Feasibility study of the prevalence of latent tuberculosis infection for Māori in the Waikato region, Aotearoa New Zealand

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Abstract

Objective: This study aimed to assess the feasibility of conducting a representative tuberculin skin test (TST) survey for Māori in Aotearoa New Zealand and to estimate the prevalence of latent tuberculosis (TB) infection.

Methods: Participants were Māori in the Waikato region, recruited by a Māori nurse, through: 1) random household selection from the Electoral Roll; 2) randomly selected prison inmates; and 3) community and health settings. A TB history and symptoms questionnaire was completed, TST performed and investigation of those with TST induration ≥10mm.

Results: Random household selection was resource intensive and only contributed 14 participants. Repeated random selection of prison lists were required to recruit 207 participants and there were no positive TST cases. Community and health settings yielded the highest participation (n=370) and the three people (0.5%) with TST ≥10mm. Age ≥45 years and history of contact with a TB case were associated with TST induration ≥5mm (n=39; 6.6%).

Conclusions: The community and health settings were the only feasible options for recruitment. The overall prevalence of a positive TST in the study population was low. A 5mm cut-off may be best to maximise sensitivity for future studies.

Implications for public health: A mixture of sample selection processes that are more targeted are needed to identify Māori with latent TB infection.

Key words: latent tuberculosis, Māori, feasibility study

The World Health Assembly in May 2014 approved a new Global Tuberculosis (TB) Strategy with ambitious goals.[1] The Strategy aimed to end the global TB epidemic, with targets to reduce TB deaths by 95%, and new cases by 90%, between 2015 and 2035. It focused on populations highly vulnerable to infection who have limited access to health care and acknowledged the need to combat both latent TB infection (LTBI) and TB disease. Aotearoa New Zealand (NZ) signed up to the Strategy.

An analysis of the epidemiology of TB in NZ from 1995-2004 concluded that TB was not declining and had marked ethnic inequities.[2] This remains true today.[3,4] There are three dominant themes: 1) TB in migrants from TB-endemic countries; 2) A mix of migration-influenced and endemic spread in Pacific people, and 3) TB in Māori, which is largely due to ongoing endemic transmission and accounts for 50% of all NZ born cases. To eliminate TB, a specific focus on preventing reactivation of LTBI, in addition to treating TB disease, will be needed. Approximately 10% of latently infected individuals develop TB disease,[5] but this can be reduced to 1% with preventive treatment.[6] There are now safe preventive treatment regimens that take as little as 12 weeks.[7]

TB is a disease of colonisation that had a devastating effect on Māori and still persists today. During the late 19th and early 20th centuries, the climate in Aotearoa NZ was used to entice people with TB to emigrate, hence the rapidly growing immigrant colonial population was enriched for TB.[8] In parallel, the Māori population declined from about 150,000 in 1820 to 46,000 in 1896.[9] The contribution of TB to this decline is unclear but a large proportion of the Māori population were likely infected with *M. tuberculosis*. Until the 1930s, TB was not even tracked in the Māori population, mirroring the general neglect of Māori health during that time. In 1935, a report from a prevalence survey in Māori in the Waiapu Valley, East Coast[10] found a very high total prevalence of all forms of TB (57/1,000 population), and LTBI rates of 48.5%.

There was no appreciable decline in Māori TB rates until the late 1940s,[11] so it is likely that there remains a large reservoir of LTBI in older Māori, which will continue to cause reactivation disease, thereby perpetuating

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endemic transmission in Māori communities. A strategy for TB elimination that is focused only on diagnosing and treating new TB disease cases is likely to have little impact on interrupting transmission for Māori.[12]

Characterising the reservoir of LTBI for Māori could be achieved through a nationally representative Māori tuberculin survey. However, the challenges of finding and recruiting a representative sample of Māori are significant. We therefore developed a feasibility study with key Māori stakeholders and communities in the Waikato District Health Board (DHB) region, which has a large Māori population,[13] a mix of urban and rural inhabitants and prison populations with a large proportion of Māori. The aims of this study were to try different methods of recruitment to assess whether it is feasible to conduct a large representative tuberculin skin test (TST) survey for LTBI, to provide a preliminary estimate of the prevalence of LTBI for Māori to inform future studies, and to ascertain whether Māori who are TST positive are willing to undergo further investigation for TB disease.

Methodology

He Pikinga Waiora (HPW), a Kaupapa Māori framework was used to guide the study. The HPW Implementation Framework has Indigenous self-determination at its core and consists of four elements: cultural-centredness, community engagement, systems thinking and integrated knowledge translation. All elements have conceptual fit with Kaupapa Māori aspirations (i.e., Indigenous knowledge creation, theorising, and methodology).

Methods

Study design, setting and eligibility

This cross-sectional feasibility study recruited people aged over one year who self-identified as Māori living in the Waikato DHB region (total population 458,202, Māori population 109,488; 24%).[13] Those who had a previous history or current diagnosis of TB disease, contra-indication to having a TST, or inability to undergo further investigation if the TST was positive were excluded from participating.

Participant recruitment

Participants were recruited through three main approaches:

1. Households identified through the NZ Electoral Roll

The NZ Electoral Roll has two components: the Māori Roll and the General Roll. To be on the Māori Roll, a person must state they are of Māori descent. The names and addresses of those of Māori descent on the Māori Roll, living in the Waikato DHB region, were obtained from the Electoral Commission. Using Google maps to indicate driving time from Hamilton central, each town or area were stratified into three lists: A) Hamilton city, B) out of Hamilton but within one hour drive time, and C) out of Hamilton but more than one hour drive time (excluded for logistical travel reasons). Names and addresses in lists A and B were randomised in Excel and a letter of invitation to participate was sent. Two lists were obtained from the Electoral Commission: one in December 2018, and another in November 2020 after an update of the Electoral Roll for the 2020 general elections. On each occasion, 100 names and addresses were randomised from each list.

If no refusal to participate was received, a Research Nurse visited each household, explained the study and that we sought to include individuals living in the selected dwelling – one person from each of the five age strata: 1–15 years, 16–24, 24–44, 45–64, 65+. If the individual agreed, their full informed written consent was obtained, and from each eligible and selected household member. For children under the age of 16 years, their assent and written consent was obtained from their parent or guardian. If there was more than one person in the household in each age stratum, a simple random process was used to select only one person. Where no one was home at the time of first visit, a calling card was left and two further visit attempts were made.

2. Prison study

The Spring Hill Correction Facility has a capacity of 1,000 male prisoners, 49% of whom identify as Māori. Three lists comprising the prisoner identification number, age and prison status (sentenced or remand) of all Māori prisoners at the facility were obtained from the Department of Corrections (June 2019, October 2019 and August 2020). Lists were stratified into three age groups – 18–24, 24–44, and 45+ years – for random selection from each age group. The resulting lists included more people than required and the Research Nurse worked through the list in sequence and liaised with the prison administrator for recruitment. Written information about the study was provided and if they did not refuse, the nurse provided full study information and sought their written informed consent.

3. Community and health settings

Representatives from a variety of organisations and hapū (sub-tribes) were consulted to identify other ways to engage with and recruit Māori in the region. The Research Nurse was well connected in the community and able to identify key contacts and mechanisms by which people could be approached for participation. Three approaches were identified:

- **Poukai** are one-day events for Māori hosted by different marae (Māori meeting place). Poukai are open to anyone and are particularly focused on being a welcoming place for those who are poor and marginalised. Information about the study was put on the relevant marae Facebook page before the event. Anyone interested in participating was asked to go to a designated area for recruitment.
- **Koroneihana** is an annual celebration of the crowning of Kiingi Tūheitia Potatau Te Wherowhero VII, the current Māori monarch. This is a week-long celebration and a large number of volunteers of all ages from various marae and hapū from the Waikato DHB region contribute to the running of the Koroneihana. The Research Nurse approached different volunteer teams to provide information about the study.
- **Hauora ihub** at Waikato Hospital is a service, with a particular focus on Māori and Pacific people, where people coming into the hospital can receive health information and on-the-spot health checks, service and advice from a Māori registered nurse. The Research Nurse was based in the ihub at certain times to recruit participants, as well as joining the mobile screening conducted by ihub staff.

Data collection and variables

Participants recruited through each of the above-stated approaches, after informed consent, completed a questionnaire asking

about socio-demographic information (age, sex, smoking status), TB history (evidence of a BCG scar, contact with a TB case, ever diagnosed with TB) and TB symptoms. A TST (chosen for practical reasons of it being less invasive than an Interferon Gamma Release Assay (IGRA), which requires a blood sample) was undertaken using five tuberculin units of purified protein derivative (5TU PPD)[14] and the diameter of induration was measured between 48 and 72 hours later. The TST was deemed positive for follow-up investigation if there was induration of ≥10 mm, except for those under five years of age who had not had BCG vaccine (≥5 mm).[15] Standard operating procedures were used for the recruitment, data collection, and TST implementation and reading.

Follow-up of participants with a positive TST

Participants with a positive TST were referred for a chest x-ray and managed according to a specified algorithm (Supplementary file) based on the National TB Guidelines.[15] TST positive participants who did not complete any specific step of the follow-up cascade i.e. TST positive to a) chest x-ray, b) clinic appointment if indicated, c) preventive treatment, and d) completed treatment course, were contacted, where possible, to ascertain the reasons for incompletion.

Sample size

A total sample size of 750 participants was chosen as a balance between a realistic number for a feasibility study and having enough data for a preliminary estimate of LTBI prevalence. We anticipated that 10-15% would be TST positive, but that it was likely that none of these individuals would have TB disease, based on the notification rate of TB for Māori and an extrapolated prevalence of less than one per 1,000 individuals. From each recruitment approach we therefore set to recruit 200 people from households, 200 from the prison and 350 from community and health settings.

Data management and statistical analysis

Data were entered into a RedCap electronic data capture tool and cross-checked. Data are described as numbers and proportions. Odds ratios were generated using logistic regression to investigate key factors (sex, age, smoking, immunocompromised medical condition, symptoms and history of contact with a TB case) thought to be associated with a TST induration of ≥5mm due to the inadequate numbers of those with a TST ≥10mm. All analyses were undertaken using Stata software version 16.0.

Ethical approval

The study was approved by the University of Otago Human Ethics Committee (Health) for community household recruitment (H18/112) and alternative recruitment (H19/093), and by the Health and Disability Ethics Committees (HDEC) (19/NTB/11) for prison recruitment.

Results

Participants

A total of 591 Māori completed the questionnaire and TST (households n=14; prison n=207; community n=370) (Figure 1). Of the 117 letters sent to households, 71 were not at the address or at home despite several contact attempts, 35 declined participation and two were not eligible resulting in only 14 people from nine households who were available for interview. This method was therefore abandoned. A high turnover of prison inmates required three lists from the Corrections Department to reach the required sample size of 207 men. Of the 370 recruited through community and health settings, 248 (67%) were recruited through Poukai, 48 (13%) through Koroneihana, and 74 (20%) through ihub.

The mean age of all participants was 43 years. All those recruited from the prison were male (by design), but most of those from households and the community were female. Almost one third (30%) of those recruited from the community were either not on the Electoral Roll or did not know if they were.

Overall, 16% were current smokers and 63% ex-smokers. The high proportion of ex-smokers in the prison (92%) was likely due to the prison smoke-free regulations (Table 1).

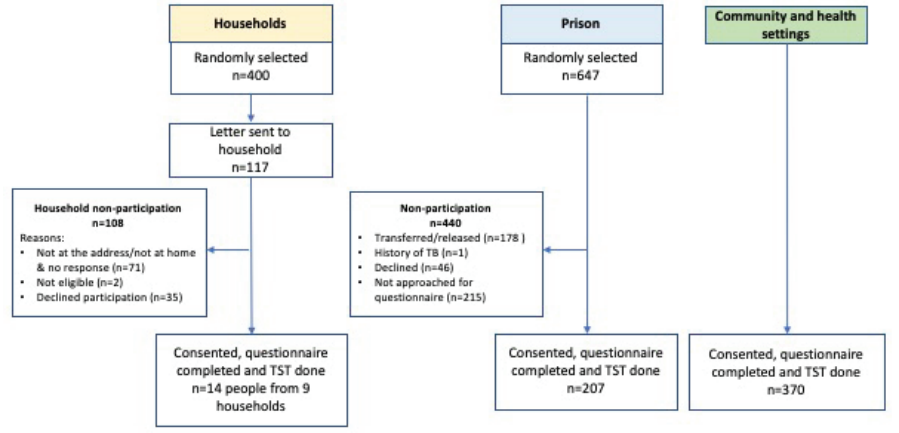
Two fifths (41%) had a BCG scar. This proportion was higher in older ages (<45=19%; 45-64=71%; 65+=61%). Of the 40 people who recalled ever having had contact with a person with TB, 17 could be classified as definite contacts within their family, and 23 as possible contacts in their family or community.

Most participants reported no symptoms of TB (73%). The majority had no reaction to the TST (85%) (Table 1). Three people aged in their 50s, all women recruited through the community, had a TST ≥10mm (0.5%; 95%CI 0.1–1.5). All three had a BCG scar. Two had a normal chest x-ray. One did not go for x-ray. None had any known previous contact with a person with TB. Symptoms of cough with phlegm and cough at night were reported by one woman who also reported having chronic obstructive pulmonary disease. She was lost to follow-up after the chest x-ray. One woman, with no symptoms, was assessed by a respiratory physician and on their advice completed a full course of TB preventive therapy.

Thirty-nine people had a TST diameter between 5-9 mm (6.6%; 95%CI 4.7–8.9) (Table 1), of whom only 10 reported any kind of symptoms – mostly dry cough, cough with phlegm or cough at night. Two reported having a TB contact.

Of those aged 45 and over, 14% (38/263) had a TST ≥5mm. Of participants with an immunocompromised medical condition, 16% (19/122) had a TST ≥5mm. Of the 17 who reported having definite contact with a TB patient, 29% (5/17) had a TST ≥5mm. Being

Figure 1: Flowchart of study participants.



aged 45 and over (adjusted odds ratio (AOR) 12.6; 95%CI 4.2–37.5), and having definite contact with a TB case (AOR 3.8; 95%CI 1.1–12.4) were associated with an increased odds of having a TST ≥5mm (Table 2).

Table 1: Characteristics of study participants, by method of recruitment.

	Households n=14	Prison n=207	Community & health n=370	Total n=591
	n (%)	n (%)	n (%)	n (%)
Sex				
Male	4 (28.6)	207 (100.0)	160 (43.2)	371 (62.8)
Female	10 (71.4)	-	204 (55.1)	214 (36.2)
Transgender	0 (0.0)	-	6 (1.6)	6 (1.0)
Age (years)				
1–15	2 (14.3)	0 (0.0)	2 (0.5)	4 (0.7)
16–24	0 (0.0)	44 (21.3)	35 (9.5)	79 (13.4)
25–44	4 (28.6)	104 (50.2)	137 (37.0)	245 (41.5)
45–64	4 (28.6)	56 (27.1)	137 (37.0)	197 (33.3)
65+	4 (28.6)	3 (1.5)	59 (15.9)	66 (11.2)
On Electoral Roll				
Yes	11 (78.6)	-	258 (69.7)	269 (45.5)
No	1 (7.1)	-	79 (21.4)	80 (13.5)
Not applicable/unknown	2 (14.3)	207 (100.0)	33 (8.9)	242 (40.9)
Smoking				
Current	0 (0.0)	4 (1.9)	92 (24.9)	96 (16.2)
Ex-smoker	6 (42.9)	191 (92.3)	176 (47.5)	373 (63.1)
Never smoked	8 (57.1)	12 (5.8)	102 (27.6)	122 (20.6)
Medical condition[a]				
Diabetes	4 (28.6)	27 (13.0)	81 (21.9)	112 (19.0)
Renal failure/kidney disease	0 (0.0)	4 (1.9)	12 (3.2)	16 (2.7)
Transplant anti-rejection therapy	0 (0.0)	2 (1.0)	3 (0.8)	5 (0.9)
Other immune suppressive condition	0 (0.0)	3 (1.5)	7 (1.9)	10 (1.7)
Other[b]	4 (28.6)	28 (13.5)	67 (18.1)	99 (16.8)
BCG scar	7 (50.0)	69 (33.3)	165 (44.6)	241 (40.8)
Ever had contact with a TB case	0 (0.0)	13 (6.3)	27 (7.3)	40 (6.8)
TB-related symptoms[c]				
Dry cough	3 (21.4)	24 (11.6)	46 (12.4)	73 (12.4)
Cough with phlegm	0 (0.0)	19 (9.2)	35 (9.5)	54 (9.1)
Cough at night	2 (14.3)	27 (13.0)	43 (11.6)	72 (12.2)
Cough with blood	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Chest discomfort or pain	0 (0.0)	6 (2.9)	8 (2.2)	14 (2.4)
Fever	0 (0.0)	4 (1.9)	2 (0.5)	6 (1.0)
Night sweats	1 (7.1)	16 (7.7)	7 (1.9)	24 (4.1)
Loss of weight	0 (0.0)	5 (2.4)	10 (2.7)	15 (2.5)
Loss of appetite	0 (0.0)	3 (1.5)	9 (2.4)	12 (2.0)
Total number of symptoms per participant				
0	10 (71.4)	145 (70.0)	277 (74.9)	432 (73.1)
1–3	4 (28.6)	59 (28.5)	87 (23.5)	150 (25.4)
4+	0 (0.0)	3 (0.5)	6 (1.6)	9 (1.5)
TST induration				
0	11 (78.6)	186 (89.9)	304 (82.2)	501 (84.8)
1–4 mm	2 (14.3)	9 (4.3)	37 (10.0)	48 (8.1)
5–9 mm	1 (7.1)	12 (5.8)	26 (7.0)	39 (6.6)
≥10 mm	0 (0.0)	0 (0.0)	3 (0.8)	3 (0.5)

Notes:

a: More than one medical condition may be indicated

b: Other types of medical conditions included asthma, hypertension, cardiac conditions, other respiratory conditions such as chronic obstructive respiratory disease

c: More than one symptom may be indicated

BCG=Bacillus Calmette-Guerin; TB=Tuberculosis; TST=Tuberculin skin test

Discussion

Our Māori feasibility study in the Waikato DHB region of Aotearoa New Zealand found that using the Electoral Roll is likely to be inefficient in finding people with LTBI. The overall low prevalence (0.5%) also limited the feasibility to assess the willingness of Māori to undergo further investigations for TB disease or to accept preventive therapy. A variety of recruitment approaches in the community that are more targeted will be more likely to identify reservoirs of LTBI among Māori.

We used three main approaches to recruit participants in an attempt to identify feasible options to conduct a larger representative survey for LTBI amongst Māori. The Electoral Roll of people aged 18 years and over who are enrolled to vote in national elections only elicited 14 people despite many attempts. It appears that there had been considerable mobility of households between election times. Moreover, of the study participants recruited through the community, almost one quarter reported they were not registered or did not know if they were on the Electoral Roll. Use of the Electoral Roll therefore appears to be time and resource-intensive with minimal benefit. Recruitment in the prison required us to obtain repeated up-to-date lists of inmates due to the high turnover and movement of inmates between prison facilities. Using community and health settings were by far the easiest way to gain access and trust resulting in high levels of recruitment. Having a locally-based Māori research nurse who was well known and connected in the community was extremely important and integral to this, as was having a research team that included senior Māori researchers. We strongly recommend that future research investigating LTBI for Māori use the HPW principles, be Māori led and well embedded in the local context with strong community engagement.[16]

In our study we found only three people with a TST of ≥10mm (0.5%) – all identified through the community. It was reassuring to find that no prison inmates had a TST≥10mm, particularly given that prisons are generally believed to be places of high TB prevalence.[17] Our overall 0.5% estimate is lower than the 3% estimate in population-based studies in low TB-incidence countries (also using a TST of ≥10mm)[18] and considerably lower than the 48% reported from the East Coast study of TB in 1935.[10] TB in NZ is likely to be concentrated in pockets where people have had contact with a person known to have TB either recently or in the past. This was evident in our study where TST reactions of ≥5mm were more common among people with a definite family TB contact, which reinforces the importance of a targeted approach to

finding these cases rather than a national representative sample.

The main purpose of testing for LTBI is to identify people who are at high risk for developing active TB disease and would benefit from preventive treatment.[15] Results from a systematic review on the risk of TB among untreated populations with a positive TST[19] showed that studies using a threshold of ≥10mm for a positive TST test had only a slightly higher incidence of TB (9.4 per 1000 person-years) than studies using a ≥5mm TST threshold (8.4 per 1,000 person-years). When we used the ≥5mm TST threshold, the prevalence of positive tests increased to 7.1% (42 people). This lower threshold could be considered in future studies, particularly when considering who should have further investigations for TB disease, and where there are other risk factors that promote reactivation of TB, such as older age, contact with a TB case or the existence of other immunocompromised conditions such as diabetes.

Our study is the first of its kind in recent years to survey LTBI among Māori. Developing recruitment methods in partnership with Māori researchers and leaders, including the Māori nurse who went on to engage with community leaders, organise testing and recruit participants was a strength of the study. There is no gold standard for diagnosing LTBI.[15,20] The choice of TST was for practical reasons for ease of use in the field setting. While this meant that a repeat visit was required to read the result, that can be subject to interpretation, and can have reduced specificity from prior BCG (especially in young children), standard operating procedures were used and the TST was undertaken by one research nurse, thereby ensuring consistency. While recruitment through the community and health settings were the most successful, a limitation of this method is that with the absence of random recruitment the results may be biased and cannot be generalised to the wider Māori population.

Conclusion, implications for public health and next steps

A Māori-led approach, offering LTBI screening for the older Māori population and those with a known TB contact rather than population-based investigations is likely to be more efficient at identifying those with LTBI and offering preventive treatment. However, this approach would not be effective at estimating LTBI prevalence for Māori.

Table 2: Participant characteristics by TST induration and factors associated with TST result of ≥5 mm.

	TST induration		Odds ratio (95% CI)	Adjusted odds ratio[a] (95% CI)
	0-4 mm n=549 n (%)	≥5 mm n=42 n (%)		
Sex				
Male	347 (63.2)	24 (57.1)	Reference	Reference
Female	196 (35.7)	18 (42.9)	1.3 (0.7–2.5)	0.9 (0.5–1.8)
Transgender	6 (1.1)	0 (0.0)	-	-
Age (years)				
1-44	324 (59.0)	4 (9.5)	Reference	Reference
45+	225 (41.0)	38 (90.5)	13.7 (4.8–38.9)	12.6 (4.2–37.5)
Any immunocompromised medical condition				
No	446 (81.2)	23 (54.8)	Reference	Reference
Yes	103 (18.8)	19 (45.2)	3.6 (1.9–6.8)	1.7 (0.8–3.5)
Current or ex-smoker				
No	111 (20.2)	11 (26.2)	Reference	Reference
Yes	438 (79.8)	31 (73.8)	0.7 (0.3–1.5)	0.5 (0.2–1.0)
Total number of symptoms per participant				
0	401 (73.0)	31 (73.8)	Reference	Reference
1-3	139 (25.3)	11 (26.2)		
4+	9 (1.6)	0 (0.0)	1.0 (0.5–2.0)	0.6 (0.3–1.4)
Contact with TB case				
No[b]	515 (93.8)	36 (85.7)	Reference	Reference
Possible contact	22 (4.0)	1 (2.4)	0.7 (0.09–5.0)	0.5 (0.06–4.0)
Definite contact	12 (2.2)	5 (11.9)	6.0 (2.0–17.8)	3.8 (1.1–12.4)

Notes:

a: Adjusted for all characteristics (sex, age, immunocompromised medical condition, smoking, symptoms, contact with a TB case)

b: Includes 97 for whom contact was unknown or not recorded

CI=Confidence Interval; TB=Tuberculosis; TST=Tuberculin skin test

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Figure 1: Screening and clinical algorithm for participants with a positive tuberculin skin test (TST) result.