Costs of primary healthcare visits and hospitalizations for scabies and bacterial skin infections in Fiji, 2018-2019

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**Funding sources:** The Big SHIFT project was funded by the National Health and Medical Research Council (NHMRC) Australia through a Project Grant: GNT1127300 and Centre for Research Excellence: GNT1153727 as well as the Scobie and Claire Mackinnon Trust. The funders had no role in the study design, data collection, data analysis and manuscript preparation.

# Abstract

Scabies and bacterial skin and soft tissue infections (SSTIs) are highly prevalent in many tropical, low-middle income settings like Fiji. The costs of these skin conditions are important to health policy as they contribute to higher healthcare costs and burdens on healthcare systems. The Big Skin Health Intervention Fiji Trial (“Big SHIFT”) carried out surveillance for scabies and SSTIs from July 2018 to June 2019 in the Northern division of Fiji, an area with high prevalence of scabies. Using data from Big SHIFT, we sought to estimate the annual direct medical costs of scabies and SSTIs for the Northern division and extrapolate these costs to the national level. The analysis undertook a health system perspective and presents results in 2020 Fijian dollars (FJ$) and United States dollars (US$). The main resource use categories were health services (clinic visits and bed days), medications, and diagnostics. We extrapolated what the total annual number of cases and direct medical costs would be for all divisions in Fiji, using earlier data on prevalence of scabies across all divisions. The average cost per outpatient case was similar for scabies and SSTI presentations (FJ$26.9 or US$12.4 for scabies). The average cost per hospital admitted SSTI case was FJ$ 974 (US$ 449) for potentially scabies-related patients and FJ$ 1,655 (US$ 763) for unlikely scabies-related SSTI patients. The estimated annual direct medical costs of scabies and SSTIs in Fiji was FJ$ 7.1 million (approximately US$ 1.8 million), with cost per capita of FJ$ 8.0 (US$ 3.6). Scabies and SSTIs lead to a heavy economic burden in Fiji and prevention would reduce these healthcare costs.

# Introduction

Scabies is a contagious and itchy skin infestation caused by the mite *Sarcoptes scabiei* var*. hominis* that can lead to secondary bacterial skin and soft-tissue infections (SSTIs). SSTIs resulting from scabies occur when bacteria penetrate through breaches in skin caused by scratching. SSTIs range in severity from impetigo and other uncomplicated infections which can be successfully treated in primary healthcare (PHC) settings ([1](#_ENREF_1)), to necrotizing fasciitis and other severe SSTIs that require hospital admission ([2](#_ENREF_2)). In 2017, The World Health Organization (WHO) acknowledged scabies as a neglected tropical disease (NTD) following recommendation from Strategic and Technical Advisory Group for NTDs ([3](#_ENREF_3)). The Global Burden of Disease study estimates the prevalence of scabies was 2.4% (185 million) in 2019 **(**[4](#_ENREF_4)**).**

The Pacific region has the highest described prevalence globally, comprising eight out of the top ten countries with the highest age-standardized disability-adjusted life-years (DALY) due to scabies ([5](#_ENREF_5)). In Fiji, scabies prevalence was measured at 36.4% and impetigo prevalence at 23.4% in the Skin Health Intervention Fiji Trial (SHIFT) conducted between 2012–2013 among the residents of the three islands of Fiji ([6](#_ENREF_6)). In Fiji, scabies is often initially treated with traditional medicines, and many individuals only seek medical care for prolonged disease or if secondary skin infection develops ([7](#_ENREF_7)). In addition, treatment adherence of affected individuals and their household contacts is low, leading to ongoing disease and perpetuation of community transmission contributing to an increased burden on the health system. In 2016, the Fiji Government released its annual Health Status Report revealing SSTIs caused 4.3% of mortality within the country ([8](#_ENREF_8)). Prolonged illness and death potentially lead to higher cost and larger burdens on health systems and the overall economy.

There is limited evidence globally around the cost of scabies and SSTIs, although the described need for healthcare services suggests a high economic burden. A 2018 cost-of-illness analysis for treating crusted scabies among Aboriginal communities in the Northern Territory of Australia found expected health care cost per patient diagnosed with crusted scabies was over 35,000 Australian dollars. We found no cost-of-illness study on of scabies or SSTIs from the Pacific. Quantifying these costs will give a more accurate estimate of the global burden of scabies, further delineate the benefits of scabies control and inform future evaluation of scabies prevention programs. Therefore, we sought to estimate the annual direct medical costs of scabies and SSTIs in Fiji.

Methods

## Study design and setting

The Northern Division, with a population of 131,914 people in 2017, is one of four primary administrative units of Fiji. Healthcare in Fiji comprises a government-run public healthcare system and a private healthcare sector ([9](#_ENREF_9)). Government health facilities provide most healthcare services, which are free to the public or provided at very low out-of-pocket cost. Public health facilities charge user fees for some services, but these fees are modest and some groups such as children under 15 years of age are exempted from these charges. In 2020, about FJ$300 million from Fiji government’s revenue was allocated to health purposes. Private providers are mainly situated in urban areas and their services are used mostly by people with formal employment.

The Big Skin Health Intervention Fiji Trial (Big SHIFT) was a before-after intervention trial of ivermectin-based mass drug administration delivered to the whole population of the Northern Division of Fiji ([10](#_ENREF_10)). Before drug administration, Big SHIFT established a monthly reporting system at all public healthcare facilities for presentations of scabies and SSTIs over a 50-week period (from 16 July 2018 to 30 June 2019) ([1](#_ENREF_1)). Data on patients presenting to the outpatient departments at subdivisional hospitals, health centers and nursing stations were collected by reviewing registers monthly. Data on scabies in children was also collected from records of the Integrated Management of Childhood Illness (IMCI) clinics through maternal and childcare nurses. Staff at all primary healthcare facilities reported presentations of scabies and the following SSTIs: infected scabies, impetigo, cellulitis, abscess, and severe SSTIs. We included all scabies and SSTI cases diagnosed in general outpatient departments, emergency departments, IMCI clinics, during school visits, and during community outreaches. Staff collected data regarding treatment, such as the antibiotic prescribed, surgical procedures performed, referral to a larger health facility, and day admission in the health facility. Diagnosis of scabies was made according to the criteria in the International Alliance for the Control of Scabies (IACS) guidelines ([11](#_ENREF_11)).

The trial also carried out prospective surveillance of SSTI admissions at the divisional hospital in Labasa over a 48-week period (between July 16 2018 and June 30 2019, with a 2-week break between 24 December 2018 and 6 January 2019) ([2](#_ENREF_2)). Cases of scabies and SSTIs were identified by reviewing admission registries and case notes of all newly admitted cases at the hospital daily. A verbal confirmation was done with the nurse in charge of each ward. Informed consent was obtained from suitable patients to be included in the study. The microbiology laboratory records in the hospital were reviewed for skin swabs to identify potential cases for enrolment in our study ([11](#_ENREF_11)). Hospital admissions for SSTIs were categorized into two groups: those potentially scabies-related (abscess, impetigo, cellulitis, pyomyositis, crusted scabies, infected scabies, necrotizing fasciitis with pure growth of Staphylococcus aureus or group A Streptococcus), and those unlikely to be scabies related (wound infections, surgical wound infections, and necrotizing fasciitis without pure growth of Staphylococcus aureus or group A Streptococcus) ([2](#_ENREF_2)).

## Costing procedure

We conducted a cost-of-illness study to estimate the cost per case of scabies and SSTIs from a health system perspective using baseline data from the Big SHIFT trial. We undertook a health system perspective because public provision of most outpatient and inpatient care is free in Fiji and user fees are insignificant to the overall health expenditure in government facilities ([9](#_ENREF_9)). The main resource use categories were health services clinic visits, diagnostic procedures, and medicines. Adopting a health systems perspective meant we did not consider costs of productivity losses from premature death or SSTI-related work absenteeism. The costs of all new cases of scabies were estimated with respect to their treatment in two settings. The first was patients with scabies who received primary health services at outpatient settings such as IMCI clinics, general outpatient clinics, emergency departments, school visits, and during community outreaches. These are referred to as primary healthcare (PHC) presentations. The second was patients with scabies and SSTI admitted to Labasa Hospital, the main referral hospital in the Northern Division of Fiji (referred to hereafter as hospital admissions).

We measured the frequency of healthcare service use for primary healthcare visits and hospitalizations as the number of PHC presentations and hospital bed days, respectively. We assumed that patients admitted during PHC presentations only stayed at the facility for one night. Our hospital admissions dataset included the number of days spent in intensive care unit (ICU), so this number was subtracted from the total hospital bed days to yield the number of bed days in general wards. The data did not include follow-up visits and repeated presentations for the same condition. The number of diagnostic procedures was calculated as the sum of skin swabs, blood cultures, and tissue cultures taken from patients admitted to the hospital.

To estimate the quantities of medications, we supplemented the utilization data collected in the trial with published treatment guidelines scabies and SSTIs in Fiji ([12](#_ENREF_12), [13](#_ENREF_13)). For outpatient cases, we did not have the names of medications prescribed, but only the formulations. Therefore, using the guidelines, we considered patients treated with topical medications were given Permethrin cream for scabies infestations. We considered that to treat the whole family as recommended in the guidelines, one tube of the cream would be sufficient. Similarly, we used benzathine penicillin injection (single dose) and co-trimoxazole (five days dosage) for those given injection and oral medications, respectively. These medications are the recommended treatment of scabies-related SSTIs (cellulitis, abscess, and impetigo).

The hospital admissions dataset included the name of medication and number of days prescribed during admission and on discharge, but not the dosage. Therefore, we categorized patients into age groups (less than 5 years, 5 to 9 years, 10 to 14 years, and 15 years and above), and then calculated the dosage using the median weight of the average age for each age group based on WHO child growth standards ([14](#_ENREF_14)). For instance, a body weight of 11kg is used for a patient less than 5 years old because that is the median weight of a 2 year 6 months old child ([14](#_ENREF_14)). If the child was prescribed Cloxacillin injection (dosage 50mg/kg up to 2000mg daily every six hours), we assumed the dose is 550mg and the daily dose is 2200mg. Each vial of cloxacillin contains 500mg, so five vials (2500mg) would be sufficient for one day. Finally, where the dosage calculated was greater than the recommended adult dose, the adult dose was used instead. S1 table contains the daily quantities of oral and injection medications used in the costing exercise.

Each unit of resource utilized by each individual patient was multiplied by unit prices (Table 1) to estimate the cost of each resource utilized by the individual patient. The unit costs of a hospital bed-day, ICU bed-day, and laboratory tests were obtained from a 2012 costing study of selected health facilities in Fiji ([15](#_ENREF_15)) and WHO-CHOICE estimates for healthcare service costs per bed-day (for hospitalized patients) or per outpatient visit at tertiary level hospitals in Fiji ([16](#_ENREF_16), [17](#_ENREF_17)). The WHO-CHOICE estimates included personnel (healthcare providers and support staff salary), capital, and patients food costs but excludes the cost of drugs and diagnostic tests ([17](#_ENREF_17)). The Fiji study reports cost estimates of various healthcare services in two hospitals (Lautoka Hospital and Colonial War Memorial Hospital (CWMH)) and Nausori PHC in Fiji. We used the same unit costs for patients admitted during PHC presentations, because the unit costs for Nausori PHC was higher than that of the two hospitals in the costing study ([15](#_ENREF_15)).

We used unit cost of outpatient visits in Nausori PHC as the base case for PHC presentations in our study. We had three estimates available for the cost per bed day (Lautoka, CWMH, and WHO-CHOICE), so we used the median of the three values (CWMH) as the base case for those admitted to general wards. We had two estimates for cost per bed day in ICU (Lautoka and CWMH), so we used the average of the two values as the base case for those in ICU. Also, we had two estimates for cost per laboratory test (Lautoka and CWMH), so we used the average of the two values as the base case for every test. Cost of surgical procedures were not estimated separately because it was captured in the unit cost of hospital bed-days based on the Irava costing study. Lastly, unit costs of medicines were largely based on procurement prices collected at CWMH Pharmacy, and supplemented with Fijian Competition and Consumer Commission (FCCC) ([18](#_ENREF_18)), or the third edition of ‘Fiji Essential Medicines List’ published in 2013, where unit costs unavailable ([13](#_ENREF_13)).

Table 1. Unit costs (in 2020 Fiji dollars) used in the costing study.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Base case**  **(low—high)** | **Source and notes** |
| Cost per outpatient visit | 25.2  (12.7—63.1) | Base case is the estimate for Nausori PHC facility, reported in Irava ([15](#_ENREF_15)). Low value is the estimate from WHO-CHOICE for a PHC facility with beds ([17](#_ENREF_17)). High value is for Lautoka hospital in Irava ([15](#_ENREF_15)). |
| Cost per hospital bed-day (ward) | 122.1  (94.0—132.9) | Base case is the estimate for CWMH reported in Irava costing study ([15](#_ENREF_15)). Low value is the estimate from WHO-CHOICE for a tertiary hospital ([17](#_ENREF_17)). High value is for Lautoka hospital, reported in Irava ([15](#_ENREF_15)). |
| Cost per hospital bed-day (ICU) | 547.8  (259.1—836.6) | Low and high values use estimates for CWMH and Lautoka hospital, reported in Irava ([15](#_ENREF_15)). Base case is average of the two values. |
| Cost per laboratory test | 28.3  (24.6—32.1) | Low and high values use estimates for CWMH and Lautoka hospital, reported in Irava ([15](#_ENREF_15)). Base case is average of the two values. |
| Cost of medicines | see S2 Table | FCCC prices (Quarter 1 2020) and Fiji essential medicines list, 3rd edition. |

CWMH, Colonial War Memorial Hospital; FCCC, Fijian Competition and Consumer Commission; ICU, intensive care unit; PHC, primary healthcare; WHO, World Health Organization; CHOICE, choosing Interventions that are cost-effective.

## Cost analysis

### Direct medical costs per case

The cost of each resource utilized by an individual patient was added to obtain the average direct medical cost of treatment of one case, separately by principal diagnoses. Principal diagnoses for hospital admitted cases were categorized into two groups: potentially scabies-related admissions; and unlikely scabies-related admissions ([2](#_ENREF_2)).

Costs are reported in 2020 Fijian dollars (FJ$) and United States dollars (US$). Costs obtained in previous years were adjusted to 2020 prices using the gross domestic product implicit price deflator following best practice guidance ([19](#_ENREF_19)). Costs obtained in previous years and different currencies were converted to Fijian Dollar using the exchange rate in that year ([20](#_ENREF_20)), before adjusting to 2020 prices. Given that scabies is usually an acute disease with a relatively short duration of illness, and we do not account for any healthcare costs accruing beyond one year, discounting was not applied ([21](#_ENREF_21)).

### Total annual direct medical costs

We also estimated the total annual direct medical costs of scabies and SSTIs in the Northern Division. Additionally, we extrapolated this total cost to the other primary administrative units in Fiji, to estimate the overall annual economic burden of scabies and SSTIs at national level.

To do this, we first converted the incidence rates for scabies presentations, SSTI presentations, potentially scabies-related admissions, and unlikely scabies-related admissions into a risk of infections over one year, using the following formulae:

Then, we calculated the risk ratio (RR) of scabies- or non-scabies related infections for each of the four categories using the odds ratio (OR) of scabies infestation between the Northern division and other Fiji divisions, and assuming the same ratio holds for SSTIs. A study by Romani ([22](#_ENREF_22)) indicated that scabies was most prevalent among residents of the Northern division compared with other regions (adjusted OR, 1.3).

From this risk ratio, we calculated the risk of infections for all other divisions in Fiji:

The final step in estimating the total annual number of cases was multiplying the risk of infection with the population for Northern division of Fiji (131,914) and other Fiji divisions (752,973) based on 2017 Fiji population census data and summing up the values.

The total number of cases was then multiplied by the respective average per case direct medical costs (separately for scabies presentations, SSTI presentations, potentially-scabies-related admissions, and unlikely scabies-related admissions). The total scabies-related cost was calculated by adding costs of scabies presentations to costs of potentially scabies-related admissions. Likewise, the non-scabies-related cost was calculated by adding costs of SSTI presentations to costs of unlikely scabies-related admissions. The total direct medical cost was calculated by adding the costs of all presentations and all admissions.

### Sensitivity analysis

A one-way sensitivity analysis was conducted to examine how sensitive the cost estimates are to variations in unit cost given the underlying uncertainty in some of the key unit cost input estimates. Patients presenting to outpatient settings were seen in various settings (general outpatient departments, emergency departments, IMCI clinics, during school visits, and during community outreaches). Therefore, we used WHO CHOICE health center with beds as lower value (all were seen in PHCs or clinics) and Lautoka hospital (assuming all were seen in subdivisional or divisional hospital) as higher value. WHO-CHOICE estimates for cost per hospital bed day were lower than those in the 2012 Fiji costing study, so we used the WHO-CHOICE estimates as the lower value and higher of the two hospitals in the costing study (Lautoka hospital) as the higher estimate to examine potential variations in hospital bed-day unit cost. For ICU, our base case used an average of estimates in Irava ([15](#_ENREF_15)), so we used the lesser of the two values (Lautoka Hospital) as the low value and the greater (CWMH) as the high value. For laboratory tests, used wide (±50%) variation to reflect reasonable uncertainty. The results of the sensitivity analysis were reported in a tornado chart.

All analyses were conducted using R version 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria).

## Ethics statement

The study was performed as part of the Big SHIFT trial investigating the effects of ivermectin-based mass drug administration for the control of scabies and SSTIs (trial ID: ACTRN12618000461291). Ethical approval for Big SHIFT was granted by the Fiji National Health Research Ethics Review Committee (reference number: 2018.38.NOR) and the Royal Children’s Hospital Human Research Ethics Committee in Melbourne, Australia (reference number: 38020). Written informed consent was obtained from all study participants who had hospital admission data collected. Consent of a parent or legal guardian was taken if the participant was less than 18 years of age. The collected information was entered into the study database and each case was assigned a case number to maintain confidentiality. data collected from primary health surveillance was deidentified and did not require individual informed consent.

# Results

## Patient characteristics

**Table 1** describes the characteristics of all patients categorized by whether the primary reason for presentation or hospitalization was scabies-related. Over a 50-week period between July 2018 and June 2019, a total of 13,736 patients presented to PHC facilities with SSTIs of which, 26.5% (3,643 patients) were diagnosed with scabies. Over 80% of PHC presentations were patients from iTaukei ethnicity. At the time of presentation, the median age was 5 years for scabies patients and 15 years for SSTI patients. Of the patients examined in PHC facilities, 108 patients required admission to the health facility.

In the 48-week surveillance period, 788 patients were admitted to hospitals with SSTIs, with clinical data available for 748 patients that provided consent for BigSHIFT to obtain demographic and clinical data. For hospital admissions, the median age was similar for potentially scabies-related and unlikely scabies-related SSTIs admissions. The median length of hospital stay was 5 days for hospitalized patients with potentially scabies-related SSTIs and 5 days for patients with unlikely scabies-related SSTIs.

Table 2. Characteristics of primary health care and hospitalized patients with skin and soft tissue infections between July 2018 and June 2019 in Northern Division, Fiji.

| **Characteristic** | **PHC presentations** | | **Hospital admissions** | |
| --- | --- | --- | --- | --- |
|  | Scabies, N=3,643 | SSTIs, N=10,093 | Potentially scabies-related SSTIs, N=569 | Unlikely scabies-related SSTIs, N=179 |
| Sex, no. (%) |  |  |  |  |
| Male | 1,914 (53%) | 5,560 (55%) | 299 (53%) | 105 (59%) |
| Female | 1,706 (47%) | 4,481 (45%) | 270 (47%) | 74 (41%) |
| Age in years, median (IQR) | 5 (1, 9) | 15 (3, 36) | 33 (9, 55) | 35 (21, 54) |
| Age category in years, no. (%) |  |  |  |  |
| 0-4 | 2,009 (55%) | 3,182 (32%) | 110 (19%) | 12 (6.7%) |
| 5-14 | 1,228 (34%) | 1,907 (19%) | 68 (12%) | 21 (12%) |
| 15+ | 384 (11%) | 4,814 (49%) | 391 (69%) | 146 (82%) |
| Ethnicity, no. (%) |  |  |  |  |
| I-Taukei | 3,080 (86%) | 8,160 (82%) | 384 (67%) | 124 (69%) |
| Others | 482 (14%) | 1,782 (18%) | 185 (33%) | 55 (31%) |
| Residence, no. (%) |  |  |  |  |
| Urban | 1,723 (47%) | 5,227 (52%) | NA | NA |
| Rural | 1,920 (53%) | 4,866 (48%) | NA | NA |
| Bed days, median (IQR) | NA | NA | 5 (3, 8) | 7 (4, 15) |

Percentages may not total 100 due to rounding. IQR, interquartile range; NA, not available; PHC, primary healthcare; SSTIs, skin and soft tissue infections.

## Health service utilization and costs

### Primary health care patients

Table 3summarizes the resource utilization and costs for scabies and SSTI presentations to PHCs, with additional details provided in S3 Table. Topical medications were prescribed for 2,972 (81.6%) patients presenting with scabies but only 1.4% of SSTI patients (S4 Table). Oral antibiotics were prescribed for 1,508 (41.4%) of scabies patients and 84.3% of patients presenting with SSTIs only. Intramuscular antibiotics were prescribed for 26.8% of scabies patients and 50.8% of SSTI patients. Though topical permethrin is the first-choice skin cream for scabies in Fiji, a sizeable proportion of patients presenting with scabies also received oral and injection medications. This is likely because it is usual very common to have to treat children with scabies for other SSTIs like cellulitis, or abscess, or impetigo using benzathine penicillin G injection or oral co-trimoxazole (Septrin). The average cost per outpatient case was similar for scabies and SSTI presentations (F$26.8 or US$12.4) (Table 3).

Table 3. Mean (standard deviation) costs per patient in 2020 Fiji dollars by resource use category of scabies- and non-scabies-related SSTIs in Northern Division, Fiji

| **Characteristic** | **PHC presentations** | | **Hospital admissions** | |
| --- | --- | --- | --- | --- |
|  | Scabies, N=3,643 | SSTIs, N=10,093 | Potentially scabies-related SSTIs, N=569 | Unlikely scabies-related SSTIs, N=179 |
| Health services | 25.3 (3.5) | 26.4 (12.4) | 911 (999) | 1,547 (1,792) |
| Medications | 1.6 (0.9) | 1.6 (0.9) | 42 (54) | 82 (153) |
| Diagnostic tests | 0.0 (0.0) | 0.0 (0.0) | 22 (17) | 26 (12) |
| Mean total costs | 26.9 (3.6) | 28.0 (12.3) | 974 (1,036) | 1,655 (1,872) |

Values in parenthesis are standard deviations. PHC, primary healthcare; SSTIs, skin and soft tissue infections.

### Hospitalized patients

The mean length of hospital stay for all patients was 8.0 days (potentially-scabies SSTIs, 6.9 days; unlikely-scabies SSTI, 11.6 days). 19.5% of all patients had a length of stay of longer than 10 days and 6.6% longer than 20 days. Figure 1 shows the distribution of hospital bed days per admitted case. 3.9% of potentially scabies-related SSTIs and 5.6% of unlikely scabies SSTI patients were admitted to the ICU. The length of stay in ICU ranged from 1 day to 8 days. All admitted cases required antibiotics with flucloxacillin and cloxacillin being the most frequently prescribed oral and injectable antibiotic, respectively. Injectable antibiotics were prescribed for a mean duration of 4.9 days and 6.7 days for potentially-scabies and unlikely-scabies SSTI patients, respectively. Oral antibiotics were prescribed for a mean duration of 8.6 days (similar for both groups of patients). Common surgeries for skin infections includes incision and “drainage”, dressing and debridement, and limb amputation. 64.2% of patients required surgery (similar for both groups of patients); though a higher proportion of patients with unlikely scabies patients (6.7%) compared with potentially scabies patients (1.1%) required amputation. Laboratory tests (including blood cultures, tissue cultures, and skin swabs) were conducted among 72% of patients.

A graph of scabies

Description automatically generated

Figure 1. Distribution of number of bed days per hospital admitted case of SSTIs.

The average cost per hospital admitted case was FJ$ 974 for potentially scabies-related and FJ$ 1,655 for unlikely scabies-related SSTI patients (Table 3). For potentially scabies-related, the average ward bed day cost was FJ$821, and ICU bed-day cost was FJ$90 per patient. For unlikely scabies-related, the average ward and ICU bed day costs were FJ$1,373 and FJ$174, respectively. In both cases, about 93% of direct medical costs were for hospital bed days. No costs are recorded for surgical procedures (including amputation), because these are assumed to be incorporated in the cost per bed day, based on the unit cost estimate from the Irava 2010 costing study ([15](#_ENREF_15))

## Total annual healthcare costs for Fiji

Extrapolating the data from the Northern Division to the rest of Fiji, the estimated annual number of PHC presentations was 75,685, and the estimated number of hospital admissions was 4,378 (equivalent to about 35,000 of hospital bed days) across all Fiji divisions (Table 4). The estimated annual direct medical costs of scabies- and non-scabies-related SSTIs in Fiji between 2018 and 2019 is FJ$ 7.0 million (FJ$ 3.8 million for scabies-related infections and FJ$ 3.2 million for non-scabies infestations). One-way sensitivity analysis indicated that variations in the cost per outpatient visit had the biggest influence on the total cost of scabies and SSTIs in Fiji (Figure 2). In all sensitivity analysis, the lowest annual cost was at least FJ$ 6.1 million.

Table 4. Estimated total annual number of cases, hospitalizations, and costs (in 2020 Fiji dollars) of scabies- and non-scabies-related SSTIs, extrapolated to all four divisions in Fiji based on 2017 census figures.

| Component | Scabies or scabies-related SSTIs | Non-scabies related SSTIs | Both scabies and other SSTIs |
| --- | --- | --- | --- |
| Number of PHC presentations | 20,311 | 55,374 | 75,685 |
| Number of hospital admissions | 3,330 | 1,048 | 4,378 |
| Cost of PHC presentations only | 545,962 | 1,552,275 | 2,098,237 |
| Cost of hospital admissions only | 3,244,966 | 1,734,721 | 4,979,687 |
| Total cost for PHC and hospital | 3,790,928 | 3,286,996 | 7,077,924 |
| Cost per capita (person) | 4.3 | 3.7 | 8.0 |

PHC, primary healthcare; SSTI, skin and soft tissue infection

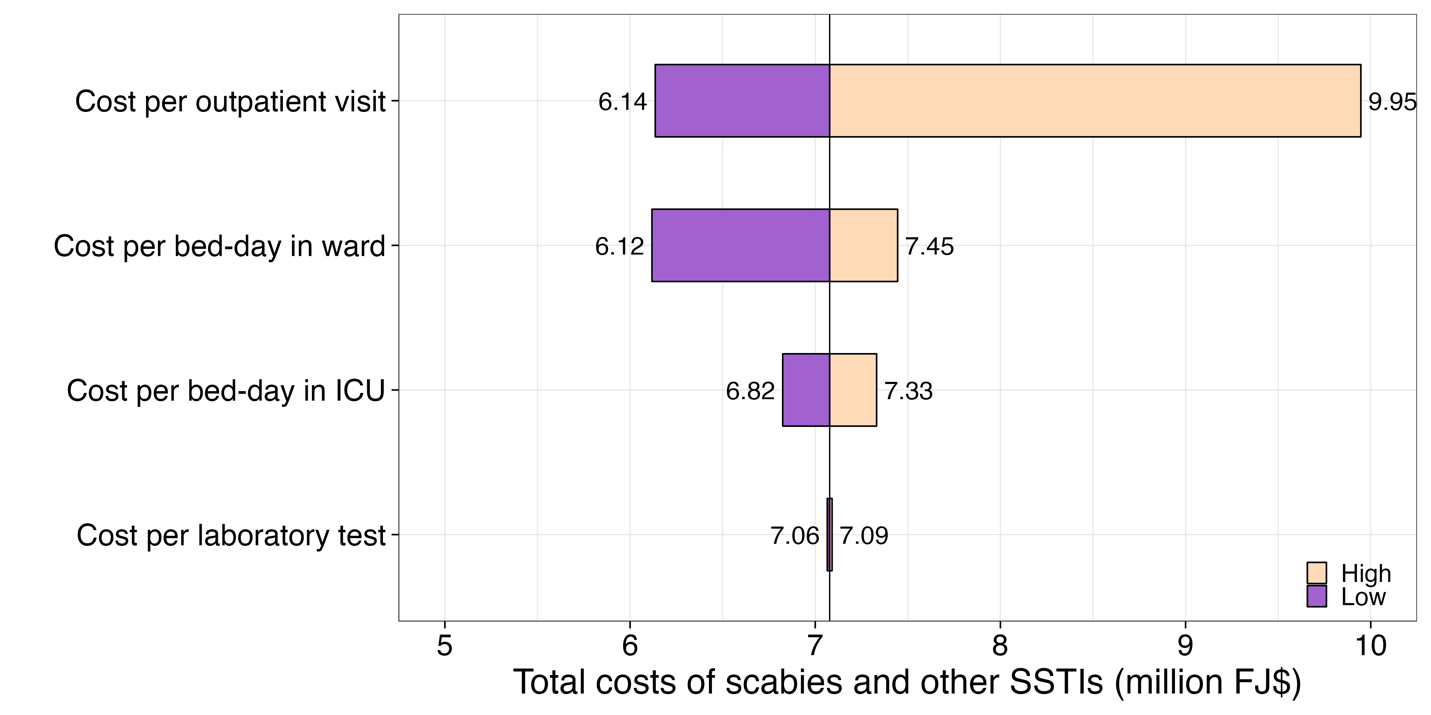


Figure 2. Total costs (in 2020 FJ$) of scabies and non-scabies skin and soft-tissue infections

# Discussion

Our study provides a first estimate of the healthcare resource use and costs of treating scabies in a highly prevalent setting prior to a mass drug administration programme. We used before-intervention data BigSHIFT trial and extrapolated these costs to the entire country. The trial provided rich information on PHC presentation and hospital admissions for scabies-and non-scabies-related SSTIs. The estimated annual direct medical costs of scabies and SSTIs in Fiji was FJ$ 7.1 million (approximately US$ 1.8 million), equivalent to 2.4% of government revenues allocated to health in 2020. Scabies and SSTIs therefore lead to a heavy economic burden in Fiji and could benefit from prevention programs.

The average costs in this study were generally lower than other estimates which were carried out in high income countries. The average cost per patient with scabies and SSTI for hospital admitted cases in our study was US$ 736 compared to the estimated annual cost described in an Australian setting for treatment of one case of pediatric scabies and pyoderma in a hospitalized setting was US$ 10,499 in 2019 ([23](#_ENREF_23)). In our study, the average cost of treatment of a case of scabies in an outpatient setting was US$ 126.9 compared to the average cost of treating a case of scabies in outpatient care in the United States was US$ 216 in 2019 ([24](#_ENREF_24)), where the cost estimate was based on claims for a privately insured population. WHO-CHOICE estimates show that healthcare services in USA and Australia are generally more expensive when compared to Fiji, so this is a possible explanation for the difference. Because these contexts were very different from Fiji, we did not explore more explanations.

The main resource use category contributing to costs was hospital bed days. Length of stay generally higher for non-scabies patients (11.6 days) compared to potentially-scabies SSTIs (6.9 days). The mean length of stay in our study (8.0 days) was higher than the mean of 4.5 reported an Australian study on children with pyoderma presumed to have scabies ([25](#_ENREF_25)). It is plausible that delayed detection and normalization of skin infections contribute to complications of scabies. In scabies endemic countries like Fiji, patients may not seek treatment of scabies unless it creates a significant disturbance to their quality of life ([26](#_ENREF_26)). Additionally, in our study injectable antibiotics were prescribed for most hospital admitted cases which might have increased average length of stay for all admitted since these medications need to be administered while admitted. The average cost of medicines for outpatient scabies in our study was $1.6 (2019 USD), which was similar to the estimated cost of medicines for treatment of outpatient pneumonia in Fiji ([27](#_ENREF_27)). In that study, the average cost of medicines ranged from $1.3 for Nausori PHC and to $2.6 for CWMH (in 2020 USD values).

A strength of this study is that it analyses the primary healthcare data obtained from a trial that was conducted among the entire population of the Northern Division of Fiji, including the children and the elderly. However, hospital surveillance was only possible at Labasa hospital, the referral center in Macuata subdivision of the Northern Division. About 74% of all admissions to Labasa hospital was among residents of Macuata division. By using data from this hospital to extrapolate from Northern Division to other divisions, we have underestimated the overall burden. Another way we might have underestimated the burden is by missing out on SSTI cases that were not recognized by clinicians or the cases that were recognized and treated but not included in patient records. Finally, because scabies is generally normalized by clinicians in endemic settings, the lesser reliance on hospitals and clinics for diagnosis and treatment may lead to under-reporting of cases. This is especially relevant in Fiji where many people choose traditional medical remedies for scabies treatment in Fiji ([7](#_ENREF_7)).

We used micro-costing approach in this study, involving direct quantification and costing of each resource use item. However, the doses of medicine given to patients were not available in our dataset; thus, we estimated the dose based on Fiji Antibiotic Guidelines ([12](#_ENREF_12)). It is likely that depending on clinicians, the doses of medicine would vary between clinical practice and recommendations from the guidelines. Thus, the estimated doses may not exactly correspond to the actual dose of medicines prescribed to the patients in this study. Data on resource use for of managing recurrent SSTI cases, for containing institutional outbreaks, non-medical costs like transportation, and indirect costs were not collected in the BigSHIFT study, which precluded adopting a societal perspective.

Notwithstanding the limitations above, our study contributes to a sparse literature on the direct medical costs of scabies and SSTIs in high prevalence settings. We find that scabies imposes a substantial economic loss to the government in relation to costs and healthcare resource utilization and the true cost is likely to be much higher than what was calculated since under-recognition of scabies is a common problem in highly endemic and resource-limited settings. Initial investment in scabies prevention and control might reduce the direct and indirect cost of treating scabies in the long term. This is the first study to provide an estimate of the cost of illness associated with scabies and SSTIs in the Pacific, an area with the highest burden of scabies. Our findings may be relevant to other countries in the Pacific, where the burden of scabies and the costs of treatment are likely to be similar to that of Fiji. Further research is needed to explicitly model the net economic burden of scabies and the cost effectiveness of preventive interventions for scabies in Fiji such as mass drug administration.

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Supplementary Tables

S1 Table. Daily quantities and unit costs (in Fijian dollar) of oral and injection medications

| Medication name | Strength | Pack size | Cost per pack | Unit cost | Cost year | Source |
| --- | --- | --- | --- | --- | --- | --- |
| Injection cloxacillin 500mg | 500mg | 1 | 0.76 | 0.76 | 2013 | Fiji essential medicines list 2013 |
| Injection gentamicin 80mg/2mL | 80mg/2mL | 1 | 0.12 | 0.12 | 2013 | Fiji essential medicines list 2013 |
| Injection penicillin procaine 4 million IU | 4 million IU | 1 | 1.41 | 1.41 | 2013 | Fiji essential medicines list 2013 |
| Injection metronidazole 500mg/100mL | 500mg/100mL | 1 | 1.80 | 1.80 | 2013 | Fiji essential medicines list 2013 |
| Injection erythromycin 1000mg | 1000mg | 1 | 10.17 | 10.17 | 2013 | Fiji essential medicines list 2013 |
| Injection ceftriaxone 1000mg | 1000mg | 1 | 2.47 | 2.47 | 2013 | Fiji essential medicines list 2013 |
| Injection ciprofloxacin 100mg/50mL | 100mg/50mL | 1 | 6.30 | 6.30 | 2013 | Fiji essential medicines list 2013 |
| Injection meropenem 1000mg | 1000mg | 1 | 40.00 | 40.00 | 2020 | ~~Assumed price (awaiting info)~~ |
| Injection septrim 480mg/5mL | 480mg/5mL | 1 | 1.80 | 1.80 | 2013 | ~~Assumed price (awaiting info)~~ |
| Injection penicillin G 4 million IU | 2.4 million IU | 1 | 0.95 | 0.95 | 2013 | Essential medicines list 2013 |
| Oral flucloxacillin 500mg | 500mg | 500 | 76.35 | 0.15 | 2020 | FCCC Fiji authorization 2020 |
| Oral penicillin 250mg | 250mg | 50 | 5.23 | 0.10 | 2020 | FCCC Fiji authorization 2020 |
| Oral amoxycillin 500mg | 500mg | 500 | 59.36 | 0.12 | 2020 | FCCC Fiji authorization 2020 |
| Oral metronidazole 200mg | 200mg | 500 | 14.28 | 0.03 | 2020 | FCCC Fiji authorization 2020 |
| Oral erythromycin 250mg | 250mg | 1,000 | 192.65 | 0.19 | 2020 | FCCC Fiji authorization 2020 |
| Oral doxycycline 100mg | 100mg | 1,000 | 192.65 | 0.19 | 2020 | Assumed price of erythromycin |
| Oral cephalexin 500mg | 500mg | 500 | 76.35 | 0.15 | 2020 | Assumed price of flucloxacillin |
| Oral septrim 480mg | 480mg | 1,000 | 33.75 | 0.03 | 2020 | FCCC Fiji authorization 2020 |
| Oral suspension flucloxacillin 125mg/5mL (100mL) | 125mg/5mL (100mL) | 1 | 2.35 | 2.35 | 2020 | FCCC Fiji authorization 2020 |
| Oral suspension penicillin 125mg/5mL (100mL) | 125mg/5mL (100mL) | 1 | 2.99 | 2.99 | 2020 | FCCC Fiji authorization 2020 |
| Oral suspension amoxycillin 125mg/5mL (100mL) | 125mg/5mL (100mL) | 1 | 1.71 | 1.71 | 2020 | FCCC Fiji authorization 2020 |
| Oral suspension metronidazole 200mg/5mL (100mL) | 200mg/5mL (100mL) | 1 | 1.05 | 1.05 | 2020 | Assumed price of septrim |
| Oral suspension erythromycin 125mg/5mL (100mL) | 125mg/5mL (100mL) | 1 | 2.46 | 2.46 | 2020 | FCCC Fiji authorization 2020 |
| Oral suspension doxycycline |  |  |  |  | 2020 | No such formulation |
| Oral suspension cephalexin 125mg/5mL (100mL) | 125mg/5mL (100mL) | 1 | 2.35 | 2.35 | 2020 | Assumed price of flucloxacillin |
| Oral suspension septrim 240mg/5mL (100mL) | 240mg/5mL (100mL) | 1 | 1.05 | 1.05 | 2020 | FCCC Fiji authorization 2020 |

S2 Table. Recommended doses for oral and injection medications in Fiji Antibiotics Guidelines

| Medication name | Dosing guide |
| --- | --- |
| Injection cloxacillin | 2000mg (child:50mg/kg up to 2g ) 6 hourly |
| Injection gentamicin | 3.2mg/kg up to 320mg daily |
| Injection penicillin | 1.5 million units (child: 50,000 units/kg up to 1.5 million units) daily |
| Injection metronidazole | 500mg (child: 12.5mg/kg up to 500mg) 12-hourly |
| Injection erythromycin | 500mg (child: 25 mg/kg up to 500mg) 6-hourly |
| Injection ceftriaxone | 2000mg (child: 50 mg/kg up to 2g) daily |
| Injection ciprofloxacin | 400mg (child:10mg/kg up to 400mg) 12-hourly |
| Injection meropenem | 1000mg (child: 20mg/kg up to 1g) 8-hourly |
| Suspension flucloxacillin | 500mg (child 12.5mg/kg up to 500mg) 6-hourly |
| Oral capsules flucloxacillin | 500mg (child 12.5mg/kg up to 500mg) 6-hourly |
| Suspension penicillin | 500mg (child: 12.5 mg/kg up to 500 mg) orally, 6-hourly |
| Oral tablets penicillin | 500mg (child: 12.5 mg/kg up to 500 mg) orally, 6-hourly |
| Suspension amoxycillin | 1000mg (child: 25mg/kg up to 1 g) 8-hourly |
| Oral capsules amoxycillin | 1000mg (child: 25mg/kg up to 1 g) 8-hourly |
| Suspension metronidazole | 400mg (10mg/kg up to 400mg ) 12-hourly |
| Oral tablets metronidazole | 400mg (10mg/kg up to 400mg ) 12-hourly |
| Suspension erythromycin | 500mg (child:10mg/kg up to 500mg) 6-hourly |
| Oral tablets erythromycin | 500mg (child:10mg/kg up to 500mg) 6-hourly |
| Oral capsules doxycycline | 100mg (child 8 years+: 2mg/kg up to 100mg) 12-hourly |
| Suspension cephalexin | 500mg (child: 12.5mg/kg up to 500mg) 6-hourly |
| Oral capsules cephalexin | 500mg (child: 12.5mg/kg up to 500mg) 6-hourly |
| Suspension septrim | 960mg (child: 24mg/kg up to 960mg) 12-hourly |
| Oral tablets septrim | 960mg (child: 24mg/kg up to 960mg) 12-hourly |

S3 Table. Healthcare resource utilization and costs (in 2020 Fiji dollars) of primary healthcare presentations for scabies- and non-scabies-related SSTIs in Northern Division, Fiji.

|  | Proportion of patients (%) | | Mean ± SD cost per patient ($) | |
| --- | --- | --- | --- | --- |
| **Characteristic** | Scabies | Non-scabies | Scabies | Non-scabies |
| Clinic visits | 100.0 | 100.0 | 25.2 ± 0.0 | 25.2 ± 0.0 |
| Bed days | 0.1 | 1.0 | 0.1 ± 3.5 | 1.3 ± 12.4 |
| Medications, topical | 81.6 | 1.4 | 0.7 ± 0.4 | 0.0 ± 0.1 |
| Medications, oral | 41.4 | 84.3 | 0.4 ± 0.5 | 0.7 ± 0.3 |
| Medications, injection | 26.8 | 50.8 | 0.5 ± 0.8 | 0.9 ± 0.9 |
| Procedure, surgical | 0.0 | 0.5 | 0.0 ± 0.0 | 0.0 ± 0.0 |
| Total per patient |  |  | 26.9 ± 3.6 | 28.0 ± 12.3 |

S4 Table. Healthcare resource utilization and mean costs (in 2020 Fiji dollars) of hospital admissions with scabies- and non-scabies-related SSTIs in Northern Division, Fiji

|  | Proportion of patients (%) | | Mean ± SD cost per patient ($) | |
| --- | --- | --- | --- | --- |
| **Characteristic** | Potentially scabies-related | Unlikely scabies-related | Potentially scabies-related | Unlikely scabies-related |
| Bed days, general ward | 100.0 | 100.0 | 821.4 ± 759.9 | 1,372.7 ± 1,502.1 |
| Bed days, intensive care | 3.9 | 5.6 | 89.5 ± 525.1 | 174.4 ± 836.3 |
| Medications, oral | 92.6 | 92.2 | 7.6 ± 25.1 | 6.3 ± 12.2 |
| Medications, injection | 97.7 | 95.0 | 34.4 ± 42.4 | 76.1 ± 153.2 |
| Procedure, surgical | 63.3 | 67.0 | 0.0 ± 0.0 | 0.0 ± 0.0 |
| Procedure, amputation | 1.1 | 6.7 | 0.0 ± 0.0 | 0.0 ± 0.0 |
| Diagnostics, blood culture | 16.2 | 15.0 | 4.6 ± 10.5 | 4.2 ± 10.2 |
| Diagnostics, tissue culture | 1.1 | 0.6 | 0.3 ± 2.9 | 0.2 ± 2.1 |
| Diagnostics, skin swab | 65.1 | 83.8 | 18.4 ± 13.5 | 23.7 ± 10.5 |
| Total per patient |  |  | 974.5 ± 1,035.5 | 1,655.3 ± 1,872.2 |