billion, respectively [22]. Little is known about the socioeconomic burden of skin disease in resource-poor settings. Studies examining the cost of skin care in these settings are rare. The socioeconomic burden is also country-specific and closely tied to the healthcare delivery model. In India, where healthcare is paid out of pocket, the median value of healthcare cost was 73% of per capita monthly income—a significant burden [23]. Musculoskeletal and connective tissue disorders (including skin diseases) comprised 3.7% of the total cost burden. Overall, cost is difficult to estimate because systems operate on a mixed economy where cash, electronic financial assets, and the barter system are used equally, evading systematic study. The highly prevalent use of community-based traditional healers operating on a barter system in these settings is also a significant barrier to comprehensive cost analysis [19, 24].

In resource-poor settings, the availability of dermatologic treatment is governed by the cost of medications. Fortunately, dermatologic diseases are receiving more attention and have increasingly been included on the WHO List of Essential Medicines [25]. This is a list of cost-effective medicines that are of relevance to public health and serves as a platform for advocacy. Even so, many dermatologic medicines from this list are not available in hospital pharmacies [26]. Integrative care models have been proposed to control costs and provide efficient care in limited resource settings with loose healthcare networks. Integrative care models focusing on neglected tropical diseases aim to use a small, inexpensive arsenal of therapeutic agents to combat a wide range of transmissible diseases, including skin diseases. It is estimated that US$0.40 per person per year could prevent a majority of the top neglected tropical diseases in Africa [27]. Successful models of cost-effective public health efforts against dermatologic diseases feature close collaboration between the national medical system and international health organizations. For example, a Peruvian initiative against the spread of mucocutaneous leishmaniasis successfully improved the scope of treatment and follow-up of patients with funding of medications and resources by the Ministry of Health [28]. Further research is needed to comprehensively describe and address socioeconomic barriers to care.

Improving Quality of Care through Innovation

The high burden and socioeconomic impact of dermatological disease, both studied and as experienced by the authors of this review, demand more attention, more resources, and more guidelines at multiple levels of care (Fig. 1). There remains a mismatch between resource allocation and the skin diseases with the greatest disability burden—both in grant funding and systematic reviews [29•, 30]. When the amount of NIH funding was compared with the relative disability burden of skin conditions, eight skin diseases (cellulitis, decubitus ulcer, urticaria, acne vulgaris, viral skin diseases, fungal skin diseases, scabies, and melanoma) were underrepresented [29•]. This is concerning because these grants and systematic reviews lead to the development of international guidelines. There is a dearth of high-quality trials on treatment approaches for skin conditions, such as HIV-associated skin conditions. Without international guidelines, healthcare professionals in already resource-strapped settings may be pushed to rely on unvalidated information, leading to patient harm [31–33]. Therefore, continued advocacy and research will be necessary to inform the treatments selected in resource-poor settings.

To overcome barriers to care, such as lack of trained dermatology professionals and limited ability to perform biopsies, recent goals of research include developing remote care and non-invasive diagnostic methods. Even within the USA, regions with no practicing dermatologists are associated with greater melanoma mortality [34]. Teledermatology can help to overcome these gaps in care, allowing for better access to a trained dermatologist, reduced travel and waiting times, and support for local staff [35]. There are a number of teledermatology networks in the resource-poor world, such as in Western Africa, South Africa, Botswana, Nepal, and Latin America. Mobile teledermatology uses cell phones to transmit images, allows for more versatility than its often more unwieldy store-and-forward counterpart, and has good concordance with the outcomes of a face-to-face visit [36–39]. Teledermatology has been validated in both infectious conditions such as HIV-associated skin conditions and chronic conditions, such as atopic dermatitis [37, 40]. A cross-sectional survey of HIV-positive patients in Botswana found that 91% of patients felt that a mobile teledermatology visit would provide the same level of care as a face-to-face visit [41]. The validity and acceptance of teledermatology therefore make it an obvious choice for expanding dermatology services.

Another way to improve access to care is to develop point-of-care diagnostic tools for dermatology. Distance to care, lack of connectivity, and poor laboratory infrastructure in many resource-poor areas preclude the widespread adoption of resource-heavy diagnostic techniques, such as skin biopsy reads by dermatopathologists [42–45]. There is a shortage of literature that addresses the development of innovative diagnostic tools for dermatology in resource-poor settings. The case of visceral leishmaniasis, a neglected tropical disease, can illustrate how government advocacy and collaboration can prompt better diagnostic tools even without an economic motive [44, 46]. The governments of India, Nepal, and Bangladesh pledged to eliminate visceral leishmaniasis by

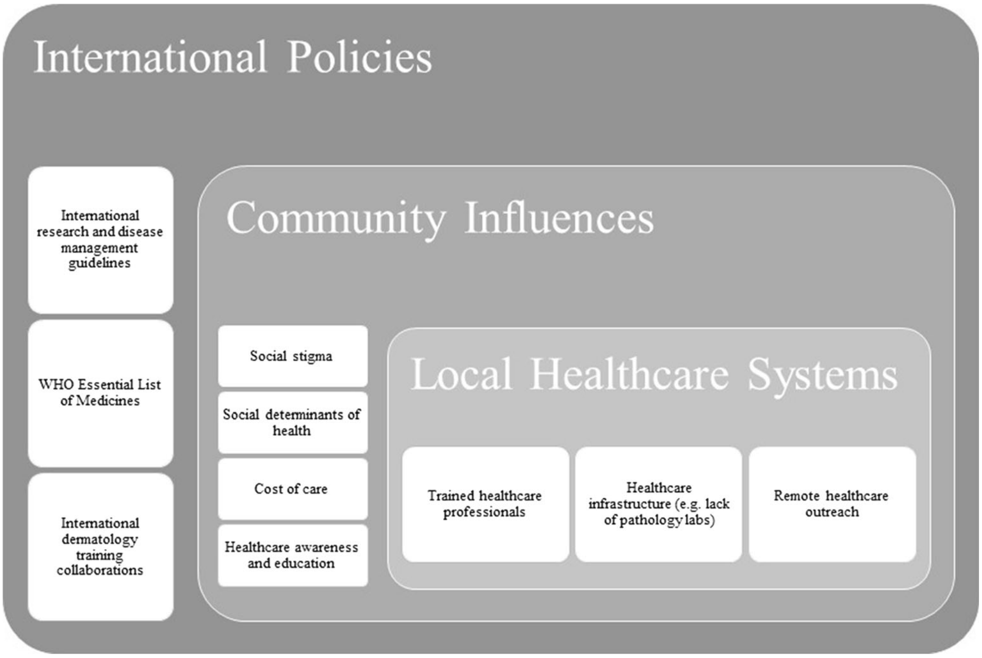

Fig. 1 Targets for improved dermatological care: for resource-poor regions, targets to achieve and barriers to overcome co-exist at three levels of engagement, from the international stage to local communities

2015, which along with improved treatment access, prompted the development of a simple point-of-care diagnostic tool which detects antibody agglutination [43, 45].

Similarly, we are engaged in an ongoing collaboration with the Infectious Disease Institute in Kampala, Uganda, to develop a point-of-care diagnostic tool for Kaposi's sarcoma (KS), a cancerous cutaneous manifestation of HIV. In resource-poor settings, KS is often diagnosed based on skin exam alone, or when based on biopsy, limited to the few hospitals with the required pathologists and equipment. Diagnosis by exam alone is strife with error, with 23% rate of misdiagnosis [47]. Developing a point-of-care diagnostic tool, ideally one that leapfrogs over the need for biopsy, will help to improve KS diagnosis and shorten time to treatment.

A third way to respond to barriers in dermatologic care is to broaden the options for in-person treatment, expanding beyond the role of the dermatologist. The shortage of trained dermatologists in many regions of the world requires transitioning of care. Task shifting describes the process by which highly trained individuals facilitate the passing of their skills to individuals with little or no prior training in a specific area [48, 49]. As the process is collaborative and the newly trained healthcare worker continues to be supported by a mentor, the term task sharing has also been employed [48]. Task shifting in the field of mental health has been widely successful, demonstrating that community health workers can be trained to provide care to individuals with mental health conditions in lower- and middle-income countries [48]. In the field of HIV/AIDS, task shifting has been deemed imperative with evidence that nurses can prescribe antiretroviral treatments just as effectively as physicians [50, 51].

There is a sparsity of physicians with dermatological training in many of low- and middle-income countries [52]. In the field of dermatology, unlike in HIV or obstetrics [53–56], there are few examples of task shifting in resource-poor settings, but the limited application of this technique has been successful. In one study, US dermatologists taught physicians, nurses, clinical officers, and technicians in East Africa how to perform punch biopsies, allowing for same day KS biopsies [57•]. As adapted from the mental health field [48], an apprenticeship model could allow dermatologists to train community health workers in resource-limited settings on diagnosis and treatment of the most common dermatological conditions, such as dermatitis, psoriasis, acne, and tinea. Therefore, task shifting provides a potential model for collaborative capacity building.

Building local capacity also requires building educational programs to train future generations of dermatologists. In Nigeria, for example, it is estimated that in 2015, 80 formally trained dermatologists served the nation's population of 182 million [58, 59]. The Regional Dermatology Training Center in Tanzania was established in 1992 to provide dermatologic training for nurses in the Sub-Saharan region [60]. Toby Maurer of the University of California, San Francisco, is also working to establish a dermatology residency training program in Uganda and Kenya. Sustained efforts are required to train regional cohorts of dermatologists to serve resource-poor regions.

Summary and Recommendations

Based on the Global Burden of Disease project, skin diseases were the 4th leading cause of non-fatal morbidity worldwide in 2010 and 2013 [4•, 6••]. This epidemiological bird's-eye view highlights variations by region and by condition—with resource-poor areas more likely to suffer the burden of infectious skin conditions, while resource-rich areas shoulder the burden of malignancies. Due to few high-quality trials in resource-poor settings, there is little data on the true impact of dermatological conditions in these regions. The limited data that highlights regional and cultural variations in the impact of dermatological symptoms, such as quality of life relating to pruritus, further underscores the need for setting-specific research. Extrapolation of findings from resource-rich nations is therefore not advised; more funding towards more studies and more services for dermatological needs in resource-poor settings is needed.

Addressing this mismatch between resource need and allocation will require dynamic solutions. Teledermatology offers one such solution by channeling dermatological expertise to areas in need. Improving dermatological training programs and task shifting care to community health workers in these areas will be critical in delivering a more tactile solution to this problem as well. Point-of-care diagnostic tools, such as for Kaposi's sarcoma, offer a glimpse into the future by bringing patients closer to life-saving treatments. In the development of solutions, however, we must remain vigilant and devoted to quality. Improving access to care is not the same as increasing access to high-quality care [61•]. Our solutions to inequities must not propagate more disparities. The devastating social stigma associated with skin diseases means that many patients are not actually "seen" by research trials and international organizations. However, these inequities in global dermatology should only further propel us towards increased commitment to delivering care to all patients, seen and unseen.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. Freeman EE. A seat at the big table: expanding the role of dermatology at the World Health Organization and beyond. J Invest Dermatol. 2014;134(11):2663–5.
2. Engelman D, Fuller LC, Solomon AW, McCarthy JS, Hay RJ, Lammie PJ, et al. Opportunities for integrated control of neglected tropical diseases that affect the skin. Trends Parasitol. 2016;32(11): 843–54.
3. Tschachler E, Bergstresser PR, Stingl G. HIV-related skin diseases. Lancet. 1996;348(9028):659–63.
4.• Hay RJ, Johns NE, Williams HC, Bolliger IW, Dellavalle RP, Margolis DJ, et al. The global burden of skin disease in 2010: an analysis of the prevalence and impact of skin conditions. J Invest Dermatol. 2014;134(6):1527–34. **Epidemiological study based on the 2010 Global Burden of Disease project that measures the burden of skin diseases worldwide, with burden of individual skin diseases measured in DALYs**.
5. WHO | Guidelines on the treatment of skin and oral HIV-associated conditions in children and adults [Internet]. WHO. [cited 2017 Mar 14] Available from: http://www.who.int/maternal_child_adolescent/documents/skin-mucosal-and-hiv/en/.
6.•• Karimkhani C, Dellavalle RP, Coffeng LE, Flohr C, Hay RJ, Langan SM, et al. Global skin disease morbidity and mortality: An Update From the Global Burden of Disease Study 2013. JAMA Dermatol [Internet]. 2017 Mar 1. **Epidemiological study based on the 2013 Global Burden of Disease project that measures the burden of skin diseases worldwide, with burden of individual skin diseases measured in DALYs**.
7. Boyers LN, Karimkhani C, Naghavi M, Sherwood D, Margolis DJ, Hay RJ, et al. Global mortality from conditions with skin manifestations. J Am Acad Dermatol. 2014;71(6):1137–43.e17.
8. Organization WH. Global report on psoriasis [Internet]. World Health Organization; 2016 [cited 2017 Mar 9] Available from: http://www.who.int/iris/handle/10665/204417.
9. Jobanputra R, Bachmann M. The effect of skin diseases on quality of life in patients from different social and ethnic groups in Cape Town. South Africa Int J Dermatol. 2000;39(11):826–31.
10. Basra M, Fenech R, Gatt R, Salek M, Finlay A. The Dermatology Life Quality Index 1994–2007: a comprehensive review of validation data and clinical results. Br J Dermatol. 2008;159(5):997–1035.
11. Chren M-M, Lasek RJ, Quinn LM, Mostow EN, Zyzanski SJ. Skindex, a quality-of-life measure for patients with skin disease: reliability, validity, and responsiveness. J Invest Dermatol. 1996;107(5):707–13.
12. Beattie PE, Lewis-Jones MS. A comparative study of impairment of quality of life in children with skin disease and children with other chronic childhood diseases. Br J Dermatol. 2006;155(1): 145–51.
13. Weisshaar E, Apfelbacher C, Jäger G, Zimmermann E, Bruckner T, Diepgen TL, et al. Pruritus as a leading symptom: clinical characteristics and quality of life in German and Ugandan patients. Br J Dermatol. 2006;155(5):957–64.
14. Worth C, Heukelbach J, Fengler G, Walter B, Liesenfeld O, Feldmeier H. Impaired quality of life in adults and children with scabies from an impoverished community in Brazil. Int J Dermatol. 2012;51(3):275–82.
15. McCabe RE, Antony MM, Summerfeldt LJ, Liss A, Swinson RP. Preliminary examination of the relationship between anxiety disorders in adults and self-reported history of teasing or bullying experiences. Cogn Behav Ther. 2003;32(4):187–93.
16. Mosam A, Vawda NB, Gordhan AH, Nkwanyana N, Aboobaker J. Quality of life issues for South Africans with acne vulgaris. Clin Exp Dermatol. 2005;30(1):6–9.
17. Hariram P, Mosam A, Aboobaker J, Esterhuizen T. Quality of life in psoriasis patients in KwaZulu Natal, South Africa. Indian J Dermatol Venereol Leprol. 2011;77(3):333–4.
18. Aghaei S, Moradi A, Ardekani G. Impact of psoriasis on quality of life in Iran. Indian J Dermatol Venereol Leprol. 2009;75(2):220.
19. Gibbs SAM. Skin disease and socioeconomic conditions in rural Africa: Tanzania. Int J Dermatol. 1996;35(9):633–9.
20. Harrison LH, Dwyer DM, Maples CT, Billmann L. Risk of meningococcal infection in college students. JAMA. 1999;281(20):1906–10.
21. Raoult D, Foucault C, Brouqui P. Infections in the homeless. Lancet Infect Dis. 1(2):77–84.
22. Lim HW, Collins SAB, Resneck Jr JS, Bolognia JL, Hodge JA, Rohrer TA, et al. The burden of skin disease in the United States. J Am Acad Dermatol [Internet]. Available from: http://www.sciencedirect.com/science/article/pii/S0190962217300166.
23. Dror DM, van Putten-Rademaker O, Koren R. Cost of illness: evidence from a study in five resource-poor locations in India. 2008.
24. Hay RJ, Fuller LC. The assessment of dermatological needs in resource-poor regions. Int J Dermatol. 2011;50(5):552–7.
25. Laing R, Waning B, Gray A, Ford N, t Hoen E. 25 years of the WHO essential medicines lists: progress and challenges. Lancet. 5;361(9370):1723–9.
26. Narwane S, Patel T, Shetty Y, Chikhalkar S. Drug utilization and cost analysis for common skin diseases in dermatology OPD of an Indian tertiary care hospital-a prescription survey. 2011.
27. Molyneux DH, Hotez PJ, Fenwick A. “Rapid-impact interventions”: how a policy of integrated control for Africa’s neglected tropical diseases could benefit the poor. PLoS Med. 2005;2(11): e336.
28. Guthmann J-P, Arlt D, Garcia LML, Rosales M, de Jesus SJ, Alvarez E, et al. Control of mucocutaneous leishmaniasis, a neglected disease: results of a control programme in Satipo Province, Peru. Trop Med Int Health. 2005;10(9):856–62.
29.• Karimkhani C, Boyers LN, Margolis DJ, Naghavi M, Hay RJ, Williams HC, et al. Comparing cutaneous research Funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases with 2010 Global Burden of Disease results. PLOS ONE. 2014;9(7):e102122. **Study examines relationship of NIAMS grant funding with relative skin disease burden for 15 skin diseases included in the Global Burden of Disease 2010**.
30. Karimkhani C, Boyers LN, Prescott L, Welch V, Delamere FM, Nasser M, et al. Global burden of skin disease as reflected in Cochrane Database of Systematic Reviews. JAMA Dermatol. 2014;150(9):945–51.
31. Paul S, Evans R, Maurer T, Muhe LM, Freeman EE. Treatment of dermatological conditions associated with HIV/AIDS: the scarcity of guidance on a global scale. AIDS Res Treat. 2016;2016: e3272483.
32. Oxman AD, Lavis JN, Fretheim A. Use of evidence in WHO recommendations. Lancet. 2007;369(9576):1883–9.
33. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ. 2008;336(7650): 924–6.
34. Aneja S, Aneja S, Bordeaux JS. Association of increased dermatologist density with lower melanoma mortality. Arch Dermatol. 2012;148(2):174–8.
35. Wootton R. Telehealth in the developing world. IDRC; 2009. 336 p.

36. Osei-tutu A, Shih T, Rosen A, Amanquah N, Chowdhury M, Nijhawan RI, et al. Mobile teledermatology in Ghana: sending and answering consults via mobile platform. J Am Acad Dermatol. 2013;69(2):e90–1.

37. Azfar RS, Lee RA, Castelo-Soccio L, Greenberg MS, Bilker WB, Gelfand JM, et al. Reliability and validity of mobile Teledermatology in human immunodeficiency virus-positive patients in Botswana: a pilot study. JAMA Dermatol. 2014;150(6): 601–7.

38. Tran K, Ayad M, Weinberg J, Cherng A, Chowdhury M, Monir S, et al. Mobile teledermatology in the developing world: implications of a feasibility study on 30 Egyptian patients with common skin diseases. J Am Acad Dermatol. 2011;64(2):302–9.

39. Lamel SA, Haldeman KM, Ely H, Kovarik CL, Pak H, Armstrong AW. Application of mobile teledermatology for skin cancer screening. J Am Acad Dermatol. 2012;67(4):576–81.

40. Armstrong AW, Johnson MA, Lin S, Maverakis E, Fazel N, Liu F-T. Patient-centered, direct-access online care for management of atopic dermatitis: a randomized clinical trial. JAMA Dermatol. 2015;151(2):154–60.

41. Azfar RS, Weinberg JL, Cavric G, Lee-Keltner IA, Bilker WB, Gelfand JM, et al. HIV-positive patients in Botswana state that mobile teledermatology is an acceptable method for receiving dermatology care. J Telemed Telecare. 2011;17(6):338–40.

42. Peeling RW, Mabey D. Point-of-care tests for diagnosing infections in the developing world. Clin Microbiol Infect. 2010;16(8):1062–9.

43. Mabey D, Peeling RW, Ustianowski A, Perkins MD. Tropical infectious diseases: diagnostics for the developing world. Nat Rev Microbiol. 2004;2(3):231–40.

44. Ridley RG. Evaluating diagnostics: VL. Nat Rev Microbiol. 2007;5:S1.

45. Yager P, Domingo GJ, Gerdes J. Point-of-care diagnostics for global health. Annu Rev Biomed Eng. 2008;10:107–44.

46. Pattabhi S, Whittle J, Mohamath R, El-Safi S, Moulton GG, Guderian JA, et al. Design, development and evaluation of rK28-based point-of-care tests for improving rapid diagnosis of visceral leishmaniasis. PLoS Negl Trop Dis. 2010;4(9):e822.

47. Amerson E, Woodruff CM, Forrestel A, Wenger M, McCalmont T, LeBoit T, Maurer T. Accuracy of clinical suspicion and pathologic diagnosis of Kaposi Sarcoma in East Africa. J Acquir Immune Defic Syndr. 1999;71(3):295–301. doi: 10.1097/QAI.0000000000000862.

48. Patel V. Global mental health: from science to action. Harv Rev Psychiatry. 2012;20(1):6–12.

49. WHO | Task shifting: global recommendations and guidelines [Internet]. WHO. [cited 2017 Apr 5] Available from: http://www.who.int/workforcealliance/knowledge/resources/taskshifting_guidelines/en/.

50. Eholié S-P, Aoussi FE, Ouattara IS, Bissagnéné E, Anglaret X. HIV treatment and care in resource-constrained environments: challenges for the next decade. J Int AIDS Soc [Internet]. 2012 Aug 22 [cited 2017 Apr 5];15(2) Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3494167/.

51. Sanne I, Orrell C, Fox MP, Conradie F, Ive P, Zeinecker J, et al. Nurse versus doctor management of HIV-infected patients receiving antiretroviral therapy (CIPRA-SA): a randomised non-inferiority trial. Lancet Lond Engl. 2010;376(9734):33–40.

52. Tsang MW, Kovarik CL. The role of dermatopathology in conjunction with teledermatology in resource-limited settings: lessons from the African Teledermatology Project. Int J Dermatol. 2011;50(2): 150–6.

53. Chu K, Rosseel P, Gielis P, Ford N. Surgical task shifting in Sub-Saharan Africa. PLoS Med. 2009;6(5):e1000078.

54. Fairall L, Bachmann MO, Lombard C, Timmerman V, Uebel K, Zwarenstein M, et al. Task shifting of antiretroviral treatment from doctors to primary-care nurses in South Africa (STRETCH): a pragmatic, parallel, cluster-randomised trial. Lancet. 2012;380(9845): 889–98.

55. Morris MB, Chapula BT, Chi BH, Mwango A, Chi HF, Mwanza J, et al. Use of task-shifting to rapidly scale-up HIV treatment services: experiences from Lusaka, Zambia. BMC Health Serv Res. 2009;9:5.

56. Shumbusho F, van Griensven J, Lowrance D, Turate I, Weaver MA, Price J, et al. Task shifting for scale-up of HIV care: evaluation of nurse-centered antiretroviral treatment at rural health centers in Rwanda. PLoS Med. 2009;6(10):e1000163.

57.• Laker-Oketta M, Wenger M, Semeere A, Castelnuovo B, Kambugu A, Lukande R, et al. Task shifting and skin punch for the histologic diagnosis of Kaposi's sarcoma in Sub-Saharan Africa: a public health solution to a public health problem. Oncology. 2015;89(1): 60–5. **Study that examined task-shifting biopsies for Kaposi's Sarcoma diagnosis in East Africa from physicians to non-physicians, finding that task-shifting led to significant increase in healthcare access**.

58. Trends-United Nations Population Division | Department of Economic and Social Affairs [Internet]. [cited 2017 Apr 11]. Available from: http://www.un.org/en/development/desa/population/theme/trends/index.shtml.

59. The Nigeria Association of Dermatologists | African Society of Dermatology and Venereology (ASDV) [Internet]. African Society of Dermatology and Venereology (ASDV). 2016 [cited 2017 Apr 11] Available from: https://www.asdvafrica.org/about-asdv/the-nigerian-association-of-dermatologists/.

60. Hu J, McKoy K, Papier A, Klaus S, Ryan T, Grossman H, et al. Dermatology and HIV/AIDS in Africa. J Glob Infect Dis. 2011;3(3):275–80.

61.• Scott KW, Jha AK. Putting quality on the global health agenda. N Engl J Med. 2014;371(1):3–5. **Perspective that emphasizes that access to high-quality care is an important goal when addressing global health need**.