Spinghar University- Kabul

Spinghar Journal of Biomedical Sciences (SJBS)

Vol. 1., No.1, October 2025, pp.60-67

Modeling the Future Burden: Projections of Scabies Prevalence in Afghanistan, Iran, and Pakistan until 2040

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ARTICLE INFO

Type: Original Article
Received: 17/07/2025
Accepted: 15/09/2025

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DOI:
https://doi.org/10.64444/sjbs.16

ABSTRACT

Background: Scabies, a neglected tropical disease (NTD), imposes a significant global burden, particularly in resource-limited and conflict-affected regions. Detailed, long-term projections are essential for informed public health planning. We aimed to model the future burden of scabies in Afghanistan, Iran, and Pakistan up to the year 2040.

Methods: The sex-disaggregated, age-standardized epidemiological data for scabies incidence, prevalence, and mortality were extracted from the Global Burden of Disease (GBD) Study 2023. Using an illness-death model (IDM) calibrated with this historical data, we projected sex-specific age-standardized prevalence rates (ASPR) for each country through 2040.

Results: In 2023, Pakistan exhibited an ASPR of 1717.83 per 100,000, approximately five times higher than Afghanistan (312.49) and Iran (332.06). Projections to 2040 indicate stagnant trends for Afghanistan (-0.11%) and Iran (-0.67%), whereas Pakistan shows a modest decline of 1.02%. The prevalence was consistently slightly higher among females across all nations, with this disparity persisting in projections.

Conclusion: Our analysis reveals a landscape of profound and persistent disparity, with Pakistan carrying an exceptionally high and slowly declining burden. The stable trends in Afghanistan and Iran suggest a state of epidemiological stagnation rather than effective control. These findings underscore an urgent need for targeted, country-specific public health interventions, including mass drug administration in Pakistan and strengthened surveillance and integrated case management in all three countries, to align with the WHO NTD roadmap goals.

Keywords: Scabies; Neglected Tropical Diseases; Modelling; Projection

Introduction

Scabies is caused by infestation with *Sarcoptes scabiei* var. *hominis*. It is a common dermatological condition with substantial global prevalence and morbidity, characterized by intense itch and rash due to mite infestation. Secondary bacterial infections such as impetigo are frequent and can lead to serious complications including sepsis and kidney disease [1–3]. The WHO classifies scabies as a Neglected Tropical Disease (NTD), highlighting its disproportion-

ate impact on populations living in poverty, in overcrowded conditions, and with limited access to clean water and sanitation [4].

The global burden of scabies is substantial, with estimates suggesting over 200 million people are affected at any given time. The disease exhibits a heterogeneous geographical distribution, with the highest prevalence observed in tropical, low-resource settings and among displaced or conflict-affected populations [5,6]. Children, the elderly, and individuals in institutional settings are particularly vulnerable [7]. Beyond physical health, scabies inflicts considerable social stigma, psychological distress, and economic loss due to healthcare costs and reduced productivity [8].

Accurate burden estimation and future projection are critical for evidence-based policy, resource allocation, and monitoring progress toward the WHO's 2030 NTD roadmap targets for control and elimination. However, reliable data on scabies epidemiology, especially long-term trends, are often scarce due to diagnostic challenges, underreporting, and a lack of sustained surveillance systems in many endemic countries [1,9].

The North Africa and Middle East region presents a complex epidemiological picture [5]. Countries like Afghanistan have endured decades of conflict, severely fragmenting health infrastructure and hindering disease control efforts [10]. Pakistan, with its large population, significant poverty rates, and recurrent natural disasters, represents a potential hotspot for NTDs like scabies, a reality confirmed by a recent hospital-based survey which found a high prevalence of the disease strongly linked to overcrowding and low socioeconomic status [11]. Scabies has been reported across most regions of Iran, with widely varying prevalence estimates by province and population group. However, data on long-term national trends and future burden are lacking, hindering evidence-based control planning [12].

Analyses of global burden estimates such as the GBD studies provide broad results but also indicate limitations in scabies surveillance and data quality that constrain forward-looking projections and granular comparisons across regions [13].

We aimed to address this gap by employing a robust modeling framework to analyze historical trends and project the future prevalence of scabies in Afghanistan, Iran, and Pakistan from 2023 to 2040. Utilizing data from 2021 GBD 2021 Study, we implemented an illness-death model to generate sex-disaggregated, age-standardized prevalence projections.

Our objectives were to: 1) quantify the current and future burden of scabies in these three countries, 2) identify and compare national and sex-specific trends, and 3) discuss the implications of these projections for achieving regional and global NTD control targets. The findings are intended to inform national health authorities and international agencies in designing targeted, effective, and sustainable interventions against this persistent cause of morbidity.

Methods

Data sources

Epidemiological data for scabies were obtained from the GBD report (GBD 2023), accessed via the Global Health Data Exchange (GHDx) repository (https://vizhub.healthdata.org/gbd-results/). The dataset included sex-disaggregated and age-standardized estimates for scabies incidence, prevalence, and total and cause-specific mortality for Afghanistan, Iran, and Pakistan from 1990 to 2023. To facilitate population-based forecasting, supplementary demographic data and population projections for the period up to 2040 were acquired from the GHDx population forecast platform (https://vizhub.healthdata.org/population-forecast/). The GBD data provides the most comprehensive and internally consistent source

for comparative cross-national and temporal analysis of disease burden.

Modeling approach

An illness-death model (IDM), a compartmental modeling framework based on a system of discrete-time ordinary differential equations is implemented. This model simulates transitions between three key health states relevant to scabies: Susceptible (S), Infected/Prevalent (I), and Death due to scabies (D). The model structure allowed for the incorporation of sex-specific parameters for transition rates (e.g., incidence, remission, and cause-specific mortality) derived from the GBD 2023 estimates.

The IDM was selected because it explicitly represents the dynamic relationship between incidence, remission, and mortality, a key requirement for chronic and relapsing conditions [14,15]. Similiar framework has been extensively applied in burden-of-disease estimation and long-term projections within the GBD study architecture [16].

The model was calibrated using the historical GBD time-series data (1990–2023) for each country and sex group. The calibration process involved adjusting model parameters within plausible ranges to minimize the discrepancy between model outputs and the observed GBD prevalence estimates for the historical period.

Once calibrated, the models were run forward from 2024 to 2040 to generate projections of the age-standardized prevalence rate (ASPR) for scabies in each country based on sex. The analysis was conducted using R statistical software (version 4.3.1) with custom-developed code for the IDM.

Results

Scabies prevalence in 2023 and projected trends to 2040

The baseline ASPR for scabies in 2023 and projected trends through 2040 are presented in Figure 1. A profound disparity was evident at baseline. Pakistan exhibited an ASPR of 1717.83 per 100,000, which was approximately five times higher than the rates in Afghanistan (312.49 per 100,000) and Iran (332.06 per 100,000).

Projected national trends to 2040

All projected percentage changes described in the text refer to changes between the first projected year (2024) and 2040, consistent with Table 1. Both Afghanistan and Iran are projected to experience minimal change. Afghanistan shows a negligible decline of 0.11% between 2024 and 2040, with the ASPR decreasing from 312.51 to 312.16 per 100,000, while Iran is projected a slight decrease of 0.67% (from 332.06 to 329.83). In stark contrast, Pakistan, despite its significantly higher baseline, is projected to experience a modest but consistent decline of 1.02% by 2040, with ASPR decreasing from 1717.83 to 1700.34 per 100,000.

Sex-specific prevalence and projections

In 2023, the scabies burden was slightly higher among females compared to males across all three countries, a pattern projected to persist through 2040 (Table 1). The projected trends for each sex-specific group mirrored the overall national patterns. Afghanistan and Iran showed remarkable stability in both male and female prevalence. Pakistan projected a declining trend for both sexes, with a more pronounced decrease observed in males (-1.35% by 2040) compared to females (-0.61%).

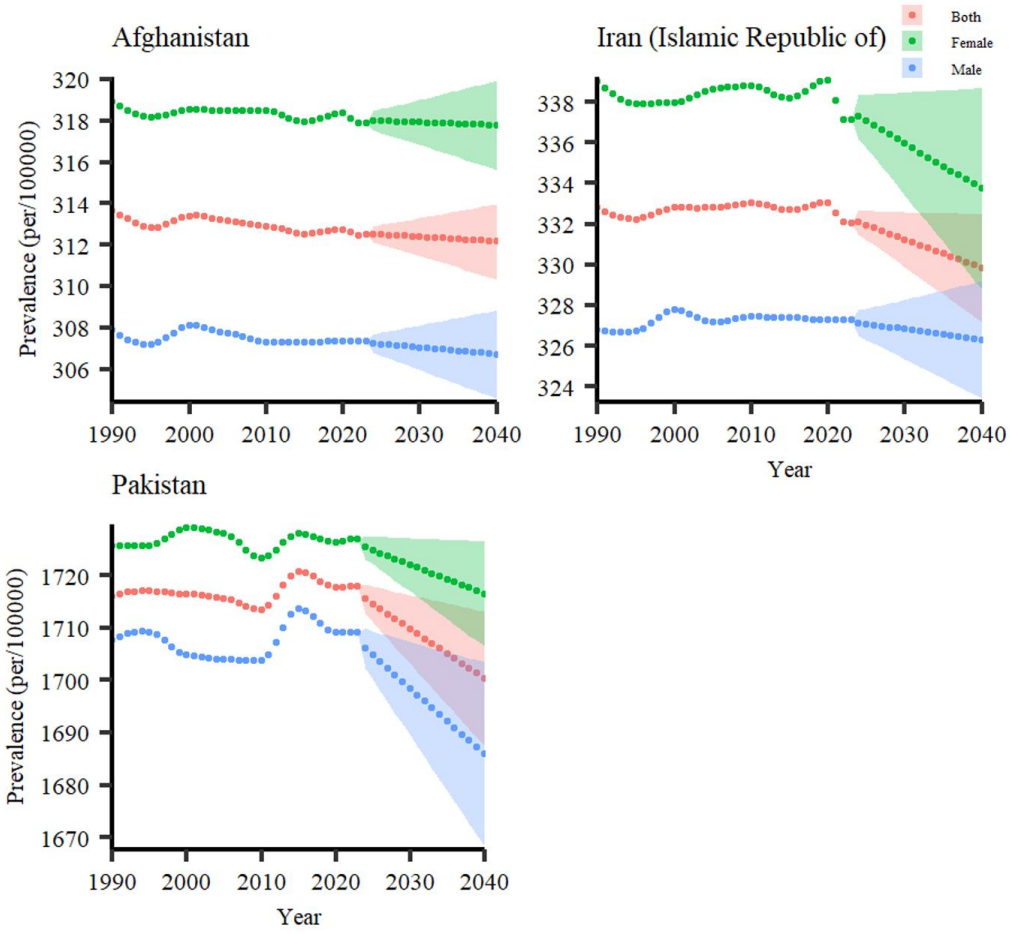

Figure 1: Observed and projected age-standardized prevalence rate (ASPR) of scabies in Afghanistan, Iran, and Pakistan in 1990-2040

Table 1: Projected age-standardized prevalence rate (ASPR) of scabies in Afghanistan, Iran, and Pakistan from 2024 to 2040. Percentage change columns reflect historical GBD comparisons (1990 vs. 2021) and projected change from the last observed year (2021) to 2040

Group	***Country***	***2024***	***2025***	***2030***	***2035***	***2040***	***Percentage change 1990 vs. 2021***	***Percentage change 2021 vs. 2040***
Both	Afghanistan	312.507(312.3-312.71)	312.485(312.23-312.74)	312.376(311.9-312.86)	312.266(311.55-312.98)	312.156(311.21-313.11)	-0.3741	-0.10621
	Iran	332.066(331.76-332.37)	331.926(331.56-332.29)	331.226(330.52-331.93)	330.528(329.48-331.57)	329.831(328.45-331.22)	-0.22415	-0.67025
	Pakistan	1715.464(1713.99-	1714.515(1712.73-1716.3)	1709.778(1706.37-1713.2)	1705.053(1699.99-	1700.342(1693.63-	0.103088	-1.0178

		1716.94)			1710.13)	1707.08)		
Female	Afghanistan	318.003(317.76-318.25)	317.989(317.69-318.29)	317.919(317.35-318.49)	317.849(317-318.7)	317.779(316.65-318.92)	-0.33156	-0.0268
	Iran	337.263(336.69-337.83)	337.04(336.35-337.73)	335.93(334.61-337.25)	334.823(332.87-336.79)	333.72(331.13-336.33)	-0.5602	-1.00382
	Pakistan	1725.344 (1724.2-1726.49)	1724.788 (1723.4-1726.18)	1722.015 (1719.36-1724.67)	1719.246 (1715.3-1723.2)	1716.481 (1711.24-1721.74)	0.076046	-0.60516
Male	Afghanistan	307.229(306.99-307.47)	307.197(306.9-307.49)	307.033(306.47-307.6)	306.87(306.03-307.71)	306.707(305.59-307.83)	-0.18497	-0.19841
	Iran	327.121(326.79-327.45)	327.07(326.67-327.47)	326.815(326.05-327.58)	326.561(325.42-327.7)	326.306(324.79-327.82)	0.137151	-0.28978
	Pakistan	1706.001 (1703.98-1708.03)	1704.738 (1702.29-1707.19)	1698.438 (1693.77-1703.12)	1692.161 (1685.24-1699.11)	1685.906 (1676.73-1695.13)	0.084917	-1.35492

Discussion

This study presents the first comparative modeling analysis projecting the burden of scabies in Afghanistan, Iran, and Pakistan to 2040. The key finding is a landscape of pronounced and persistent disparity, characterized by Pakistan's exceptionally high burden relative to its neighbors, alongside generally stable national trends that suggest a state of epidemiological equilibrium for this NTD.

The most striking result is the disproportionate burden of scabies in Pakistan. The 2023 ASPR aligns with the WHO's characterization of scabies as an NTD of poverty and overcrowding [13]. The projected decline of only 1.02% by 2040 is epidemiologically insignificant, indicating that without substantial intervention, Pakistan can be considered as a hyperendemic zone. This persistent burden reflects underlying drivers, including high population density, poverty, inadequate sanitation, and limited healthcare access in many regions that are deeply entrenched and known risk factors for sustained transmission of scabies [5,7,17]. The slow pace of change suggests that current public health measures are insufficient to alter the transmission dynamics fundamentally. This finding is a clear mandate for the urgent scale-up of proven interventions, such as mass drug administration (MDA) with ivermectin, which has achieved dramatic reductions in prevalence in other high-burden island settings [18,19].

In contrast to Pakistan, both Afghanistan and Iran demonstrate remarkably stable prevalence rates. This stability should not be misconstrued as successful control but rather as a "stagnant equilibrium." In Afghanistan, this likely reflects a fragile health system devastated by decades of conflict, where implementing structured NTD programs like MDA is profoundly challenging [10,12]. The lack of a downward trend underscores the severe constraints on health service delivery. Iran's stable, intermediate burden may reflect more robust infrastructure but indicates a potential gap in prioritizing scabies control, possibly due to competing health priorities or the absence of a targeted national program. Stability in both contexts signals a failure to implement the intensive, community-based con-

trol strategies required to reduce transmission [12].

The consistently higher prevalence of scabies among females across all three countries has important implications for intervention design. Because women often serve as primary caregivers for children who constitute a key reservoir for scabies transmission targeting caregivers through maternal and child health services, antenatal care visits, and community-based health education may enhance early detection and treatment adherence [17,20]. Integrating scabies screening and treatment into maternal, reproductive, and primary health care settings may help reduce prolonged infestation and household-level transmission, particularly in settings where gender-related barriers delay care-seeking for dermatological conditions [21]. Incorporating such gender-sensitive delivery strategies is therefore likely to improve both equity and effectiveness of scabies control efforts [8,9].

To enhance the policy relevance of these projections, feasible and context-specific scabies control strategies should be considered. In Pakistan, where the hyperendemic transmission can be occurred, integrating scabies control into primary health care (PHC) through routine case detection and targeted ivermectin-based MDA in high-burden districts may offer the greatest epidemiological impact, as demonstrated in other endemic settings [8,18,19]. In Afghanistan, where health system capacity is constrained by conflict, population displacement, and limited infrastructure, embedding scabies diagnosis and treatment within humanitarian, refugee, and mobile health programs, supported by trained community health workers, represents a pragmatic and scalable approach [10,21]. In Iran, where the prevalence remains relatively stable but non-negligible, school-based screening and treatment programs, coupled with strengthened dermatological surveillance within PHC, could help interrupt transmission among children, a recognized reservoir of infection [7,12,20]. Across all three settings, integrating scabies management into routine PHC services, ensuring sustained access to permethrin and ivermectin, and strengthening community awareness and early care-seeking behavior are consistent with the WHO NTDs Roadmap and are essential to moving beyond the observed epidemiological stagnation toward meaningful burden reduction [8,9]

This study has several limitations. First, it relies on modeled GBD data, which, while comprehensive, may not capture fine-grained subnational variations, especially in hard-to-reach or conflict-affected regions like Afghanistan. Second, our projections are based on historical trends and demographic shifts; they cannot account for the potential future impact of sudden policy changes, successful new control programs, or large-scale humanitarian interventions, which could alter trajectories. Third, the model assumes parameters remain constant beyond the calibration period, which may not hold true. Fourth, the analysis does not incorporate potential changes in risk factors like population displacement or climate, which could influence transmission. Finally, a further limitation is that this analysis is restricted to national-level estimates, which may obscure substantial subnational heterogeneity. Scabies transmission is often highly clustered, and localized hotspots such as specific provinces or districts in Pakistan, informal settlements, or refugee and internally displaced populations in Afghanistan may follow epidemiological trajectories that differ markedly from national averages. Consequently, while national projections are informative for high-level planning, they may underestimate the intensity and persistence of transmission in high-risk settings that are critical targets for effective scabies control programs and resource allocation

Conclusion

The epidemiological future of scabies in Afghanistan, Iran, and Pakistan until 2040, as projected by our model, is one of persistent and disproportionate burden. The stark five-fold disparity between Pakistan and its neighbors, coupled with a general trend of stagnation, highlights a critical public health gap. Effective management requires moving beyond the status quo. Bold, country-specific, and resource-appropriate control strategies are urgently needed. These must be informed by local transmission dynamics and address the specific barriers faced by vulnerable groups, particularly women and children. For Pakistan, this means initiating large-scale MDA programs. For Afghanistan and Iran, it requires integrating scabies management into primary healthcare and launching targeted community-based interventions. Without such a concerted effort, scabies will remain a significant, yet preventable, source of morbidity and reduced quality of life in these populations for generations to come.

Ethics approval

This study utilized publicly available, aggregated data from the GBD database. No individual or identifiable human or animal data were used; therefore, ethical approval and informed consent were not required.

Acknowledgments

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The authors declare no competing interests.

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