Epidemiology of Tuberculosis and BCG vaccine uptake among Pasifika in Aotearoa New Zealand

Rhonita Teresa Schütz

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Abstract

Tuberculosis (TB) has many known risk factors that contribute to its persistence worldwide, particularly in developing countries. Aotearoa New Zealand (NZ), as a high-income country, is fortunate to fall in the low-risk category. However, the incidence of TB is more common in particular ethnic groups such as Pasifika. The Pasifika population exhibit a unique set of vulnerabilities that increase their susceptibility to TB disease. Recent studies have reported a 13.1 per 100,000 notification rate for Pasifika in contrast to 0.5 per 100,000 among the European ethnic group in Aotearoa NZ. The Bacillus Calmette–Guérin (BCG) vaccine is the only licensed vaccine widely used to prevent TB. The World Health Organization (WHO) recommends BCG inclusion in neonatal vaccination schedules, depending on the TB epidemiology of the country. Many high incidence countries in the Pacific have been recommended to administer one dose to all neonates. However, countries with a low incidence of TB, such as Aotearoa NZ, can focus vaccination on high-risk groups only, through recommendation by healthcare workers to parents. Recommendation is based on specific eligibility criteria, meaning that all Pasifika children born in Aotearoa NZ are not necessarily entitled to BCG vaccination. Therefore, this study aims to identify strategies for improving TB prevention efforts by identifying the level of protection against TB for Pasifika. Given their higher TB burden and vulnerabilities, assessing the effectiveness of the BCG vaccination programme to capture at-risk populations is particularly important for these vulnerable ethnic groups.

A Pasifika framework, Te Kora, was employed to guide a convergent parallel mixed methods design. To understand the epidemiology of TB and the BCG vaccine uptake among Pasifika in Aotearoa NZ, a quantitative observational study and a qualitative interpretive descriptive study were undertaken. TB and BCG data from 2006 to 2023 were descriptively analysed. Maroro (conversations) was used as the method to generate qualitative data to understand the perceptions of healthcare professionals on the BCG vaccination programme and TB prevention efforts. The qualitative data was then analysed with Conventional Content Analysis (CCA).

The quantitative results showed that Pasifika and Asian populations in Aotearoa NZ had the highest TB incidence rates from 2006 to 2023, with average incidence rates of 11.4 per 100,000 (confidence interval (CI): 8.2 – 15.3) and 27.5 per 100,000 (CI: 23.5 – 32) respectively. Further analysis of the Pasifika population showed a higher percentage (average of 55%) of TB incidence among the less dominant Pasifika ethnicities such as Kiribati, Tokelau, Tuvalu and Niue. BCG vaccination rates were steadily high among the

Asian population, with an average rate of 1000.7 per 100,000 (CI: 975.8 – 1026.2). BCG rates were also reasonably high among Pasifika, however, there was an observed rapid significant decrease to exceedingly low vaccination rates from 2011 to 2023. The average BCG vaccination rate for Pasifika was 519.4 (CI: 500.3 – 539.3) per 100,000, however, based on the significant decrease which reached vaccination rates as low as 26.6 per 100,000 (CI: 21.7 – 32.2), the Pasifika population were significantly under-vaccinated. Further analysis of the Pasifika vaccination rates indicated that Pasifika ethnicities were proportionately vaccinated relative to their population sizes except for the Cook Island Māori and Niuean ethnicities. This highlights the need for an increase in BCG vaccine uptake for the Pasifika population, especially among the less dominant Pasifika ethnicities, which have the highest proportion of TB notifications.

Three main categories were constructed from the qualitative data that outlined barriers for the BCG vaccination programme and TB prevention efforts. These include systemic gaps in identifying at-risk groups, which identified knowledge gaps among healthcare workers and fragmented referral processes. The second category, perceptions of TB disease and BCG vaccine among migrants and Pasifika communities, identified stigma and migrants' perception of TB risk. The third category is system-based factors that affect BCG uptake and TB reduction, such as the BCG policy and programme changes, the Pasifika umbrella, and effective communication.

This study explored the effectiveness of current TB prevention efforts, particularly the BCG vaccination programme among at-risk populations in Aotearoa NZ with a focus on the Pasifika population. The findings highlighted specific barriers from the qualitative data that must be addressed in order to improve the current BCG vaccination programme. The study recommends system-level improvements to progress TB prevention among Pasifika, such as increasing training for healthcare workers to enhance risk assessment, uniform referral processes for all regions, disaggregated data, and health promotion strategies specifically to target TB stigma. The results of this work highlighted particular improvements that are needed to protect the Pasifika populations from TB.

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Abbreviations

ARPHS	Auckland Regional Public Health Service
AUTEC	Auckland University of Technology Ethics Committee
BCG	Bacillus Calmette–Guérin
CCA	Conventional Content Analysis
CDC	Communicable Disease Control
CI	Confidence Intervals
CVD	Cardiovascular Disease
DHB	District Health Board
DOTs	Directly observed treatment, short-course
EPTB	Extra-Pulmonary Tuberculosis
ERP	Estimated Resident Population
ESR	The Institute of Environmental Science and Research
GP	General Practice/Practition
ID	Infectious Disease
IMAC	Immunisation Advisory Centre
LTBI	Latent-Tuberculosis-Infection
MDR	Multi-Drug Resistant
MELAA	Middle Eastern / Latin American / African
NCD	Non-communicable Disease
NHI	National Health Index
NIR	National Immunisation Register
NZ	New Zealand
PHU	Public Health Unit
PICT	Pacific Island Countries and Territories
PTB	Pulmonary-Tuberculosis
TA	Thematic Analysis
TB	Tuberculosis
WHO	World Health Organization
WPR	Western Pacific Region

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Dedication

To my late uncle Bwebwetaake John Ratieta, who passed away midway through this research journey. Your sudden departure left a profound void in our hearts. Thank you for exemplifying unwavering resilience and an extraordinary work ethic, even in the face of adversity and disability. My pursuit of higher education has always been driven by a desire to ensure your quality of life. I dedicate this thesis to you.

"Miss no single opportunity of making some small sacrifice, here by a smiling look, there by a kindly word; always doing the smallest right and doing it all for love." – St. Thérèse of Lisieux

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Note: AI tools were utilised in this study to organise and summaries journal articles and for editing purposes.

Attestation of Authorship

“I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated and referenced, along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.”

Signed: R.T.Schutz

Date: 24/06/2025

This study was approved by the AUT Ethics Committee on the 12 July 2024, under the Ethics Application number 24/109

Chapter One: Introduction

This chapter will introduce the main concepts that provide the foundation of the study. It will first discuss the background context of tuberculosis (TB) disease. This includes the complex pathogenesis and mechanisms of the disease-causing agent *Mycobacterium tuberculosis (M.tb)* that continues to hinder prevention and management of TB on an individual and population level. The chapter will then explore the uneven global distribution of TB burden, highlighting regions and populations which are at greater risk of TB, especially in the Pacific region. This leads to the TB epidemiology in Aotearoa NZ with a focus on the Pasifika population which experience a higher burden of TB. Risk factors and social determinants of health that influence the TB burden within this population will then be explored. The background context of the BCG vaccine will also be provided, including global recommendations and guidelines set by the World Health Organization (WHO). This leads into an overview of the BCG vaccine programme in Aotearoa NZ which focuses on high-risk groups of the population. The chapter will then outline the aim and objectives of the study together with an overview of the structure of the thesis.

Overview of TB

TB is an airborne disease caused by the bacilli *M.tb*, an intrinsically complex bacterium that can often evade the immune system due to its successful pathogenesis (Forrellad et al., 2013). The origins of *M.tb* dates back to more than 150 million years (Barberis et al., 2017), where TB epidemics have occurred throughout the centuries. One well known TB epidemic is the '*white plague'* which occurred in the eighteenth century in the Western European Region. The mortality rates reached up to 900 deaths per 100,000 of the population (Barberis et al., 2017). *M.tb* strains then evolved over the years resulting in *Mtb* strains with enhanced virulence and transmissibility (Delogu et al., 2013). These strains continued to evolve and spread throughout the globe. In time, the widespread resulted in the WHO declaring TB as a global emergency in 1993 (Delogu et al., 2013; Zumla et al., 2009).

COVID-19 surpassed TB as the leading cause of death from a single infectious agent. However, in 2024, TB has once again taken that title (World Health Organization [WHO], 2024) and continues to be a significant public health challenge exerting a widespread global burden. In 2021, approximately 10.6 million people became ill with TB (Falzon et al., 2023). According to Falzon et al. (2023) this was an increase (4.5%) from earlier years indicating a global expansion of the burden of disease. Global TB mortality was reported in 2021 as 1.6 million. Although COVID-19 significantly disrupted the previous downward trends of the global TB burden during the pandemic, another factor that also affected these

estimated figures is that there is no confirmation that the figures represent undiagnosed cases, those without access to primary healthcare (Bagcchi, 2022) and those who did not seek medical attention. Therefore, these rates may be underestimates.

Pathogenesis

Despite TB's long existence making the disease one of the most prominent in medical literature throughout the years, there is still a lot more to the bacteria to understand (Elwood, 2010). TB disease usually occurs in two stages. The first stage is infection which occurs when aerosol droplets containing *M.tb* are inhaled. The immune response usually contains the bacteria with recruited macrophages and other immune cells that form a granuloma in the lungs to limit mycobacterial damage and spread. The evolved virulence of the bacterium enables it to avoid or modulate the immune response (Forrellad et al., 2013). Ideally, immune cells such as macrophages will eliminate the bacteria by engulfing it in a phagosome (an intracellular vesicle). Phagosomes fuse with lysosomes consisting of enzymes (such as hydrolase) and reactive oxygen and nitrogen (Forrellad et al., 2013). The fusion of phagosomes and lysosomes is crucial to eliminate the bacteria. However, *M.tb* strains have evolved virulence and mechanisms, such as the ability to inhibit the fusion of phagosomes and lysosomes, enabling it to evade destruction (Forrellad et al., 2013). For long periods of time, *M.tb* can remain dormant within a granuloma of immune cells which is known as Latent TB infection (LTBI), in which the host or infected individual will have no symptoms. *M.tb* granulomas can also migrate out of the lungs and lodge in other organs of the body where it may eventually progress to active TB (Craft et al., 2022). This is known as extra-pulmonary TB disease which is not infectious.

Progression to active TB

The second stage occurs when infection progresses to active TB which is when *M.tb* is no longer contained within the granuloma in the lungs. This can happen at any given time. The progression often depends on three main categories of factors and determinants of health. The first relates to the host, such as the immune competence and immunogenetic background of the individual, the second are factors relating to the host's environment, and the third are factors that relate to the pathogen or bacteria. These will determine the progression of TB disease where the dormant bacteria become active and replicate in which classic symptoms will be present among these individuals (Forrellad et al., 2013). Although this is a serious health concern on an individual level, TB can become a serious public health concern when *M.tb* are released into the airways and expelled in aerosol

droplets thereby enabling the disease's infectious potential (Smith, 2003; Craft et al., 2022).

Treatment and multi-drug-resistant TB (MDR-TB)

According to the 2019 guidelines for TB control in Aotearoa NZ, LTBI treatment is offered to high-risk individuals only. High-risk individuals are determined by recent exposure to TB disease, those with ongoing medication or taking medication that compromise their immune function. The death rate from TB is as high as 50% without treatment (Riaz et al., 2024) due to the properties of *M.tb* that make the bacterium intrinsically resistant (Gygli et al., 2017).

Treatment for both LTBI and active TB require strong drugs for regimens that can require up to more than 12 months course of anti-TB drugs. The anti-TB drugs consist of four first line drugs known as Isoniazid, Rifampicin, Ethambutol and Pyrazinamide. This combination of drugs, however, can cause many severe side-effects such as drug-induced hepatitis, renal failure, cutaneous and haematological reactions, and gastrointestinal intolerance (Forget & Menzies, 2006). Recommended drug combinations will depend on the individual screening for treatment eligibility, for example normal test results for liver function and presence of other co-morbidities, as well as individual drug-susceptibility are initially taken into consideration. Identified abnormalities or drug-susceptibilities among TB cases may delay or lead to discontinuation of treatment which creates a very complex case as the likelihood of morbidity and mortality increases for these individuals.

Discontinuation or incomplete therapy or treatment can result in *M.tb* strains that have lower susceptibility to the first line drugs (Fox et al., 2017; Gygli et al., 2017), which is known as acquired MDR-TB. An individual can also be infected with MDR-TB through transmission, which is when a case that has already 'acquired' or developed MDR-TB, transmits the drug-resistant TB to another, via aerosol droplets (Fox et al., 2017). MDR-TB requires second line anti-TB drugs which are less potent and more toxic than the first-line drugs. Typically, the second-line anti-TB drugs have low treatment success rates, and treatment regimens can go on for up to 20 to 24 months (Jang & Chung, 2020). Contact and genomic tracing efforts have identified primary transmission as the most common transmission method (Yang et al., 2017). Thus, if MDR-TB outbreak is not prevented, especially among vulnerable populations, it could be a public health risk on a global scale.

Geographic distribution of TB

Globally, the distribution of the burden of TB is disproportionate. Three regions have been identified where TB is most concentrated as of 2023. These regions are South-East Asia

(45%), Africa (24%), and the Western Pacific (17%) (WHO, 2025). The 2023 and 2024 WHO TB report revealed that TB incidence has increased in the Western Pacific regions (WPR). The disproportionate geographic distribution of TB is also evident across the WPR. This region is home to an estimated 1.9 billion people across 37 countries and territories, including small countries with a few thousand populations and large countries with more than one billion populations (Viney et al., 2015). These countries span across a wide range of socio-economic categories from low to high-income.

According to Viney et al. (2015) the WPR accounted for 18% of the estimated global incidence of TB in 2018. The study further indicated that the WPR's share to the global TB incidence has relatively remained stable in more recent years, 2022 (18%) and 2023 (17%). This suggests that there has been no significant reduction in TB incidence within this region. Furthermore, the WPR has significant TB disparities highlighted in the study by Viney et al. (2015) which reported more than 300 cases per 100,000 population across low and middle-income countries. This includes the Philippines (554), Mongolia (428) and Cambodia (302). The more isolated and smaller Pacific Islands Countries and Territories (PICTs) within the WPR, Kiribati (349), the Marshall Islands (434), Papua New Guinea (432) also reported more than 300 cases per 100,000 population (Viney et al., 2015). These PICTs are experiencing endemic levels of TB (defined as more than 100 new and relapse cases per 100,000 population) (WHO, 2021) annually.

Additionally, a more recent study further highlighted the burden of TB among the smaller and more isolated PICTs with incidence rates. The Marshall Islands' incidence rate was reported to be as high as 483 per 100,000 and Kiribati with 425 per 100,000 in 2020 (Yanagawa et al., 2023). The study also reported the high numbers of TB cases in more PICTs such as Fiji (590), Kiribati (510), the Solomon Islands (450) and the Marshall Islands (290) (Yanagawa et al., 2023). These incidence rates and number of cases highlight a higher risk of TB for the Pacific population, especially in low-income countries. In contrast, high and middle-income countries within the PICTs subregion reported significantly low incidence rates (less than 10 cases per 100,000), placing them in the pre-elimination phase (Lönnroth et al., 2015). This includes Wallis and Futuna, the Cook Islands, Samoa, American Samoa, Australia and Aotearoa NZ (Viney et al., 2015).

TB in Aotearoa NZ

TB incidence rates in Aotearoa NZ have been reported to be as low as 4.2 per 100,000 during the 1985 to 1990 period (Stehr-Green, 1992). However, there was an observed increase to 10 per 100,000 from 1995 to 2004 (Das et al., 2006). A study by Howie et al. (2005) highlighted the burden of TB in Aotearoa NZ among children during 1992 to 2001. The study reported a TB rate for adolescents (under 16 years old) of 4.8 per 100 000 which

increased to 10.1 in 1999. The study also revealed the rate of 6.2 per 100,000 for children (under 5 years old). In addition, the study found that rates differed among ethnic groups which outlined Pasifika and African groups to have the highest rates. Overall, these sources indicate a disproportionate distribution of TB across the population of Aotearoa NZ.

More recent studies have provided the current burden of TB in Aotearoa NZ. Verrall et al. (2020) reported an incidence rate of 6.3 per 100,000, thus, the country remain as low risk by WHO standards. However, the disproportionate distribution has persisted to recent years. Voss et al. (2006) reported a TB outbreak in 2006 among Pasifika that increased their incident rate to an overwhelming 95.3 per 100,000. This was the highest rate ever recorded for this group. The disparities are also notable geographically. In 2020, there were 311 new TB cases with the highest notifications from three regions, Auckland, Counties Manukau and the Hutt Valley in Wellington (The Institute of Environmental Science and Research [ESR], 2023). The higher notifications from Auckland and Wellington suggest that TB incidence is higher in larger urban centres with denser populations. Auckland and Wellington also have the highest numbers of Pasifika residents across the country (Statistics NZ-Tatauranga Aotearoa [Stats NZ], 2023).

Most TB notifications were among foreign-born individuals, Aotearoa NZ-born new cases were highest among Māori with an incidence rate of 3.7 per 100,000 and Pasifika with a rate of 3.2 per 100,000 (ESR, 2023). This has been a steady trend for these ethnic groups throughout 2016 to 2019. In comparison, New Zealand European and Other ethnicities had a reported rate of 0.3 per 100,000 in 2020 (ESR, 2023). The highest notifications of new TB cases among foreign-born individuals were from Southern and Central Asia, Southeast Asia and Pasifika ethnicities.

Aligning with the End TB strategy, the pre-elimination phase in Aotearoa NZ is defined as having a notification rate of 10 per 100,000 or lower (Verrall et al., 2020). This has been achieved in the European ethnic group with 0.6 per 100,000. However, the notification rate for the Pasifika ethnic group is above the 10 per 100,000 threshold, with a notification rate of 15.5 per 100,000 (Verrall et al., 2020). In 2023, the notification rate was reported at 6.1 per 100,000 for the whole population in Aotearoa NZ (Te Whatu Ora, 2025). The highest was among the 20 to 29 years old age group. It was also highest among three ethnic groups. This includes Asian (28.2 per 100,000), Middle Eastern/Latin American/African (MELAA) (15.8 per 100,000) and Pacific peoples or Pasifika (13.1 per 100,000) (Te Whatu Ora, 2025).

The epidemiology of TB in Aotearoa NZ highlight inequities within the population. Although the sources have indicated a steady low TB risk status for the country, TB burden is highest among the younger population, densely populated regions and specific ethnic groups such as Pasifika with consistently high rates and evident vulnerability to TB outbreaks. TB burden

is also higher among those who were foreign-born suggesting migration and international travel as contributing risk factors.

Risk factors and determinants of health affecting Pasifika

The Pasifika population represents a small group of just more than 8% of Aotearoa NZ's population (Stats NZ, 2024) and consists of many Pacific Island ethnicities. According to the 2023 census, Samoan ethnicity account for almost half of the Pasifika population (49%), followed by Cook Island Māori (21%), Tongan (22%), Niuean (8%), Fijian (5%), Tokelauan (2%), Tuvaluan (1.5%) and Kiribati (1%) (Stats NZ, 2023). In the Aotearoa NZ context, policy and discourse combine those of Pacific ancestry (both born in New Zealand and those who migrated from different neighbouring Pacific Islands) and define them by the umbrella term 'Pasifika' or 'Pacific Islander' (Enari & Haua, 2021). TB prevalence and incident rates differ for each Pacific Island country, which is also true for the different ethnic cohorts within the Pasifika umbrella in Aotearoa NZ. Thus, using Pasifika as an umbrella category has often resulted in the deficit of Pasifika ethnic-specific data availability and consequently past research and literature have focused on the Pasifika population as a whole. This has often overlooked the nuances and diversity within the population, which is not ideal for targeted TB initiatives or policies developed for the Pasifika population.

Cultural aspects

The value of connections, especially to their natural environment and how it connects to perception of wellbeing is an important aspect of Pasifika culture (Teariki & Leau, 2024). According to Teariki and Leau (2024) it is less well known how Pacific peoples living in Aotearoa NZ draw on those connections. Perhaps this has influenced the need to often go back to their native islands. Connections to people, particularly family, extended family and communities are vital to maintain in Pasifika culture (Tautolo et al., 2020). This indicates one of the many reasons for Pasifika to often travel back to their native islands including visits from family and extended family members from the Pacific Islands. The value of connections has also shaped the tight-knit nature among Pasifika (Cui, 2023) and has influenced common mingling and gathering among Pasifika communities (Cui, 2023).

Due to their fluid movement to neighbouring islands of the Pacific with known higher incidence of TB, the Pasifika population in Aotearoa NZ are at higher risk of exposure to *M.tb*, which often results in LTBI that becomes active at a later stage. The most common cause for *M.tb* infection and transmission is exposure abroad (Srivastava et al., 2015). Foreign-born individuals and migrants face continued risk due to transmission within their communities, particularly among recent arrivals and those who travel back to high-incidence

native countries. The tight-knit cultural nature of family units that include extended family members and communities exacerbates *M.tb* transmission and contribute to Pasifika's vulnerability to TB. This suggests a need to address TB burden at the root cause such as risk factors and determinants of health that affect Pasifika. Particularly for neighbouring Pacific islands with higher incidence of TB.

Pasifika cultural factors relate to well-known risk factors of TB such as household crowding. A study by Baker et al. (2008) found that TB incidence in Aotearoa NZ is associated with household crowding due to increase likelihood of inhaling higher burden of *M.tb* if a household member has active TB. However, household crowding in this context can be interpreted in two ways. The first is through the Pasifika lens as most indigenous populations of the Pacific Islands consist of larger family units and normally prefer to live in communal settings, comprised of intergenerational living which can extend to distant relatives (Ministry for Pacific Peoples, 2021). What is usually deemed as an overcrowded household is essentially an important aspect of the Pacific culture. The second is through a social determinant of health lens associated to low socioeconomic status which also predominately affects Pasifika in Aotearoa NZ and contributes largely to the vulnerability of Pasifika to TB. Key indicators of low socio-economic status are also evidently higher among Pasifika.

Social determinates of health

Significant socioeconomic inequalities are evident among the Pasifika population (Talemaitoga, 2010) with over-representation in unemployment, lower-skilled workers and low-income earners (Stats NZ, 2002). This exacerbates barriers such as access to healthcare leading to poor health outcomes in Aotearoa NZ. A review by Sa'u Lilo (2020) reported that in comparison to non-Pasifika groups of the population, Pasifika have the highest prevalence of non-communicable disease (NCDs) including obesity, diabetes, cardiovascular disease (CVD), stroke and high blood pressure (Sa'u Lilo, 2020). These diseases compromise the immune system. Therefore, Pasifika are more susceptible to activation of LTBI, resulting in a disproportionate disease burden among Pasifika children (Voss et al., 2006), and adults in Aotearoa NZ. This also affects treatment eligibility as TB patients usually require healthy and full function of vital organs to start treatment, which is not always the case for Pasifika due to these higher rates of comorbidities (Talemaitoga, 2010).

The Pasifika worldview also plays a part in determinants of health that affect TB susceptibility. The Pasifika worldview encompasses a holistic worldview that emphasises physical, mental, social and cultural well-being as interconnected and interdependent (Teariki & Leau, 2024). The health system in Aotearoa NZ is predominately modelled to

Western structures with universal approaches that emphasise a “one-size-fits-all” concept (Tenbensel et al., 2023; Wilson et al., 2021), where services do not incorporate culturally appropriate approaches. The health system therefore overlooks most of the specific health needs within the Pasifika population which exacerbates barriers to access of healthcare for Pasifika. While the health sector has been increasingly responsive to Pasifika health needs (Wright & Hornblow, 2008), a significant lack of culturally appropriate services is evident (Williamson & Harrison, 2010). These aspects highlight Pasifika vulnerability to TB which indicate cultural and social determinants of health that are unique to Pasifika living in Aotearoa NZ. The next section will discuss the BCG vaccine programme, with a focus on the Pasifika population.

BCG vaccine

The Bacillus Calmette–Guérin (BCG) vaccine is the only licensed vaccine widely used to prevent TB (Lancione et al., 2022). According to the Immunisation Handbook, the duration of protection provided by the BCG vaccine has not been confirmed. Although it is estimated to provide approximately 10 to 15 years of protection, this may vary in some populations (Te Whatu Ora, 2020). This indicates that the efficacy of the BCG vaccine reduces with increasing age. The BCG vaccine is also known to induce adverse side-effects (Sellami, 2018), particularly in individuals with immune compromising conditions. These aspects of the BCG vaccine contribute to the WHO recommendations for BCG vaccination which is based on the individual country’s epidemiology of TB. High burden countries are recommended to administer one dose to all neonates (Lancione et al., 2022; WHO, 2008), which is implemented in most developing PICTs with high burden of TB. Therefore, foreign-born Pasifika (especially those born in high TB incidence countries) living in Aotearoa NZ are usually vaccinated with BCG. In low TB burden countries, (such as Aotearoa NZ) high-risk groups may be specifically targeted (Lancione et al., 2022). Thus, Pasifika who were born in Aotearoa NZ usually miss out on BCG vaccination which is a concern given their high risk of both *M.tb* infection and TB disease.

BCG vaccine programme in Aotearoa NZ

BCG vaccination programmes and policies differ in low-risk countries and are tailored to their TB epidemiology including their own definitions of high-risk, which varies and evolves across countries (Lancione et al., 2022). In Aotearoa NZ, the universal approach for neonatal BCG vaccination was removed in 1990 when the country reached low incidence rates (Howie et al., 2005). A BCG vaccination programme that targets high-risk groups was implemented thereafter, where BCG vaccination is based on healthcare worker’s recommendation to identified at-risk groups (Te Whatu Ora, 2025). A meta-analysis of 26 cohort studies found

that neonatal BCG vaccination had just about 18% efficacy against TB which provides a modest level of protection (Te Whatu Ora, 2025). Therefore, the main role of the BCG vaccination programme in Aotearoa NZ is to protect young children who are vulnerable and at greatest risk of disease (Te Whatu Ora, 2025). The current eligibility criteria for young children (from newborn up to 5 years of age) to be recommended to receive the BCG vaccine are as follows (Te Whatu Ora, 2025):

- live in a house with whānau member or person with either current TB or a history of TB
- have one or both parents or household members or carers who within the last five years lived for a period of six months or longer in countries with a TB rate ≥40 per 100,000
- during their first five years will be living for three months or longer in a country with a TB rate ≥40 per 100,000.

The programme provides the vaccine at no cost to individuals who meet the criteria.

Study rationale

There is limited literature available on the TB burden for the separate Pasifika ethnicities as well as the BCG vaccine uptake among the Pasifika population and the general population in Aotearoa NZ. Further investigation to provide more information on BCG vaccine coverage in Aotearoa NZ is beneficial to gain insight into who among the population are protected against TB. Although the Pasifika population is not formally and explicitly listed as 'high risk' for TB in Aotearoa NZ, they are more likely to meet the BCG vaccination eligibility criteria based on the relevant risk factors and determinants of health previously discussed. There is also limited literature on the perceptions of healthcare professionals on BCG vaccination programmes and TB prevention efforts.

To provide more insight on this issue for the Pasifika group in Aotearoa NZ, this study aimed to inform improvements to the BCG vaccine programme including improvements to TB prevention efforts in general. This study aim was addressed by describing the epidemiology of TB among the Pasifika population in Aotearoa NZ, to understand who is at-risk. The study aim was also addressed by producing BCG vaccination coverage to investigate which Pasifika ethnicities received the neonatal BCG vaccination and are therefore, more protected against TB. Understanding healthcare professional's perceptions and perspectives on the BCG vaccination programme and TB prevention was beneficial for developing recommendations on how to improve the BCG vaccination programme and offer better protection for the Pasifika population in Aotearoa NZ.

Study aim and objectives

The study aim is to identify strategies for preventing TB disease and improving BCG vaccine uptake for the Pasifika population.

The study objectives are:

1. To identify who is at risk of TB in Aotearoa NZ with a focus on the Pasifika population;
2. To explore who has received the BCG vaccine within the Pasifika population in Aotearoa NZ;
3. To explore healthcare professional's perspectives on the BCG vaccination programme and TB prevention efforts, with a focus on the Pasifika population; and
4. To make recommendations to reduce the burden of TB among Pasifika communities including improvements to the current BCG programmes in Aotearoa New Zealand.

Significance of the Study

This research will have implications for reducing the burden of TB among the Pasifika population. The study aim and objectives aspire to understand the TB burden among Pasifika and gain insight into more accurate representation of TB patterns and epidemiology among the various Pasifika ethnicities in Aotearoa NZ. The study aim and objectives also aspire to understand the level of protection against TB within the Pasifika population and the various Pasifika ethnicities. Additionally, the study will contribute to the growing knowledge of healthcare professionals' perception of vaccines and vaccinations including the implemented programmes, particularly for Pasifika. This will enable more targeted approaches for TB interventions.

Structure of the Thesis

This thesis consists of six chapters. The first chapter introduced the background of *M.tb* mechanisms and the TB burden globally, in the Pacific region, and in Aotearoa NZ. This highlighted at-risk populations of TB such as Pasifika, and the risk factors and determinants that make this population vulnerable to TB. It also provided the background of the BCG vaccine and the global recommendation set by the WHO. The chapter then introduced the BCG vaccination programme in Aotearoa NZ leading to the rationale and significance of the study.

Chapter two, presents a review of literature on global, national and regional TB epidemiology to highlight the current knowledge of TB trends and vulnerable populations. It also reviews literature on international risk factors and determinants of health that affect TB trends on a

global, national and population group level. It then leads to a review of international literature on BCG vaccination, programmes and the perceptions of healthcare professionals on BCG vaccination. The chapter then concludes with identified knowledge gaps. Chapter three introduces the adopted methodology for the study. It begins with introducing my worldview and positionality as the researcher. It then discusses the Pasifika framework, Te Kora (Schutz, 2022), that guides a convergent parallel mixed-methods design. This chapter then describes the quantitative and qualitative phases. It then leads to a discussion about research rigour and ethical considerations.

Chapter four presents findings from the quantitative phase consisting of estimated TB rates by ethnicity, to identify at-risk groups of the population. The chapter then presents the BCG vaccination rates by ethnicity, to identify their level of protection against TB.

Chapter five will present the findings from the qualitative phase consisting of three categories from healthcare professional's perspectives about TB disease and the BCG vaccine programme. It begins with the first category which is *systemic gaps in identifying at-risk groups* and lead to the second category, *perceptions of TB disease and BCG vaccine among migrants and Pasifika communities.* Lastly, the chapter will end with the third category, *system-based factors that affect BCG uptake and TB reduction.*

Chapter six will critically discuss the main findings from both the quantitative and qualitative phases of the study. The chapter will focus on integrating the findings from the quantitative and qualitative phases and critically discuss these findings with existing literature. Finally, the chapter will end with recommendations produced from this study and a conclusion.

Chapter Two: Literature Review

The literature review consists of two sections. The first section reviews literature on TB epidemiology to analyse existing knowledge of the TB burden including general risk factors and social determinants that influence the TB disease burden and its distribution. The purpose of this section is to establish a foundational understanding of TB as a global, regional and national public health concern. The second section will review literature focusing on the evolution of BCG vaccination programmes and the effectiveness of changes made. This section also includes the rationale behind the changes made focusing on literature relating to healthcare professionals' perception of BCG vaccination and programmes.

Search strategy

Support from a university librarian was sought to enhance database search for relevant sources. The databases used to find articles related to the study aim include Scopus, MEDLINE, CINAHL, PubMed, ProQuest and Google Scholar. Sources from government and public health organisations such as Te Whatu Ora, ESR, and WHO were also utilised to retrieve relevant literature. The search strategy used combinations of the following terms:

- "BCG vaccine" OR "BCG implementation" OR "BCG programme" OR "BCG immunisation" OR "targeted vaccination"
- "Tuberculosis" OR "TB" OR "Mycobacterium Tuberculosis"
- "Pasifika" OR "Pacific Islander"
- "Aotearoa" OR "New Zealand"
- "Perceptions" OR "knowledge"
- "Healthcare workers" OR "Healthcare professionals."
- "Risk factors" OR "Determinants of health"

The identified relevant sources included past and current articles with no set timeframe to explore patterns of TB epidemiology and the evolution of BCG policies or programmes. It also included articles in different languages with provided English translations, to examine the span of the global use of the BCG vaccine. Relevant international sources pertaining to risk factors of TB were selected based on common findings from both low-income and high-income countries. Those without English translations were excluded from the list of chosen articles. The sources were then organised in EndNote to manage the references.

Section one

Global TB burden

The TB burden continues to have an impact on a lot of lives throughout the world. The burden can be examined through many metrics such as incidence, newly diagnosed cases and mortality. According to the WHO (2024) report, it is estimated that one-quarter of the global population is infected with *M.tb* where 10.8 million of those infected, developed TB disease in 2023. The estimated annual incidence of TB disease globally, exhibit a steady increasing trend. The figures were reported to be 10.1 million in 2020, 10.4 million in 2021 and 10.7 million in 2022 (WHO, 2024).

In 2019, there were 7.1 million newly diagnosed cases, however a significant decrease by 18% to 5.8 million was reported in 2020 (WHO, 2024). The decrease, however, did not continue in the following years. Conversely, the figures increased annually with 6.4 million in 2021, 7.5 million in 2022 and 8.2 million in 2023. The year 2023 had the highest figure ever to be recorded since global monitoring for TB began in 1995 (WHO, 2024). The 18% decrease observed in 2020, reflects the disruptions to TB related services such as diagnostics and treatment during the COVID-19 pandemic (WHO, 2024). The resurgence in 2021 and the subsequent increasing trend in 2022 and 2023, reflect a gradual global recovery of TB related services. The reported high figures for newly diagnosed cases, particularly in 2023, highlight the severe impact of COVID-19. These high figures were attributed to the diagnosis of a backlog of undetected and untreated cases (WHO, 2024). Furthermore, the potential reactivation of LTBI, triggered by COVID-19 may have contributed to the high figures of newly diagnosed cases (Colby, 2022). The increasing trend, however, underlines the urgent need for renewal of global efforts to eliminate TB.

One challenge for global efforts is the significant gap between the two metrics (global incidence and global newly diagnosed cases) which have persisted throughout the years (WHO, 2024). This gap is estimated at 2.7 million in 2023 (incidence of 10.8 million and 8.2 million newly diagnosed cases). This discrepancy is primarily due to underdiagnosis and underreporting to national authorities, particularly during the COVID-19 pandemic (WHO, 2024). The gap underscores the need to increase surveillance or case detection, treatment coverage and prevention, especially in low-middle income countries that contribute significantly to this global gap.

Global TB mortality followed the same trend which increased in 2020 and 2021 due to COVID-19 related disruptions. Prior to the pandemic, mortality was steadily declining in the years leading up to 2019. The reported increase in 2020 (1.3 million deaths), again highlights the severe impact of the COVID-19 pandemic.

Global efforts to eliminate TB

Global efforts to eliminate TB commenced in 1991 when The World Health Assembly established specific targets for the year 2000. The set targets were to achieve 85% successful treatment and 70% detection of TB cases (Dirlikov, 2015). The aim of these targets was to reduce TB incidence and prevalence annually by 5 to 10%. In 1993, the WHO declared a “global TB emergency” to enhance and expand international attention and political commitment (Dirlikov, 2015). Global efforts then evolved as the severity of the epidemic continued. This led to the development of a new strategy focused on detection and reporting of cases to health services and provision of short-course chemotherapy, the following year. The strategy was officially known as directly observed treatment short course (DOTs) in 1995. This strategy was aggressively promoted globally after positive outcomes post implementation in China and other regions (Dirlikov, 2015). However, there were barriers to implementing this strategy at the national level when funding and political commitment were not prioritised.

As more TB organisations at various levels grew, as well as the recognised financial constraints cause by TB, the WHO convened an ad hoc committee in London in 1998. This event was paramount for partnership and collaborative capabilities where global entities were joined by different bilateral organisations, private companies, non-government organisations and newly formed research and funding institutions, thereby facilitating united efforts to target the TB burden (Dirlikov, 2015). By the year 2000, DOTs further expanded globally resulting in 148 countries who were committed to implementing the strategy. The strategy was further improved by 2006 as the Stop TB Strategy was launched. The Stop TB Strategy focused on community engagement to address MDR-TB and HIV co-infection (WHO, 2006).

The WHO’s End TB Strategy and United Nations’s (UN) Sustainable Development Goals incorporated the commitment of WHO and UN Member States since 2014 and 2015, respectively, to eliminate the global TB epidemic by 2035 (WHO, 2023). The strategy is founded on a global TB free vision with zero mortality, disease and suffering caused by TB. Thus, specific milestones were established for the years 2020, 2025 and 2030 to significantly reduce the TB burden by targeting reductions of incidence, mortality and catastrophic costs (WHO, 2023). The milestones for 2025 were set for reduction of incidence rate by 50%, mortality by 75% and for 0% of households to face TB related costs. To achieve these milestones, the strategy focuses on patient-centred care and prevention, intensified research and innovation, and strong policies and supportive systems (WHO, 2023; WHO, 2024). Based on the disruptions of the COVID-19 pandemic and the increasing trends in incidence and mortality, the milestones set for 2025 are unlikely to be met.

TB burden in Pacific Island countries and territories

The burden of TB in the Pacific Island countries and territories (PICTs) subregion has been increasing. There was a reported 58% increase in TB cases from the year 2000 (146 per 100,000) to 2013 (231 per 100,000) (Viney et al., 2015). Another study by Yanagawa (2023) examined the burden of TB within this subregion over a period of 20 years (2000 to 2020) and found consistency with the increasing trend. The study reported a rise in incidence rate from the year 2000 (62 per 100,000) to 2020 (69 per 100,000). There was also a 29% increase in TB cases during this period, including mortality rising from 176 in 2000 to 268 in 2020 (Yanagawa, 2023). Given the geographic size of the subregion (more than 20 PICTs made up of more than 1300 islands) and relatively small population (estimated 3.4 million), the impact of the increasing changes in TB cases, TB incidence rates and mortality are significant.

The uneven distribution of TB burden is evident in the PICTs subregion with some individual countries experiencing endemic proportions and some at the pre-elimination phase. For instance, Yanagawa (2023) reported TB incidence rates below 10 per 100,000 in 2018 and 2020 for American Samoa, Samoa, Wallis and Futuna, placing these countries in the pre-elimination phase. In contrast, the incidence rates reported for the Marshall Islands was 483 per 100,000 (95% CI: 370–611) and Kiribati 425 per 100,000 (95% CI: 323–540). Both countries exceeded the WHO's threshold for endemic proportions (Yanagawa, 2023). The years 2012 and 2013 highlighted the continuous pattern of increasing high incidence rates among certain countries within this subregion. The highest incidence rate was reported by Viney (2014) for Kiribati 331 per 100,000 in 2012 which increased to 398 per 100,000 in 2013. The second highest in this subregion was Papua New Guinea with 292 per 100,000 in 2012 to 309 per 100,000 in 2013. The Marshall Islands had 252 per 100,000 in 2012 and 283 per 100,000 in 2013. Viney (2014) also reported a high incidence rate of 182 per 100,000 for Tuvalu in 2013. In terms of TB cases, Yanagawa (2023) revealed that in 2020, four countries accounted for 78% of all TB cases in this subregion. This included Fiji (590), Kiribati (510), the Solomon Islands (450) and the Marshall Islands (290) (Yanagawa, 2023).

MDR-TB remains a serious concern in several PICTs, particularly in Micronesia. There were 52 cases of MDR-TB or rifampicin-resistant TB (MDR/RR-TB) across 11 PICTs between 2015 and 2019, including two outbreaks in Chuuk State of the Federated States of Micronesia (Wiegandt & Stapledon, 2010; Yanagawa, 2023). The concern for MDR-TB in this subregion is reiterated further by Wiegandt and Stapledon (2010) who stressed the alarmingly high presence of MDR-TB in the subregion. Yanagawa (2023) also reiterated the threat of MDR-TB considering the complexity and cost of treatment which is a major concern for low-middle income PICTs.

The study by Yanagawa (2023) provided insight into the distribution of TB burden across the PICTs subregion and indicated that a high proportion of TB cases (19%) occurred in children (under 15 years of age) in 2020. In comparison to the reported global proportion for children (12%) and the wider WPR (4%), this is significantly higher. Thus, TB disproportionately affects children in PICTs to a greater extent (Yanagawa, 2023)

The sources have highlighted the increasing burden of TB within the PICTs subregion throughout 2000 to 2020. Particularly increasing incidence rates, case numbers and mortality. Incidence and case numbers remain low in countries like Samoa and American Samoa, while a significant increase continued in countries like Fiji, Kiribati and the Marshall Islands. MDR-TB also presents challenges for the subregion particularly affecting Micronesian territories. The subregion also has a reported high TB burden among children in comparison to the wider WPR and global proportions. These contrasting trends highlight the unequal distribution of TB burden in the wider WPR observed by the varying levels of TB epidemiology across the PICTs and suggest that unique factors and determinants are influencing TB transmission and control in each country.

TB risk factors and determinants

Several studies have investigated risk factors and determinants of TB disease globally. The three main categories of risk factors and determinants are immunological, environmental and health systems (Dowdy, 2021). Studies have shown that the three categories can influence or determine the two-stage process to the progression of TB disease following exposure to the *M.tb* bacilli (Narasimhan et al., 2013; Srivastava et al., 2015). Furthermore, the three categories of risk factors and determinants can fall under exogenous and endogenous factors. Exogenous factors are known to play an important role in speeding up the progression from exposure to infection which usually results in LTBI. This is determined by the bacillary load in the sputum and proximity to the TB case (Narasimhan et al., 2013). Endogenous factors relate to progression from infection to active TB disease (Narasimhan et al., 2013; Srivastava et al., 2015), which usually involves activation of LTBI. Both exogenous and endogenous factors contribute to TB infection and disease at both the individual and population level.

Exogenous factors

Bacillary load in sputum

The concentration of bacilli in the sputum governs the infectiousness of a TB case, therefore, determines the progression from initial exposure to becoming infected with *M.tb* for disease contacts (Narasimhan et al., 2013; Srivastava et al., 2015). Studies have indicated that

Pulmonary TB (PTB) cases with sputum smear-positive are significantly more infectious than those with smear-negative (Narasimhan et al., 2013; Srivastava et al., 2015). Thus, sputum smear-positive cases have been greatly connected with higher prevalence and incidence of infection and disease among contacts (Narasimhan et al., 2013; Srivastava et al., 2015). Narasimhan et al. (2013) described a prospective study that revealed TB contacts had an increased risk of *M.tb* infection or positive TST if the index case had a higher load of bacilli (sputum smear grade of 1-10 bacilli per field) with 1.98 (CI = 0.75–5.23) times the odds. Much higher bacilli load or sputum smear grade from the index case (more than 10 bacilli per field) resulted in 5.88 (CI = 1.60–21.3) times the odds of a positive TST among contacts. This clearly demonstrates that the likelihood of having a positive TST and therefore likelihood of *M.tb* infection, is higher in contacts if the index case has higher-grade sputum or bacilli load. Narasimhan et al. (2013) and Srivastava et al. (2015) also reported that one sputum positive TB case can infect approximately 10 individuals per year which can result in two new cases of TB. Therefore, early detection of sputum positive cases is crucial to control and prevent TB transmission.

Prolonged contact and proximity to infectious TB case

Bacillary load is influenced by several factors, including the frequency of coughing by the index case, as well as the duration and proximity of contact with an infectious individual. Those most likely to be in proximity and prolonged contact with TB cases include household contacts (HHCs), caregivers, and healthcare workers (Narasimhan et al., 2013). Therefore, these individuals will have greater risk of *M.tb* infection. This notion has been shared in many studies which highlight duration and proximity as a significant risk factor for both infection and disease (Laghari et al., 2019; Morán-Mendoza et al., 2010; Narasimhan et al., 2013; Shimeles et al., 2019; Srivastava et al., 2015; Tekkel et al., 2002). For example, being an HHC of a TB case will increase the likelihood of developing TB by 15 times more (OR = 15.29, 95% CI: 5.38–43.46) (Laghari et al., 2019). Similarly, Shimeles et al. (2019) reported an increase in TB risk by threefold among those with a household member who previously had TB (AOR = 3.00, 95% CI: 1.60–5.62). In terms of duration, the study by Laghari et al. (2019) revealed the significance of prolonged contact by reporting that contact for more than 18 hours significantly increased the risk of developing TB (OR = 4.68, 95% CI: 1.20–18.29) while Coorey et al. (2022) found that 19.4% of 402 TB cases had prior contact with a TB case, making it the most common risk factor. Despite differences in sample size, variables and study design, these findings consistently highlight the significant role of prolonged contact and proximity for TB transmission, infection and disease.

Indigenous, Ethnic Minorities and Migrants/Immigrants

Studies have shown that ethnic minorities and indigenous populations are at-risk groups of TB due to the higher burden of other predisposing factors. In Canada and Australia, factors such as renal failure, diabetes, alcohol abuse, smoking, overcrowding, poverty and less access to healthcare are more common among indigenous populations (Narasimhan et al., 2013). This has substantially contributed to TB transmission and TB disease and increased risk for indigenous groups. The study by Coorey et al. (2022) further reiterated this by stating that indigenous people born in Australia have TB rates that are four-fold higher than non-indigenous people born in Australia. This risk factor indicates a vulnerability for the indigenous Pacific Island peoples who have migrated to Aotearoa NZ (referred to as Pasifika), as 32.6% are born overseas (Stats NZ, 2024). Furthermore, Nava-Aguilera et al. (2009) found that being an ethnic minority increases risk of TB transmission 3 times more (OR 3.03, 95%CI 2.21– 4.16) and being a native of a country (indigenous) two times more (OR 2.33, 95%CI 1.76–3.08). These common findings highlight that TB largely impacts indigenous populations to a greater extent, which is mirrored in the Pasifika population in Aotearoa NZ.

Couceiro et al. (2011) reported that immigrant populations had higher risk of pulmonary TB. Migration is also highlighted as a social determinant of health that affects ethnic minorities (Srivastava, 2015) especially in low or/and middle TB-burden countries where TB is often high among these groups within the population (Srivastava et al., 2015). This is often linked to predisposing factors, including socioeconomic status and challenges accessing healthcare which are more common/prevalent among migrants in low or/and middle TB-burden countries such as Aotearoa NZ. Challenges with access to healthcare is exacerbated among undocumented migrants due to fear of deportation (Srivastava et al., 2015).

Immigration has been identified as a risk factor for exogenous reinfection of TB (Qiu et al., 2022). A DNA fingerprint analysis of TB patients detected that 84% of TB cases were among foreign-born individuals as a result of LTBI reactivation from *M.tb* infections acquired abroad (Srivastava et al., 2015). Foreign-born individuals and migrants face continued risk due to transmission within their communities, particularly among recent arrivals and those who travel back to high-incidence countries of origin. As risk factors, migration or being a foreign-born are particularly concerning for the Pasifika population who live in Aotearoa NZ as 30.6% of the population arrived or migrated to Aotearoa NZ within the last decade (Stats NZ, 2024). However, 76% percent of total TB notifications in 2016 were among people born outside of Aotearoa NZ (Verrall et al., 2020).

Low socioeconomic status

TB has been known as a disease of poverty due to risk factors such as high population density, cramped conditions, and poor ventilation that are common among those with low socioeconomic status with poor living conditions (Srivastava et al., 2015). These environmental and social determinants, particularly low socioeconomic status, are strongly associated with TB infection and disease (Narasimhan et al., 2013; Oxlade & Murray, 2012; Srivastava et al., 2015). For instance, Oxlade and Murray (2012) reported that TB prevalence in India ranged from 201 per 100,000 (95% CI: 142–260) among the wealthiest quintile to 1,105 per 100,000 population (95% CI: 919–1291) among the poorest. Similarly, a case-control study by Shimeles et al. (2019) found that individuals from low-income households were more than twice as likely to develop TB compared to those with higher incomes (AOR = 2.2, 95% CI: 1.28–3.78). The same study also highlighted the role of limited education, which is a key indicator of low socioeconomic status, showing that illiterate participants had double the risk of TB compared to those with basic literacy (AOR = 2.15, 95% CI: 1.05–4.40) (Shimeles et al., 2019). In Estonia, Tekkel et al. (2002) identified unemployment, low income and limited education as significant risk factors. In Portugal, other key indicators of low socioeconomic status are also reported as risk factors for TB such as unemployment (Couceiro et al., 2011). Furthermore, Nava-Aguilera et al. (2009) reported that homelessness nearly tripled the odds of TB transmission (OR = 2.87; 95% CI: 2.04–4.02). Homelessness was also a common risk factor among TB cases in Australia (Coorey et al., 2022).

Collectively, these findings emphasise that low socioeconomic status significantly elevates TB risk, particularly in low- and middle-income settings. The economic disparities between Pasifika and non-Pasifika are evident in the over-representation of Pasifika among unemployed, lower skilled workers and low-income earners (Stats NZ, 2002). The lack of these attributes accentuates the vulnerabilities of those of low socioeconomic status thereby increasing the likelihood of associated factors such as overcrowding and poor ventilation which increases TB transmission (Srivastava et al., 2015) and TB disease.

Overcrowding and Poor Ventilation

People with low socioeconomic status are more likely to be exposed or live in overcrowded and poorly ventilated settings. As previously discussed, bacillary load, prolonged contact and proximity to an infectious case significantly increases infection and transmission of *M.tb* (Couceiro et al., 2011; Laghari et al., 2019; Narasimhan et al., 2013; Shimeles et al., 2019; Srivastava et al., 2015). Overcrowded and poorly ventilated environments can, therefore, exacerbate infection and transmission of *M.tb*. This is reiterated in a case-control study which found that those living in homes with no windows or one window were almost two

times more likely to develop TB compared to those living in homes with more windows (AOR = 1.81, 95% CI: 1.06–3.07) (Shimeles et al., 2019). This emphasises adequate ventilation as crucial for reducing TB risk. Overcrowded or densely populated settings also contribute to increased infection and transmission of *M.tb* (Lönnroth et al., 2008; Narasimhan et al., 2013). Several studies have evidently stressed the crucial role of overcrowding or densely populated settings such as bars, homeless shelters, prisons, and other institutional settings. Nava-Aguilera et al. (2009) revealed that history of imprisonment increased the odds of TB infection 2 times more (OR = 2.21; 95% CI: 1.71–2.86). Similarly, Qiu et al. (2022) linked history of imprisonment to exogenous TB reinfection, while Silva et al. (2018) found that imprisonment doubled the risk of developing MDR-TB among individuals with PTB (OR = 2.02). In addition to low socio-economic status that often influences overcrowded living conditions, cultural determinants also contribute. In the Pasifika context, large households, large family units and communal settings are important aspects of Pasifika culture. However, several sources have identified this as a significant risk factor or cultural determinant for TB and therefore highlight Pasifika's vulnerability.

Health system-related factors

Several studies have identified health system related factors for TB transmission and disease. The key health system related factors include delay in diagnosis and treatment which increases the duration of the TB cases' infectious period thereby increasing transmission. Narasimhan et al. (2013) reported evidence of strengthening health systems in China in which notifications of TB were improved through online-based reporting thus, improving hospital referrals from 59% to 87%. This also improved detection, management and treatment of sputum positive PTB cases which in turn ensure lower transmission. This highlights that the reliance on passive case findings which depends on individuals seeking medical attention when they experience TB symptoms, as well as the individual's ability to recognise these symptoms, is not an effective approach as it often delays diagnosis and treatment thereby increasing the duration of infectious cases in communities (Laghari et al., 2019).

Delays in diagnosis and treatment can also be affected by health system related factors such as facilities that lack diagnostic equipment, lack of staff or high workload for staff. This also means multiple appointments and locations to travel for patients which often affect costs, transport and time (Laghari et al., 2019).

Some studies have also reported healthcare settings as high risk for acquiring TB. Shimeles et al. (2019) identified previous history of hospital admission to increase risk of TB by almost more than three times (AOR 3.39, 95% CI: 1.64–7.03). Srivastava et al. (2015) also reported healthcare workers' risk of acquiring TB is high due to increase likelihood of exposure. The

need for adequate infection control in healthcare settings is therefore crucial to prevent transmission among staff, patients and visitors.

These sources have highlighted the risk of TB disease following exposure to *M.tb* is governed by the exogenous factors discussed. The combination of the infectiousness of the case, prolonged contact or close proximity to the infectious case including social determinants of health and system related factors, increases susceptibility to TB disease and transmission, particularly among the Pasifika population.

Endogenous factors

Endogenous factors typically advance the progression from infection (usually LTBI patients) to disease, in relation to the host or individual's capability to contain or eliminate the infection (Narasimhan et al., 2013). On an individual level, endogenous factors include certain conditions such as medications or existing diseases that weaken the immune system. However, on a population level, the impact of endogenous risk factors can vary depending on the prevalence of these conditions in certain environments, areas or settings, therefore some may argue that endogenous factors can also be considered as exogenous (Qiu et al., 2022).

HIV co-infection

HIV co-infection is well known to be one of the most potent risk factors for TB disease as it extensively suppresses the immune system (Narasimhan et al., 2013; Nava-Aguilera et al., 2009). HIV co-infection can increase risk of TB disease by 6 to 26 times more (Coorey et al., 2022; Jurado & Palacios, 2018; Srivastava et al., 2015). On a population level, Qiu et al. (2022) identified HIV co-infection as an exogenous risk factor. This is evident in certain areas with high prevalence of HIV which in turn had an increase in TB incidence (Couceiro et al., 2011; Lönnroth et al., 2008; Narasimhan et al., 2013). This highlights that immune-suppressing conditions such as HIV infection impacts the TB burden significantly on an individual and at the population level.

Diabetes mellitus

Diabetes mellitus (DM) is another significant risk factor that suppresses or weakens the immune system and therefore it can accelerate the progression to TB disease (Coorey et al., 2022; Li et al., 2024; Lönnroth et al., 2008; Narasimhan et al., 2013; Silva et al., 2018). One study claimed that the odds of developing TB are 2.44 to 8.33 times more among patients with DM than those without DM (Silva et al., 2018). On a global level, DM among TB cases has been reported to have the highest prevalence in countries of Asia, North America and Oceania (Workneh et al., 2017). The high prevalence of DM among TB cases in Oceania

indicates that DM is a prominent risk factor for TB in the Pacific. This is confirmed by several reports on DM in the Pacific such as Foliaki and Pearce. (2003) which stated that diabetes is nearing epidemic proportions among populations in the Pacific. In 2023, Te Whatu Ora (2024) reported that the Pasifika population in Aotearoa NZ had the highest prevalence of diabetes (125.5 per 1000, CI: 124.3 – 126.6). The high prevalence of DM among Pasifika accentuates this population's greater risk of TB disease. Moreover, Pasifika typically face greater socio-economic difficulty which highlights what Holder-Pearson and Chase (2022) described as a double burden.

Malnutrition

Sinha et al. (2024) claimed that malnutrition is the world's leading risk factor for TB. Many studies have confirmed the significant link between malnutrition and TB disease which highlights the impact of malnutrition on the hosts' immune response against TB infection (Jurado & Palacios, 2018; Lönnroth et al., 2008; Morán-Mendoza et al., 2010; Narasimhan et al., 2013; Srivastava et al., 2015). Both malnutrition and TB have greater impacts in most developing countries and regions globally (Srivastava et al., 2015), which again highlights the role of low-socioeconomic status in exacerbating common risk factors of TB (Morán-Mendoza et al., 2010). One study reported that malnourished children's risk of TB disease increases by two times compared to children who are well-nourished (Narasimhan et al., 2013). The same study also reported that malnourished adults' adjusted hazard of TB disease increased by six- to ten-fold. Key indicators of malnutrition such as low body mass index have been found internationally to increase risk of TB (Nguenha, 2025; Oxlade & Murray, 2012; Sinha et al., 2024).

A study conducted in Estonia reported shortage of food, which is another key indicator of malnutrition, as one of the main risk factors for TB (Tekkel et al., 2002). In the Aotearoa NZ context, Pasifika children are reported to experience severe to moderate food insecurity (Ministry of Health, 2019). According to the Ministry of Health (2019), food insecurity can range from malnutrition due to food deprivation and malnutrition due to consuming high-calorie foods with little/minimum crucial nutrients. The latter is of specific concern for the Pasifika population in Aotearoa NZ with reported high rates of obesity particularly among Pasifika youth (Lousich et al., 2023; Oliver, 2011). The high burden of obesity and food insecurity among Pasifika underlines their increased risk of TB disease due to malnutrition.

The sources have identified key endogenous risk factors that accelerate progression of TB disease. The authors highlighted the significant impact of impaired immunity on an individual and population level such as HIV co-infection. Endogenous risk factors that indicate the significant high-risk of TB disease among Pasifika are DM and malnutrition which have been

identified as prevailing immunosuppressing conditions within this population group.

Section two

Overview of Bacillus Calmette-Guérin (BCG) vaccination

The BCG vaccine was first introduced in 1921 and has remained as the only preventative vaccine against TB (Zwerling, 2011). Despite the long period of use, the BCG vaccine has undergone controversial critique by several research studies throughout the years. As mentioned in the introduction chapter, the use of the BCG vaccine varies in different countries based on WHO recommendations due to many considerable/substantial aspects. Among many, is the debatable efficacy of the vaccine, with many studies claiming that it is most effective at reducing risk of TB among children, thus indicating that the efficacy of the vaccine reduces in adulthood (Colditz et al., 1995; Hatherill & Cobelens, 2022; WHO, 2001, 2008; Zwerling, 2011). Another aspect of the vaccine is that it hinders diagnostic tests such as the Tuberculin skin test (TST) which can be used to identify *M.tb* infection (WHO, 2014; Zwerling, 2011). BCG vaccination can result in a positive TST therefore, *M.tb* infection or latent TB in these individuals can not be confirmed through this diagnostic route. The last aspect that affects BCG vaccination policies and programmes is that it is resource consuming, especially over a lengthy period of time (Hersh et al., 2003; Rahman, 2001; Wallgren, 1955). Consequently, most countries have adopted unique BCG policies and programmes specifically for neonates, based on WHO recommendations and the country's burden of TB (Zwerling, 2011).

Universal BCG vaccination

A majority of countries have historically implemented a universal or mass BCG vaccination approach which has been found to elicit beneficial outcomes such as high vaccination coverage. One example of the high vaccination coverage achieved through universal vaccination is the WHO and UNICEF (United Nations Children's Fund) global BCG vaccination campaign implemented in 26 countries from 1951 to 1953 (WHO, 1955). High vaccination coverage was observed in countries where this campaign was implemented such as Pakistan which reported 99% vaccination of 4 million identified TST negative individuals (Roelsgaard et al., 1957). The success of the campaign was extended to provide cover to both urban and rural areas of the entire country (Roelsgaard et al., 1957). The campaign highlights the effectiveness of a universal vaccination approach which is crucial in high TB burden countries. This notion is reiterated in the Infuso and Falzon (2005) study which claimed BCG coverage was as high as 83% to 99.8% in countries implementing a universal vaccination policy. Interestingly, numerous low burden countries still maintain

universal BCG vaccination (Zwerling, 2011).

Today, many high burden countries in the Pacific are implementing universal BCG vaccination programmes and policies that include the vaccine in routine immunisation schedules for newborns. This includes PICTs such as Fiji, Vanuatu, Solomon Islands, Papua New Guinea and others (Zwerling, 2011). Conversely, several studies indicate higher inclination to the limitations of the universal vaccination approach based on the aforementioned aspects of the BCG vaccine (Hatherill & Cobelens, 2022; Wallgren, 1955; WHO, 2001). Therefore, to mitigate these aspects, low TB burden countries tend to adopt targeted vaccination approaches (Hersh et al., 2003) aimed to capture at-risk populations only.

Targeted BCG vaccination

A study by Zwerling (2011) identified several countries with reported changes to their BCG programme in the last two decades including 33 countries that had multiple vaccination programmes. The main change is the policy transition from universal vaccination to targeted vaccination. A study by Lancione et al. (2022) claimed that this transition in identified European countries continued to decrease TB incidence, therefore suggesting that targeted vaccination can be as effective as the universal vaccination approach. However, the reported ongoing changes and refinements of BCG policies and programmes across nations indicate limitations to targeted vaccinations. Such limitations have been identified in several studies which include the differing levels of contraindications guidelines. These guidelines tend to be stricter among low burden countries (WHO, 2001) who typically transition to targeted vaccination (WHO, 2001). Contraindication guidelines often exclude certain individuals who are HIV-positive, TST-positive, pregnant and with certain skin conditions from vaccination (WHO, 2001). The lack of BCG vaccination data was also identified as a limitation to targeted vaccinations (Infuso & Falzon, 2006; Pilger, 2012). This restricted monitoring of BCG coverage among the targeted high-risk groups. One study also stressed the need for routine collection of information from TB cases such as BCG status and eligibility (Infuso & Falzon, 2006). This could enable evaluation research to improve targeted BCG vaccination programmes.

Healthcare professional's perception of BCG vaccination policies.

Another limitation to the success of the targeted vaccination (in terms of the transition from universal to a targeted approach or refinements to the policy) is the lack of updated knowledge of the new policy among healthcare workers and communities (Gordon, 2007; Rossignol et al., 2011; Zwerling, 2011). This is especially concerning as certain groups can be missed for vaccination particularly for migrants who may not be knowledgeable on BCG

vaccination policies in their country of origin and their new host country (Zwerling, 2011). This again extends to healthcare workers who are not necessarily expected to know all separate BCG vaccination policies in different countries, therefore identification of migrants who may need the vaccine is not easily recognised (Zwerling, 2011). This resonated with a study in France which claimed that BCG immunisation of target groups increases when GPs are knowledgeable on vaccination guidelines (OR 1.4, CI: 1.1 – 1.9) as well as GPs' perception or awareness of TB as a common disease (OR 2.2, CI: 1.1 – 4.5) (Rossignol et al., 2011).

Among the identified countries that have transitioned to targeted vaccination, 29 consider the vaccine as compulsory and 7 consider the vaccine as voluntary (WHO, 2001). This indicates another limitation to the success of a targeted vaccination policy. The variations in regional and national health systems' processes and political commitment in terms of policymakers' perspectives on TB and their emphasis on prevention determines the level of policy implementation (WHO, 2001).

The transition from universal to targeted vaccination has many benefits for low incidence countries. Although targeted vaccination can be as effective as the universal approach in reducing low incidence, studies over the years have identified certain limitations that can hinder its success. The continued universal approach in some high burden countries such as PICTs, highlights the high risk for migrant families and communities to miss out on BCG vaccination especially if they have migrated to a low burden country that is implementing targeted BCG vaccination.

BCG vaccination in Aotearoa NZ

As mentioned in the introduction chapter, Aotearoa NZ initially implemented a universal or mass vaccination approach. Currently, the BCG vaccination policy or programme targets identified at-risk groups of the population. Throughout the years, the policy has been refined and implemented at varying levels throughout separate regions of the country (Hickling, 1963). The study by Hickling (1963) suggested the rationale behind the targeted vaccination approach aligned with the known aspects of the BCG vaccine previously discussed such as the continuous expenditure or cost of the universal or mass vaccination approach. The study stated that as a low TB burden country, the universal approach was not justifiable therefore, supported targeted vaccination. However, the study suggested modifications for improvement. Interestingly, one suggestion was to incorporate BCG vaccination in routine TSTs, thereby increasing coverage of suspected *M.tb* infected individuals who would be deemed to be at-risk.

Summary of literature review

This literature review explored and analysed national and international studies concerning the span of TB epidemiology and general risk factors and determinants of heath. This section of the literature review has highlighted the global increasing trend of TB and the role of the COVID-19 pandemic in exacerbating the burden of disease as well as challenging global efforts to eliminate TB. This section also revealed the uneven distribution of TB, particularly in the WPR and PICTs subregion (such as Fiji, Kiribati, Tuvalu, Marshall Islands and more), highlighting vulnerabilities for low-middle income countries that has influenced their high burden of TB. Literature on common risk factors and determinants of health have emphasised the vulnerabilities and high risk of TB among the Pasifika population in Aotearoa NZ. Particularly highlighting factors where Pasifika are overrepresented such as indigenous or ethnic minorities or migrants, low socio-economic status and associated indicators, as well as comorbidities or immune suppressing conditions.

The second section of this literature review established the evolution of BCG vaccination policies and programmes internationally, including the implicit rationale for the changes made to these policies. This section revealed that international policies and programmes on BCG vaccination have undergone several changes worldwide, particularly for low burden countries. Aligning with the WHO recommendation, the majority of low burden countries have switched from universal or mass vaccination to a targeted policy or programme. Other attributable factors relate to certain aspects of the BCG vaccine such as the debated efficacy, impact on diagnostic tests and consumption of resources. This section also revealed that a targeted programme can be as effective as the universal vaccination in terms of reducing TB incidence. However, there were notable limitations to the targeted approach that can hinder its effectiveness. These include contraindication guidelines, inability to evaluate the new policy or programme, lack of knowledge of the new policy or programme among healthcare workers and communities, variation in processes, political commitment and perceptions of TB among policy makers. Consequently, these further highlights migrant families' vulnerability in missing out on the vaccine, particularly when they have migrated to a low burden country that is implementing a targeted vaccination programme. This resonates with migrants in Aotearoa NZ, especially Pasifika migrants from high burden countries.

International literature that explicitly explores the perceptions of healthcare professionals on BCG vaccination policies and programmes is scarce. This also applies to Aotearoa NZ, which hindered the literature review from exploring healthcare professionals' level of support and the considerable aspects behind decision-making or rationale for current prevention efforts and the established BCG eligibility criteria for the whole country. There is also no known study in Aotearoa NZ on the BCG vaccination coverage for the whole population, particularly for Pasifika, which is essential for identifying the population's level of protection

against TB. Thus, the current study aims to address these gaps by providing insights into at-risk populations and their BCG vaccination coverage as well as exploring perceptions of healthcare professionals on current prevention efforts and the BCG vaccination programme in Aotearoa NZ. The next chapter will discuss the methodology that will be utilised to address the aim of the current study.

Chapter Three: Methodology

Choosing an appropriate methodology is crucial for addressing the study's aim and objectives effectively. The aim of this research is to identify strategies for preventing TB disease and improving BCG vaccine uptake for the Pasifika population in Aotearoa NZ. To address this study aim, the specific research objectives are:

1. To identify who is at risk of TB in Aotearoa NZ with a focus on the Pasifika population;
2. To explore who has received the BCG vaccine within the Pasifika population in Aotearoa NZ;
3. To explore healthcare professional's perspectives on the BCG vaccination programme and TB prevention efforts, with a focus on the Pasifika population; and
4. To make recommendations to reduce the burden of TB among Pasifika communities including improvements to the current BCG programmes in Aotearoa NZ.

This chapter outlines the methodology, which is framed from a Pasifika perspective to ensure cultural practices and safety are integrated throughout the research. The chosen Pasifika methodology is the Te Kora framework (Schutz, 2022), which has its origins in Kiribati and embodies its values. The Te Kora framework will guide a parallel convergent mixed-method study design, incorporating both quantitative and qualitative phases. The quantitative phase was an observational study, while the qualitative phase involved maroro (conversations) with healthcare professionals. The chapter will also discuss the ethical considerations and address issues related to research rigour.

Positionality and Paradigm

My choice to adopt a Pasifika methodology stemmed from my upbringing in Kiribati, where I spent vital years learning my culture and language which has shaped my interests, values, beliefs and assumptions of reality. My undergraduate education in biomedical science further contributed to my interest in research, particularly for communicable diseases. Furthermore, I was fortunate enough to work in the Pasifika cultural support space at the Auckland Regional Public Health Service (ARPHS), supporting Pasifika families that have been affected by notifiable diseases. This involved strategic planning to reduce barriers that Pasifika cases and their families in Auckland faced during communicable disease outbreaks. I noticed that common barriers for disease management and elimination efforts affected Pasifika families, preventing them from completely and efficiently participating in public health efforts. This was particularly challenging given the impact of TB outbreaks on their

families, as notifications of TB were still common in Pasifika whānau and communities, including outbreaks in Kiribati communities where children have been hospitalised with pulmonary TB. This motivated my interest to conduct research on TB prevention among Pasifika, with a particular interest in BCG vaccine uptake. I have a neonatal BCG vaccine scar on my left arm, as many other Pasifika people born in the Islands do, since it is included in the vaccine schedule in some Pacific Island countries with high prevalence of TB such as Kiribati. Although it may have protected me against active TB throughout my childhood, I started to wonder if the vaccine would have made a difference to Aotearoa NZ-born Pasifika people, since it is not included in their neonatal vaccine schedule, nor are they necessarily entitled to it as part of the national immunisation schedule. These factors have influenced and shaped my research interests, along with my research worldview.

Pioneers of Pasifika research have often contended with dominant Western research philosophies that can marginalise Pasifika epistemologies with notions of validity and truth (Matapo, 2016). Matapo (2016) emphasised Pasifika paradigms as grounded in Pasifika epistemology, rooted by Pasifika values, knowledge and ethics. This highlights fluidity, multiplicity and relationality of the Pasifika worldview where there is no one, fixed or pure truth within Pasifika knowledge. My worldview is influenced tremendously by my Pasifika heritage and upbringing in Kiribati, particularly my exposure to traditional medicine practices that draw from a holistic point of view, which is based on the fluidity, multiplicity and relationality fundamentals. I migrated with my family to Aotearoa NZ as a child and spent the majority of my life and education in Aotearoa NZ. The predominant Western systems in Aotearoa NZ resulted in my resonating with these notions of validity and truth and formed my position in research to acknowledge Western research paradigms alongside my Pasifika worldview, particularly appreciating their different ways of generating knowledge. However, as a Pacific Islander living in Aotearoa NZ, I lean more towards what Naepi (2019) described as the need to build a more complex understanding of Pasifika issues, that derive from Pasifika people's understanding of the world and their interactions with the world to create knowledge, to break the damaging cycle of Pasifika research based on Western paradigms. This is because Pasifika worldviews are often at risk of misinterpretation, especially when cultural context is removed (Teariki & Leau, 2024). Therefore, a methodology that can accommodate multiplicity and fluidity of the Pasifika worldview and cultural values was necessary for my study given the Pasifika population was the focus of inquiry. Furthermore, it also needs to align with my own set of beliefs and assumptions of reality. The overall study will therefore draw from a Pasifika research worldview, utilising Te Kora as a framework (Schutz, 2022) to guide the study.

Mixed-method study design

According to Byrne and Humble (2006), the research issue should be the primary determinant of the employed methodology of the study. After considering the research aim and objectives, it was decided that a quantitative observational approach would be required to address the first and second objectives. The third and fourth objectives would require a qualitative interpretive descriptive approach (Thorne, 2016). Therefore, a mixed-methods approach, specifically a convergent parallel design was the most appropriate one to address the study aim and objectives (Creswell & Clark, 2017). A mixed-methods design is suitable for this study by providing the opportunity for myself as the researcher to address confirmatory questions through the quantitative phase as well as exploratory questions through the qualitative phase in one study, overcoming the limitations of employing a single approach or method (Byrne & Humble, 2006). Findings from both phases can complement one another and provide more meaningful understanding of the study aim, which involves the diverse and differing points of view of healthcare professionals. Additionally, mixed-methods researchers approach are often pragmatic and acknowledge paradigms as social constructions and can adopt different methodological tools to address the complex realities of the world (Byrne & Humble, 2006). Thus, the mixed-methods design also aligns with the principles and underpinnings of the Pasifika worldview which goes beyond single methodologies and embraces diverse epistemologies in its application.

Te Kora framework and rationale for application

In the Aotearoa NZ context, policy and discourse combine those of Pacific ancestry (both born in New Zealand and those who migrated from different neighbouring Pacific Islands) and define them by the umbrella term ‘Pasifika’ or ‘Pacific Islander’ (Enari & Haua, 2021). Upon migrating to Aotearoa NZ, I was introduced to the diversity of Pasifika, where I found my I-Kiribati cultural principles and values to share commonalities across the differing Pacific ethnicities. This is a crucial aspect to consider when applying a Pasifika methodology such as Te Kora.

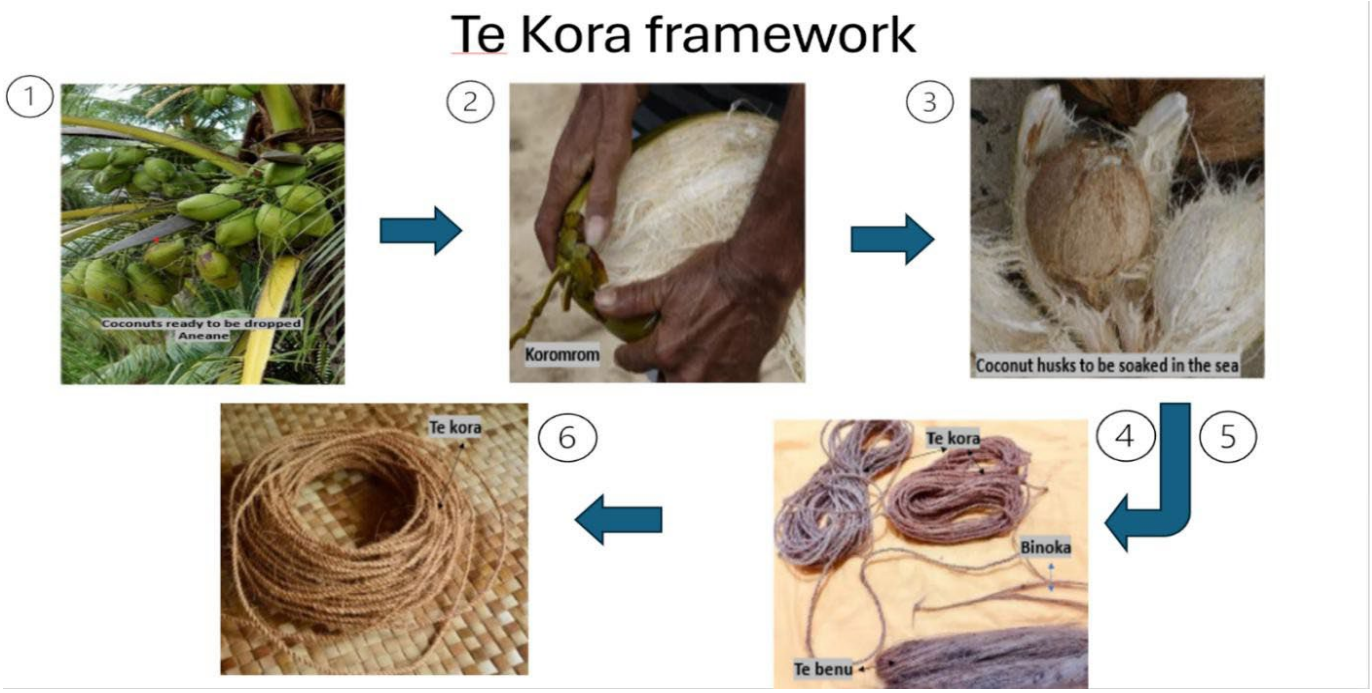
The Te Kora framework is steered by the three main principles of Kiribati cultural etiquette which are applied to the process of making kora (the local string) (Schutz, 2022). The first principle is Bauariria - “Bau” means vow and “Ariria” means to tighten bonds and forming connectedness. People, living and non-living things and the natural environment exist over time and space in interdependency and interconnectedness (Teariki & Leau, 2024). This is an important aspect to the holistic systems of the Pasifika worldview as Teariki and Leau (2024) stated when discussing the recurring principles in Pasifika research. This is complemented by the second principle of Kaomataaki - “Kao” to invite and “Aomataaki” to

make certain of the person (Schutz, 2020). Kaomataaki is about showing courtesy and acknowledging the value of consultations. Kaomataaki touches on the responsibility and accountability of the researcher to demonstrate a culturally appropriate approach to creating the bonds of bauariria. These bonds and connectedness are essential for enduring over time, therefore, the values of respect and trust endorsed by Bauariria and Kaomataaki, are vital to protect and nurture these relationships. The third principle is Iokinibwai - “Ioki” exchange of goods, food, or services and is also referred to ‘reconciliation’, and “Bwai” means things. This reflects the concept of how resources are utilised and shared to benefit contributing parties to also nurture and protect bonds, relationships and connectedness in the holistic systems, ensuring reciprocity. These principles are showcased across developed pan-Pacific methodologies, emphasising the shared Pacific cultural values centralising respect, reciprocity and relationships (Naepi, 2019). Thus, the Te Kora framework is appropriate as a framework for this research based on the Pasifika population in Aotearoa NZ.

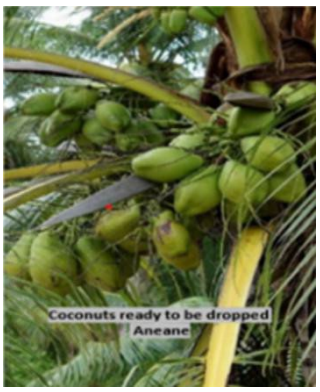
The Te Kora framework is based on the Kiribati cultural practice of making traditional string from coconut husks based on six main steps/ or phases (Figure 1) in which the kora string is the finished product (Schutz, 2020). This is a common practice across the Pacific Islands dating back to the voyaging age, because the fibre extracted from the husk, also known as coir, is waterproof and exceptionally durable. Thus, it is ideal for crafting strings and ropes used for lashing canoes, huts and has many more uses. An example of this practice for producing strings from coconut husks is the Fijian magimagi, Samoan afa and Tongan kafa. Although the processes are unique to each traditional method of producing kora, the steps/phases share similarities with one another, which will enable Pasifika or other Pacific Island ethnicities in Aotearoa NZ to relate to the Te Kora framework and its applications.

Additionally, the Te Kora framework utilises the Kiribati language which is beneficial for myself as the researcher in capturing a deeper essence of meaning and nuance in its application to the study, having Kiribati as my first language. Consequently, I was further motivated to select and adopt the Te Kora framework to guide this mixed-method study design, to reflect Pasifika cultural values that operate within the diverse Pasifika worldview, in order to accommodate its multiplicity, fluidity and relationality especially to myself as the researcher and the Pasifika population in Aotearoa NZ. The following sections will describe the Te Kora framework phases as applied to the quantitative and qualitative phases summarised in Figure 1.

Figure 1. Images relevant to steps of making Te Kora (Schutz, 2022, p. 65)



Te Kora framework applied to the quantitative and qualitative phases



Phase one, Tarakai. The first step in making te kora is tarakai, which involves the initial surveillance of available resources in the land, such as plantations. Primarily, coconut trees are inspected for their suitable green and youthful colour before being harvested. The village then gathers to assign roles to men, women, and children in the collective process of making te kora. In research, this phase corresponds to the initial scoping of the project and relationship building.

Quantitative Phase - A supervision team was developed with the required knowledge and skills, including Dr Nadia Charania, Dr Taniela Lolohea, and Dr Janine Paynter. Together, we established fortnightly meetings to discuss the proposed study design and available data and networked with national and regional TB experts. Relationship building included liaising with paediatric infectious disease experts, as suggested by my supervisors and the scholarship provider committee (Te Niwha, the national infectious disease research platform). Moreover, I had discussions with key personnel at the Ministry of Health, as well as representatives from the National Public Health Service. Liaison also occurred with the ARPHS BCG team and the Institute of Environmental and Research (ESR) about what data is available and

could be accessed for this study. This phase also included developing the research proposal and obtaining appropriate ethical approvals, which will be detailed further in the ethical considerations section later in the chapter.

Qualitative Phase - Relationship building began with introducing the proposed study to staff at Te Whatu Ora ARPHS who are knowledgeable on TB policies and programmes, including public health nurses and programme coordinators. Community engagement events were held for initial consultation and relationship building with a Pacific sports club in Wellington with a demographic range of 15- to 50-year-old men and women and with members of Kiribati Nurses and Health Professionals Association Inc. A presentation of the study was delivered to both groups to gain their input. Feedback, concerns and advice from the audience were noted and informed of the indicative questions that would be used for maroro (conversations) with healthcare professionals (participants).

Phase 2, Koromrom. This process is when green coconut husks and other relevant material are separated from the coconut shell. The coconut shell contains liquid and young coconut flesh, which are separated for food, whilst the coconut husks are put in bags and weighed down by big rocks in large holes dug in the lagoon. In research, this involves searching and selecting relevant knowledge, data, and materials to better understand the background context.

Quantitative Phase - A review of literature was conducted, to outline epidemiological background information on TB prevalence, incidence and mortality measures including the risk factors on a global scale, the Pacific region and within Aotearoa NZ. This information has been included in the previous literature review chapter.

Qualitative Phase - A review of literature was conducted on TB social inequalities and determinants of health in relation to the BCG vaccine and programme, particularly among the Pasifika population. This included national and international literature on the perceptions of healthcare professionals on BCG vaccination programmes. This information has also been included in the previous literature review chapter.

Phase 3, Tiribenu and Tawaan te benu. This phase involves removing the soaked husks after three months which are then beaten with a wooden mallet to soften them. They are then placed under the sun to dry. This phase is lengthy but is required to produce quality 'benu'. In research, this involves data collection, transcription and translation (if required), and familiarisation with the data, building on the first two phases.

Quantitative Phase - To address the first objective, TB notification records were collected from ESR from 2006 (when the National Immunisation Record (NIR) started recording reliable immunisation data) to the most recent data available at the time of collecting data, which was the year 2023. It was anticipated that only a small dataset would be available from 2006 onwards, due to the low TB incidence rate (6.3 per 100,000) in New Zealand. After receiving ethics approval, a formal data request was sent to ESR for line level data on TB notifications (individuals with line and test details). The individuals were de-identified by encrypting the National Health Index (NHI). The research team could not view NHI numbers but were able to link the TB notifications with the Ministry of Health's NHI demographic data.

For the second objective, which related to investigating who has received the BCG vaccine, BCG vaccination records for the whole population were obtained from the Ministry of Health's NIR from 2006 after receiving appropriate ethical approvals. The NIR data for BCG were provided with date of vaccination. The NHI numbers were also encrypted and linked to the NHI population demographic data, thus, the same ethnicity data were linked to both TB notifications and immunisations. The purpose of collecting these datasets specifically, was to enable identification of who is most at-risk of TB (objective 1) and who is getting vaccinated (objective 2). Since we cannot know for certain who is eligible for BCG vaccination in Aotearoa NZ, this required assessment of the incidence of TB (number of 'at risk' people), in comparison to the number of BCG vaccinations for each ethnic group.

One of my supervisors, Dr Janine Paynter, who is a biostatistician and expert in analysis of large quantitative datasets, provided curated summary datasets from the raw total response data provided by ESR and NIR, to ensure the scope of the study was within 120 points of the Master's thesis level (noting that there was also a qualitative phase of the presented study to complete). TB and BCG vaccination data

were available for European, New Zealander, Asian, Pacific peoples (Pasifika), Middle Eastern-Latin American-African (MELAA) and Other ethnicities. MELAA, New Zealander and Other ethnicities were combined with the European group for analysis due to the low counts of TB and BCG vaccination data. The TB and BCG vaccination data received did not include multiple ethnicities; therefore, those who identified with more than one ethnicity may not have been represented or accounted for. Prioritisation of ethnicities for TB rates were European or Other (including New Zealanders), and MELAA, Māori, Asian and Pasifika including additional analysis for the ethnicities or subgroups within Pasifika.

Qualitative Phase

Sampling strategy

Purposive sampling with an inclusion/exclusion criteria was used to identify and select individual healthcare professionals who were especially knowledgeable and experienced in vaccine programme implementation, as well as policy decision-making at regional and national levels (Palinkas et al., 2015). This study included healthcare professionals who have been directly involved in decision-making of the BCG vaccine programme, from a clinical/scientific, epidemiological and/or educational perspective, and had been in their role for at least three years. Healthcare professionals (participants) did not necessarily need to be of Pasifika descent themselves as the focus of the questions were on how to reduce TB disease burden among the Pasifika population within the context of their roles. This enabled the study to capture a range of perceptions on the effectiveness of the current BCG vaccine programme, including the factors that were considered in decision-making and recommendations for improvements.

Participants were selected from both national and regional levels, with a focus on the Auckland region as it is the region with the largest Pasifika population (Stats NZ, 2010), and highest TB notification rate in Aotearoa NZ (ESR, 2023). The study participation invitations were sent to four candidates who met the inclusion criteria. The small sample size was predetermined to accommodate the 120 point scope of the research Masters programme considering there was also a quantitative phase of the study. Three candidates from the Auckland region responded and gave consent to participate in the study.

Data collection

The research tool known as maroro (conversation), which complements Te Kora

framework, was employed in the qualitative data collection phase to align with the Pasifika lens used in this research and as Pasifika people were the focus of the study (Schutz, 2022). Maroro is similar to the research tool talanoa (Vaioleti, 2006) in the sense that it is used to remove barriers between participants and the researcher, creating an open and free environment to share personal views and experiences (Namoori-Sinclair, 2020) which produces ‘karaki’ (stories) as data (Schutz, 2020).

An interview guide (Appendix D) that asked about TB prevention strategies in Aotearoa NZ, focusing on the effectiveness of the current BCG vaccine eligibility criteria and vaccine programme, was produced. The literature review and community engagement sessions informed which questions were to be included in the interview guide. Pilot testing of the interview guide was conducted with my supervisors.

A study invitation along with a participation information sheet (Appendix B) and consent form (Appendix C) was sent via email to the identified potential participants. Three participants responded and returned signed consent forms. A follow-up email was then sent to establish a time and date for the maroro session in-person or via Microsoft Teams depending on location and availability of the participant. The maroro sessions took place in September 2024 with one in-person and two via Microsoft Teams. The maroro began with introducing myself and background particularly my motivation and relationship to the study and leading on to discussing the concept of maroro to set an informal environment to freely express themselves in conversation. All three sessions were recorded for effective generation of “verbatim transcription” of the data (Jamshed, 2014), which I manually transcribed using Microsoft Word in preparation for analysis.

Phase 4 Bobinoka and Phase 5 Kakano. Phase 4 involves the dried coconut husks fibres being manually pulled out and rolled together to make single filaments known as ‘binoka’. Phase 5 is Kakano, which is when two binoka are tied together at the ends and rolled to form the twisted single kora. In research, this involves analysing the findings including undertaking statistical analysis and developing categories.

Quantitative Phase - Incidence rates of TB and BCG vaccination were calculated using Equation 1 based on counts (as numerator ‘*O*’). The Aotearoa NZ population

estimates for each ethnic group provided by the Statistics NZ–Tatauranga Aotearoa census series were utilised for linear interpolation and produced the denominator (‘*E*’). Equation 2 was implemented in the FORECAST.LINEAR function in Microsoft Excel and graphs of the calculated denominators were produced for visual verification. Incidence rates and vaccination coverage rates per year and ethnic groups were then calculated including 95% confidence intervals (Public Health England, 2018). The 95% confidence intervals (CI) were calculated using Byar's method where 100 (1–0.05)% confidence limits for the observed number of events are given by (Equation 3).

Equation 1. Incidence rates

$$\mathrm{RP100K} = \left(\frac{O}{E}\right) \times 100,000$$

Equation 2. Forecast linear

$$a = \bar{y} - b\bar{x}$$

Equation 3. 95% Confidence Intervals

$$O_{lower} = O \times \left(1 - \frac{1}{9O} - \frac{z}{3\sqrt{O}}\right)^3$$

$$O_{upper} = (O+1) \times \left(1 - \frac{1}{9(O+1)} + \frac{z}{3\sqrt{(O+1)}}\right)^3$$

When counts were below 6, presentation of results can increase the risk of identification of individuals, so these results are not shown. Excel was used to estimate trend lines and the association between incidence over time. The study produced percentages of total TB notifications using Pasifika Census population data for three Pasifika subgroups (Samoan, Tongan and ‘Other’).

Vaccination coverage is normally presented as a percentage, however, in this study, we have used ‘incidence’ in order to compare the proportion of the people who are vaccinated with BCG in Aotearoa NZ with the proportion of people who are diagnosed with TB in Aotearoa NZ. Although the vaccine is mainly for children younger than 5 years old, there were small numbers of vaccinations for those above 5 years old, thus, total population from Linear Interpolation were utilised for the denominator for BCG vaccination rates. Vaccination percentages were produced using Pasifika census data for seven Pasifika subgroups (Samoan, Tongan, Cook

Island Māori, Tokelauan, Niuean, Fijian and 'Other' or All other Pacific ethnicities).

Qualitative Phase - To provide valuable insights of participants' perspectives and perceptions, reflexive thematic analysis (TA) was initially chosen as the method to analyse the collected qualitative data (Braun & Clarke, 2013; 2019; Campbell et al., 2021). This method is appropriate to identify, analyse, and report patterns within the context of this study as it can enable flexibility with other qualitative methodological decisions (Terry et al., 2017). Therefore, reflexive TA is not predetermined to a particular paradigm or methodology, which is needed in this study context to address the unique aforementioned theoretical and practical underpinnings of this study that are based on Pacific worldviews.

However, upon reflection, a conventional content analysis (CCA) approach (Hsieh & Shannon, 2005) was deemed to be a more appropriate method of data analysis for several reasons. Firstly, there is limited literature on the phenomenon of interest, which is exploring the perceptions of TB and BCG vaccine among healthcare professionals. Secondly, CCA can enable researchers to immerse themselves in the data and enable new insights to emerge (Hsieh & Shannon, 2005). Lastly, after familiarisation of the collected data, the nature of the collected data was focused on development and implementation of TB prevention strategies. There was a lack of the essence of in-depth experiences or emotions of the participants that would have been more appropriate for reflexive TA. Thus, CCA was chosen as the method to analyse the data.

CCA follows five steps (Morse & Field, 1995): i) Familiarisation - I listened to the recordings of each maroro session as well as reading the transcribed transcripts over a few times to familiarise myself with the contents of the conversations; ii) Coding word by word to develop codes - I then highlighted the exact words from the transcripts that I believed captured the main concepts; iii) Developing the initial coding scheme - based on my impressions of the data, I produced the coding scheme from my summarised labels and codes directly from the text; iv) Sorting codes - next I sorted my codes into categories based on how different codes were related and linked. I then sorted my codes to cluster under the relevant categories, creating meaningful subcategories. A tree diagram was then produced to organise these categories into a hierarchical structure. v) Defining categories and subcategories and codes - finally, I defined each category with its subcategories and codes including examples for each code that are identifiable from the data to prepare

for reporting the findings.

Phase 6 Te Kora is the final product. In this phase, 'kora' (local string) is produced. In research, this phase is the completed thesis and any other research outputs. In this study, the quantitative results were combined with the qualitative results together with the other chapters to produce the final thesis.

Rigour

Rigour is essential for the mixed methods design and the whole study. Reflexivity is key for me to ensure rigour by allowing personal reflection as the researcher and my role in the production of knowledge (Trainor & Bundon, 2021). This includes the why, what and how knowledge is produced. Reflexive conversations with people involved in this study such as my supervisors, began to establish who I am and what values I bring to the study. Therefore, aspects of my personal, functional and disciplinary reflexivity were utilised in this study. This means that my values, methods and aspects of the research design and academic disciplines can be acknowledged as contributing factors to the production of knowledge (Wilkinson, 2013). During maroro sessions for data collection, I noted my own responses to participants' stories and wrote in my reflexive journal to help me understand what aspects of the data I found particularly of interest when undertaking the analysis. This helped to ensure that I was part of the process as an active tool in the data collection and analysis process.

Rigour specific to the mixed method approach was also ensured by providing clear justifications for using the mixed-methods design to address the research aim and objectives. This includes clarifying and justifying the sampling, data collection and analysis for both quantitative and qualitative phases, particularly within Te Kora framework thereby being explicit with regard to the theoretical and epistemological guidance of the study. Lastly, rigour for a mixed-methods approach was ensured by including evidence of the integration of findings from both quantitative and qualitative components (Lorenzini et al., 2024).

Ethical considerations

Ethics approval from the Auckland University of Technology Ethics Committee (AUTEC) was sought for the study and approved (Appendix A) in July 2024, enabling data collection to commence. My scholarship provider Te Niwha is in partnership with ESR and assisted

with accessing data from ESR and Ministry of Health by introducing me to people to consult with, once approval from AUTEC was obtained. The Te Niwha committee also supported the identification and connections of myself and my supervisors to relevant Pasifika community leaders and stakeholders for initial maroro (conversation) and whanaungatanga for the study. Consultations with Pasifika communities were then undertaken to ensure the integration of culturally appropriate guidance throughout the study. Furthermore, my supervisor, Dr. Taniela Lolohea, who has extensive expertise in Pasifika methodologies and customs, also provided guidance throughout the research process.

A data management plan was developed for the study to ensure data sovereignty. This includes collecting, storing, and handling as per AUTEC protocols and guidance from my supervisors for the qualitative data. The quantitative data was managed by my supervisor Dr Janine Paynter (University of Auckland) who is the data custodian. The data was stored at the University of Auckland data repository with double authentication protection servers. Quantitative and qualitative data access was restricted to myself and supervisors.

The employed Te Kora framework, as previously mentioned, comprised three fundamental principles (Bauariria, Kaomataaki, and Iokinibwai) that embody Pasifika values of respect, reciprocity and relationships to ensure cultural appropriateness in this study. These principles were also integral to the ethical considerations of this research. During the quantitative phase, collected data of TB notifications were de-identified and summarised to prevent the identification of small groups and ensure privacy. For the qualitative phase, after identifying and selecting key informants, a study invitation, along with participant information sheets (Appendix B) and consent forms (Appendix C), was sent for their consideration. It was emphasised that their participation was voluntary. Confidentiality was maintained throughout the study, given the nature of the inquiry. Consent to audio record the maroro sessions was sought, and participants were given the opportunity to review transcripts of their interviews, as mentioned in the consent forms. They were also given the option to refrain from discussing certain questions or topics and could withdraw from the study at any stage. Appropriate framing of results was also considered to ensure that attention is directed towards system level changes required to support the health and wellbeing of Pasifika communities.

Dissemination and presenting of findings to Pasifika communities and leaders/stakeholders are planned upon completion of the research. This is to ensure that Pasifika can utilise the findings to make changes to BCG vaccination programme to

benefit Pasifika. Sharing the findings to Pasifika communities also ensures collaborative values and endorse Pasifika leadership. Overall, these considerations contribute to integrating iokinibwai and kaomataaki to strengthen bond and relationships of bauariria with contributing parties. This included the participants and Pasifika communities from which this data was derived from. The findings have also been presented at Te Niwha infectious disease summits.

Summary

This chapter outlined the employed methodology of the study which included Te Kora framework's application to the parallel convergent mixed-methods study design consisting of quantitative and qualitative phases. The quantitative phase was an observational study, while the qualitative phase involved maroro (conversations) with healthcare professionals. The chapter also discussed the ethical considerations and research rigour. The results from both quantitative and qualitative phases, and data integration will be examined and critically discussed in the following chapters.

Chapter Four: Quantitative Results

This chapter will describe the findings from the quantitative phase of the study. It will present and describe the TB and BCG results from the descriptive analysis of the quantitative component.

Quantitative Findings

Linear interpolation using Census data

The census website produced an estimated resident population (ERP) for Aotearoa NZ by ethnic group for the years 2006, 2013, 2018 and 2023. The linear interpolation method was used to forecast the ERP for the years in between to produce the denominators for the period of 2006-2023 using Microsoft excel as shown in Tables 1, 2 and 3. Graphs were produced for visual verification of calculated values as shown in Figures 2, 3 and 4.

Table 1. Linear interpolation forecast for ERP 2006-2013 per ethnicity

Year	Total	European or Other (including New Zealander)	Māori	Pacific	Asian	MELAA (Middle Eastern, Latin-American and African)
2006	4184600	3213300	624300	301600	404400	38600
2013	4442100	3312100	692300	344400	541300	53100
2007	4221386	3227414	634014	307714	423957	40671
2008	4258171	3241529	643729	313829	443514	42743
2009	4294957	3255643	653443	319943	463071	44814
2010	4331743	3269757	663157	326057	482629	46886
2011	4368529	3283871	672871	332171	502186	48957
2012	4405314	3297986	682586	338286	521743	51029

Figure 2. Linear interpolation forecast 2006-2013

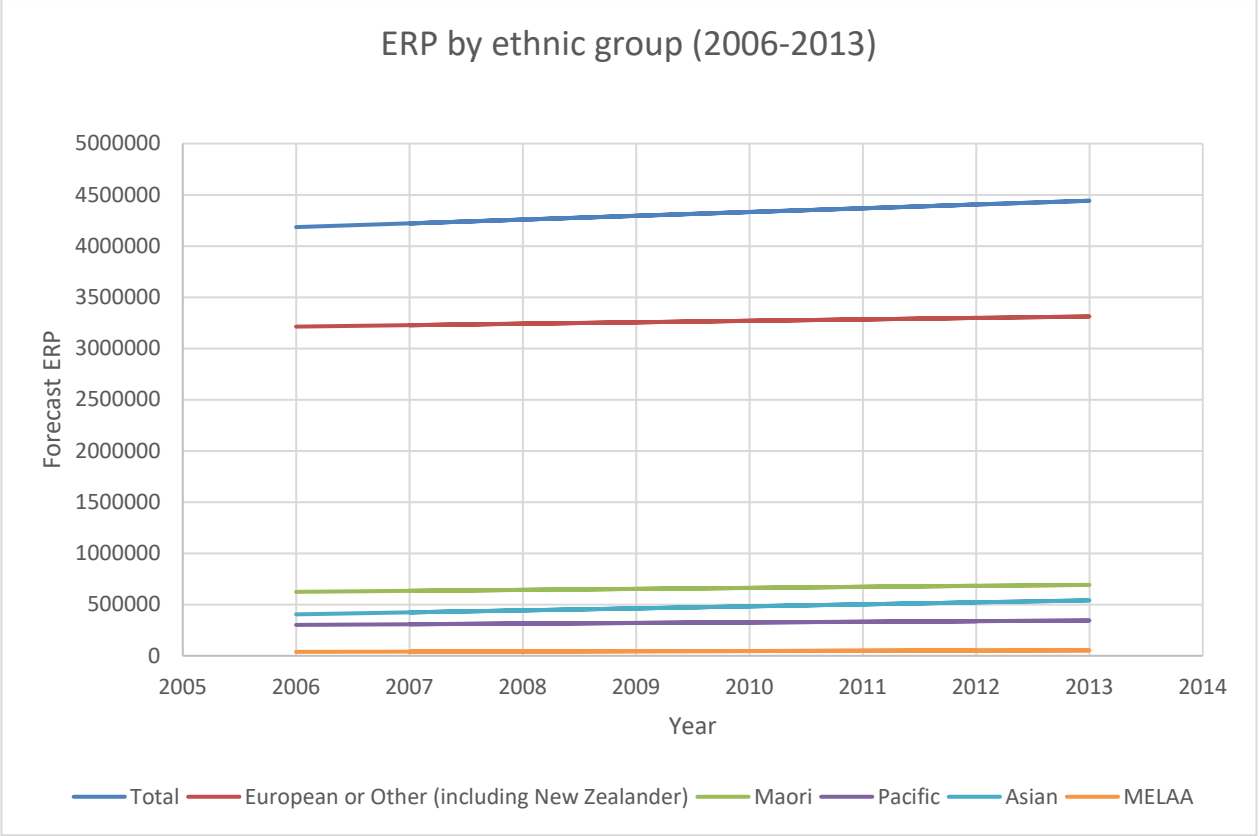


Table 2. Linear interpolation forecast for ERP per ethnicity 2014-2018

Year	Total	European or Other (including New Zealander)	Māori	Pacific	Asian	MELAA
2013	4442100	3312100	692300	344400	541300	53100
2018	4900600	3441700	816500	407700	770600	77000
2014	4533800	3338020	717140	357060	587160	57880
2015	4625500	3363940	741980	369720	633020	62660
2016	4717200	3389860	766820	382380	678880	67440
2017	4808900	3415780	791660	395040	724740	72220

Figure 3. Linear interpolation forecast 2014 to 2018

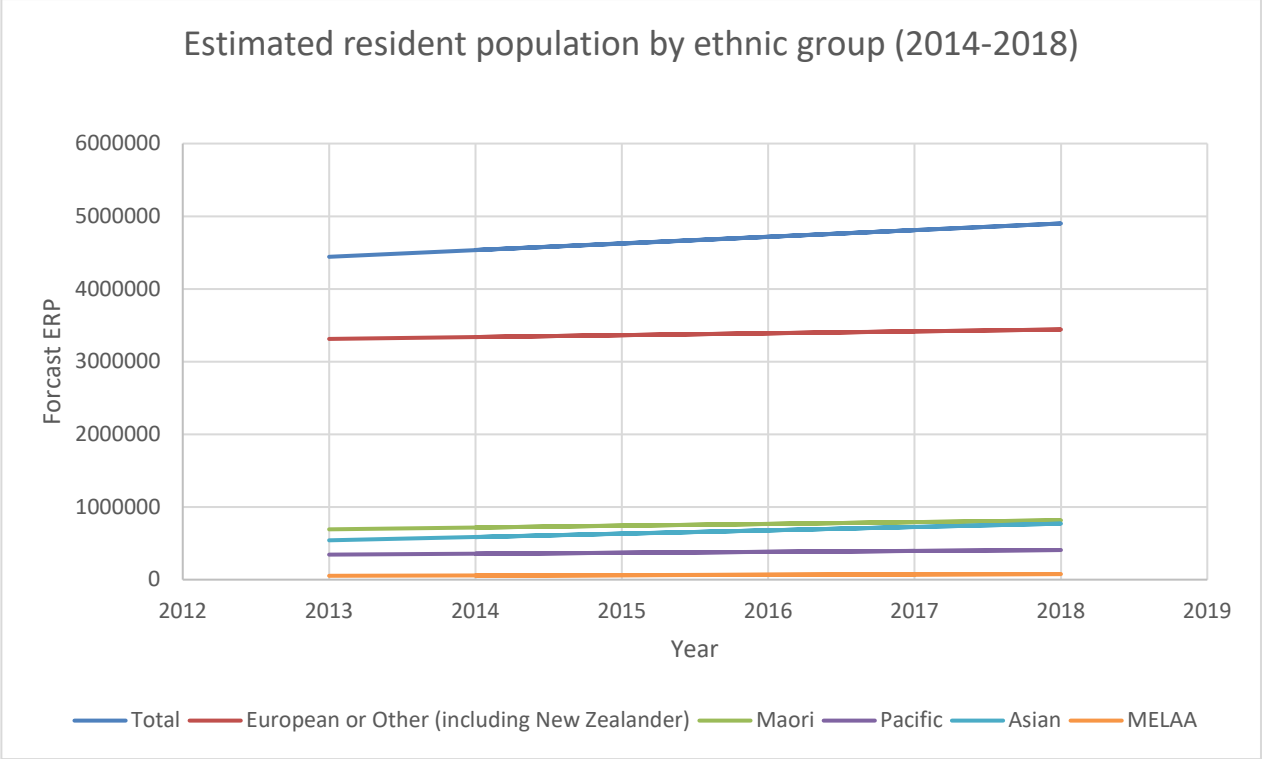
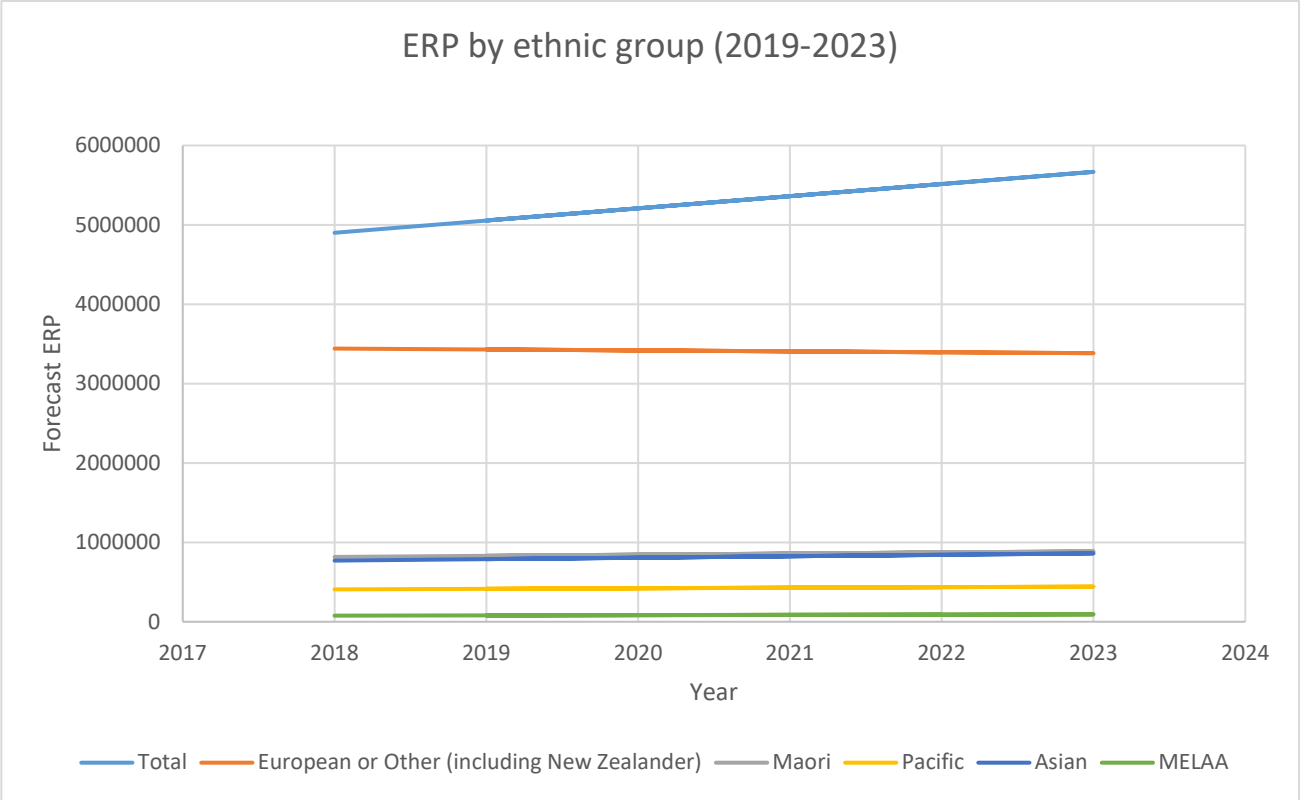


Table 3. Linear interpolation forecast for ERP per ethnicity 2019-2023

Year	Total	European or Other (including New Zealander)	Māori	Pacific	Asian	MELAA
2018	4900600	3441700	816500	407700	770600	77000
2023	5668203	3383742	887493	442632	861576	92760
2019	5054121	3430108.4	830699	414686	788795	80152
2020	5207641	3418516.8	844897	421673	806990	83304
2021	5361162	3406925.2	859096	428659	825186	86456
2022	5514682	3395333.6	873294	435646	843381	89608

Figure 4. Linear interpolation forecast 2019-2023



The reliability of ERP values obtained through linear interpolation is indicated by the consistent trends shown across Figures 2, 3 and 4. The data shows an increasing population over the years, with European or Other (including New Zealander) as the largest demographic group in Aotearoa NZ. Māori and Asian groups follow with significantly lower population numbers. The smallest demographic groups are Pacific (Pasifika) and MELAA.

Incidence rate of TB per 100,000 by ethnicity (2006-2023)

TB notification data (TB cases officially reported) were obtained from ESR for the years 2006 to 2023 for the whole population of Aotearoa NZ. Raw TB notification data was curated, and TB incidence rates were calculated per 100,000 population (as described in chapter 3 *phase 4 and 5*) for four ethnic groups in Aotearoa NZ using the liner forecasts as denominators. The first group is a combination of those who identify as European or Other (including New Zealander) and Middle Eastern/Latin American/African (MELAA). This combination was due to the minimal data sets for 'Other' and 'MELAA'. Therefore, the rates produced do not represent the rate for each individual ethnicity within this group. The second group is Māori, third is Pacific (or Pasifika in this study's context) and fourth is Asian. The estimated TB incidence rates produced in Table 4 will be presented in graphs and analysed for each group.

Table 4. Estimated Incidence rate per 100,000 (2006-2023)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
European or Other (including New Zealander) + MELAA	1.4		1.6	1.8	1.4	1.7	1.4		1.2	0.8	1.5	1.0	1.1	1.1				
Māori	6.4	7.7	6.7	7.5	5.1	5.6	5.6	3.6	4.5	3.0	3.5	3.0	2.8	3.4	3.3	1.7	1.7	1.6
Pacific	2.3	7.1	17.8	12.2	16.6	16.3	10.9	11.6	15.7	17.6	9.9	9.9	10.3	12.5	9.0	9.1	5.5	10.2
Asian	11.4	27.6	31.6	32.8	35.0	31.7	32.4	29.2	29.5	28.4	26.4	29.0	26.0	25.4	26.4	26.2	21.7	24.6
Total	3.3	6.0	6.8	6.9	7.0	7.0	6.6	6.2	6.6	6.3	6.3	6.4	6.2	6.3	6.1	5.8	4.8	5.4

Colour gradient indicator: green= low TB rate (less than 5 per 100,000), yellow= medium TB rate (5-10 per 100,000) and red= high TB rate (more than 10 per 100,000). TB incidence notification data for European or Other (including New Zealander) + MELAA group was suppressed for the years 2007, 2013, 2020, 2021, 2022 and 2023, therefore no incidence rates were produced in those years for this group. A total of 243 TB notifications did not report ethnicity therefore, not represented in the rates produced. TB incidence notification data for Pasifika was reported separately for Samoan, Tongan and Other Pacific. Samoan and Tongan notifications were suppressed due to less than 6 counts for the years 2006, 2007, 2013, 2021,2022 and 2023, therefore true incidence rates for Pasifika are likely to be slightly higher due to the missing counts.

Confidence Intervals

95% Confidence intervals (CI) were calculated for each incidence rate (as described in chapter 3 *phase 4 and 5*) to provide reliable statistical representation (Table 5).

Table 5. TB Incidence rates and CIs 2006 to 2023

	2006	CI Lower	CI Upper	2007	CI Lower	CI Upper	2008	CI Lower	CI Upper	2009	CI Lower	CI Upper	2010	CI Lower	CI Upper	2011	CI Lower	CI Upper	2012	CI Lower	CI Upper	2013	CI lower	CI Upper	2014	CI Lower	CI Upper
European or Other (MELAA + New Zealander)	**1.4**	0.9	1.6				**1.6**	1.2	2.1	**1.8**	1.3	2.3	**1.4**	1.0	1.9	**1.7**	1.3	2.2	**1.4**	1.0	1.9				**1.2**	0.8	1.6
Māori	**6.4**	4.6	8.7	**7.7**	5.7	10.2	**6.7**	4.8	9.0	**7.5**	5.5	9.9	**5.1**	3.6	7.2	**5.6**	4.0	7.8	**5.6**	3.9	7.6	**3.6**	2.3	5.3	**4.5**	3.1	6.3
Pacific	**2.3**	0.9	4.8	**7.1**	4.5	10.8	**17.8**	13.5	23.2	**12.2**	8.7	16.7	**16.6**	12.4	21.6	**16.3**	12.2	21.2	**10.9**	7.7	15.1	**11.6**	8.3	15.8	**15.7**	11.8	20.4
Asian	**11.4**	8.3	15.2	**27.6**	22.8	33.1	**31.6**	26.6	37.2	**32.8**	27.8	38.5	**35.0**	29.9	40.7	**31.7**	26.9	37.0	**32.4**	27.7	37.7	**29.2**	24.8	34.1	**29.5**	25.2	34.2
Total	**3.3**	2.8	3.9	**6.0**	5.3	6.8	**6.8**	6.1	7.7	**6.9**	6.2	7.8	**7.0**	6.2	7.8	**7.0**	6.3	7.9	**6.6**	5.9	7.4	**6.2**	5.5	6.9	**6.6**	5.9	7.4

	2015	CI Lower	CI Upper	2016	CI Lower	CI Upper	2017	CI Lower	CI Upper	2018	CI Lower	CI Upper	2019	CI Lower	CI Upper	2020	CI Lower	CI Upper	2021	CI Lower	CI Upper	2022	CI Lower	CI Upper	2023	CI Lower	CI Upper
European or Other (MELAA + New Zealander)	**0.8**	0.5	1.1	**1.5**	1.1	1.9	**1.0**	0.7	1.4	**1.1**	0.8	1.5	**1.1**	0.7	1.5												
Māori	**3.0**	1.9	4.5	**3.5**	2.3	5.1	**3.0**	1.9	4.5	**2.8**	1.8	4.2	**3.4**	2.2	4.9	**3.3**	0.5	4.8	**1.7**	1.0	2.9	**1.7**	1.6	3.8	**1.6**	0.9	2.6
Pacific	**17.6**	13.6	22.4	**9.9**	7.0	13.6	**9.9**	7.0	13.5	**10.3**	7.4	13.9	**12.5**	9.4	16.4	**9.0**	6.4	12.4	**9.1**	6.5	12.4	**5.5**	3.5	8.2	**10.2**	7.4	13.6
Asian	**28.4**	24.4	32.9	**26.4**	22.6	30.5	**29.0**	25.2	33.2	**26.0**	22.5	29.8	**25.4**	22.0	29.1	**26.4**	23.0	30.2	**26.2**	22.8	29.9	**21.7**	18.7	25.1	**24.6**	21.4	28.2
Total	**6.3**	5.6	7.1	**6.3**	5.6	7.0	**6.4**	5.7	7.2	**6.2**	5.5	7.0	**6.3**	5.6	7.0	**6.1**	5.5	6.8	**5.8**	5.1	6.4	**4.8**	4.3	5.5	**5.4**	4.8	6.1

CI Lower= Lower Confidence Interval, CI Upper= Upper Confidence Interval.

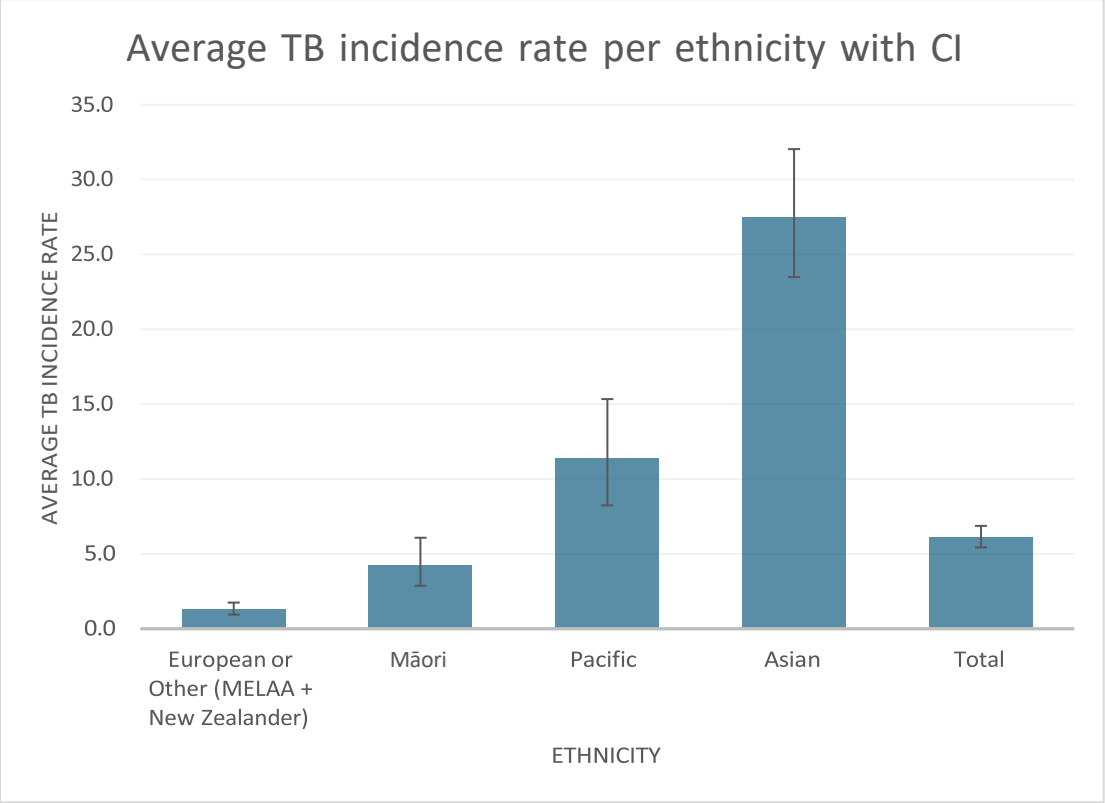
Estimated TB incidence rates (Table 4) and CIs (Table 5) per group were averaged and produced in Table 6.

Table 6. Average incidence rates and 95% CI per ethnicity for the period 2006-2023

Ethnicity	Average rate	CI lower	CI upper
European or Other (MELAA + New Zealander)	1.3	0.9	1.7
Māori	4.3	2.9	6.1
Pacific	11.4	8.2	15.3
Asian	27.5	23.5	32.0
Total	6.1	5.4	6.9

Average TB incidence rates and CIs were graphed below in Figure 5.

Figure 5. Average TB incidence rate per ethnicity with CI

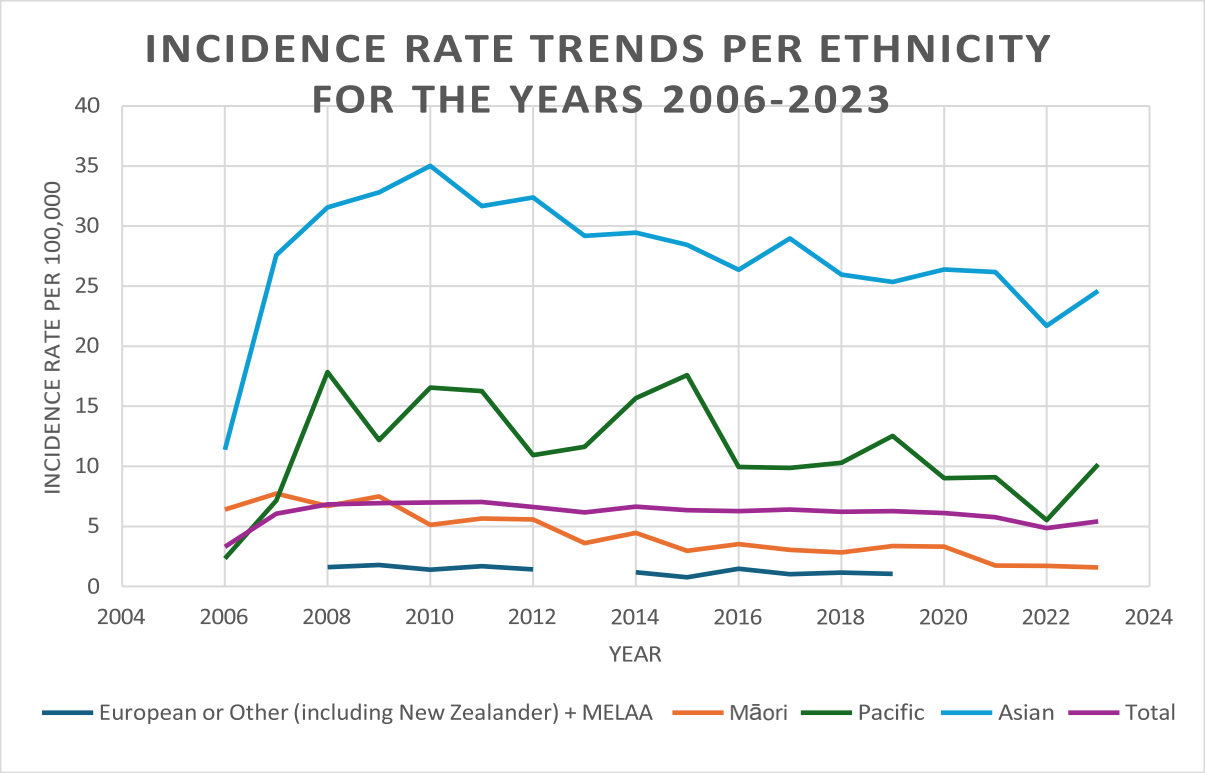


The confidence intervals calculated exhibit typical patterns for reliable CIs as shown in Figure 5. For larger population groups such as European or Other (including New Zealander) + MELAA and Total (whole population), the incidence rates have a narrow range of CI. In contrast, smaller populations such as Pasifika, display a wider range of CI.

Analysis of estimated TB rates per ethnic group

Analysis of estimated TB rates for all population groups

Figure 6. Incidence rate trends per ethnicity for the years 2006-2023

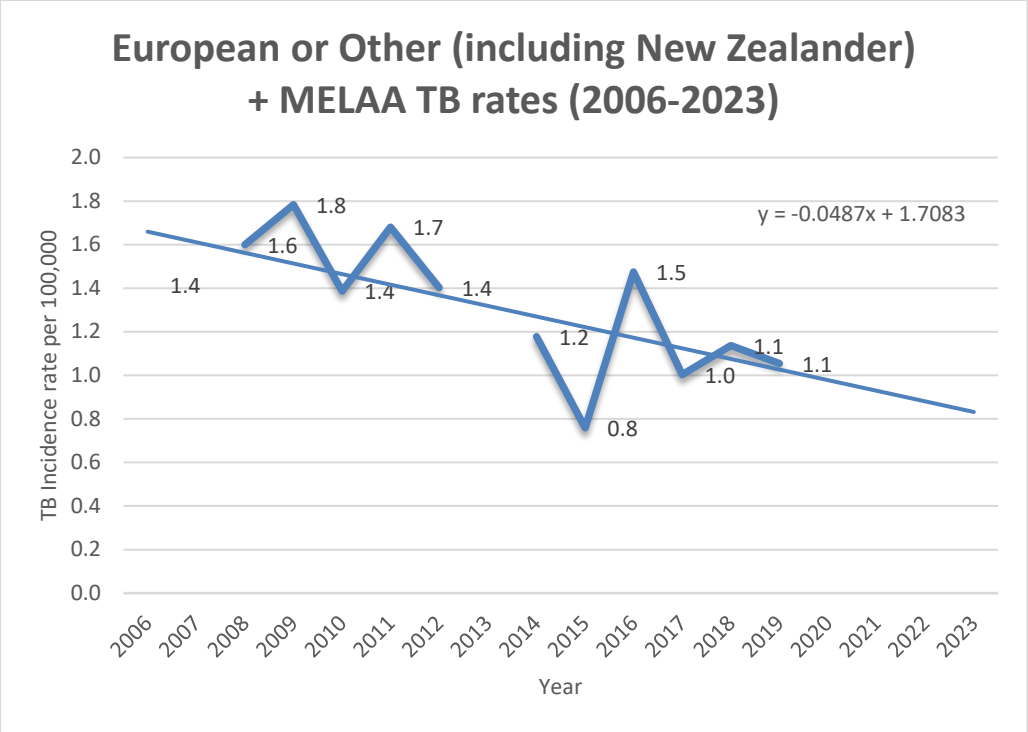


Suppression of TB notifications affected reliability of incidence rates calculated for European or Other (MELAA + New Zealander). Additionally, missing ethnicities for TB notifications were not represented and affected reliability of TB incidence rates for all groups.

TB incidence rates for the total population show a low steady trend with an average of 6.1 per 100,000 (CI: 5.4 - 6.9) throughout the 2006-2023 period. The four ethnic groups show fluctuations in TB rates over the years, with consistently higher TB rates observed in Asian and Pasifika populations during this period as observed in Table 4. Figure 6 shows the significantly higher incidence rates for both Asia and Pasifika across all four groups. The European or Other (including European) + MELAA group display significantly lower rates compared to the Asian and Pasifika groups. Māori incidence rates have also been consistently lower than Asian and Pasifika rates. The trends overall highlight Asian and Pasifika groups to have a higher burden of TB. Furthermore, suppression of low counts impacted Pasifika rates overall, meaning that these estimates are slight underestimates of the true incidence rates.

Analysis of estimated TB rates for European or Other (including New Zealander) + MELAA

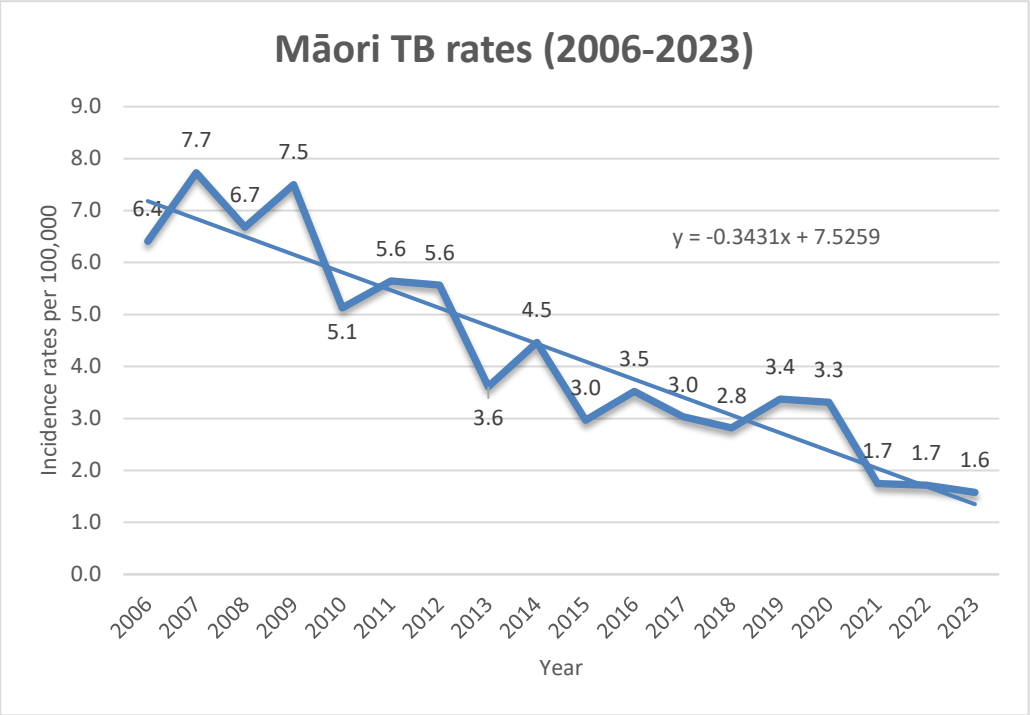
Figure 7. European or Other (including New Zealander) + MELAA TB incidence rate (2006-2023)



The estimated TB rates for European or Other (including New Zealander) + MELAA shown in Figure 7, highlight a low burden of TB among this population group, with an average rate of 1.3 per 100,000 (CI: 0.9 – 1.7). The trendline indicates a slow decline over the years, with a slope value of -0.0487. This value is reasonable given the low TB rates at present. TB notifications were suppressed for the years 2007, 2013, 2020, 2021, 2022 and 2023, for this group due to low counts. This is reflected in the gaps in Figure 7. These suppressions further emphasise the low burden within this group. However, it is difficult to determine the MELAA subgroup's share to this group's incidence rates which means the TB burden among MELAA may be obscured.

Analysis of estimated TB rates for Māori

Figure 8. Māori TB incidence rate (2006-2023)



The incidence rates indicate a higher burden of TB among Māori with an average incidence rate of 4.3 (CI: 2.9 – 6.1). In comparison, the European or Other (including New Zealander) + MELAA group have an average of 1.3 per 100,000 (CI: 0.9 – 1.7). Therefore, the average TB incidence rate is significant for Māori in terms of a higher burden of TB, despite a considerably low average rate. There were fluctuations in increasing TB rates over the years shown in Figure 8, however, the trendline indicates an overall moderate decline (slope value -0.3431) of TB rates over the years for Māori.

Analysis of estimated TB rates for Asian

Figure 9. Asian TB rates 2006-2023

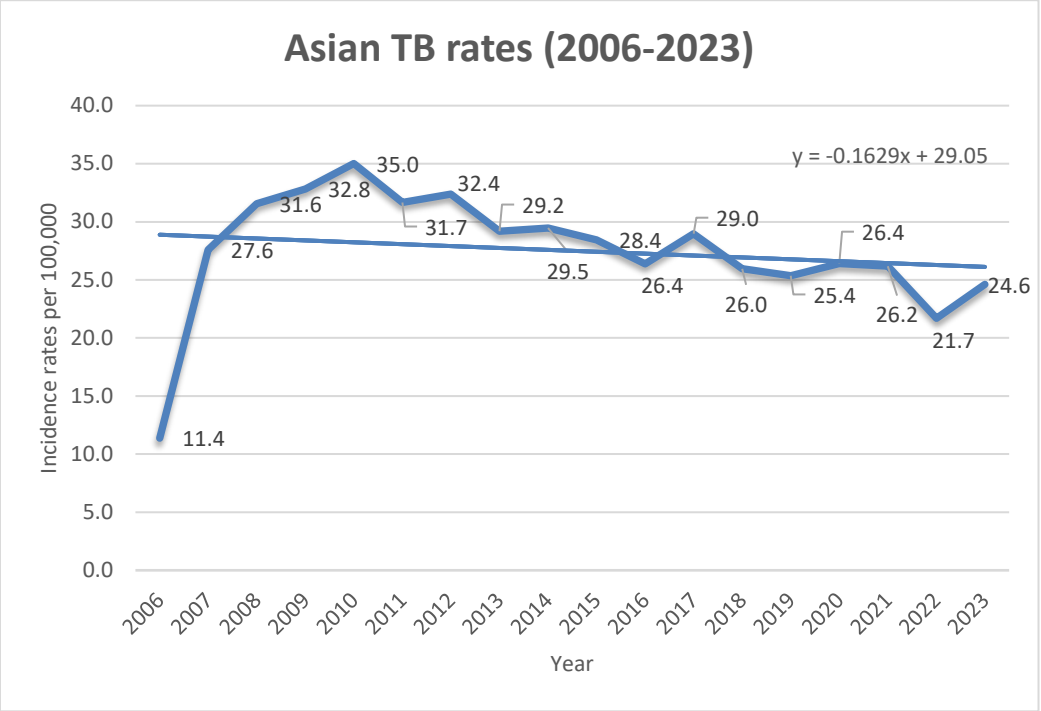
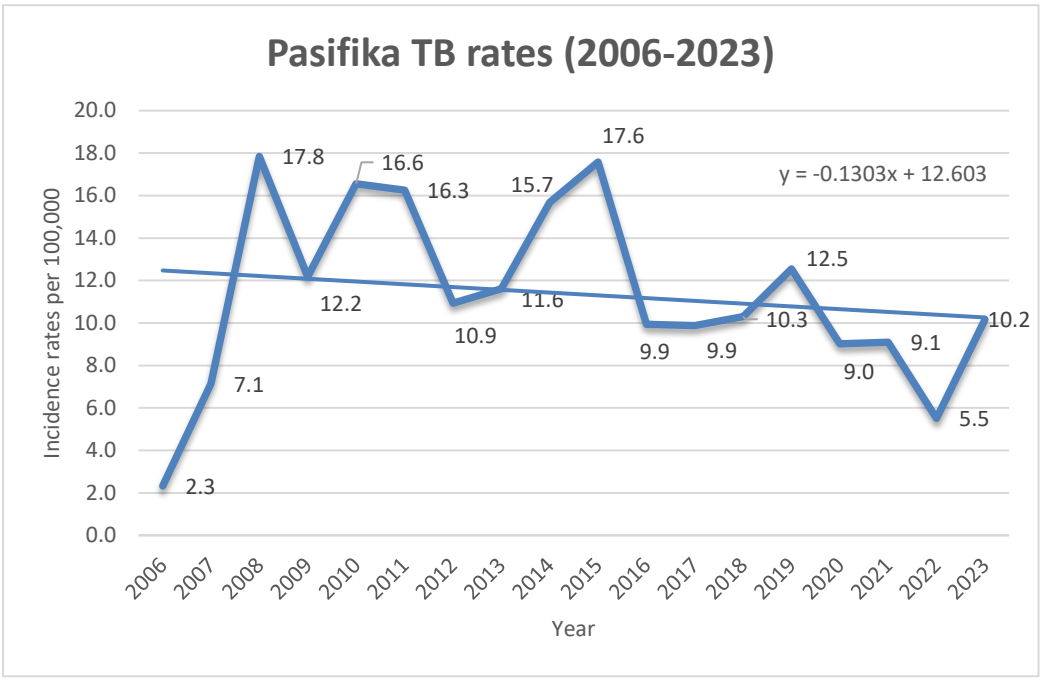


Figure 9 shows the highest burden of disease in Aotearoa NZ was among the Asian group with an average rate of 27.5 per 100,000 (CI: 23.5 – 32.0). The trendline shows an almost steady trend with no significant decline throughout the years which is indicated by the slope value -0.1626. This highlights the consistent high burden of TB within this group over the years.

Analysis of estimated TB rates for Pasifika

Figure 10. Pasifika TB incidence rate (2006-2023)



A near steady trend of high TB incidence rates is observed for the Pasifika population. The trendline indicates a slow decline (slope value -0.1303), however, the rates exhibit notable fluctuations observed in Figure 10. The incidence rate peaked at 17.8 (CI 13.48-23.17) per 100,000 in 2008. On average this group had an estimated incidence rate of 11.4 per 100,000 (CI: 8.2 – 15.3), the second highest average incidence rate behind the Asian group. This is a significant high burden of TB for Pasifika in comparison to the European or Other (including New Zealander) + MELAA group (average incidence rate of just 1.3 per 100,000).

The fluctuations displayed in Figure 10 can be influenced by several factors. In this study's context, one possible factor is that the total TB notification data for the Pasifika group was produced by combining TB notifications of the three Pasifika ethnic groups (Samoan, Tongan and Other Pacific) provided by ESR. However, TB notification numbers were suppressed for Samoan and Tongan ethnicities in some years (2007, 2013, 2021, 2022,2023), due to low counts (less than six). Therefore, the incidence rates for those specific years are underestimates due to the missing counts from the suppressed notifications and may have affected the fluctuating trend of incidence rates.

To further elaborate on the Pasifika trend, percentages of the three Pasifika ethnicities' TB notifications are provided in Table 7 below for each year, utilising the Pasifika population total from 2006 to 2023, obtained from linear interpolation as the denominator.

TB trends within Pasifika groups

Table 7. Percentage of Pasifika TB notifications for 2006 to 2023

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Other Pasifika	100.0	50.0	44.6	61.5	57.4	63.0	54.1	65.0	60.7	46.2	36.8	46.2	38.1	50.0	78.9	74.4	66.7	75.6	54.7
Samoan	0.0	50.0	35.7	20.5	22.2	16.7	24.3	35.0	19.6	38.5	42.1	23.1	38.1	34.6	0.0	25.6	33.3	24.4	27.8
Tongan	0.0	0.0	19.6	17.9	20.4	20.4	21.6	0.0	19.6	15.4	21.1	30.8	23.8	15.4	21.1	0.0	0.0	0.0	17.5

Colour indicator: white= low percentage (below 15%), light red= medium percentage (15%-40%) red= high percentage (above 40%). Suppression for both Samoan and Tongan ethnicities (less than 6 counts) resulted in 100% of all TB notification from Other Pasifika group in 2006. The same for Tongan ethnicity impacting 2007, 2013, 2021, 2022, and 2023 and Samoan for 2020. The remaining years without suppressions provide clearer insight to Pasifika TB proportions.

Despite the missing counts, Table 7 show that percentage of TB notifications per year for the period of 2006 to 2023 are highest in 'Other Pasifika' ethnicity which is also illustrated in Figures 11 and 12 below.

Figure 11. Percentage of Pasifika TB notifications for 2006 to 2023 column graph

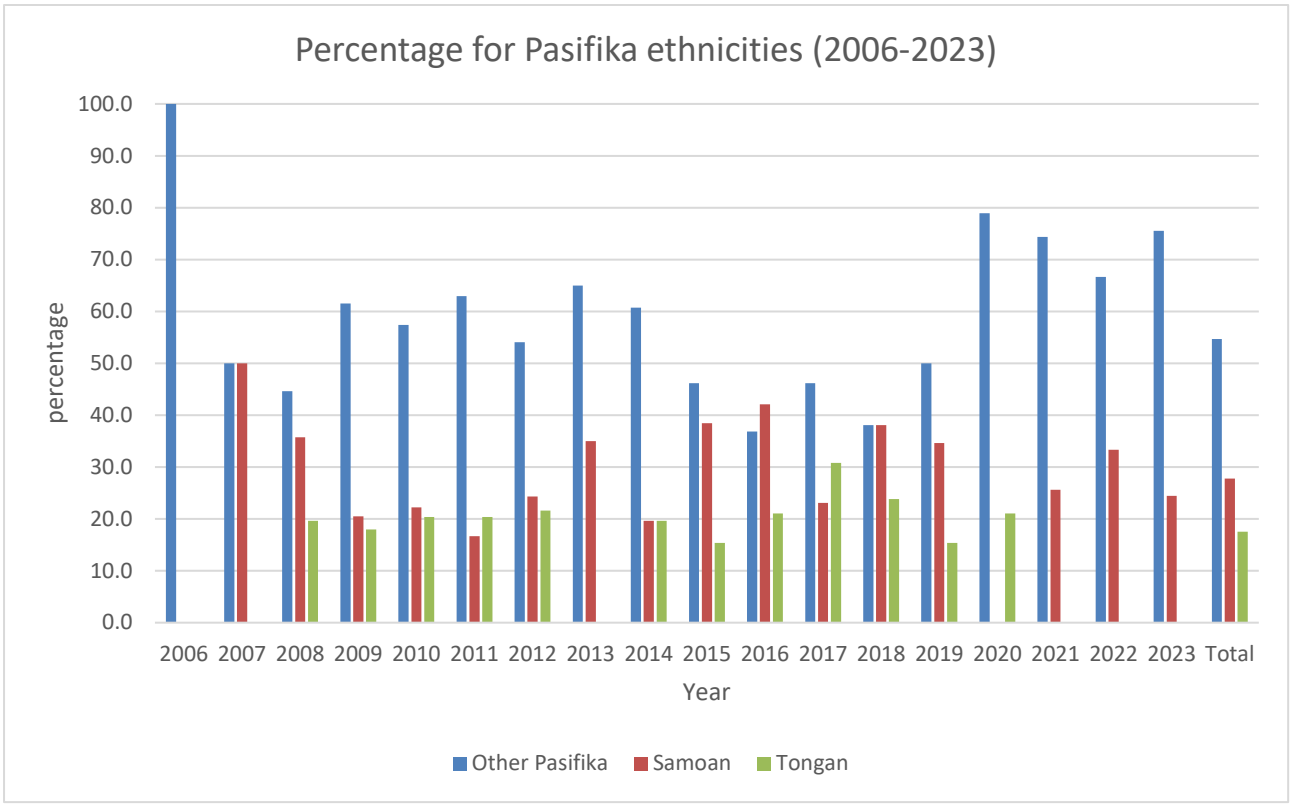
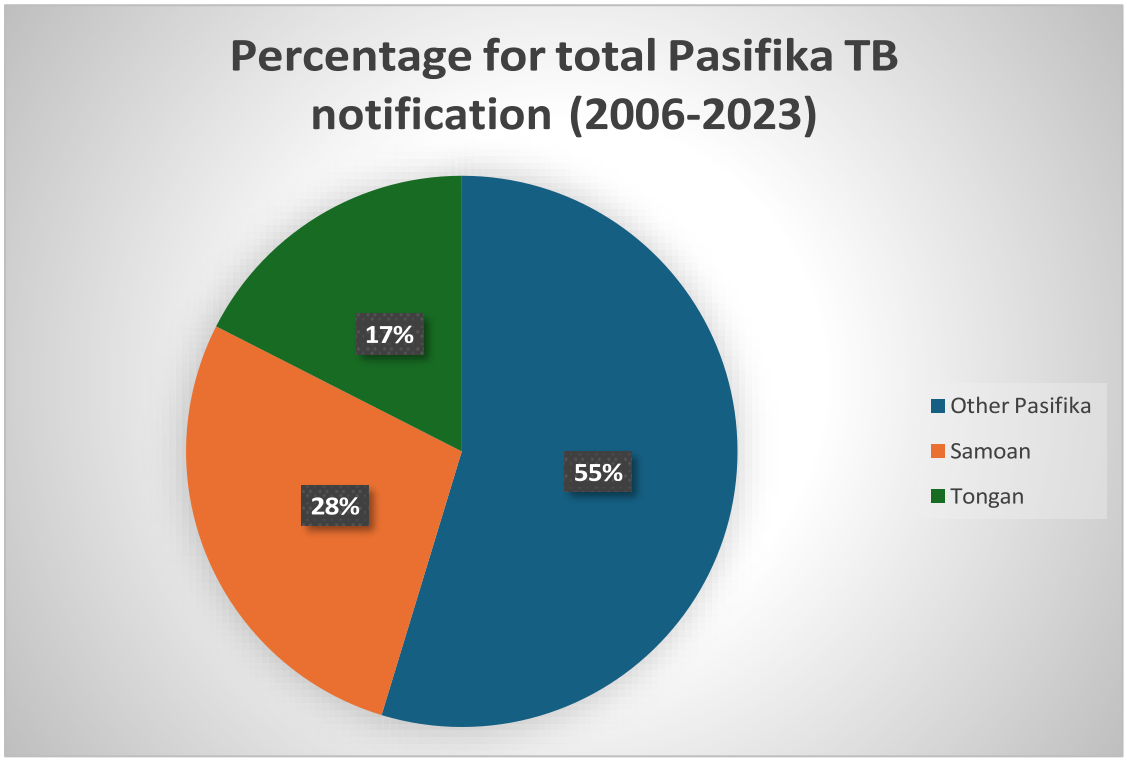


Figure 12. Percentage for total Pasifika TB notification for the years 2006 to 2023



Figures 11 show a consistently high percentage of TB notifications among the 'Other' Pasifika group in comparison to the Samoan or Tongan ethnicities. Figure 12 supports this finding by illustrating that more than half of total TB notifications over the 2006 to 2023

period occurred among ‘Other Pasifika. The high percentage among ‘Other’ Pasifika emphasises that the Pasifika ethnicities included within this subgroup are at a greater risk of TB infection and disease. ‘Other’ Pasifika subgroup consists of Pasifika ethnicities such as Cook Island Māori, Fijian, Niuean, Tokelauan, Tuvaluan and Kiribati. A more detailed analysis for this subgroup is necessary, however due to the lack of disaggregated TB notification data, TB rates cannot be produced for the ethnicities within the ‘Other’ subgroup. Thus, further analysis will focus on the three Pasifika ethnicities with provided TB notifications (Samoan, Tongan and Other Pasifika) utilising percentages.

Pasifika TB notification percentage in relation to proportions of the Pasifika population

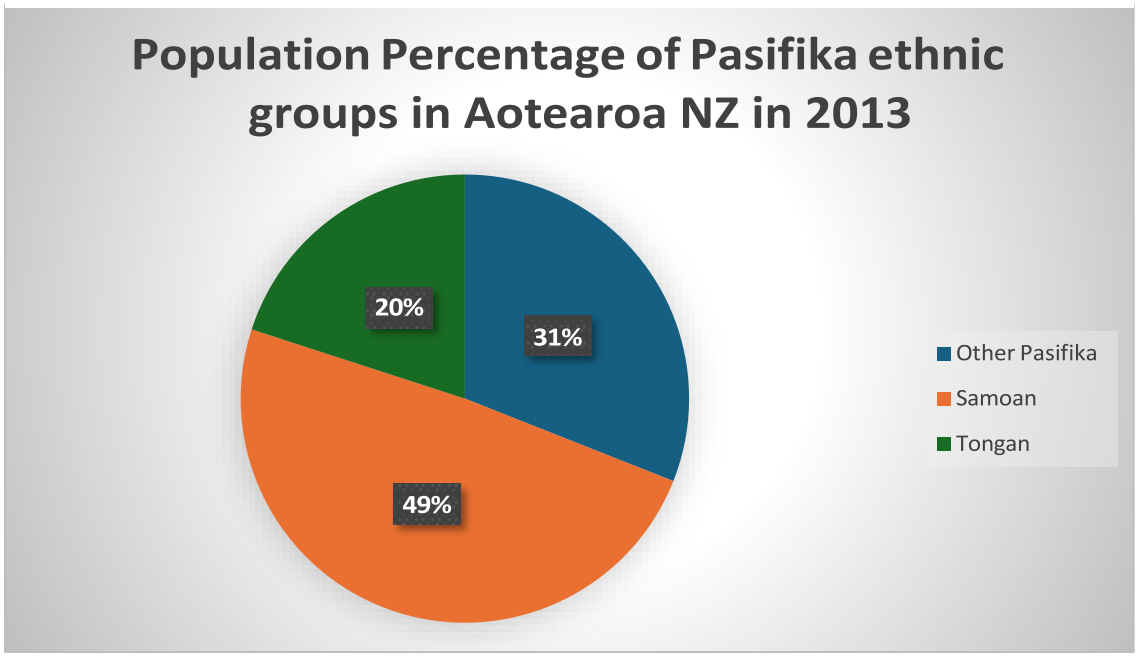
To examine the TB notifications in relation to the population proportions of different Pasifika ethnicities, the current study refers to the Pasifika ethnicities’ population estimates from the 2013 Census (Pasefikaproud, 2016). Although more recent population estimates would provide a more comprehensive comparison for this study, such data for Pasifika ethnicities is only available for specific years such as 2013. Utilising the 2013 Pasifika population estimates is judicious considering the total Pasifika ethnic makeup or proportions per ethnicity have mostly remained stable through to recent years (Stats NZ, 2023). Therefore, the following analysis will compare the percentage of TB notifications and population estimates for the three Pasifika ethnic groups for the year 2013. This will provide further insights into specific at-risk groups within the broader Pasifika population. Population percentages for Samoan, Tongan and ‘Other’ ethnicities for 2013 were produced using the 2013 total Pasifika population obtained from Linear Interpolation as the denominator.

Table 8. Population estimates of Pasifika ethnicities in Aotearoa NZ (2013) as percentage.

	Population %
Other Pasifika	31
Samoan	49
Tongan	20
Total	100

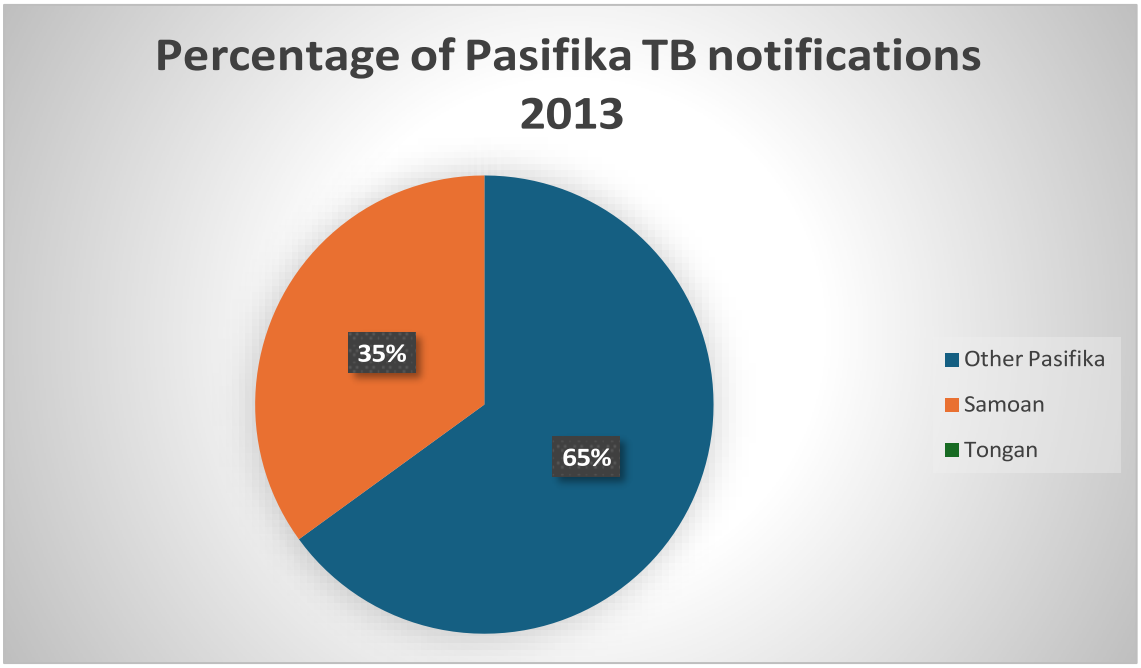
Table 8 shows that the Samoan ethnic group accounts for almost half (49%) of the total Pasifika population in 2013. The Tongan ethnic group is the second largest with 20% of the total Pasifika population. The remaining ethnicities are categorised under ‘Other Pasifika’, which includes Cook Island Māori, Fijian, Niuean, Tokelauan, Tuvaluan and Kiribati ethnic groups. These ethnicities account for 31% of the total Pasifika population in Aotearoa NZ which is illustrated in Figure 13 below.

Figure 13. Percentage of population estimates for Pasifika ethnic groups in Aotearoa NZ 2013



Additionally, the three Pasifika subgroups' population percentage in 2013 was compared with the percentage of Pasifika TB notifications in 2013 (Figure 14). The percentage of Pasifika TB notifications in 2013 was obtained using the total number of TB notifications for Pasifika in 2013 as the denominator.

Figure 14. Percentage of Pasifika TB notifications 2013



TB notifications for the Tongan group were less than 6 therefore suppressed for 2013 and represented as 0%.

Although Figures 13 and 14 are specific for the year 2013, they provide an overview of the TB situation among the three Pasifika ethnic subgroups in Aotearoa NZ. The Samoan

subgroup accounts for almost half of the Pasifika population at 49%, with 35% of total Pasifika TB notifications. This indicate that the percentage of TB notifications for the Samoan subgroup is lower than their population proportion, suggesting a relatively lower risk of TB for this group. In contrast, the 'Other' Pasifika subgroup, accounts for 31% of the total Pasifika population but 65% of all Pasifika TB notifications. This significant discrepancy highlights that TB is more prevalent among the 'Other' Pasifika ethnicities, which emphasises a higher risk of TB within these populations. A more comprehensive analysis for these ethnicities is necessary considering that there may be certain ethnicities within this subgroup who may have contributed more to the 65% of TB notifications for Pasifika and therefore will be at greater risk. The suppression of TB notifications for the Tongan ethnicity indicates the low TB incidence for this group or just for the year 2013 alone. Nonetheless, the suppression for the Tongan subgroup indicates a lower risk.

Summary

In summary, linear interpolation provided reliable ERP utilised as the denominator for TB incidence rates for four ethnic groups from 2006 to 2023. CIs for TB incidence rates were produced which indicated acceptable reliability. The incidence rates highlighted the European or Other (including New Zealander) + MELAA group to have the lowest risk of TB in Aotearoa NZ. However, further analysis is required to determine the level of risk for the MELAA group. Māori is also identified to have low risk of TB, however in comparison to The European or Other (including New Zealander) + MELAA group, TB incidence rates for Māori is significantly higher. Nonetheless, Māori TB incidence rates exhibit a decreasing trend. The highest incidence rates among the four ethnic groups were the Asian group, followed by the Pasifika group with the second highest TB incidence rates. This underscores Asian and Pasifika's greater risk of TB disease considering acquired TB or exposure outside of Aotearoa NZ and exposure in Aotearoa NZ.

Due to the lack of disaggregated data, TB incidence rates could not be produced for each Pasifika ethnicity within the Pasifika group. Further analysis on the available data for three Pasifika ethnicities (Samoan, Tongan and Other Pasifika) showed that the 'Other Pasifika' subgroup has had the highest TB burden throughout the 2006-2023 period. Disaggregated population data for Pasifika was available for 2013, therefore, to compare percentages of TB incidence and population size for the three Pasifika ethnicities, TB notification percentages for the year 2013 was utilised. This further confirmed the higher burden of TB among the 'Other' Pasifika group which comprise of Cook Island Māori, Fijian, Niuean, Tokelauan, Tuvaluan, and Kiribati. A more comprehensive analysis for 'Other' Pasifika subgroup is required as some ethnicities may have contributed more to the notification percentage and therefore at greater risk. The next section will present the analysis of BCG vaccination rates per ethnicity.

BCG vaccination rates

BCG vaccination data was obtained from NIR and rates were calculated per 100,000 of the total population (as described in chapter 3 *phase 4 and 5*) for Asian, European, MELAA and Other ethnic groups, Māori and Pacific Peoples (Pasifika) for TB incidence rates shown in Table 9. The estimated BCG vaccination rates with CIs (Table 10) were graphed and analysed per ethnicity.

Table 9. BCG vaccination rates per 100,000 (2006-2023)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
European, MELAA and Other	39.1	47.1	55.8	57.2	64.8	64.2	53.7	46.7	45.3	48.3	24.5	10.9	14.9	31.8	24.4	23.5	30.2	17.0
Māori	62.3	73.2	82.3	88.8	99.5	58.0	24.6	17.6	18.3	19.8	6.9	0.8	4.0	8.9	6.4	5.7	8.6	5.4
Pacific Peoples	1048.4	1318.4	1597.7	1530.3	1882.2	996.8	169.7	142.6	128.0	157.7	70.1	26.6	35.3	66.1	49.8	51.8	48.2	29.8
Asian	932.0	1077.5	1207.6	1185.8	1411.4	1378.0	1368.3	1097.4	1287.4	1303.0	506.1	127.4	613.5	1291.5	684.4	769.8	1139.6	632.8
Total Population	206.1	252.6	299.7	299.7	364.0	292.3	220.6	183.6	214.2	230.4	98.2	29.8	111.4	230.7	128.5	139.3	199.0	110.2

Colour gradient indicator: green=high vaccination rate (above 500 per 100,000), yellow= medium vaccination rate (80 to 500 per 100,000) and red= low vaccination rate (below 80 per 100,000). There were 266 vaccinated individuals who did not report their ethnicity for this period and were therefore excluded from the estimated rates. There was a suppression of data in the 'Other' ethnic subgroup due to low counts which may have affected the accuracy of the combined European, MELAA and Other rates.

Table 9 shows a significant decline of BCG vaccinations for all ethnicities as shown further along the table with deeper shades of red with the exception of the Asian group.

CIs for BCG vaccination rates

95% CIs were calculated (as described in chapter 3 *phase 4 and 5*) per ethnicity for the period 2006-2023 to provide reliable statistical representation.

Table 10. Confidence Intervals for BCG vaccination rates 2006-2023

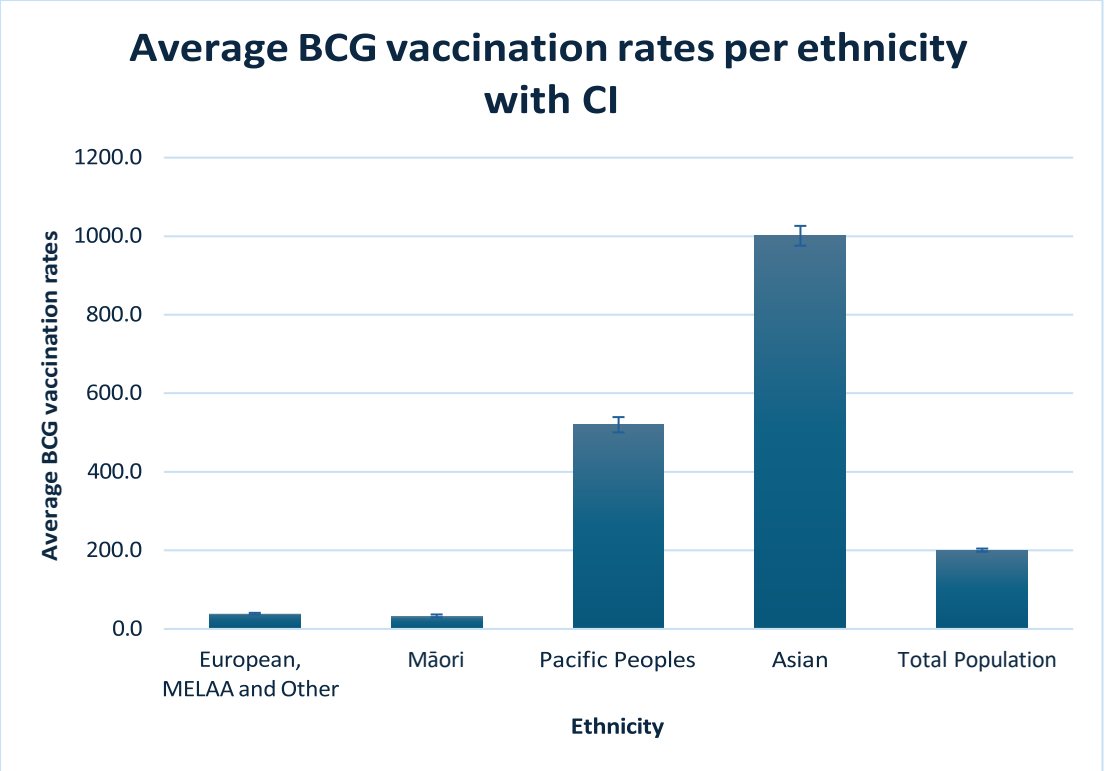
	2006	CI Lower	CI Upper	**2007**	CI Lower	CI Upper	**2008**	CI Lower	CI Upper	**2009**	CI Lower	CI Upper	**2010**	CI Lower	CI Upper	**2011**	CI Lower	CI Upper
European, MELAA and Other	**39.1**	36.9	41.3	**47.1**	44.8	49.5	**55.8**	53.3	58.4	**57.2**	54.6	59.8	**64.8**	62.1	67.6	**64.2**	61.5	67.0
Māori	**62.3**	56.3	68.8	**73.2**	66.7	80.2	**82.3**	75.5	89.7	**88.8**	81.7	96.3	**99.5**	92.1	107.4	**58.0**	52.4	64.0
Pacific Peoples	**1048.4**	1012.2	1085.6	**1318.4**	1278.2	1359.6	**1597.7**	1553.8	1642.5	**1530.3**	1487.7	1573.7	**1882.2**	1835.4	1929.9	**996.8**	963.1	1031.3
Asian	**932.0**	902.5	962.2	**1077.5**	1046.4	1109.2	**1207.6**	1175.5	1240.4	**1185.8**	1154.6	1217.6	**1411.4**	1378.1	1445.4	**1378.0**	1345.7	1410.8
Total population	**206.1**	201.8	210.5	**252.6**	247.8	257.4	**299.7**	294.5	304.9	**299.7**	294.6	304.9	**364.0**	358.4	369.8	**292.3**	287.3	297.5
	2012	CI Lower	CI Upper	**2013**	CI Lower	CI Upper	**2014**	CI Lower	CI Upper	**2015**	CI Lower	CI Upper	**2016**	CI Lower	CI Upper	**2017**	CI Lower	CI Upper
European, MELAA and Other	**53.7**	51.2	56.2	**46.7**	44.4	49.1	**45.3**	43.1	47.6	**48.3**	46.0	50.7	**24.5**	22.9	26.2	**10.9**	9.9	12.1
Māori	**24.6**	21.0	28.6	**17.6**	14.6	21.0	**18.3**	15.3	21.7	**19.8**	16.7	23.3	**6.9**	5.2	9.0	**0.8**	0.3	1.6
Pacific Peoples	**169.7**	156.1	184.1	**142.6**	130.2	155.8	**128.0**	116.5	140.3	**157.7**	145.1	171.0	**70.1**	61.9	79.0	**26.6**	21.7	32.2
Asian	**1368.3**	1336.7	1400.4	**1097.4**	1069.6	1125.6	**1287.4**	1258.5	1316.7	**1303.0**	1275.0	1331.4	**506.1**	489.3	523.3	**127.4**	119.3	135.8
Total population	**220.6**	216.2	225.0	**183.6**	179.6	187.6	**214.2**	209.9	218.5	**230.4**	226.1	234.8	**98.2**	95.4	101.1	**29.8**	28.3	31.4
	2018	CI Lower	CI Upper	**2019**	CI Lower	CI Upper	**2020**	CI Lower	CI Upper	**2021**	CI Lower	CI Upper	**2022**	CI Lower	CI Upper	**2023**	CI Lower	CI Upper
European, MELAA and Other	**14.9**	13.6	16.2	**31.8**	30.0	33.8	**24.4**	22.8	26.1	**23.5**	21.9	25.1	**30.2**	28.4	32.0	**17.0**	15.6	18.4
Māori	**4.0**	2.8	5.7	**8.9**	7.0	11.2	**6.4**	4.8	8.3	**5.7**	4.2	7.5	**8.6**	6.8	10.8	**5.4**	4.0	7.2
Pacific Peoples	**35.3**	29.8	41.6	**66.1**	58.5	74.4	**49.8**	43.3	57.0	**51.8**	45.2	59.1	**48.2**	41.9	55.2	**29.8**	25.0	35.4
Asian	**613.5**	596.2	631.3	**1291.5**	1266.5	1316.8	**684.4**	666.5	702.7	**769.8**	751.0	788.9	**1139.6**	1116.9	1162.6	**632.8**	616.1	649.8
Total population	**111.4**	108.4	114.3	**230.7**	226.5	234.9	**128.5**	125.4	131.6	**139.3**	136.2	142.5	**199.0**	195.3	202.8	**110.2**	107.5	113.0

BCG vaccination rates and CIs were averaged and presented in Table 11 and Figure 15.

Table 11. Average BCG vaccination rate with CI

	Average	CI Lower	CI Upper
European, MELAA and Other	38.9	36.8	41.0
Māori	32.8	29.3	36.8
Pacific Peoples	519.4	500.3	539.3
Asian	1000.7	975.8	1026.2
Total Population	200.6	196.6	204.6

Figure 15. Average BCG vaccination rates per ethnicity with CI



The CIs produced indicate the reliability of calculated BCG vaccination rate values observed in Figure 15 by the overall narrow interval ranges with expected slightly wider ranges observed for smaller population groups such as Pacific peoples (Pasifika).

Analysis of estimated BCG vaccination rates per ethnicity

Analysis of estimated BCG vaccination rates for the whole population.

Figure 16. BCG vaccination rates per ethnicity 2006-2023

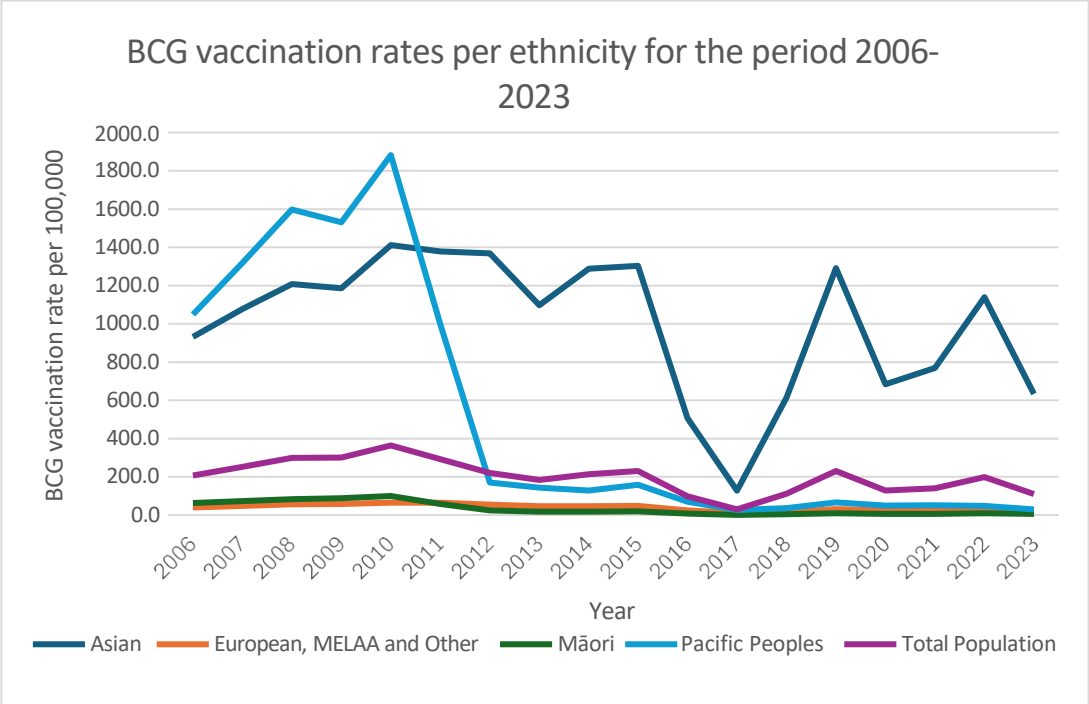
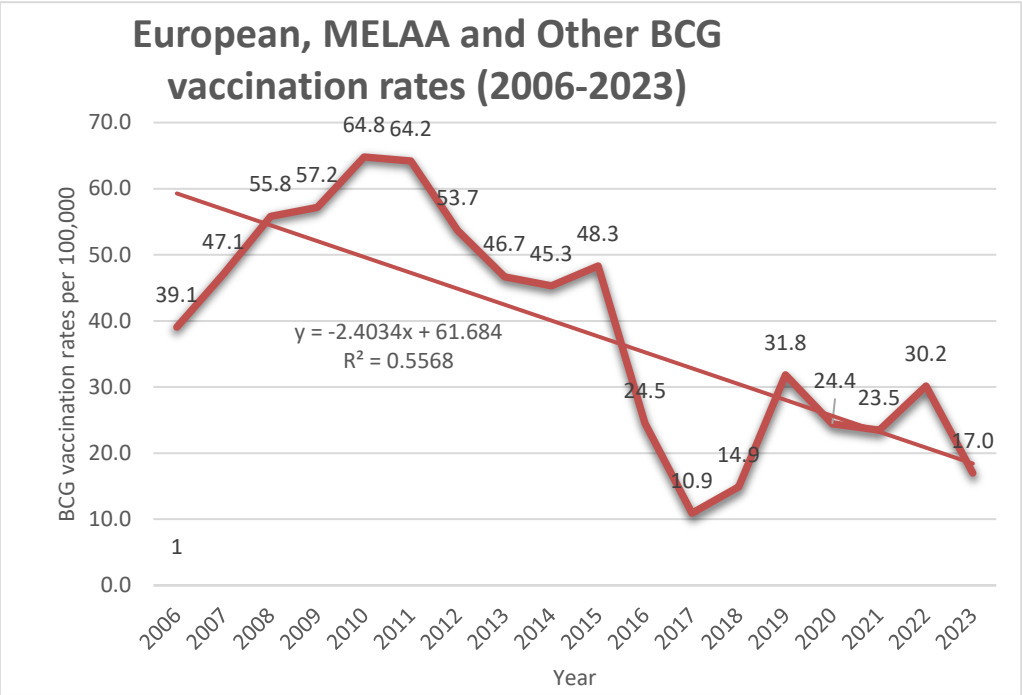


Figure 16 show that the BCG vaccination rates for the total population was relatively low with an average rate of 200.6 per 100,000 (CI: 196.6 – 204.6). There were major fluctuations in BCG vaccination rates across all four groups within the 2006-2023 period with a significant drop in vaccination rates during 2016 to 2018. This was attributable to the global stockout of the BCG vaccine which affected the country between 2015 and 2018 (Ministry of Health, 2018). The stockout is important to consider as it affected the vaccination trends across all groups. Māori and European, MELAA and Other groups were the least vaccinated with vaccination rates consistently below the rates for the total population. BCG vaccination rates have been consistently high among the Asian group (except in the 2016-2018 period) indicating a high vaccination coverage for this group. Vaccination peaked in 2010 for most groups particularly in the Pasifika group, however Pasifika's vaccination rates fell drastically from 2011 onwards and have remained significantly low throughout the rest of the period (as shown in Table 9) making them one of the least vaccinated groups. The BCG vaccination rates were calculated utilising the Linear Interpolation denominator (total population). This is important to consider as BCG vaccinations are for children under 5 years old. The BCG vaccination data included children over five years old who also received the vaccine, therefore, an age-based denominator rather than the total population, would provide more accurate insights.

Analysis of estimated BCG vaccination rates for European, MELAA and Other

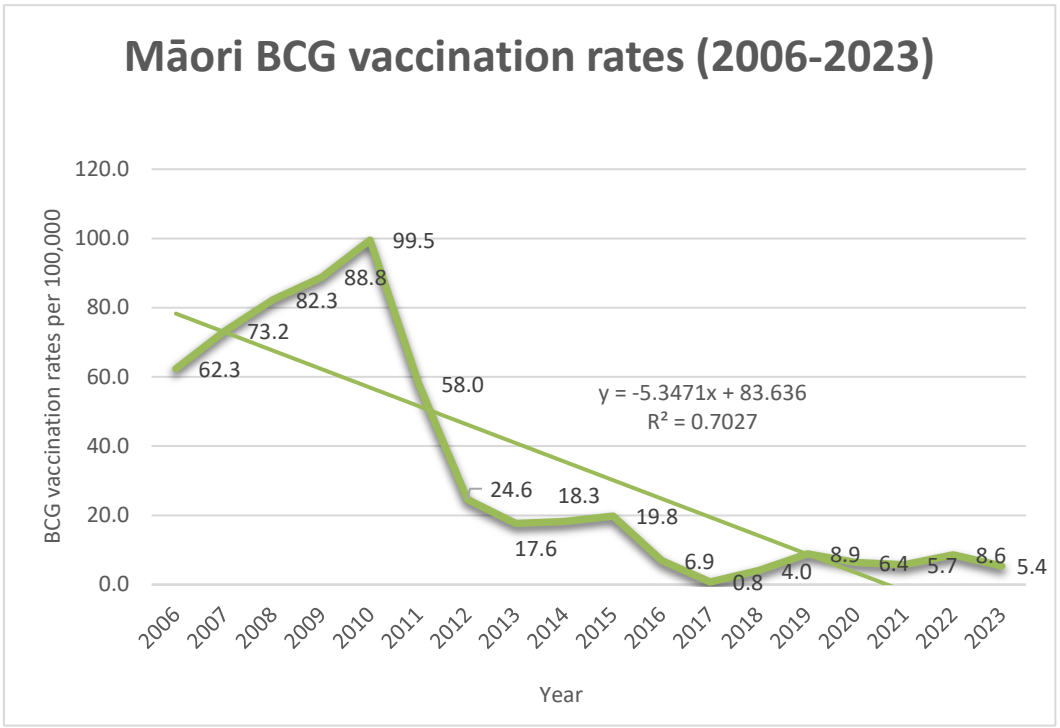
Figure 17. BCG vaccination rates for European and other + MELAA group (2006-2023)



BCG vaccination rates for the European, MELAA and Other population were significantly low (as observed in Figure 17) with an average of rate of 38.9 per 100,000 (CI: 36.8 – 41.0). The vaccination rate peaked at just 64.79 per 100,000 (CI 62.08-67.593) in the year 2010 and have fluctuated downwards since then. The trendline indicates a moderately fast decline (slope value -2.4034) of BCG vaccination among this group.

Analysis of estimated BCG vaccination rates for Māori

Figure 18. BCG vaccination rate for Māori group (2006-2023)



Māori vaccination rates were the lowest in the country, showing a rapid decline (slope value -5.3471). This is more than twice the decline of European, MELAA and Other group. The trendline indicates zero vaccine coverage for this group in the years after 2023 as shown in Figure 18.

Analysis of estimated BCG rates for Asian

Figure 19. BCG vaccination rate for Asian group (2006-2023)

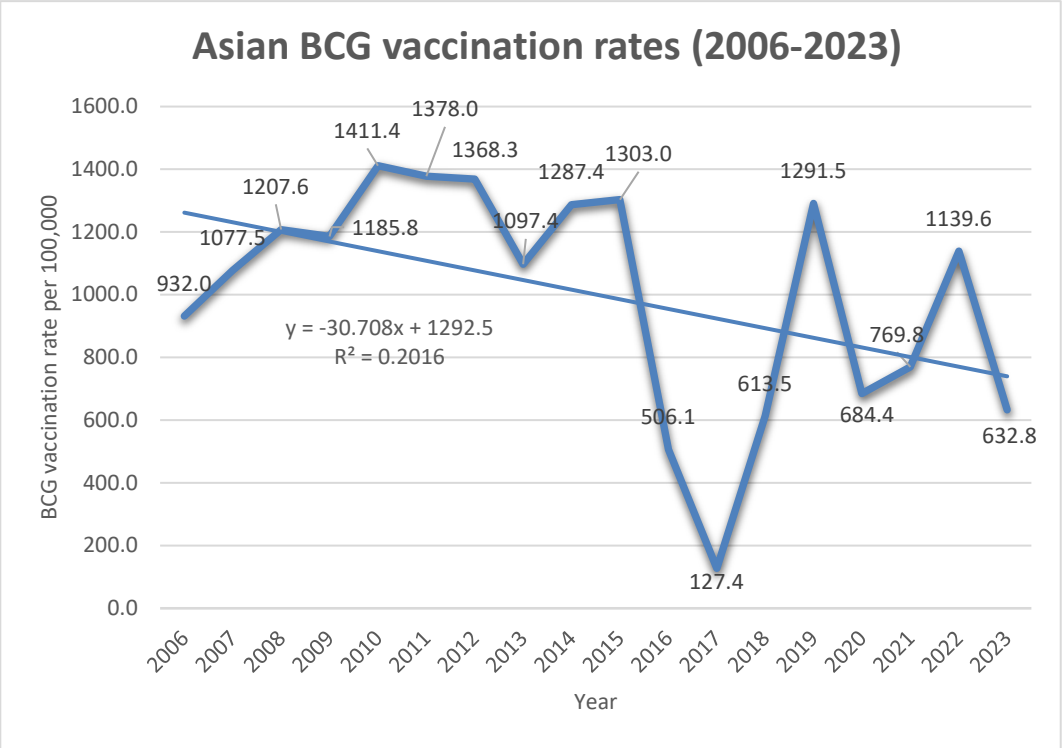
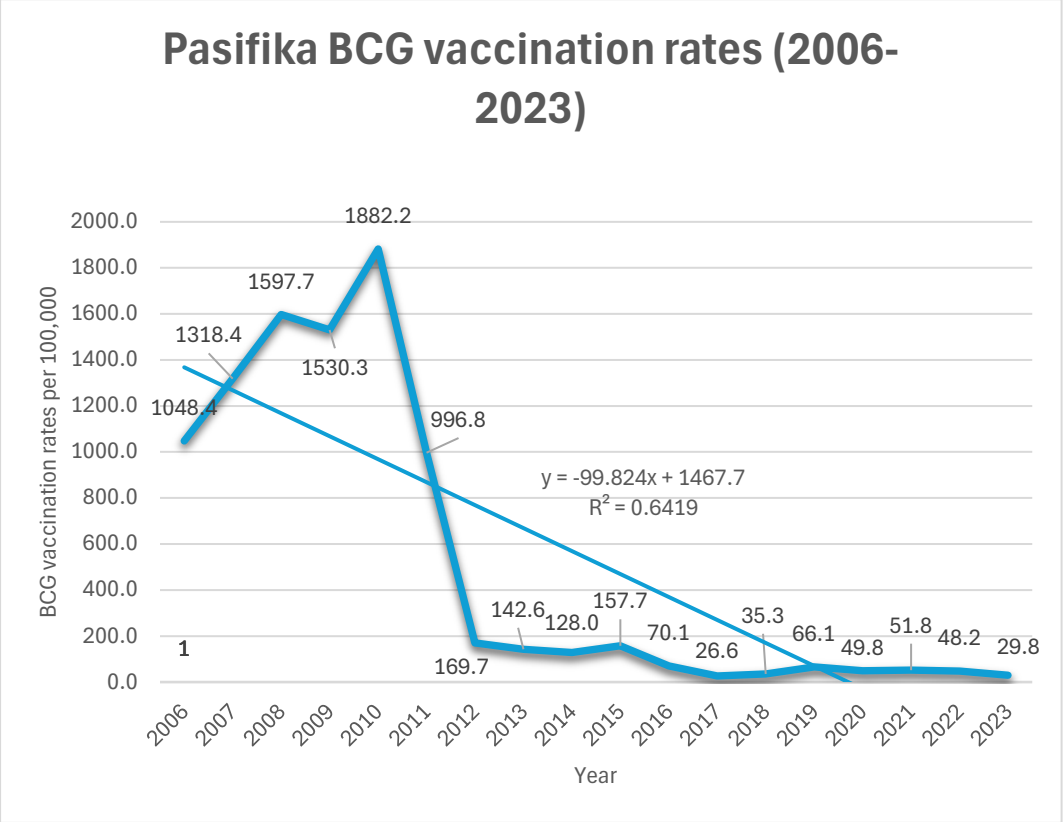


Figure 19 show consistently high vaccination rates among the Asian population indicating that they were the most vaccinated group in the country. There were a few fluctuations in vaccination rates throughout the 2006 to 2023 period and peaked at 1411 per 100,000 (CI 1378-1445.4) in 2010. The rates have remained relatively high since then (except for the 2016 to 2018 period). The trendline however, indicates a very steep and rapid decline shown by the slope value of -30.708. This suggests a substantial annual reduction in vaccination for this group. However, the rapid decline in vaccination rates caused by the BCG vaccine stockout, may have affected the slope value to overstate the long-term decline.

Analysis of estimated BCG rates for Pasifika

Figure 20. BCG vaccination rates for Pasifika (2006-2023)



Pasifika showed high vaccination coverage in the years leading to 2010 as shown in Figure 20. However, the trendline shows a significant and exceedingly rapid decline from 2011 reaching rates as low as 26.58 per 100,000 (CI 21.74-32.18). The decline is the most rapid across all the four groups shown by the slope value of -99.824 which predicts zero vaccinations after 2023 for Pasifika. The vaccine stockout may have heavily influenced the slope value however, unlike the Asian group which experienced a recovery in vaccination rates post vaccine stockout years, the Pasifika vaccination rates remain significantly low. At present, there are no known links or correlations to known factors that may have influenced the significant decline in vaccinations from 2011 to more recent years. The average vaccination rate for this group is 519.4 per 100,000 (CI: 500.3 – 539.3) which is reasonably high, however, the significant low rates from 2011 onwards suggest that the average vaccination rate for Pasifika was as low as the Māori and European, MELAA and Other groups from 2011 to 2023.

Analysis of BCG vaccinations per Pasifika ethnicity

The NIR provided specific BCG vaccination counts for each Pasifika ethnicity from 2005 to 2023, including Samoan, Tongan, and those categorised under ‘Other Pasifika’ (Cook Island Māori, Tokelauan, Niuean, Fijian). However, Tuvalu and Kiribati were grouped with the

remaining ‘all other Pacific ethnicities’ in this data. Due to the lack of population data for each Pasifika ethnicity, vaccination rates could not be calculated. Consequently, BCG vaccination counts for each Pasifika ethnicity are presented as percentages, using the total number of Pasifika BCG vaccinations from 2005 to 2023 (provided by ESR) as the denominator. Therefore, the percentages produced reflect each ethnicity’s vaccination counts out of the total number of combined Pasifika ethnicities vaccinated with BCG during this period, rather than out of the total Pasifika population. The percentages of Pasifika BCG vaccinations are presented below in Table 12 and in the graph shown in Figure 21.

Table 12. BCG vaccination percentage for each Pasifika ethnicity 2005-2023

Total Response Ethnicity	Percentage
Samoan	50.3
Tongan	22.9
Cook Island Māori	13.5
Tokelauan	2.5
Niuean	5.7
Fijian	8.5
All other Pacific ethnicities	6.8

Figure 21. Pasifika ethnicities vaccination percentage 2005-2023

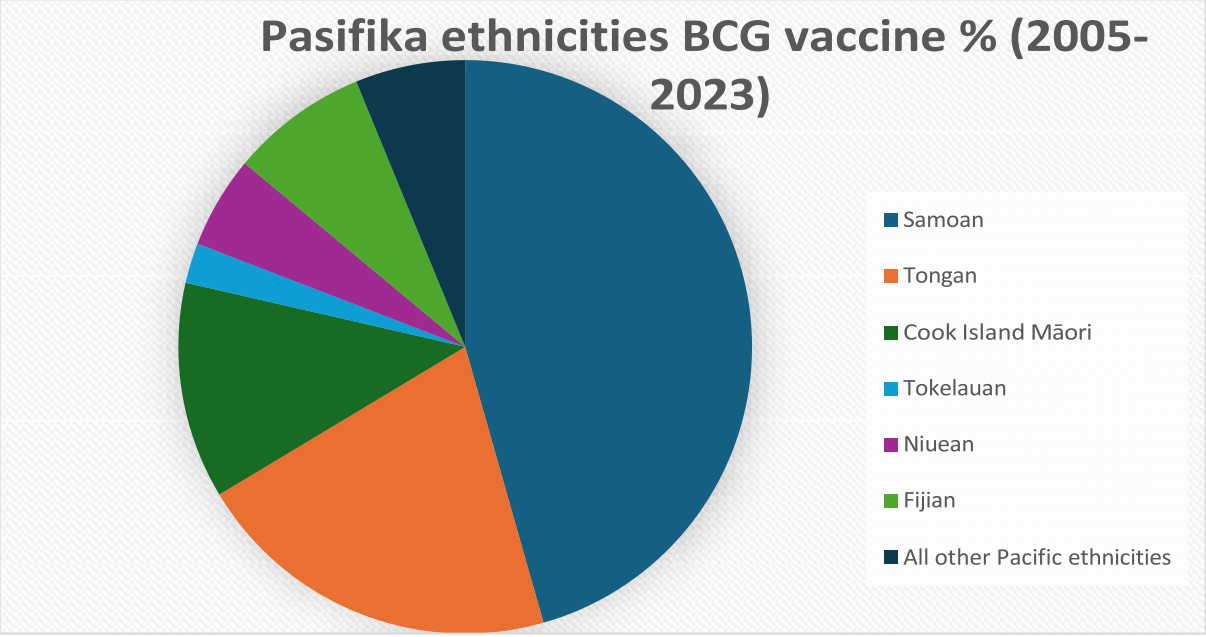


Table 12 and Figure 21 indicate that Samoan, Tongan, and Cook Island Māori had the highest vaccination proportions among Pasifika ethnicities from 2005 to 2023. In contrast,

Niuean, Tokelauan, Fijian and all other Pacific ethnicities had much lower percentages, indicating they were the least vaccinated. These percentages likely reflect the varying population sizes of each group. For example, Samoan, Tongan, and Cook Island Māori are the larger Pasifika population groups in Aotearoa NZ, which corresponds to their higher vaccination numbers. Conversely, Niuean, Tokelauan, Fijian, and all other Pacific ethnicities are smaller population groups, reflecting their lower vaccination numbers.

Analysis of Pasifika population per ethnicity

For further insight, we again refer to the Pasifika subgroup's population percentages from the 2013 Census due to limited population data. The total Pasifika population obtained from Linear Interpolation for 2013 was utilised as the denominator. This enables the present study to compare the varying population sizes with their respective vaccination proportions. The population percentages of the seven Pasifika subgroups are presented in Table 13 and Figure 22 below.

Table 13. Pasifika ethnicity population percentage in 2013

Ethnicity	Population %
Samoan	49
Tongan	20
Cook Island Māori	21
Tokelauan	2
Niuean	8
Fijian	5
All other Pacific ethnicities)	1.7

Figure 22. Pasifika ethnicities population percentages 2013

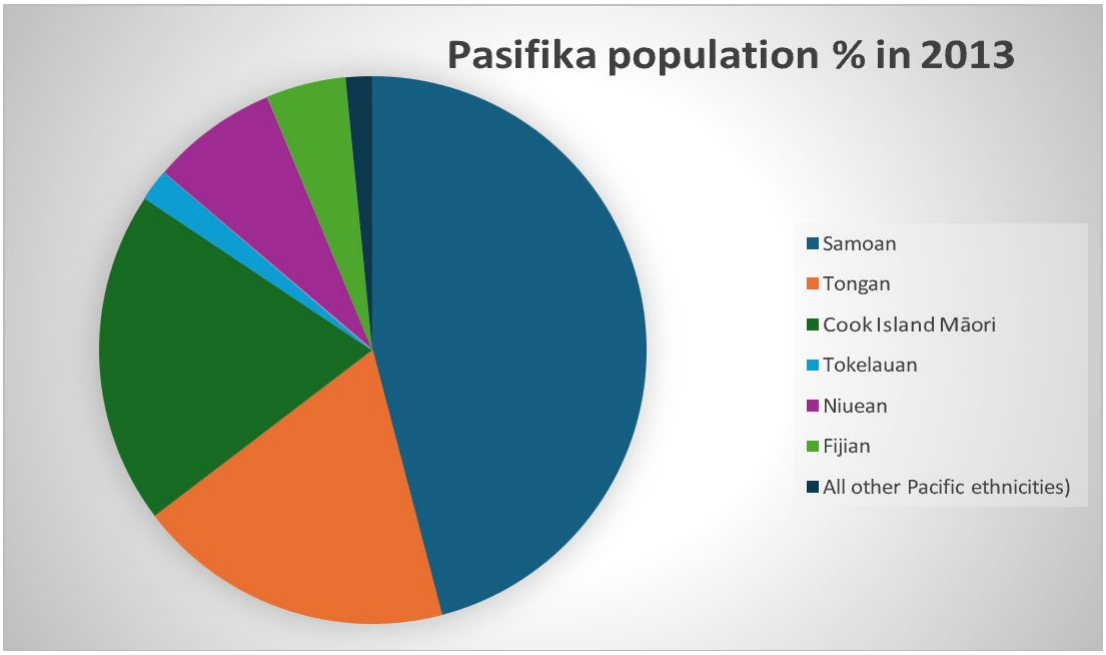


Table 13 and Figure 22 show the Pasifika populations by ethnicity in 2013. Population data or percentages from 2005 to 2023 would be ideal for direct comparison to BCG vaccination percentages and offer a more accurate view of vaccination proportions per ethnicity for this period. However, using the 2013 Pasifika population percentages for this comparison, can also provide insight of vaccination proportions, as Pasifika population proportions per ethnicity have mostly remained consistent to the present day. Another aspect to consider for this analysis in terms of suitable comparisons is that the BCG vaccination percentages per ethnicity are based on the total number of vaccinated Pasifika for 2005 to 2023 as the denominator, rather than total number of the Pasifika population for this period. This means the percentages represent each ethnicities' vaccination counts out of the total number of Pasifika peoples vaccinated with BCG.

BCG vaccination percentages per ethnicity for the period 2005 to 2023 (Table 12) corresponds reasonably well to the 2013 Pasifika ethnicity population percentages (Table 13). For instance, the Samoan and Tongan groups show highest vaccination coverage among Pasifika (50.3% and 22.9% respectively), followed by Cook Island Māori (13.5%) which reflects their higher population sizes (Samoan 49%, Tongan 20% and Cook Island Māori 21%). The Cook Island Māori subgroup however, had a lower vaccination proportion relative to their population indicating that they are under-vaccinated.

For the smaller populations such as Tokelauan, Niuean and Fijian and all other Pacific ethnicities, the BCG vaccination percentages for the period 2005 to 2023 also corresponds reasonably well to their population proportions. For example, the vaccination percentages for Tokelauan, Niuean, Fijian and all other Pacific are 2.5%, 5.7%, 8.5% and 6.8% respectively

and the population percentages for these groups are 2%, 8%, 5% and 1.7% respectively. This indicates that the Tokelauan, Fijian and all other Pacific were reasonably well vaccinated. The Niuean subgroup had a lower vaccination proportion relative to their population proportion, therefore this subgroup is under-vaccinated. Overall, the vaccination and population proportions suggest that the current BCG vaccination efforts are capturing each Pasifika group reasonably well with the exception of the Cook Island Māori and Niuean subgroups.

Summary

In summary, the BCG vaccination rates produced with CIs provided an insight into the BCG vaccination coverage for the whole population. The vaccination rates were affected by the BCG vaccine stockout years nevertheless, the rates indicated Asian and Pasifika as the most vaccinated groups. However, the vaccination rates for Pasifika did not recover post stockout years. Pasifika vaccination rates have also remained significantly low from 2011 to 2023, placing them among the least vaccinated groups such as Māori and European, MELAA and Other. Further analysis of Pasifika ethnicities' BCG vaccination proportions in comparison to their population sizes in 2013 (due to unavailable data) indicated that Cook Island Māori and Niuean ethnicities were under-vaccinated.

TB and BCG vaccination results summary

TB incidence and BCG vaccination trends for the whole population have remained reasonably steady throughout the years 2006 to 2023. However, TB trends indicate specific groups of the population are at higher risk of TB such as the Asian and Pasifika group. When comparing BCG vaccination rates among ethnic groups, the Asian group had high vaccine coverage throughout the years (average of 1000.7 per 100,000, CI: 975.8 – 1026.2), indicating a certain level of protection against TB for this population. However, different protection or prevention efforts against TB may be needed other than BCG vaccination for this group due to their steady high rates of TB.

Conversely, the BCG vaccination rate for Pasifika showed a rapid significant decline throughout the years. The average BCG vaccination rate for this group is 519.4 per 100,000 (CI: 500.3 – 539.3) which indicates reasonable protection against TB. However, the significant declining trend is a concern for this group. Particularly as the average vaccination rate post 2011 may be as low as the Māori and European, MELAA and Other groups. This is a concern as Pasifika's TB rates continue to remain high. Pasifika's exceedingly low BCG vaccination coverage from 2011 onwards also highlight that this group is significantly under-vaccinated therefore Pasifika children are under-vaccinated and unprotected against TB, especially neonates born after 2011.

When BCG vaccination was examined for Pasifika ethnic subgroups, the findings revealed a proportionate BCG vaccination uptake in terms of the subgroups' population sizes in Aotearoa NZ. The highest vaccination percentages were among the more dominant Pasifika ethnic subgroups, Samoan and Tongan which reflects their population proportions. This indicates a reasonably decent level of protection for these subgroups. The same observation is applicable to the less dominant Pasifika ethnicities particularly the Tokelauan, Fijian and all other Pasifika ethnic subgroups which have higher vaccination proportions compared to their population proportions. However, the subgroups with low vaccination coverage in comparison to their population proportions are the Cook Island Māori and Niuean. Due to the lack of disaggregated TB data, the present study could compare both subgroup's TB risk to their vaccination proportions. However, based on the high TB rates observed for 'Other' Pasifika (which includes Cook Island Māori and Niuean) and the low vaccination coverage for both groups, more interventions may be needed to increase BCG vaccine uptake for Cook Island Māori and Niuean.

Overall, the BCG vaccination programme and efforts are effective in capturing majority of at-risk Pasifika populations, however, BCG vaccination rates for Pasifika were significantly low from 2011 to 2023. Furthermore, TB rates remain high for the whole Pasifika group. TB rates also remain higher in the less dominant Pasifika subgroups with two subgroups identified to have low BCG vaccination coverage. This suggests room for improvement for the BCG vaccination programme and general TB prevention efforts. The next chapter will present the findings of healthcare professional's perceptions of the current BCG vaccination programme and TB prevention efforts to explore strategies for improvements.

Chapter Five: Qualitative Results

This chapter will describe the findings from the qualitative phase of the study. It will explore the three categories derived from the conventional content analysis (CCA) of the qualitative data from the maroro (conversations) with three healthcare professionals.

Overview of qualitative findings

The three participants ranged in expertise and experience. Participant 1 is a vaccine educator programme manager, participant 2 is a medical doctor with a specialty in paediatric infectious diseases and participant 3 is a Public Health Communicable Disease Control (CDC) charge nurse. All three participants reside and are employed across the Auckland region. Their perceptions and experiences of the BCG vaccine programme and TB prevention efforts were explored during the maroro sessions. From the CCA, three categories were constructed.

The first category is *systemic gaps in identifying at-risk groups.* It outlines the health system's main pathways for identifying population groups at-risk for TB and determining eligibility for the BCG vaccine. This is discussed in the context of the healthcare system's reform from a regionalised system to a unified single health organisation. Additionally, it explains how changes in BCG policy and programmes have shifted from a universal approach to a more targeted approach within the framework of this reform. As mentioned in the literature review chapter, the current BCG programme to target at-risk groups consist of an eligibility criterion for young children only (from newborn up to 5 years of age) to be recommended to receive the BCG vaccine based on the three following criteria (Te Whatu Ora, 2025):

- live in a house with whānau member or person with either current TB or a history of TB
- have one or both parents or household members or carers who within the last five years lived for a period of six months or longer in countries with a TB rate ≥40 per 100,000
- during their first five years will be living for three months or longer in a country with a TB rate ≥40 per 100,000.

The outline of the health system's pathways of identifying at-risk populations for TB and BCG eligibility from the first category frames the findings of the second and third categories. The second category *perceptions of TB disease and BCG vaccine among migrants and Pasifika communities* is about health workers' perceptions and experiences with migrant and

Pasifika communities regarding BCG vaccine uptake and TB prevention efforts. The third category *system-based factors that affect BCG uptake and TB reduction* outlines the participants' experiences and perceptions of limitations of the current BCG vaccine itself and programme as well as TB prevention efforts.

Category 1: Systemic gaps in identifying at-risk groups

Four subcategories were constructed within this category, the first two describe the main pathways of how TB at-risk groups and BCG eligibility are identified. The third and fourth subcategories describe health systems gaps and healthcare workers' knowledge gaps in identifying at-risk groups/children.

TB notification pathway

To evaluate the health system's capabilities to effectively capture TB at-risk groups within the population, one participant described the primary to tertiary healthcare notification process of Auckland Region's Public Health units. Primary, tertiary and Public Health units (PHUs) previously operated under separate district health boards (DHBs); however, this structure w reformed to operate under the single health organisation, Health New Zealand Te Whatu Ora. The participant explained that when a patient is seen in primary healthcare, such as at general practices (GP), displaying common TB symptoms, the GP would refer the patient to tertiary healthcare to confirm the diagnosis. The patient is referred to Auckland City Hospital, the only facility in the region equipped for comprehensive diagnostic testing and isolation for infectious diseases. The patient is then transferred and managed at Auckland City hospital once diagnosis is confirmed. The next step is for the PHUs to manage the patient's TB exposure at the community level to mitigate transmission. Despite the single health system structure in the country, the notification process from tertiary healthcare to public health is regionalised throughout the country. According to the participant, there is a single respiratory team at Auckland City Hospital responsible for notifying Public Health infectious disease (ID) teams of TB cases for the Auckland region. The notifications of the TB cases are then picked up and managed by specific local PHUs. The PHUs within Auckland and throughout the country function independently at an operational level. This brief outline provided by the participant highlights the role of primary healthcare, such as GPs, as key facilitators in the identification, treatment and management of TB cases. It also offers insight into the effectiveness and capacity of the Auckland region to manage TB cases at the tertiary operational level, which appears to be robust in accommodating the current TB burden. However, the participant expressed concerns of the

health system's high potential to be overwhelmed if surges of TB burden occur, especially with the evident rise in TB cases in 2024.

> *"So this year so far we already have over 140 plus TB cases, so it is higher than any other years in the past 5 years … and we from the trends we got, we're thinking it's going to reach to the… more than 170 at the end of the year." (Participant 3)*

The high potential for Auckland City Hospital's capacity to be overwhelmed when surges of TB occur, provides implications for regions outside Auckland. Considering Auckland as one of the main and larger cities in Aotearoa NZ, cities outside of Auckland are not as well equipped with less resources which means they are most likely to be overwhelmed to a greater extent during events of TB surges. The process outlined also provided insight into the separate operational levels of the PHUs for identifying TB at-risk groups, who would then be screened for BCG eligibility. This process is elaborated further in the next subcategory

Pathways of identifying BCG vaccine eligibility

In the Auckland region, the two Public Health pathway processes for offering the BCG vaccine were also described by a participant. Following tertiary notification of confirmed TB cases, the Public Health CDC team would conduct contact tracing and offer BCG vaccination appointments to identified children of the case's household members under five years old, who would be deemed to have been exposed to TB. This captures the first eligibility criteria: *live in a house with whānau member or person with either current TB or a history of TB.* The second pathway of identification is through the assessment process of midwifery care during pregnancy. One of the participants emphasised midwives' necessary comprehensive assessment of children's (including unborn children) eligibility for the BCG vaccine by stating:

> *"On the Well Child book, there is a first thing is the BCG so the midwife will do initial screening to the population, you know on the register and of course registered under them [midwives] to see if they are eligible or not." (Participant 3)*

The responsibility then falls on the parents who received the recommendation to book their children's BCG vaccine appointment via an online booking system on the regional Public Health website, containing a screening questionnaire that captures all three of the eligibility criteria. If the child is eligible for the free BCG vaccination, the screening proceeds to appointment booking at a nearby BCG clinic. The two processes highlight Public Health CDC

teams and midwives as key facilitators for BCG recommendations. The next subcategory will explore system gaps that affect the capabilities of public health teams and midwives to effectively screen and recommend BCG vaccination, ultimately impacting BCG uptake among at-risk children.

Gaps in the system for identifying at-risk groups

Although the current operating processes for Auckland region appear robust, two participants discussed system-based gaps at a national level when answering questions about how at-risk groups are identified for BCG recommendations and whether they think the process is effective. One argument they highlighted is that at-risk children can be missed and not receive the BCG recommendation due to the separate regional and local operating levels of the different PHUs throughout the country. As one participant mentioned,

> *"What I'd say then is if you do identify a child who should be referred but hasn't been, is because there's differences across how the referral processes work." (Participant 2)*

Another system-based gap discussed was specific to the online booking system which some PHUs rely on entirely for BCG recommendations. The participants highlighted that the implementation of the online booking system can enable at-risk children to miss out on the vaccine due to issues with access to technology for some families. Additionally, the online booking system introduces another barrier if parents lack the initiative to book the vaccine appointment themselves in the first place. In comparison to the previous universal vaccination approach, where most children were offered the vaccine after birth without an eligibility screening, these factors were easily mitigated as parents would not have to access technology nor book for their children's vaccination themselves. Two participants emphasised this:

> *"I mean that leaves issues for people who have struggles with IT and struggles actually accessing IT." (Participant 1)*

> *"The family find barriers and having to pick up a phone to make this appointment or email this appointment you know." (Participant 2)*

The participants also stated that the BCG vaccine recommendation is often overlooked since the policy and programme change from the universal vaccine approach to focusing on at-risk

groups only, therefore the vaccine is not included in the childhood immunisation schedule. This issue is exacerbated by the many existing responsibilities of midwives, often making it challenging to recall and consider BCG eligibility among other vaccines that need to be recommended and especially if they are not vaccinators themselves. Two participants described this:

> *"very busy sector, they're [midwives] not offering (to administer) the vaccine themselves so it's probably not the first thing they are thinking about …" (Participant 1)*

> *"they [midwives] just want to do the six weeks imms and yeah rather than also doing an eligibility check for… BCG." (Participant 2)*

Another point raised by a participant is that the second eligibility criterion, which involves parents or household members living in countries with a TB rate of ≥40 per 100,000 for six months, necessitates a list of countries that meet this criterion, which has been produced for healthcare workers to refer to. The participant emphasised that more attention is needed for the list, as TB rates in countries can fluctuate annually and therefore more countries may need to be included on the list. Consequently, more children in Aotearoa NZ may be eligible for the BCG vaccine but are missing out on being recommended for it. The participant stressed this:

> *"I would say about that, is that if we don't regularly refreshen (or) review the incidence, you know what is the current incidence rate in a country there may be countries that aren't on the list." (Participant 1)*

The separate operating levels of Public Health Units (PHUs) throughout the country, the reliance on an online booking system for BCG eligibility screening and appointment booking, and the need for close monitoring of the list of countries with a TB rate of ≥40 per 100,000 were all identified as system-based gaps that can result in at-risk children missing out on being offered the BCG vaccine. Another gap that contributes to at-risk children missing out on BCG vaccination is the knowledge gap among healthcare workers in terms of the BCG eligibility programme, which is elaborated further in the next subcategory.

Knowledge gap of healthcare workers for identifying at-risk groups

Since the shift from a universal vaccination approach, the BCG eligibility programme was designed to capture at-risk groups only. This means that healthcare workers need to know of the programme and be familiar with children's eligibility criteria within the programme. One participant stated that Public Health nurse teams hold BCG education workshops designed by the Immunisation Advisory Centre (IMAC) to midwives at least two to three times a year. However, a reoccurring notion from participants when asked on their thoughts of the mechanisms for identifying at-risk groups of the population, is a recognisable knowledge gap of the BCG vaccine itself and the programme among healthcare providers. Interestingly this also includes midwives, despite attending the education sessions. Delivering education sessions only to midwives also introduces the opportunity for at-risk pregnant mothers to miss receiving a recommendation for BCG vaccination, depending on whether mothers are receiving obstetrician care or midwifery care, as obstetricians may be less aware of the BCG programme. Another participant also recognised that although healthcare providers may be aware of the BCG vaccine itself and the BCG programme, they may not necessarily know of the referral process as two participants shared,

> *"The system is not perfect. Children do slip through the net. Midwives and probably also obstetricians may not understand some of the nuances of who's eligible and who's not." (Participant 1)*

> *"my impression … it's done appallingly badly… well the need for the vaccine needs to be recognised… at birth. So therefore, the midwife, obstetrics women's health needs to identify and I don't believe that enough midwives are even aware. So I think there's a huge issue with our midwives obstetrics population being aware that this programme exists and needs to actually identify these mothers and suggest to them they get vaccinated." (Participant 2)*

The knowledge gap also extends to GPs whom participant 2 perceive to typically not recognise TB high-risk countries which would have been included in the list of countries with TB rate of ≥40 per 100,000. Therefore, familiar presenting symptoms of TB are often overlooked in patients who are from or visited these countries and would have high risk of exposure. Considering that the TB rate in New Zealand is low, GPs do not come across the disease enough to consider the possibility of TB, resulting in no diagnosis of TB. This often means that contacts of TB cases are not identified and followed up by public health workers for BCG vaccine recommendation. The knowledge gap of the BCG vaccine and the BCG programme's eligibility criteria among healthcare workers create situations where at-risk children could miss

out on a BCG vaccination. To elaborate further on how at-risk children are missing out on the BCG vaccine, the next category will focus on TB and BCG knowledge gaps at community level.

Category 2: Perceptions of TB disease and BCG vaccine among migrants and Pasifika communities

Within this category, three subcategories were constructed which explores migrants and Pasifika communities' behaviours and attitudes towards TB disease and the BCG vaccine. The results focus on how this affects primary healthcare and public health efforts for TB prevention and BCG promotion, from the perspective of the participants as healthcare professionals.

Migrants' perceptions of TB

Although Aotearoa NZ is considered a low-risk country for TB, it is important to keep TB on the radar as it remains a significant global health issue. All three participants shared the same concern regarding how often migrants from high-risk countries forget or neglect TB risk upon arriving in Aotearoa NZ. This includes migrants who live in Aotearoa NZ and travel back to visit their home countries that have high TB rates. This often leads to less concern and less proactive TB prevention measures among migrants, especially if they do not feel ill due to the association of Aotearoa NZ with a new, clean, or disease-free environment. This lack of concern is often rooted in a lack of awareness about the mechanisms of the TB-causing bacterium *M.tb*, in terms of exposure and disease progression over time, as the bacterium can be suppressed by the immune system upon exposure, causing the disease to remain inactive. However, it can become active at any given time. From their perspective as healthcare professionals, participants noted that migrants generally did not realise that exposure to the bacterium results in first-generation migrants having the same risk of TB incidence as the population in their country of origin and that the risk only starts to decrease among their children (second-generation migrants). This is due to the prolonged time spent in high-risk countries which increases their risk of exposure, as well as common mingling with the same communities upon migrating to Aotearoa NZ. The risk also continues as family members and friends visit from high-risk countries. Two participants emphasised this,

> *"when they [migrants] go back, they think of it as going home so they don't think about the risk of what actually travelling to home means." (Participant 1)*

> *"so here [Aotearoa NZ] I'm clean and there's no TB." (Participant 3)*

This suggests that increasing awareness and knowledge about TB exposure and disease progression among migrant communities, especially communities travelling to and from certain high-risk countries with high TB burden, would lead to a better understanding that living in a low-risk country like Aotearoa NZ does not eliminate TB risk as exposure may occur elsewhere, and the disease can still become active later on.

The lack of awareness about TB exposure and disease mechanisms, as well as the low TB rate in Aotearoa NZ also contributed to the shift of migrants' perspective on BCG vaccination. This was emphasised by one participant's experience with a migrant family of a child who had not been vaccinated and died from TB,

> *"The family thought 'well we came to New Zealand. New Zealand doesn't have TB. Why should I vaccinate my child'. So, they don't identify that there is an ongoing risk of TB. They totally know it [BCG] but it's like 'well we've left there [high-risk country], we don't have to worry'. So, they don't race to get their kids vaccinated." (Participant 2)*

This suggests that these factors affect migrants' perspectives about TB upon migrating to Aotearoa NZ which ultimately impacts TB incidence and BCG uptake among at-risk groups of migrants. The next category will explore other factors that also affect BCG uptake among at-risk groups of the population.

The effects of TB stigma on BCG and TB initiatives

Stigma was a reoccurring point of discussion with all three participants when discussing their thoughts about how to better understand and address cultural nuances and factors that can influence perceptions of TB. The participants suggested that stigma of TB is still very much attached to current ideologies that emerged from its historical context which still affects particular ethnic groups and communities to a greater extent. An example outside of Aotearoa NZ that one participant stated involves historical interpretations and assumptions of the disease that rooted racial stigma to TB. Suggesting that racial stigma has created gaps in the health system in terms of who is more likely to be offered the BCG vaccine and affect the chances of receiving the vaccine in particular ethnic groups who may have been at-risk.

> *"There was this very racist assumption or skin colour assumption that [TB] disease was more prevalent in different parts of the population … if you had two families from*

South Africa and one was black South African and the other was white South African, you could almost guarantee the black South African was told about the BCG vaccine, but the white South African wasn't." (Participant 1)

The same participant also acknowledged racial stigma in the Aotearoa NZ context when answering same maroro questions above, with a particular interest to the Pasifika population by stating,

"… we still have a lot of underlying biases around things like this … that it was a brown people's disease." (Participant 1)

This possibly contributed to the Pasifika communities' perceived reputation that TB is more common among themselves in comparison to non-Pasifika groups of the population. One participant pointed out that TB stigma is also often rooted in its perceived connection to poverty and poor hygiene. This stigma can lead to reluctance among families to participate in initiatives and programmes aimed at controlling or reducing TB, particularly within specific ethnic groups such as Pasifika communities. In tightly knit communities, participants noted that this reluctance can be further exacerbated by the fear of shame and judgment from community members if it becomes known that a household or family has TB. One participant mentioned:

"… a lot of stigma around TB. Poor, dirty." (Participant 2)

One of the Public Health efforts to mitigate community TB outbreaks, which is commonly disrupted by TB stigma, is contact tracing of confirmed TB cases. The need to shield themselves and other extended family members from the perceived shame and ridicule that comes with TB, exceeds the health protection benefits of adhering to necessary programmes such as contact tracing. Two of the participants expressed the obvious evasion of information sharing among TB cases and their family members to public health workers. This was again observed by participants among Pasifika communities but also extended to other ethnic groups of the population such as African communities, highlighting racial stigma rooted in a historical context as a contributing factor. Insufficient information to carry out effective identification of possible exposed or at-risk family and community members often resulted in ineffective public health risk mitigation due to the absence of identified disease contacts who would need diagnostic testing to confirm TB exposure at an early stage. The participants shared their points of view and experience with TB stigma and contact tracing:

"I mean I find it equally as interesting getting TB history, you know asking for TB history, and they'll all say no ... they totally deny it … I don't know if there's any point really asking it because majority of time, they'll say no regardless." (Participant 2)

"… so that was a Tuvalu community. I hugely agree there is stigma in the community not that I'm assuming that, it actually it's from the patient from the family they tell me that please please do not tell anybody because once one family know then the whole community will know." (Participant 3)

Participant 2 also shared an example of stigma and obtaining TB history for contact tracing from a clinical point of view. The example was on a very clear community transmission resulting in a child with LTBI activating to TB disease upon exposure, evident by the conversion of the second Mantoux test meaning the child was recently exposed to an active TB case. However, public health nurses faced immense difficulty when trying to identify the index case as family members indicated great reluctance to engage to avoid any association with TB. This often resulted in crucial information on family TB history being withheld, demonstrating the impact of stigma in increasing public health risk.

"The child had lived in Kiribati so it's possible that they had had it and then it had reactivated here in New Zealand. The repeat one on this child, this two-year-old, was positive … so had converted so that means she had to have been exposed to somebody who was infectious and this child we'd had with the pleural effusion wasn't infectious … so somebody else … well then it turned out that they went every weekend across to [location] to a Grandma, she had actually previously been known to have had TB and had been treated in New Zealand and had reactivated, but they [case's family] had never mentioned this weekly… this weekend visit to family over in [location] … so they don't tell us because of that stigma. Even though the nurses can be very discreet, they just don't want to talk about TB." (Participant 2)

Another example that highlights TB stigma as an issue for public health community efforts is when contact tracing extends to community church groups. Reluctance to share information and engagement with public health advice is evident. One public health method for TB outbreak mitigation among church members and communities is liaison and rapport building with pastors or church leaders. The participant's impression is that one of the reasons for pastors/church leaders' reluctance and sometimes refusal to engage is due to other impacts of stigma on the church organisation such as financial factors. This is because funding for the church is often provided by the church members therefore, public health measures for TB

would disrupt financial flow which pastors/community leaders often rely on. The participant shared this sentiment:

> *"I still… have absolute classic stories about trying to find these families because of that stigma. Churches are disasters because the funding for the pastor comes from that community and if you start to say there's TB in the community, then they get horrendously upset about it." (Participant 1)*

Stigma surrounding TB also affects the uptake of the BCG vaccine among the Pasifika population. This reluctance is partly due to the vaccine's association with TB, which increases unwillingness to seek vaccination. Interestingly, one participant noted that the BCG vaccine is included in the immunisation schedule for children in other Pacific countries with high TB prevalence. This suggests that there should be a certain level of awareness and reduced stigma towards the BCG vaccine within Pasifika communities in Aotearoa NZ, particularly among recent migrants. This is because the universal vaccination approach in these countries should introduce notions of normalcy towards the BCG vaccine. However, compared to non-Pacific ethnicities in Aotearoa NZ who also come from high-prevalence countries, participants noted that Pasifika in Aotearoa NZ were less likely to actively seek the vaccine. One participant expressed interest to know why stigma affects Pasifika to a greater extent:

> *"… you know I say to these families 'but you all get it [BCG] in Kiribati'… I am fascinated by why there is that difference between the Asian approach or, cause they are also concerned stigma-wise, but they seem all readily able to get it ... but why is there that difference, because both of them are coming from countries where they know they need to get it. You know … Kiribati and the Tuvaluans know they should get it, the Filipinos know they should get it. The Filipinos will go out and get it and the Pasifika won't go and get it." (Participant 2)*

Stigma also affects targeted public health initiatives for TB prevention, as the existing eligibility criteria for the BCG vaccine can already contribute to TB-related stigma among those eligible. Concerns that targeted initiatives might further increase stigma among at-risk groups have led to the absence of public health targeted TB initiatives. This presents a challenge in finding effective and culturally appropriate ways to communicate public health advice through targeted health promotion initiatives. Two participants shared the same notion:

"I mean there's always a risk when you say you are going to a country or a foreign country or you will have contact with people from a (high-risk) country, it's very stigmatising it's like… and you know 'this group over here aren't'..." (Participant 1)

"… health promotion, health information… without stigmatising people, I think that's also one of the huge challenges" (Participant 3)

Overall, the historical context of TB has resulted in racial stigma, including associations with poverty and poor hygiene, which has affected TB and BCG vaccine initiatives. TB stigma impacts public health efforts such as contact tracing, preventing families and communities from engaging or sharing TB history, particularly among Pasifika which often leads to increased public health risks. Stigma has also affected BCG vaccine uptake among Pasifika, despite its inclusion in the immunisation schedules of their countries of origin. Participants noted that implementing targeted initiatives is challenging due to the potential to further stigmatise at-risk groups of the population. Pasifika communities were perceived by participants to be more affected by TB stigma. To explore this issue further, the next subcategory will focus on healthcare workers' experiences with Pasifika communities.

Healthcare workers experience with Pasifika communities

This subcategory outlines the perceived attitudes and behaviours of Pasifika communities towards the BCG vaccine and TB disease, based on the experiences and perspectives of the three participants. One issue highlighted by a participant is the lack of awareness or knowledge about the vaccine and the existing BCG programme among Pasifika families and communities in Aotearoa NZ, including those from high-risk countries. In addition to the perceived low proactive measures taken by Pasifika to seek the vaccine in an effort to distance themselves from TB stigma, a participant noted that lack of awareness also contributed to this low proactivity. The participant further noted that non-Pasifika ethnicities from high-prevalence countries appear to be more aware of the vaccine and are more proactive in seeking it, compared to Pasifika.

"… so a lot of Asian families are very aware and actively seek it, but I think a lot of Pacific families are not aware of it and so they don't seek it." (Participant 2)

Disparities that Pasifika are more likely to encounter also contribute to them missing vaccine appointments. One participant shared experience of Pasifika families facing financial challenges that prevented them from attending BCG appointments. This issue was further

amplified by cultural factors, such as the common large family units that often include more children to care for in addition to a newborn baby, highlighting that vaccination is not the main priority. Another participant interestingly hinted that the previous universal approach, which offered the BCG vaccine in maternity wards, could have accommodated these challenges, eliminating the need for a separate visit for the BCG vaccine, thereby reducing potential access barriers.

> *"I suspect they struggle to get to those appointments … exactly, there's too much going on … and of course, we know that because many of them are missing already their six-week vaccination so if they can't get their six-week vaccination, how can they possibly get a BCG which is another completely separate visit … then I think there is the other problem is that the mothers, even if they are aware of it, are so busy in those first few weeks of life that it's too hard to pick up a phone and make an appointment and then get to the appointment." (Participant 2)*

> *"…for example one car in the family and the husband drive the car out to work and the wife look after the young whānau at home (and does) not even have a chance to connect with anybody … the vaccination may not be the priority not just say for BCG but for everything, so they have their fit their family … and (any) other priority is maybe more important." (Participant 3)*

One participant shared their perception of Pasifika attitudes towards vaccination, highlighting passive avoidance of accountability of some parents with a history of TB. These parents would have been recommended to vaccinate their children but have not followed through with the vaccination. When these children later develop active TB and the parents are asked whether the child had been vaccinated, the participant shared:

> *"I'll say something about a BCG and they'll say … 'yeah we couldn't find … how to get it' or '… was never offered to us', so sometimes it's that passive thing … we actively didn't do anything, but nobody told us to do something. So, there is that voice." (Participant 2)*

Another issue was that Pasifika were frequently missing their BCG vaccine appointments. When one participant was asked a maroro question on the appropriateness of the current targeted approach of the BCG programme and whether the participant would consider expanding the eligibility to the wider public as it was in previous years, the participant pointed out that Pasifika peoples who have been identified as eligible for the BCG vaccine,

on several occasions did not show up to BCG appointments. The participant believes that the free programme is currently not being well-utilised by the targeted groups which raises concerns about expanding the programme further, as resources allocated to the free programme may go to waste.

> *"Pacific who were eligible, particularly Pacific who were eligible for it just weren't coming so they were wasting a vast amount of time either trying to trace them… chase them down on the maternity unit and follow them up (at) home or actually get them into clinics and so it just wasn't happening." (Participant 2)*

Moreover, healthcare professionals experienced frustration when they offered treatment to Pasifika individuals with LTBI and they ended up not accepting it. Although treating LTBI is crucial to prevent it from progressing to active TB, the treatment is optional especially as LTBI is asymptomatic and individuals are still able to function normally in daily activities. Pasifika's reluctance or refusal to undergo treatment suggested to healthcare professionals that Pasifika do not prioritise or incorporate prevention medicine. The lack of symptoms is perceived to be the main factor for Pasifika's attitudes and behaviours towards TB prevention treatment. However, it was noted that healthcare professionals' frustration with Pasifika's lack of engagement with preventative medicine made them feel deflated in their efforts.

> *"Well I get it when I'm offering treatment for latent TB infection, so a positive Mantoux (test)… completely well child, you know… medicine at the top of the cliff you know… before they drop off and get TB and they won't take it, because the child is completely well and healthy and why would I want to give him medical treatment for this well child?. So it frustrates me that one thing I can do in medicine is to actually try and do some preventative medicine out there that isn't vaccines or anything else, and they refuse it and I sort… again … my cynical self has gotten a little bit like 'actually I'm not even going to fight this any longer' but it very much frustrates me, that I could do something to make an impact, and they won't take it because their child looks so well." (Participant 2)*

Another participant also shared the same sentiment with an example of an experience with a Pasifika family's perceived attitude and behaviour towards TB prevention in relation to Pasifika's cultural family dynamics and systems. The participant was very experienced with working with Pasifika families and communities and acknowledged the hierarchy and roles of senior members of the family and communities especially considering their different

priorities. The participant explained the extra considerations when approaching Pasifika families for encouragement to consider preventative medicine for TB, such as LTBI treatment, highlighting the participant's perception of reluctance and lack of incorporation of prevention measures among Pasifika.

> *"Tuvaluan case and it was an outbreak … for me, my feeling is … so when I come in to the family I can see that you know that of course there's a structure of the family. There's Mum, Dad, and I really that's one I try to connect with … their parents first then is the case. The case was 17 years old and I think that they may have a lot of priorities in the family because it's a big family and there's a lot of things for them to worry (about) and consider to plan and if even with LTBI latent TB sleeping … there is no symptoms, no illness, so they feel it's not important because 'I'm feeling fine, I'm very fit'. I don't know if there is any programme or education you know, go to their church or something to let them know that latent TB can become active TB in the future … especially when you're older can have other comorbidities" (Participant 3)*

Another aspect of Pasifika's cultural family dynamics and systems that contributed to healthcare professionals' perception of Pasifika attitudes and behaviours specific to TB prevention is the close-knit nature of their families and communities. Confidential information is often shared freely among themselves, and individual privacy can be unusual. This leads to TB cases not wanting any communication of confidential medical information with healthcare workers, due to the possibility of family and extended family members finding out. This often disrupted effective communications with TB cases and disease contacts and contributed to the perception that Pasifika do not prioritise their health or prevention of disease. The participant is also experienced in Pasifika family dynamics and shared an experience of taking extra steps for TB communications with Pasifika families to ensure privacy:

> *"I have to tell my registrar, here [Aotearoa NZ] when you write letters to the GP most services would send a copy to the families, just routinely so copy to the GP copy to the families, it's just done routinely by the typists. My TB letters are not, I only send copies to the family if they have given permission. Because they complain about it, because people of course, random people in the household open letters." (Participant 2)*

Healthcare professionals' experiences with Pasifika families and communities have contributed to their perception of Pasifika's attitudes and behaviours towards disease

prevention, specifically TB prevention, as mostly non-compliant. This involved factors that affected Pasifika's attitudes and behaviours to not readily incorporate TB prevention measures such as BCG vaccination, contact tracing, LTBI treatment and effective communication with healthcare professionals. These factors that affect Pasifika's attitudes and behaviours towards TB prevention initiatives included lack of awareness of the BCG vaccine and the programme and social and cultural determinants. This has led to healthcare professionals' reduced enthusiasm to potentially expand the BCG eligibility criteria to the wider public, including less enthusiasm to offer prevention medicine to Pasifika if the efforts won't be well received. To explore the issue further, the next category will look at system-based factors that also affect TB prevention efforts.

Category 3: System-based factors that affect BCG uptake and TB reduction

This category consists of six subcategories which explores system-based factors around the BCG policy and programme changes (as previously mentioned) including its advantages and disadvantages with a focus on the Pasifika population.

BCG policy and programme changes

The participants explained that BCG vaccination in Aotearoa NZ initially did not have an eligibility criterion and the vaccine was administered to the wider public. The neonatal BCG was later introduced and implemented initially for high-risk districts and offered in maternity wards and the outpatient clinics also offered BCG vaccination by appointment. It was later refined to the current programme based on eligibility criteria, introduced to target high-risk groups only and adjusted to the TB situation of the country. One of the participants who was previously involved in developing the national TB guidelines that altered BCG guidelines stated the decision around changing the BCG programme to focus on high-risk groups only was based on two reasons. The first was to align with what WHO was recommending for low-risk countries (detailed in the literature review chapter). The second reason relates to the impact on health system resources when offering BCG in maternity wards and hospital outpatient clinics, which required a team of trained vaccinators to be available to administer the vaccine. The decision to change the BCG programme and introduce the eligibility criteria was further reinforced by the fact that eligible individuals (including Pasifika at that time) were not attending appointments at outpatient clinics and were being missed in maternity wards due to short post-delivery stays. The participant highlighted that the previous universal approach that included the BCG vaccine offered in the maternity wards, eliminated barriers such as identifying at-risk children and conducting eligibility screenings. This suggests that BCG uptake among at-risk babies were higher prior to the introduction of the BCG eligibility

programme's targeted approach which requires identification of at-risk groups. The participant stated,

> *"… where in the old days when it was all done before you left the hospital, you know you had a captive audience" (Participant 1)*

Some disadvantages that emerged since the change of BCG programme from the wider public to the current BCG eligibility criteria were also discussed. One participant stated that large cohorts of people who were initially eligible for the free vaccine were told they were no longer eligible after the eligibility criteria was introduced. This resulted from the list of high-risk countries produced which excluded many countries deemed low risk from the criteria. This included some Pacific countries, therefore, reducing eligibility of Pasifika children in New Zealand. Interestingly, the participant reported that people who were no longer eligible still wanted their children vaccinated.

> *"The risk criteria became more complicated so … I guess one of the things I found very interesting was when the criteria changed, with how many people from countries that were no longer considered high-risk, still wanted their children to get the BCG vaccine ... because their three other children had had it, and suddenly this infant wasn't eligible." (Participant 1)*

Despite this, the participant expressed full support of the current BCG programme when answering questions during the maroro session on whether the current BCG eligibility criteria appropriately capture those at-risk. The participant expressed a clinical perspective based on what they were currently experiencing with TB cases at the tertiary healthcare level,

> *"Yes, I totally, totally support that as well … in terms of what I see coming in with TB … I think they are the ones who should get it. So you know the family history one [criteria], well certainly I see children where you know this family history of the Grandfather, and they reactivate here … and so if those children already got BCG, it means I don't necessarily have to put them on that sort of window prophylaxis over that two-month time period so I totally I think the family history one, the high-risk countries absolutely and … living in a household or something … yes absolutely … and I don't think it should be broadened." (Participant 2)*

All three participants also shared their perspective about the current BCG programme, whether it is appropriate in supporting vaccine uptake for targeted at-risk groups compared

to the previous universal approach. All three participants supported the current programme considering the efficacy of BCG decreases in adolescence and therefore, the role of BCG vaccine in Aotearoa NZ is to reduce pulmonary and extra-pulmonary TB among young children. Two of the participants suggested that the programme is appropriate for the current TB rates of Aotearoa NZ and should not be broadened, however, the programme still has room for improvement in terms of effectively capturing at-risk groups.

> *"Should it go back to something like all adolescence, all school aged children like we used to have many many years ago, would be totally inappropriate in this day and age and for the rates that we have … so we need to say how do we put, resources into getting those children." (Participant 1)*

> *"So, I actually totally support what the current programme is and … believe that they are the children that need it but, I think that we can do better in delivery of it." (Participant 2)*

One participant expressed support for the BCG programme despite financial concerns within the health system. While some healthcare professionals advocated for improving the BCG programme, others argued for discontinuing it due to the funding and resources required to maintain the free vaccination programme. The participants' support for continuing the BCG programme stems from their clinical perspective. They shared an example from a few years ago during a BCG stockout, where they observed a child who had not been vaccinated and later developed severe TB meningitis, resulting in serious disabilities. The absence of the BCG vaccine and programme, therefore, significantly impacts the TB burden among children. The participant shared this sentiment:

> *"Some people could argue well should we just drop it altogether? That's the other argument that comes to me every so often. Is there a role (for) the BCG programme to continue in New Zealand? I strongly support it and believe that it stay this way … for me personally I believe strongly that the BCG programme should continue." (Participant 2)*

Additional skills and requirements for healthcare professionals

Another system-based factor in Aotearoa NZ that affects effective BCG vaccine uptake is the additional training required for nurses and vaccinators. This also has an impact on the financial aspects of the health system due to the ongoing training sessions needed for

vaccinators. This is because administering BCG vaccine requires specific techniques to deliver it intradermally, therefore, only approved vaccinators (Gazeta vaccinators) who have completed this extra training, can deliver it. This additional requirement has also resulted in the very small number of available BCG vaccinators. As previously mentioned, this affects outreach programmes as the scarcity of vaccinators means there is less capacity to visit identified at-risk families and communities that do not have the means to get the vaccine themselves. This also presents issues for at-risk children in hospitals who cannot readily receive the BCG vaccine due to the lack of qualified vaccinators. Consequently, this delays or prevents vaccination of at-risk families.

> *"…the intradermal vaccines very specific, specific training umm… it's a tricky technique" (Participant 1)*

Another participant stated another disadvantage specific to healthcare workers is the skills being lost with less opportunities to practice or train to administer the BCG vaccine since it no longer requires large team of vaccinators to accommodate larger cohorts of eligible babies in maternity wards and outpatient clinics. This includes Mantoux skin test techniques and intradermal delivery of the BCG vaccine. Currently, there is a limited number of trained vaccinators for the BCG vaccine, resulting in fewer opportunities for BCG outreach programmes in communities.

> *"there's less and less experience, so when you talk to some of the nurses on the frontline, there's less and less nurses who have been trained and doing these intradermal [vaccinations]." (Participant 2)*

Current TB treatment and BCG vaccine disadvantages

Although the BCG vaccine currently serves as an effective preventative measure against TB, one participant stressed that a more effective and improved vaccine needs to be designed in order to eliminate strains on resources such as time and costs spent on intradermal vaccine delivery and training. Another disadvantage pointed out by a participant was that it is a live vaccine which can result in complicated side effects on the fragile immune system of children and neonates, especially if they have undiagnosed immune disorders. This contributed to system-wise factors that affected BCG uptake in general.

> *"I see in my clinical … the BCG adverse reactions that are significant that the nurses feel (a) need to come and see me." (Participant 2)*

First line drugs currently used for TB treatment are also an issue which can elicit severe side effects. The issue is amplified with MDR-TB which requires second line drugs that are stronger than the first-line drugs. A participant highlighted the need for better drugs as it is currently contributing to the burden of disease especially for TB cases with existing comorbidities who are not able to start treatment and may also mean they cannot be treated. Better drugs are crucial as antibiotic options are running out for MDR-TB. The current treatment also affects social and financial factors for the patients as often they cannot attend school or work due to severe side effects of the drugs. The participant highlighted prevention as crucial to mitigate the issue:

> *"But at the end of the day prevention is going to be the thing that sorts TB." (Participant 1)*

Treatment for TB in Aotearoa NZ follows WHO regulations to prevent MDR-TB by the Direct Observed Therapy (DOTs) programme, where healthcare professionals must directly observe patients taking the medication. This means public health nurses need to visit patients at home or at the location they are in at a specific time to take their medication. This again, contributes to strain in time and costs for healthcare professionals and the health system as one participant stated:

> *"trying to chase people down for … DOTs and you know… they're not at this address so you got to go to this address so maybe this one because actually they don't have a fixed abode but they have these four places where they might sleep, you know … that to actually do that requires more than it just being your job [public health nurses job]…" (Participant 1)*

More appropriate and effective communication with communities needed

Participants were asked questions around their thoughts on the diverse ethnicities within the Pasifika population, and how to better understand and address cultural nuances and factors that can influence perceptions of TB disease as well as any other suggestions to reduce the TB burden among the Pasifika population. Communication was the main point discussed when answering these questions. One participant shared their experience with the health system often exhausting all attempts to engage Pasifika with health initiatives. The participant noted one way to increase engagement is to listen to the communities more,

especially when designing targeted initiatives that require a balance of cultural appropriateness and tough messaging.

> *"I really do think we need to take a lead from people within the community… you know you've got to communicate in a way that is appropriate and conveys the message that is understood and is also … I don't think you can make all messages acceptable because you know sometimes things are tough to hear but I do think we need to…" (Participant 1)*

All three participants shared the same perspective on communication efforts to communities and communication within communities as a way of reducing the TB stigma, highlighting necessary appropriate partnerships to support this. For instance, having community leaders openly talk and communicate more with their communities about TB would be one helpful approach. All three participants shared the same sentiment on communication:

> *"And so we need to take those lessons around not putting stigma on people and communicating just around, you know … this is what is important" (Participant 1)*

> *"New Zealand Pacific leaders… community leaders to understand TB, you need to take it out to the community, you need to get your pastors, your church leaders, your community leaders … out there understanding it [TB] … it has to come from in your community, you need families prepared to talk and share their experiences. And until your community elects to talk about it, you're not going to progress … while you continue to want to keep it hidden and that stigma… It's really, it's got to be grass roots level" (Participant 2)*

> *"Education is important and also… education can help reduce the stigma as well" (Participant 3)*

In terms of communication from health services to the community, when participants were asked maroro questions on whether a targeted approach would promote more engagement with regard to prevention measures, particularly among Pasifika communities, one participant acknowledged the lack of targeted initiatives and pointed out that a targeted programme would usually involve health promotion initiatives. The participant stressed that the potential challenges of a targeted approach and emphasised the need for appropriate

communication, particularly to accommodate a community's level of health literacy and awareness.

> *"I do know that brochures come in different languages but that also assumes a level of literacy within written language … which is not always the case across the board." (Participant 1)*

The participant also stated that the knowledge gap among healthcare workers relating to the BCG vaccine and programme, increase the risk of miscommunicating the importance of the BCG vaccine to families. This knowledge gap can also undermine the effectiveness of targeted prevention initiatives, particularly when designing and delivering these initiatives. Thus, inadequate understanding among healthcare workers can be a significant barrier to clear and effective communication as the participant emphasised,

> *"I think we need to do better with ensuring that maternity carers, whether obstetrician or midwives, do a better job at communicating the value of BCG vaccine for at-risk infants." (Participant 1)*

Pasifika umbrella in the Aotearoa NZ context

One participant highlighted that decision making around Pasifika initiatives and policies are usually based on the Pasifika umbrella that all Pasifika ethnicities in Aotearoa NZ are placed under. This presents an issue for the second criterion of the BCG programme which determines eligibility based on whether you come from one of the countries listed as high-risk. The more dominant Pasifika ethnicities, such as Samoa and Tonga, have low TB prevalence and therefore are not included in the list. This would categorise Pasifika as low risk as Samoan and Tongan ethnicities make up most of the Pasifika population. This suggests that although the less dominant Pasifika ethnicities, such as Kiribati and Tuvalu, are captured on the list as high-risk, decisions for policies and programmes in general for Aotearoa NZ that are based on the Pasifika umbrella, can risk overlooking specific issues and thereby introduce disparities to this population. This is because each Pasifika ethnicity exhibits unique disease profiles based on their country of origin, particularly given the uneven TB burden across Pacific countries and Pasifika within Aotearoa NZ.

> *"we make assumptions based on what we see as the dominant Pacific cultures as well" (Participant 1)*

This is also observed around decision making to change or modify the BCG programme to a more targeted approach and introducing the eligibility criteria. The participants previously mentioned that one of the contributing factors around the decision to introduce the BCG programme was based on the Pasifika population not attending BCG appointments. They also stated that the decision was also based on Pacific countries who have been dropped from the high-risk list which are mainly the dominant Pasifika ethnicities in Aotearoa NZ.

> *"So even if they did get appointments they didn't arrive. So, was it necessary that the Samoans, Tongans received it when their rates were below this 40 per 100,000?" (Participant 2)*

The participant also shared their perspective on the current BCG programme as appropriate in terms of capturing those at-risk and broadening it to include the wider Pasifika population would be inappropriate considering the dominant Pasifika ethnicities are not necessarily at-risk. One participant noted that:

> *"We see very little [TB] in our Pasifika or Māori population now so I actually do think the programme is right. I've been asked this before about … when we do get say a Samoan family or something, but I don't believe that … it's appropriate to be broadening our vaccine programme. I think we do need to focus on the high-risk populations, broadening it out to the one of cases in Samoan, Pasifika or you know Tongan families or something is not resource appropriate. So, I do think the programme is right and I think it should stay what it is." (Participant 2)*

Another participant acknowledged the less dominant Pasifika communities are often overlooked when decisions are made for all Pasifika. This suggests the smaller Pacific ethnic communities or less dominant Pasifika ethnicities often have less access to BCG or TB initiatives and promotion efforts due to limited specific resources.

> *"It's like being left over, it's such a small community that among the Pacific, the bigger Pacific community and … they may not have the connections or there's a barrier there to …" (Participant 3)*

This includes specific data. Evaluating the BCG eligibility criteria is challenging for Pasifika in terms of data specificity and availability. One participant discussed the uncertainty of how to improve the delivery of the BCG eligibility programme because there is no specific data keeping for denominators required for analysis, especially for each of the three criteria. For

example, specific data is not collected for those who live in a house with whānau member or person with either current TB or a history of TB, have one or both parents or household members or carers who within the last five years lived for a period of six months or longer in countries with a TB rate ≥40 per 100,000 and those during their first five years will be living for three months or longer in a country with a TB rate ≥40 per 100,000. This has affected prioritisation of research on BCG vaccine uptake for specific groups. The participant explained,

> *"And until you get that figure then I don't think we can really improve this programme… so that's always been my concern is that we have no denominator of how many should have received it…and because we can't measure anything it drops lower in anybody's priority list" (Participant 2)*

This is a particular issue with the Pasifika umbrella in terms of evaluating the effectiveness of the programme for this group, considering the various ethnicities within the Pasifika umbrella. The health system's data collection usually categorises all Pasifika ethnicities under "Pasifika" or often combines the less dominant Pasifika ethnicities under "Other Pasifika". This makes it difficult to determine which Pasifika ethnicities are most at risk of TB and whether they are adequately vaccinated.

Therefore, improving or monitoring the BCG eligibility programme for Pasifika is difficult. Furthermore, the participant stressed the challenges with the health systems' data collection for ethnicity is also affected by how TB cases report their own ethnicity.

> *"… well you should be able to do it [obtain data] for Kiribati and Tuvalu, if they say that's their ethnicity" Participant 2*

Impact of COVID-19 to the TB space

Participants discussed the impact of COVID-19 on TB rates in Aotearoa NZ in relation to attitudes and behaviours towards vaccination and lessons from pandemic unpreparedness. As mentioned in the first category, the participants shared concerns of increasing TB rates post COVID-19 pandemic. One participant shared predictions of increase in TB cases from TB experts, as attributable to lack of prioritisation of BCG vaccination and TB related services during the pandemic. The participants discussed further that TB cases will increase as a result of COVID-19 impacts on determinants of health such as increased stress, loss of employment and other illnesses re-introduced to the country as borders re-opened.

"… COVID … stopped a lot of TB programmes and certainly took away any priority of TB in this country but of course the thing was we also…stopped immigration, TB rates dropped off as well" (Participant 2)

"So post COVID the economic impact… the stress… a lot of the redundancy or resignation or restructure (of) everything so people feel more stressful than ever before … so these (are) all the factors can trigger the TB disease from LTBI and become active TB disease." (Participant 3)

On that note, COVID-19 social distancing measures may play a role on people's perception on how exposure works. This could benefit health promotion and education efforts particularly for supporting a better understanding of TB exposure. This was pointed out by a participant:

"Maybe COVID has changed that slightly, maybe we do think more about someone coming into my home." (Participant 1)

It was noted that the COVID-19 vaccine mandate may have negatively impacted general attitudes towards vaccines. This was largely due to inadequate preparation for communicating public health information and advice during the pandemic, which enabled misinformation to circulate. The participant emphasised that this experience offers valuable lessons for preparing for TB outbreaks. Specifically, it highlights the importance of addressing communication gaps promptly to prevent the spread of misinformation.

"I think pre-COVID we know there was a drop off [vaccination rates] but not so much across Pacific, it definitely was with Māori immunisation rates but COVID made everything worse, it made access worse … then the vaccine happened so quickly, and you know it was easy to get … misinformation was out there, it was amplified … and we allowed you know … there was space …where we didn't know stuff, there was space for rumours to fill that space …" (Participant 1)

System-based factors affecting BCG uptake and TB reduction, especially among Pasifika include changes in BCG policy and programmes, targeting at-risk groups, and the lack of specific data to evaluate the effectiveness of these initiatives. Additional factors include the strain on resources for vaccinator training, limitations of the current BCG vaccine, and TB prevention strategies such as LTBI treatment. Furthermore, challenges in designing targeted approaches, particularly communication strategies within Pasifika communities in Aotearoa NZ, and the impact of the COVID-19 pandemic also played substantial roles.

Summary of qualitative results

The qualitative findings highlighted three categories that created barriers to BCG vaccination uptake and TB prevention efforts. The first category revealed systemic gaps in identifying at-risk groups such as a fragmented referral and notification process across regions. This included reliance on online booking systems that presented barriers for families without access to technology. The first category also identified the common lack of awareness of the BCG vaccine and programme among healthcare workers. This also included the limited number of trained vaccinators to deliver the vaccine.

The second category highlighted community-level barriers that indicated TB stigma as a barrier for effective contact tracing and BCG vaccine uptake among the Pasifika population. Additionally, migrants' misunderstanding of the risk of TB upon arrival in Aotearoa NZ is also another barrier. Lastly, the second category emphasised that cultural and social determinants play a large role in community-based barriers for TB prevention and BCG vaccine uptake.

The third category indicated programme changes from a universal approach to target at-risk groups of the population has created challenges for vaccine uptake. There are also current concerns on loss of vaccinator skills due to fewer BCG vaccinations in comparison to the universal approach. The Pasifika umbrella also presents challenges in terms of evaluating current prevention efforts especially for the BCG vaccine programme. This includes decision making based on the Pasifika umbrella which often overlooks the less dominant Pasifika ethnicities. The COVID-19 pandemic is highlighted to have exacerbated TB risk due to its disruption to BCG vaccination and TB services. The last category also found that healthcare professionals perceive a lack prioritisation of prevention and non-compliance of Pasifika. Lastly, the healthcare professionals recognised the need for TB health promotion with culturally appropriate and effective communication, which includes partnership with Pasifika communities. These findings will be discussed further in the next chapter.

Chapter Six: Discussion and Conclusion

This chapter discusses the key findings from the quantitative and the qualitative phases of this study. It will present the summary of the main findings from both quantitative and qualitative phases which are integrated and discussed in three main sections. The first is system-based barriers affecting access to the BCG vaccine and TB prevention strategies. The second is perceptions of TB at community level and lastly, implications for targeted prevention. Within these three sections, the study's findings will be critically discussed in relation to existing literature. The chapter will then discuss the implications of these findings for practice and policy. It will also state the strengths and limitations of this study. Lastly, the chapter will discuss implications for future research and end with the study conclusion.

Summary of the main findings

The findings revealed that Aotearoa NZ has had a steady trend of low TB incidence throughout the 2006-2023 period with an average of 6.1 per 100,000 (CI: 5.4 - 6.9). However, the findings highlight a greater risk for the Asian and Pasifika populations with high average rates of 27.5 per 100,000 (CI: 23.4 – 32) and 11.4 per 100,000 (CI: 8.24 – 15.3) respectively. The findings also revealed that TB incidence was more common among the less dominant Pasifika ethnic groups or 'Other' Pasifika which consist of Pasifika ethnicities other than Samoan and Tongan. The qualitative findings correspond to this finding as participants shared their perspectives on the current BCG vaccination programme and stated observations based on the Pasifika umbrella. The participants observed less TB notifications from the more dominant Samoan and Tongan groups which emphasised that Samoan and Tongan groups are not at-risk. Therefore, Pasifika are not necessarily categorised as at-risk. Thus, the Pasifika umbrella is identified in the third category of the qualitative findings as one of the *system-based factors that affect BCG uptake and TB reduction.*

When BCG vaccination rates were examined, the Asian population had the highest rates (average of 1000.7 per 100,000, CI: 975.8 – 1026.2) which remained high throughout the years. Conversely, the BCG vaccination rate for Pasifika showed a rapid significant decline throughout the years. The average BCG vaccination rate for Pasifika is 519.4 per 100,000 (CI: 500.3 – 539.3) which indicate reasonable protection for this group, however the significant reduction from 2011 to 2023 which reached exceedingly low rates (as low as 26.6 per 100,000, CI: 21.7 – 32.2) indicate that Pasifika are significantly under-vaccinated. The contrasting trends between Asian and Pasifika vaccination rates are reflected in the qualitative findings relating to stigma. The participants in the current study noted that vaccine hesitancy also differed in both groups emphasising that the Asian group would actively seek

the vaccine whereas Pasifika would tend to avoid it due to the vaccine's association with TB. TB stigma is identified as one of the *perceptions of TB disease and BCG vaccine among migrants and Pasifika communities* from the second category of the qualitative main findings.

When BCG vaccination was examined for the Pasifika ethnic subgroups, the findings revealed a reasonably proportionate BCG vaccination uptake in terms of the subgroups' population sizes in Aotearoa NZ. The highest vaccination percentage were among the more dominant Pasifika ethnic subgroups. The same observation is applicable to the less dominant Pasifika ethnicities except for Cook Island Māori and Niuean ethnicities. This suggest that the BCG vaccination programme is effective in capturing the majority of at-risk Pasifika populations. However, BCG vaccination rates have been significantly low from 2011 to 2023 and TB rates remain higher in the less dominant Pasifika subgroups. This suggests room for improvement for the BCG vaccination programme and general TB prevention efforts. The qualitative findings highlighted the need to improve the effectiveness of BCG vaccination programme when participants discussed the knowledge gap among healthcare workers. The knowledge gap is identified in the first category as one of the *systemic gaps in identifying at-risk groups*.

The qualitative findings further revealed the participant's perspective for improving the BCG vaccination programme and TB reduction efforts in general. This includes the need for more appropriate and effective communication with communities emphasising the role of community led and collaborative strategies. The participant's perspective on the need for appropriate and effective communication with communities stemmed from the unpreparedness during the COVID-19 pandemic which enabled the circulation of misinformation. Lastly, the participants also stressed the need for disaggregated data which can enable the evaluation of the BCG vaccination programme for improvements.

Section one: System-based barriers affecting access to the BCG vaccine and TB prevention strategies

The quantitative findings revealed that while the current BCG programme in Aotearoa NZ is designed to target at-risk populations, several systemic gaps hinder its effectiveness. A significant decline in BCG vaccination rates among Pasifika populations since 2011 was observed, despite these groups experiencing higher TB incidence rates compared to European, MELAA and Other ethnic populations. This finding is reiterated in international studies highlighting indigenous populations and ethnic minorities (Nava-Aguilera et al., 2009) to have a higher risk of TB in countries with low TB incidence such as Canada and Australia (Coorey et al., 2022; Narasimhan et al., 2013; Srivastava et al., 2015). This reoccurring

pattern for indigenous people in low-risk settings suggest that other factors and determinants play a key role.

Qualitative insights in the present study highlighted system-based barriers and gaps in Aotearoa NZ such as fragmented referral pathways across regions despite the single unified system of the health sector. International literature on fragmented system of care is emphasised to negatively impact patients (Shepherd, 2016). The participants in the present study reported inconsistencies in PHU operations including the varying levels of reliance on digital booking systems across the country that exclude families with limited digital access. International literature such as Djatmiko et al. (2025) highlighted factors that indicate the limitations on the reliance on digital health system especially among marginalised communities. This includes communities in low socioeconomic settings who would often prioritise essential items in households such as food and water. Therefore, investments in technology are not prioritised. Furthermore, communities in traditional settings often prefer face-to-face interactions over digital participation due to skepticism of an automated decision-making tool (Djatmiko et al., 2025). In the present study, participants stated that some PHUs in Aotearoa NZ rely entirely on the digital booking system for BCG eligibility and appointment booking. This may increase disparities of BCG vaccination coverage across the country particularly for Pasifika families that often experience these factors significantly.

Moreover, the qualitative findings highlighted that the shift from a universal approach to the current BCG vaccination programme which targets at-risk groups only, has introduced new barriers. The participants in the present study explained that while the BCG vaccination programme is resource-efficient, a barrier to its effectiveness is the knowledge gaps or lack of awareness of the BCG eligibility criteria among healthcare workers. This is a significant barrier given the role of healthcare workers in eligibility screening and recommendation to parents who are deemed to be at-risk. Healthcare workers' knowledge gap about vaccinations is reiterated in international studies suggesting that improvements to healthcare workers' knowledge on vaccinations can lead to better uptake (Napolitano et al., 2019). Healthcare workers' knowledge is essential considering their role in primary care for early detection, diagnosis and referral for TB patients. This has often resulted in missed opportunities for vaccination among at-risk groups (Zwerling, 2011), which has been reported to result in increase of TB notifications by international reviews in France and Sweden (Lancione et al., 2022; Rossignol, 2011). International studies have also suggested that training among healthcare workers to improve vaccination knowledge has increased vaccination coverage in certain areas (Napolitano et al., 2019; Uskun et al., 2008). Thus, improving healthcare workers knowledge is essential for the effectiveness of a targeted vaccination approach in reducing the TB burden. Abbott et al. (2022) stated that targeted

vaccination may not be as resource-efficient than universal vaccination when reduction in TB risk and notifications are considered.

A review of BCG vaccination policy changes in Sweden and France, who also switched from universal vaccination to targeting at-risk groups, found that incidence of TB increased and BCG vaccination coverage decreased among at-risk populations (Abbott et al., 2022). The study by Faust et al. (2019) stressed the need for system-based strengthening in Canada in order to achieve adequate TB control and BCG vaccination among high-risk indigenous populations, especially when universal BCG vaccination was removed. This resonates with Aotearoa NZ's current targeted BCG vaccination programme where disparities of TB across ethnic populations are observed. Particularly for indigenous Pacific Island people who live in Aotearoa NZ (Pasifika). However, the study by Lancione et al. (2022) stated that targeted vaccination programmes have been found to be as effective as the universal approach by many European countries. Therefore, the targeted BCG vaccination programme in Aotearoa NZ will need improvement through system-based strengthening to reduce the higher burden of TB among vulnerable groups such as Pasifika.

Section two: Perceptions of TB at the community level

This section will discuss perceptions that affect BCG uptake and TB prevention at the community level with a focus on Pasifika communities. This includes stigma, perception of TB among migrants and perceptions of healthcare professionals of Pasifika communities.

The findings have highlighted TB stigma as a barrier for BCG vaccine uptake and TB prevention efforts, particularly among Pasifika communities. This is echoed in existing literature on TB stigma such as Yadav (2024) who stated that stigma associated with TB is one of the key obstacles to TB prevention. The qualitative participants in the present study discussed continued association of TB with poverty, uncleanliness and racial assumptions that stem from historical events when TB disease was poorly understood. These associations to TB are reiterated by Srivastava et al. (2015) who stated that TB has been known as a disease of poverty. Epidemiological literature has validated this sentiment by providing statistical evidence of the strong association between poverty (Oxlade & Murray, 2012), low income (Shimeles et al., 2019; Tekkel et al., 2002), poor living conditions (Srivastava et al., 2015) and TB infection or disease. These well-known risk factors have contributed to the perceptions of TB and exacerbated the stigma of those with the disease. This often undermines public health prevention efforts such as contact tracing, LTBI treatment and BCG vaccine uptake which is reflected in the quantitative findings which revealed less BCG vaccination rates among Pasifika compared to their Asian counterparts despite the high TB rates among both groups.

In addition, an interesting finding from the qualitative data is the contrast in willingness to seek the BCG vaccine between the Asian and Pasifika groups. The quantitative data identified both groups to have high burden of disease and therefore well-known risk factors should exacerbate TB stigma among both groups. However, qualitative participants in the present study expressed interested to know why the Asian group showcased greater willingness to seek and receive the vaccine compared to Pasifika. The different routes of TB related communications with Pasifika TB cases described by the participants, emphasises that individual privacy is unusual among Pasifika. The lack of individual privacy indicates a contributing factor to TB stigma among Pasifika families and communities. This is also reported in South Pacific Commission (2020) which stated that in Pacific Island societies, open communication is valued over privacy. This stems from oral traditions from the past where knowledge, skills and history were often not documented but passed down through story telling (Lilomaiava-Doktor, 2020). Therefore, sharing of information is common in Pacific culture. Pasifika may avoid the vaccine out of fear of being stigmatised due to the vaccine's association with TB disease. Especially when that information is shared among family and community members. The contrast between two groups indicate that TB stigma affects Pasifika to a greater extent due to cultural factors or norms which are important to understand. Reducing stigma is key to improving engagement to prevention efforts and improving BCG vaccination uptake (Arora et al., 2025), especially for Pasifika.

The findings also indicate perceptions of TB risk among migrants, especially Pasifika migrants, as a barrier to BCG uptake and TB prevention. Qualitative data found that migrants often neglect the BCG vaccine and TB prevention due to the perception that TB risk diminishes upon arrival in Aotearoa NZ and the lack of understanding of *M.tb* mechanisms which can cause LTBI that can later become active TB. The study by Wieland et al. (2012) reported the same finding among immigrant and refugee participants by highlighting the variety of misperceptions of TB transmission including the lack of knowledge about LTBI. These perceptions of TB contribute to higher incidence of TB among migrants which is echoed in epidemiological literature such as Couceiro et al. (2011) who reported that immigrant populations had higher risk of pulmonary TB. Migration is also highlighted as a social determinant of health that affects ethnic minorities (Srivastava et al., 2015). Srivastava et al. (2015) further discussed that 84% of the TB cases among foreign-born persons resulted from reactivation of infections acquired abroad. This highlights that perception of TB risk contributed to the high incidence of TB among Pasifika migrant communities.

This leads to another finding from the qualitative data relating to healthcare professionals. Participants who are healthcare professionals, expressed how often they experienced

frustration due to the perceived non-compliance of Pasifika regarding missed appointments or refusal of preventative services such as LTBI treatment. However, they also acknowledged the socioeconomic constraints, cultural factors and system-based barriers that affect Pasifika's perceived non-compliance and behaviours. Talemaitonga. (2010) and Firestone et al. (2018) shared the same understanding when discussing improvements to health barriers for Pasifika. The studies stressed that although Pacific Island peoples in Aotearoa NZ are collectively known as Pasifika, they come from various parts of the Pacific with approximately 20 different island groups (Talemaitonga, 2010). Therefore, Pasifika ethnicities have their own set of unique identities consisting of different languages, traditions, cultural and spiritual beliefs (Talemaitonga, 2010). Thus, socioeconomic and sociocultural experiences and knowledge of health and well-being impact each Pasifika ethnicities' individual interactions with health services (Firestone, 2018). In addition, a literature review on adherence research consistently show that interventions improved adherence when it addresses the beliefs, behaviours, and relationships that affect adherence, especially for Pasifika (Ioasa-Martin, &. Moore, 2012). The health system in Aotearoa NZ predominantly aligns with Western structures which does not always accommodate Pasifika's holistic view for health and well-being. Therefore, Pasifika's perceived behaviours and attitudes towards BCG vaccination and TB prevention must be understood within the broader context of social determinants of health rather than individual blame.

Section three: Implications for targeted prevention

This section will discuss findings that have implications for targeted TB prevention strategies such as community partnership and collaboration as well as the importance of disaggregated data.

The qualitative data underlined the need for more culturally responsive and nuanced public health strategies. This is further emphasised when participants in the present study discussed lessons from the COVID-19 pandemic which abruptly disrupted TB related services globally and nationally. The pandemic particularly fueled vaccine hesitancy due to misinformation and poor communication from health authorities. This is similar to the findings from that of Fridman et al. (2021) which stated that the COVID-19 pandemic steered the decline in general vaccine attitudes and intentions of getting vaccinated since the pandemic. The participants in the present study emphasised the importance of enabling Pasifika communities to lead prevention strategies to address misinformation and poor communication, especially through key Pasifika leaders from church and community organisations. This is especially important for the less dominant Pasifika communities as the

quantitative findings have highlighted their higher burden of TB. The need for community-led strategies is echoed throughout international and national literature (Matheson et al., 2009; Baciu et al., 2017; Nickel & von dem Knesebeck, 2020; Rong et al., 2023). The findings from the present study further revealed lessons from the COVID-19 pandemic in terms of community-led communications and underlined the importance of clear, timely and culturally appropriate messaging. This will provide a source of information for Pasifika that encompass familiarity and trust (Lansing et al., 2023) thereby increase willingness to incorporate TB prevention and BCG vaccination.

Another implication for targeted prevention identified in the present study is the need for disaggregated data. This is essential for targeted interventions (Pan American Health Organization, 2020). Participants in the present study highlighted the lack of disaggregated data as one key barrier for evaluating the effectiveness of the BCG vaccination programme which specifically targets at-risk populations. The quantitative findings showed that TB incidence is disproportionately higher among the less dominant Pasifika ethnicities. However, policy and data collection subsume all Pasifika ethnicities into one category in Aotearoa NZ. This was a particular problem for the current study which was observed in the quantitative phase for Pasifika. The lack of specific data for each Pasifika ethnicity obscured the TB burden among the less dominant Pasifika ethnicities. This makes it difficult to truly identify which Pasifika ethnicities are at higher risk of TB, therefore, the effectiveness of the BCG vaccination programme to capture at-risk populations cannot be evaluated fully for Pasifika. Moreover, the present study further highlights the need for disaggregated data as qualitative insights revealed that decision making for the BCG vaccination programme and policies are often based on the Pasifika umbrella which can obscure each Pasifika ethnicity's specific needs particularly for effective TB prevention strategies.

Summary

In summary, the present study stresses the complexity of system-based barriers that are intertwined with community level perceptions of TB and determinants of health that affect the effectiveness of TB prevention in Aotearoa NZ. While the quantitative data indicate the BCG vaccination programme is effective in capturing identified populations at-risk, the disproportionate TB incidence across the population and the rapid decline in BCG uptake among Pasifika, suggests for a refinement of the programme. This can be achieved through a multilevel approach through strengthening of health system practices and empowering communities.

Recommendations for practice and policy

The findings of the present study suggest that while the BCG vaccination programme aligns with the WHO recommendation for low incidence countries, the programme requires refinement to enhance its effectiveness to ensure equitable outcomes for TB disparities in Aotearoa NZ. The key recommendations are:

Refinement of referral pathways

Based on the qualitative findings, the current operating system of PHUs for BCG and TB referrals is fragmented across the country with some PHUs implementing a hybrid of in-person screening and an online booking system. However, some PHUs rely entirely on the online-booking system for the BCG vaccine eligibility screening. Additionally, the participants stressed the need for close monitoring of the list of countries with a TB rate of ≥40 per 100,000. This list is essential for BCG eligibility screening particularly to capture those who travel or migrated from those countries and are deemed to be at high risk for TB. However, the participants stated that this list is utilised and monitored at different levels across Aotearoa NZ. According to WHO (2001), variations in regional and national health systems' processes and political commitment can limit the success of a targeted vaccination policy. Thus, a uniform referral pathway for BCG eligibility screening and monitoring of the list of high burden countries throughout the country, is recommended for effective referrals for both BCG vaccination and TB patients. Health policymakers should refine and implement a uniform referral pathway in which all PHUs and primary healthcare in Aotearoa NZ can adhere to.

Enhancing healthcare workers' training

The BCG eligibility programme is a targeted programme that captures at-risk groups only. This means that healthcare workers need robust knowledge of the programme and be familiar with children's eligibility criteria within the programme. The participants stated that there was a lack of knowledge among healthcare workers regarding individuals who are deemed to be at risk. This includes GPs who often do not suspect TB during initial risk assessments due to the low burden of TB in Aotearoa NZ. Therefore, an enhancement of healthcare workers' knowledge is recommended to effectively capture at-risk groups. At present, BCG education sessions are delivered to midwives only. Provision of specific education sessions for midwives, GPs, obstetricians and vaccinators on BCG eligibility and TB risk assessment should be conducted with frequent refresher sessions.

Increase community health education on TB risk

The study found that migrants from high-risk countries often forget or neglect TB risk upon

arriving in Aotearoa NZ due to the association of Aotearoa NZ with a new, clean, or disease-free environment. This often leads to less concern and less proactive TB prevention measures and willingness to seek the BCG vaccine, especially if they do not feel ill. Therefore, the increase of community health education about TB risk is recommended. Health promotion strategies that are tailored for migrants' perceptions of TB should be implemented. This can include modules on the mechanisms of *M.tb* infection which can lead to LTBI that can progress to TB disease at any given time. Tupai-Firestone et al. (2017) described implementation of a health promotion strategy that consists of interactive learning modules specific to Pasifika youth. The study stated that the participants were able to develop preventative action plans that addressed the targeted issue. Therefore, the health promotion strategies should also include input from Pasifika communities, especially the less dominant Pasifika communities to ensure partnership and collaboration thus, ensures a culturally appropriate strategy that can enhance engagement.

Enhancing data disaggregation

The quantitative findings revealed that TB incidence rates are higher among 'Other' Pasifika ethnicities. However, due to the lack of disaggregated data, the current study was not able to determine which ethnic subgroups categorised under 'Other' Pasifika had a higher risk of TB. Thus, a refinement of data collection practice to include ethnic minorities is recommended. This would be beneficial for future research to identify high-risk populations and inform improvements to targeted TB prevention efforts. Data disaggregation can improve representation for marginalised populations and ethnic minorities, thereby enabling a more robust understanding of subgroup health disparities (Ponce et al., 2025). However, it is important to note that enhancing data disaggregation practices can have implications in further stigmatising marginalised populations and ethnic minorities. Therefore, the inclusion of ethical guidelines that uphold values such as data sovereignty of Pasifika ethnic minorities is essential when enhancing data disaggregation.

Community empowerment

Stigma was identified in the qualitative findings as a significant barrier for BCG vaccination uptake and TB prevention efforts among Pasifika. The participants stressed the need to address TB stigma at grass root levels. Therefore, collaboration with Pasifika to enable community-led strategies that address TB stigma is recommended. This can be achieved through collaborations with Pasifika leaders to strengthen TB communications with communities. Pasifika leaders play a key role in increasing community engagement; therefore, collaborations to prepare TB communication materials and resources that are consistent, culturally appropriate and balance health literacy levels are essential. This can

enable Pasifika leaders to deliver effective TB communication resources that aim to reduce stigma to their communities. These resources can also be utilised during unforeseen pandemics to mitigate circulation of misinformation.

Strengths and Limitations

A strength of this study was using a mixed methods design that enabled the presentation of quantitative findings that are complemented by the qualitative findings. This enabled a more comprehensive understanding of the burden of TB and the BCG vaccine uptake in certain groups of the population such as Pasifika. The mixed methods design also enabled deeper understanding of the barriers that influence BCG vaccination uptake and TB prevention efforts among identified high-risk groups. The study was further strengthened by the Te Kora framework as it enabled a culturally appropriate guide to this study, especially for the Pasifika focus of inquiry.

The quantitative phase was limited by unavailable specific data for Pasifika subgroups and data suppression. This affected estimates of TB and BCG vaccination rates for each ethnicity throughout the 2006 to 2023 period. In addition, the qualitative phase was limited by the small sample size of healthcare professionals and restricted to the Auckland region. Therefore, the qualitative findings exclude the perspectives of healthcare professionals on TB prevention from all other regions of the country.

Implications for future research

This study did not include perceptions of Pasifika communities on TB and the BCG vaccine. This is essential for informing policy and practice to enable targeted TB prevention efforts that are tailored to the specific needs of Pasifika communities. Further qualitative research on Pasifika communities, particularly the less dominant Pasifika communities to explore experiences and perspectives on TB and the BCG vaccine may produce a more nuanced understanding of the certain barriers that influence the high burden of TB.

The quantitative findings revealed a significantly rapid decline in Pasifika BCG vaccination rates from 2011 onwards. A study will need to be conducted to identify factors affecting this decline, including the implications for the level of protection against TB for Pasifika. A quantitative study involving cohorts with children who were vaccinated before 2011 and children who have not been vaccinated, may be able to reveal the factors and implications of this decline. A qualitative study involving interviews with parents can also identify reasons for this decline in BCG vaccination rates.

This study did not include further analysis of the diverse Asian population group who have been identified to have the highest rates of TB. Further descriptive quantitative studies would

be beneficial to identify which Asian ethnicities are at greater risk of TB. This can enable more targeted prevention efforts for this population group.

The qualitative findings highlighted the need for effective communication strategies that can reduce barriers for TB prevention efforts. This is particularly important for Pasifika's perceived non-compliance with prevention efforts. A quantitative cohort study can enable the identification of the most effective strategies for Pasifika. In addition, a qualitative study exploring Pasifika's cultural and traditional methods of communication will enable the identification of effective communication strategies for Pasifika.

Conclusion

This study focused on identifying at-risk groups of the population and the effectiveness of the BCG vaccination programme at capturing at-risk populations in Aotearoa NZ with a focus on the Pasifika population. It also explored strategies that can improve BCG vaccination uptake and TB prevention efforts. The unique vulnerabilities of Pasifika to TB infection and disease are supported by existing literature, particularly certain factors and determinants of health where they are overrepresented. The study has identified the Asian and Pasifika populations to be at greatest risk of TB. Furthermore, it also identified higher rates of TB among the less dominant Pasifika subgroups. The current BCG vaccination programme has reasonably captured the population groups identified to be at greater risk based on the BCG vaccination rates. An appropriate level of protection against TB is indicated for the Asian population, however Pasifika requires an increase of vaccination coverage. The BCG vaccination rates indicate the less dominant Pasifika subgroups are also proportionately vaccinated except for the Cook Island Māori and Niuean ethnicities. As TB rates are still higher among Pasifika, especially among the less dominant Pasifika ethnicities and BCG vaccination rates which have been exceedingly low from 2011 for the whole Pasifika population, improvements to the BCG vaccination programme and TB prevention efforts are required.

This study also explored strategies to improve TB prevention through the perspectives of healthcare professionals. The study identified barriers to BCG vaccination uptake and TB prevention efforts. This includes systemic gaps in identifying at-risk groups, community-level barriers and the transition from a universal vaccination approach to the current targeted BCG vaccination programme. The rationale behind the transition has been identified in the qualitative findings which aligns with the WHO recommendations for low TB incidence countries. The rationale also aligns with international literature on countries who have transitioned to a targeted approach. However, the study highlights system level changes and

community led strategies to improve the success of the current BCG vaccination programme and TB prevention efforts in Aotearoa NZ. This will improve TB disparities among Pasifika, thereby improving health equity for this ancient TB disease.

References

Abbott, S., Christensen, H., & Brooks-Pollock, E. (2022). Reassessing the evidence for universal school-age BCG vaccination in England and Wales: re-evaluating and updating a modelling study. *BMJ Open*, *12*(1), e031573. https://doi.org/10.1136/bmjopen-2019-031573

Arora, V. K., Chopra, K. K., & Rajpal, S. (2025). Tuberculosis and stigma: Break the silence. *Indian Journal of Tuberculosis*, *72*, S1-S2. https://doi.org/https://doi.org/10.1016/j.ijtb.2025.02.015

Baciu, A., Negussie, Y., & Geller, A. (2017). *Communities in Action: Pathways to Health Equity.* (Vol. 4). National Academies Press. https://www.ncbi.nlm.nih.gov/books/NBK425849/

Bagcchi, S. (2023). WHO's Global Tuberculosis Report 2022. *Lancet Microbe*, *4*(1), e20. https://doi.org/10.1016/S2666-5247(22)00359-7

Baker, M., Das, D., Venugopal, K., & Howden-Chapman, P. (2008). Tuberculosis associated with household crowding in a developed country. *Journal of Epidemiology and Community Health*, *62*(8), 715-721. https://doi.org/10.1136/jech.2007.063610

Barberis, I., Bragazzi, N. L., Galluzzo, L., & Martini, M. (2017). The history of tuberculosis: from the first historical records to the isolation of Koch's bacillus. *J Prev Med Hyg*, *58*(1), E9-e12.

Byrne, J., & Humble, Á. M. (2007). An introduction to mixed method research. *Atlantic research centre for family-work issues*, *1*, 1-4.

Campbell, K., Orr, E., Durepos, P., Nguyen, L., Li, L., Whitmore, C., Gehrke, P., Graham, L., & Jack, S. (2021). Reflexive Thematic Analysis for Applied Qualitative Health Research. *Qualitative Report*, *26*, 2011-2028. https://doi.org/10.46743/2160-3715/2021.5010

Braun, V., & Clarke, V. (2013). Successful qualitative research: A practical guide for beginners.

Colby, S., & Shah, R. (2022). TB Reactivation Following COVID-19 Infection. *CHEST*, *162*(4), A329. https://doi.org/10.1016/j.chest.2022.08.255

Colditz, G. A., Berkey, C. S., Mosteller, F., Brewer, T. F., Wilson, M. E., Burdick, E., & Fineberg, H. V. (1995). The efficacy of bacillus Calmette-Guérin vaccination of newborns and infants in the prevention of tuberculosis: meta-analyses of the published literature. *Pediatrics*, *96*(1 Pt 1), 29-35.

Coorey, N. J., Kensitt, L., Davies, J., Keller, E., Sheel, M., Chani, K., Barry, S., Boyd, R., Denholm, J., Watts, K., Fox, G., Lowbridge, C., Perera, R., Waring, J., Marais, B., &

Viney, K. (2022). Risk factors for TB in Australia and their association with delayed treatment completion. *The International Journal of Tuberculosis and Lung Disease*, *26*(5), 399-405. https://doi.org/10.5588/ijtld.21.0111

Couceiro, L., Santana, P., & Nunes, C. (2011). Pulmonary tuberculosis and risk factors in Portugal: a spatial analysis. *The International Journal of Tuberculosis and Lung Disease*, *15*(11), 1445-1455. https://doi.org/10.5588/ijtld.10.0302

Craft, J., Gordon, C., Huether, S. E., McCance, K. L., & Brashers, V. L. (2022). *Understanding Pathophysiology Australia and New Zealand Edition* (Elsevier, Ed. 4 ed.).

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and Conducting Mixed Methods Research*. SAGE Publications. https://books.google.co.nz/books?id=A39ZDwAAQBAJ

Cui, Y. (2023). *Sense of Community in Aotearoa / New Zealand: How Different Ethnic Groups See Community Through Participatory Planning Processes* Te Herenga Waka-Victoria University of Wellington]. Open Access Te Herenga Waka-Victoria University of Wellington.

Das, D. K., Baker, M., & Calder, L. (2006). Tuberculosis epidemiology in New Zealand: 1995-2004 [Article]. *New Zealand Medical Journal*, *119*(1243). https://www.scopus.com/inward/record.uri?eid=2-s2.0-33750267413&partnerID=40&md5=81a6c4372ec3456aed6cd9a7fd866591

Delogu, G., Sali, M., & Fadda, G. (2013). The biology of mycobacterium tuberculosis infection. *Mediterr J Hematol Infect Dis*, *5*(1), e2013070. https://doi.org/10.4084/mjhid.2013.070

Dirlikov, E., Raviglione, M., & Scano, F. (2015). Global Tuberculosis Control: Toward the 2015 Targets and Beyond. *Annals of Internal Medicine*, *163*(1), 52-58. https://doi.org/10.7326/m14-2210 %m 25915859

Djatmiko, G. H., Sinaga, O., & Pawirosumarto, S. (2025). Digital Transformation and Social Inclusion in Public Services: A Qualitative Analysis of E-Government Adoption for Marginalized Communities in Sustainable Governance. *Sustainability*, *17*(7), 2908. https://www.mdpi.com/2071-1050/17/7/2908

Dowdy, D. (2021). *The basic epidemiology of tuberculosis (TB)*, Henry Stewart Talks. https://doi.org/10.69645/VNZB5496

Elwood, K. (2010). [Tuberculosis: A Comprehensive Clinical Reference, H. Simon Schaaf, Alimuddih Zumla]. *Clinical Infectious Diseases*, *50*(2), 288-288. http://www.jstor.org.ezproxy.aut.ac.nz/stable/27799563

Enari, D., & Haua, I. (2021). A Māori and Pasifika Label—An Old History, New Context. *Genealogy*, *5*(3), 70. https://www.mdpi.com/2313-5778/5/3/70

Falzon, D., Zignol, M., Bastard, M., Floyd, K., & Kasaeva, T. (2023). The impact of the COVID-19 pandemic on the global tuberculosis epidemic. *Front Immunol*, *14*, 1234785. https://doi.org/10.3389/fimmu.2023.1234785

Faust, L. S., Yoko Bocking, Natalie. (2019). A systematic review of BCG vaccination policies among high-risk groups in low TB-burden countries: implications for vaccination strategy in Canadian indigenous communities. *BMC Public Health*, *19*(1), 1504. https://doi.org/10.1186/s12889-019-7868-9

Firestone, R., Funaki, T., Dalhousie, S., Henry, A., Vano, M., Grey, A., Jull, A., Whittaker, R., Te, & Morenga, L., & Ni Mhurchu, C. (2018). Identifying and overcoming barriers to healthier lives. *Pacific Health Dialog 21*(2), 54-66. https://doi.org/10.26635/phd.2018.913

Foliaki, S., & Pearce, N. (2003). Prevalence and causes of diabetes in Pacific people. *PACIFIC HEALTH DIALOG*, *10*(2), 90-98.

Forget, E. J., & Menzies, D. (2006). Adverse reactions to first-line antituberculosis drugs. *Expert Opin Drug Saf*, *5*(2), 231-249. https://doi.org/10.1517/14740338.5.2.231

Forrellad, M. A., Klepp, L. I., Gioffré, A., Sabio y García, J., Morbidoni, H. R., de la Paz Santangelo, M., Cataldi, A. A., & Bigi, F. (2013). Virulence factors of the Mycobacterium tuberculosis complex. *Virulence*, *4*(1), 3-66. https://doi.org/10.4161/viru.22329

Fox, G. J., Schaaf, H. S., Mandalakas, A., Chiappini, E., Zumla, A., Marais, B. J. (2017). Preventing the spread of multidrug-resistant tuberculosis and protecting contacts of infectious cases. *Clinical Microbiology and Infection*, *23*(3), 147-153. https://doi.org/https://doi.org/10.1016/j.cmi.2016.08.024

Fridman, A., Gershon, R., & Gneezy, A. (2021). COVID-19 and vaccine hesitancy: A longitudinal study. *PLOS ONE*, *16*(4), e0250123. https://doi.org/10.1371/journal.pone.0250123

Gordon, M., Roberts, H., & Odeka, E. (2007). Knowledge and attitudes of parents and professionals to neonatal BCG vaccination in light of recent UK policy changes: A questionnaire study. *BMC infectious diseases*, *7*, 82. https://doi.org/10.1186/1471-2334-7-82

Gygli, S. M., Borrell, S., Trauner, A., & Gagneux, S. (2017). Antimicrobial resistance in Mycobacterium tuberculosis: mechanistic and evolutionary perspectives. *FEMS Microbiol Rev*, *41*(3), 354-373. https://doi.org/10.1093/femsre/fux011

Hatherill, M., & Cobelens, F. (2022). Infant BCG vaccination is beneficial, but not sufficient. *The Lancet Global Health*, *10*(9), e1220-e1221. https://doi.org/10.1016/S2214-109X(22)00325-4

Hersh, A. L., Tala-Heikkilä, M., Tala, E., Tosteson, A. N., & Fordham von Reyn, C. (2003). A cost-effectiveness analysis of universal versus selective immunization with Mycobacterium bovis bacille Calmette-Guérin in Finland. *Int J Tuberc Lung Dis*, *7*(1), 22-29.

Hickling, S. (1963). Tuberculosis in New Zealand, Past, Present and Future [Journal article]. *New Zealand Medical Journal*, *62*(369), 221–229.

Holder-Pearson, L., & Chase, J. G. (2022). Socio-Economic Inequity: Diabetes in New Zealand [Opinion]. *Frontiers in Medicine*, *Volume 9 - 2022*. https://doi.org/10.3389/fmed.2022.756223

Howie, S., Voss, L., Baker, M., Calder, L., Grimwood, K., & Byrnes, C. (2005). Tuberculosis in New Zealand, 1992–2001: a resurgence. *Archives of Disease in Childhood*, *90*(11), 1157-1161. https://doi.org/10.1136/adc.2004.066415

Hsieh, H.-F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, *15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687

Infuso, A., & Falzon, D. On Behalf of the Euro-Tb, Network. (2006). European survey of BCG vaccination policies and surveillance in children, 2005. *Euro Surveill*, *11*(3), 5-6. https://doi.org/10.2807/esm.11.03.00604-en

Ioasa-Martin, I., & Moore, L. J. (2012). Problems with non-adherence to antipsychotic medication in Samoan new Zealanders: A literature review. *International Journal of Mental Health Nursing*, *21*(4), 386-392. https://doi.org/https://doi.org/10.1111/j.1447-0349.2011.00801.x

Jamshed, S. (2014). Qualitative research method-interviewing and observation. *J Basic Clin Pharm*, *5*(4), 87-88. https://doi.org/10.4103/0976-0105.141942

Jang, J. G., & Chung, J. H. (2020). Diagnosis and treatment of multidrug-resistant tuberculosis. *Yeungnam Univ J Med*, *37*(4), 277-285. https://doi.org/10.12701/yujm.2020.00626

Jurado, L. F., & Palacios, D. M. (2018). Tuberculosis: A Risk Factor Approach. In J.-M. N. Kayembe (Ed.), *Tuberculosis*. IntechOpen. https://doi.org/10.5772/intechopen.73538

Laghari, M., Sulaiman, S. A. S., Khan, A. H., Talpur, B. A., Bhatti, Z., & Memon, N. (2019). Contact screening and risk factors for TB among the household contact of children with active TB: a way to find source case and new TB cases. *BMC Public Health*, *19*(1), 1274. https://doi.org/10.1186/s12889-019-7597-0

Lancione, S., Alvarez, J. V., Alsdurf, H., Pai, M., & Zwerling, A. A. (2022). Tracking changes in national BCG vaccination policies and practices using the BCG World Atlas. *BMJ Glob Health*, *7*(1). https://doi.org/10.1136/bmjgh-2021-007462

Lansing, A. E., Romero, N, J., Siantz, E., Silva, V., Center, K., Casteel, D., & Gilmer, T. (2023). Building trust: Leadership reflections on community empowerment and engagement in a large urban initiative. *BMC Public Health*, *23*(1), 1252. https://doi.org/10.1186/s12889-023-15860-z

Li, J., Zhao, Y., Jiang, Y., Zhang, Y., Zhang, P., Shen, L., & Chen, Z. (2024). Prevalence and Risk Factors of Diabetes in Patients with Active Pulmonary Tuberculosis: A Cross-Sectional Study in Two Financially Affluent China Cities [Article]. *Diabetes, Metabolic Syndrome and Obesity*, *17*, 1105-1114. https://doi.org/10.2147/DMSO.S450507

Lilomaiava-Doktor, S. (2020). Oral Traditions, Cultural Significance of Storytelling, and Samoan Understandings of Place or Fanua. *Native American and Indigenous Studies*, *7*, 121. https://doi.org/10.5749/natiindistudj.7.1.0121

Lönnroth, K., Migliori, G. B., Abubakar, I., D'Ambrosio, L., de Vries, G., Diel, R., Douglas, P., Falzon, D., Gaudreau, M. A., Goletti, D., González Ochoa, E. R., LoBue, P., Matteelli, A., Njoo, H., Solovic, I., Story, A., Tayeb, T., van der Werf, M. J., Weil, D., Zellweger, J. P., Abdel Aziz, M., Al Lawati, M. R., Aliberti, S., Arrazola de Oñate, W., Barreira, D., Bhatia, V., Blasi, F., & Raviglione, M. C. (2015). Towards tuberculosis elimination: an action framework for low-incidence countries. *Eur Respir J*, *45*(4), 928-952. https://doi.org/10.1183/09031936.00214014

Lönnroth, K., Williams, B. G., Stadlin, S., Jaramillo, E., & Dye, C. (2008). Alcohol use as a risk factor for tuberculosis – a systematic review. *BMC Public Health*, *8*(1), 289. https://doi.org/10.1186/1471-2458-8-289

Lorenzini, E., Osorio-Galeano, S. P., Schmidt, C. R., & Cañon-Montañez, W. (2024). Practical Guide to Achieve Rigor and Data Integration in Mixed Methods Research. *Investigacion y Educacion en Enfermeria*, *43*(3), e02. https://doi.org/10.17533/udea.iee.v42n3e02

Lousich, K. L., Tautolo, E. S., & Schluter, P. J. (2023). Relationship between perceived and measured body size among Pacific 14-year-olds in Aotearoa|New Zealand: Findings from the Pacific Islands Families Study. *J Paediatr Child Health*, *59*(8), 968-973. https://doi.org/10.1111/jpc.16442

Matapo, J. (2016). Becoming posthuman: Navigating pacific epistemology in Pasifika research. PESA Conference 2016 Knowledge Ecologies,

Matheson, A., Dew, K., & Cumming, J. (2009). Complexity, evaluation and the effectiveness of community-based interventions to reduce health inequalities. *Health Promotion Journal of Australia*, *20*(3), 221-226. https://doi.org/https://doi.org/10.1071/HE09221

Ministry for Pacific Peoples. (2021). *Pacific Aotearoa Status Report A snapshot*. https://www.mpp.govt.nz/assets/Reports/Pacific-Peoples-in-Aotearoa-Report.pdf

Ministry of Health. (2018). *Technical Guidelines for Tuberculin Skin Test*. Wellington: Ministry of health Retrieved from https://www.health.govt.nz/publications/technical-guidelines-for-tuberculin-skin-test#:~:text=From%202015%20to%202018%20there%20was%20a,complete%20the%20Tuberculosis%20BCG%20vaccination%20online%20course.

Ministry of Health. (2019). *Household Food Insecurity Among Children in New Zealand.* Ministry of Health. https://www.health.govt.nz/system/files/2019-04/household-food-insecurity-among-children-new-zealand-health-survey-jun19.pdf

Morán-Mendoza, O., Marion, S. A., Elwood, K., Patrick, D., & FitzGerald, J. M. (2010). Risk factors for developing tuberculosis: a 12-year follow-up of contacts of tuberculosis cases. *The International Journal of Tuberculosis and Lung Disease*, *14*(9), 1112-1119.

Morse, J. M., & Field, P.-A. (1995). *Qualitative research methods for health professionals* (2 ed.).

Naepi, S. (2019). Pacific research methodologies. In *Oxford research encyclopedia of education*. https://doi.org/https://doi.org/10.1093/acrefore/9780190264093.013.566

Namoori-Sinclair, R. (2020). *The Impact Of Pac Policy On Pacific Women's Health And Wellbeing: The Experiences Of Kiribati Migrants* [Te Heranga Waka-Victoria University of Wellington]. Open Access Te Heranga Waka-Victoria University of Wellington.

Napolitano, F., Bianco, A., D'Alessandro, A., Papadopoli, R., & Angelillo, I. F. (2019). Healthcare workers' knowledge, beliefs, and coverage regarding vaccinations in critical care units in Italy. *Vaccine*, *37*(46), 6900-6906. https://doi.org/https://doi.org/10.1016/j.vaccine.2019.09.053

Narasimhan, P., Wood, J., Macintyre, C. R., & Mathai, D. (2013). Risk factors for tuberculosis. *Pulm Med*, *2013*, 828939. https://doi.org/10.1155/2013/828939

Nava-Aguilera, E., Andersson, N., Harris, E., Mitchell, S., Hamel, C., Shea, B., López-Vidal, Y., Villegas-Arrizón, A., & Morales-Pérez, A. (2009). Risk factors associated with recent transmission of tuberculosis: systematic review and meta-analysis [Review article]. *The International Journal of Tuberculosis and Lung Disease*, *13*(1), 17-26.

Nguenha, D., Ndebele, F., Saavedra, B., Mambuque, E., Acácio, S., Cárdenas, V., Chihota, V., Grant, A., Yimer, G., Fielding, K., Cobelens, F., Churchyard, G., & Garcia-Basteiro, A. L. (2025). BMI as a predictor of progression from TB infection to active TB in PLHIV. *The International Journal of Tuberculosis and Lung Disease*, *29*(2), 54-59. https://doi.org/10.5588/ijtld.24.0287

Nickel, S., & von dem Knesebeck, O. (2020). Do multiple community-based interventions on health promotion tackle health inequalities? *International Journal for Equity in Health*, *19*(1), 157. https://doi.org/10.1186/s12939-020-01271-8

Oliver, M., Rush, E., Schluter, P., Sundborn, G., Iusitini, L., Tautolo, E.-S., Paterson, J., & Heimuli, J. (2011). An exploration of physical activity, nutrition, and body size in Pacific children. *AUT Pacific Islands Families Study Of those Born in 2000, at Manukau City, New Zealand*, *17*(2), 176.

Oxlade, O., & Murray, M. (2012). Tuberculosis and Poverty: Why Are the Poor at Greater Risk in India? *PLOS ONE*, *7*(11), e47533. https://doi.org/10.1371/journal.pone.0047533

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Adm Policy Ment Health*, *42*(5), 533-544. https://doi.org/10.1007/s10488-013-0528-y

Pan American Health Organization. (2020). *Why Data Disaggregation is key during a pandemic*. https://iris.paho.org/bitstream/handle/10665.2/52002/Data-Disaggregation-Factsheet-eng.pdf

Pasefikaproud. (2016). *The profile of Pacific peoples in New Zealand*. https://www.pasefikaproud.co.nz/assets/Resources-for-download/PasefikaProudResource-Pacific-peoples-paper.pdf#:~:text=The%20eight%20main%20Pacific%20ethnic%20groups%20in,population%20aged%200%E2%80%9314%20years%20were%20Pacific%20children.

Pilger, D., Nguipdop-Djomo, P., Abubakar, I., Elliman, D., Rodrigues, L, C., Watson, J, M., Eastman, V., & Mangtani, P. (2012). BCG vaccination in England since 2005: a survey of policy and practice. *BMJ Open*, *2*(5), e001303. https://doi.org/10.1136/bmjopen-2012-001303

Ponce, N. A., Becker, T., & Shimkhada, R. (2025). Breaking Barriers with Data Equity: The Essential Role of Data Disaggregation in Achieving Health Equity. *Annual Review of Public Health*, *46*(Volume 46, 2025), 21-42. https://doi.org/https://doi.org/10.1146/annurev-publhealth-072523-093838

Public Health England. (2018). *Analytical Tools for Public Health*. Retrieved from https://fingertips.phe.org.uk/profile/guidance.

Qiu, B., Wu, Z., Tao, B., Li, Z., Song, H., Tian, D., Wu, J., Zhan, M., & Wang, J. (2022). Risk factors for types of recurrent tuberculosis (reactivation versus reinfection): A global systematic review and meta-analysis. *International Journal of Infectious Diseases*, *116*, 14-20. https://doi.org/https://doi.org/10.1016/j.ijid.2021.12.344

Rahman, M., Sekimoto, M., Takamatsu, I., Hira, K., Shimbo, T., Toyoshima, K., & Fukui, T. (2001). Economic evaluation of universal BCG vaccination of Japanese infants. *International Journal of Epidemiology*, *30*(2), 380-385. https://doi.org/10.1093/ije/30.2.380

Riaz, S. M., Sviland, L., Hanevik, K., & Mustafa, T. (2024). Cause of death in patients with tuberculosis: A study based on epidemiological and autopsy records of Western Norway 1931-47. *Journal of Infection and Public Health*, *17*(11), 102563. https://doi.org/https://doi.org/10.1016/j.jiph.2024.102563

Roelsgaard, E., Christensen, H., & Iversen, E. (1957). BCG-vaccination programme in Pakistan. *Bull World Health Organ*, *17*(2), 187-202.

Rong, T., Ristevski, E., & Carroll, M. (2023). Exploring community engagement in place-based approaches in areas of poor health and disadvantage: A scoping review. *Health & Place*, *81*, 103026. https://doi.org/https://doi.org/10.1016/j.healthplace.2023.103026

Rossignol, L., Guthmann, J. P., Kernéis, S., Aubin-Auger, I., Lasserre, A., Chauvin, P., Pelat, C., Hanslik, T., Lévy-Bruhl, D., & Blanchon, T. (2011). Barriers to implementation of the new targeted BCG vaccination in France: A cross sectional study. *Vaccine*, *29*(32), 5232-5237. https://doi.org/https://doi.org/10.1016/j.vaccine.2011.05.020

Sa'u Lilo, L., Tautolo, E. S., & Smith, M. (2020). Health literacy, culture and Pacific peoples in Aotearoa, New Zealand: A review *pacifichealth*, *3*. https://doi.org/https://doi.org/10.24135/pacifichealth.v3i0.4

Schütz, T. (2022). *Navigating Health Practices for I-Kiribati Immigrants in New Zealand* [Open Access Te Herenga Waka-Victoria University of Wellington]. https://openaccess.wgtn.ac.nz/articles/thesis/Navigating_Health_Practices_for_I-Kiribati_Immigrants_in_New_Zealand/19242600

Sellami, K., Amouri, M., Kmiha, S., Bahloul, E., Aloulou, H., Sfaihi, L., Guirat, R., Mseddi, M., Kamoun, T., Hachicha, M., & Turki, H. (2018). Adverse Reactions Due to the Bacillus Calmette-Guerin Vaccine: Twenty Tunisian Cases. *Indian J Dermatol*, *63*(1), 62-65. https://doi.org/10.4103/ijd.IJD_327_17

Shepherd, S. (2016). Coordinated care: a patient perspective on the impact of a fragmented system of care on experiences and outcomes, drawing on practical examples. *Future Hosp J*, *3*(2), 136-138. https://doi.org/10.7861/futurehosp.3-2-136

Shimeles, E., Enquselassie, F., Aseffa, A., Tilahun, M., Mekonen, A., Wondimagegn, G., & Hailu, T. (2019). Risk factors for tuberculosis: A case–control study in Addis Ababa, Ethiopia. *PLOS ONE*, *14*(4), e0214235. https://doi.org/10.1371/journal.pone.0214235

Silva, D. R., Muñoz-Torrico, M., Duarte, R., Galvão, T., Bonini, E. H., Arbex, F. F., Arbex, M. A., Augusto, V. M., Rabahi, M. F., & Mello, F. C. d. Q. (2018). Risk factors for

tuberculosis: diabetes, smoking, alcohol use, and the use of other drugs. *Jornal Brasileiro de Pneumologia*, *44*.

Sinha, P., Ezhumalai, K., Du, X., Ponnuraja, C., Dauphinais, M. R., Gupte, N., Sarkar, S., Gupta, A., Gaikwad, S., Thangakunam, B., Paradkar, M., Christopher, D. J., Mave, V., Viswanathan, V., Ellner, J. J., Kornfeld, H., Horsburgh, C. R., Jr, Padmapriyadarsini, C., & Gupte, A. (2024). Undernourished Household Contacts Are at Increased Risk of Tuberculosis (TB) Disease, but not TB Infection—a Multicenter Prospective Cohort Analysis. *Clinical Infectious Diseases*, *79*(1), 233-236. https://doi.org/10.1093/cid/ciae149

Smith, I. (2003). Mycobacterium tuberculosis Pathogenesis and Molecular Determinants of Virulence. *Clinical Microbiology Reviews*, *16*(3), 463-496. https://doi.org/doi:10.1128/cmr.16.3.463-496.2003

South Pacific Commission. (2020). *Cultural Etiquette in the Pacific Guidelines for staff working in Pacific communities*. https://hrsd.spc.int/sites/default/files/2021-07/Cultural_Etiquette_in_the_Pacific_Islands_0.pdf

Srivastava, K., Kant, S. & Verma, A. (2015). Role of Environmental factors in Transmission of Tuberculosis. *Journal of Health*, *2*(4). https://doi.org/https://journalofhealth.co.nz/wp-content/uploads/2015/12/DHH_Kant_TB.pdf

Statistics NZ–Tatauranga Aotearoa. (2002). *Pacific Progress: A Report on the Economic Status of Pacific Peoples in New Zealand.* S. N. Zealand. https://www.stats.govt.nz/reports/pacific-progress-a-report-on-the-economic-status-of-pacific-peoples-in-new-zealand/

Statistics NZ–Tatauranga Aotearoa. (2010). *Demographics of New Zealand's Pacific Population -Pacific Progress 2010-*. Statistics New Zealand-Tatauranga Aotearoa Ministry of Pacific Island Affairs. https://www.stats.govt.nz/assets/Uploads/Reports/Demographics-of-New-Zealands-Pacific-Population-2010/Demographics-of-New-Zealands-Pacific-Population-June-2010.pdf

Statistics NZ–Tatauranga Aotearoa. (2024). *2023 Census population counts (by ethnic group, age, and Māori descent) and dwelling counts*. https://www.stats.govt.nz/information-releases/2023-census-population-counts-by-ethnic-group-age-and-maori-descent-and-dwelling-counts/

Statistics NZ–Tatauranga Aotearoa. (2023). *Place and ethnic group summaries Pacific Peoples*. https://tools.summaries.stats.govt.nz/ethnic-group/pacific-peoples

Stehr-Green, J. K. (1992). Tuberculosis in New Zealand, 1985-90 [Article]. *The New Zealand medical journal*, *105*(939), 301-303.

https://www.scopus.com/inward/record.uri?eid=2-s2.0-0027118194&partnerID=40&md5=dd8e811a014fa0a4efeae307620021ae

Talemaitonga, A. (2010). The health of Pacific peoples in Aotearoa is "everybody's business". *BPJ*(32), 5-9 https://bpac.org.nz/bpj/2010/november/docs/BPJ_32_upfront_pages_5-9.pdf

Tautolo, E. S., Faletau, J., Iusitini, L., & Paterson, J. (2020). Exploring success amongst Pacific families in New Zealand: findings from the Pacific Islands Families Study. *PACIFIC HEALTH DIALOG*, *21*(5), 216-225. https://doi.org/10.26635/phd.2020.627

Te Whatu Ora. (2024). *Virtual Diabetes Register and web tool*. Te Whatu Ora-Health New Zealand. https://www.tewhatuora.govt.nz/for-health-professionals/data-and-statistics/diabetes/virtual-diabetes-register-web-tool#:~:text=The%20Pacific%20population%20had%20the,CI:%2031.9%2C%2032.2).

Te Whatu Ora. (2025). *Immunisation Handbook*. file:///C:/Users/rtsch/Downloads/immunisation-handbook-2025-version-v3.pdf

Te Whatu Ora. (2025). *Tuberculosis*. Te Whatu Ora-Health New Zealand. https://www.tewhatuora.govt.nz/for-health-professionals/clinical-guidance/immunisation-handbook/23-tuberculosis#:~:text=23.4.,-2.&text=%5B14%5D%20Studies%20conducted%20since%20the,they%20already%20have%20latent%20infection.&text=The%20current%20recommendation%20to%20use,treatment%20of%20latent%20TB%20infection.

Teariki, M. A., & Leau, E. (2024). Understanding Pacific worldviews: principles and connections for research. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *19*(2), 132-151. https://doi.org/10.1080/1177083X.2023.2292268

Tekkel, M., Rahu, M., Loit, H. M., & Baburin, A. (2002). Risk factors for pulmonary tuberculosis in Estonia. *The International Journal of Tuberculosis and Lung Disease*, *6*(10), 887-894. https://www.ingentaconnect.com/content/iuatld/ijtld/2002/00000006/00000010/art00007

Tenbensel, T., Cumming, J., & Willing, E. (2023). The 2022 restructure of Aotearoa New Zealand's health system: Will it succeed in advancing equity where others have failed? *Health Policy*, *134*. https://doi.org/10.1016/j.healthpol.2023.104828

Terry, G., Hayfield, N., Clarke, V., & Braun, V. (2017). Thematic analysis. *The SAGE handbook of qualitative research in psychology*, *2*(17-37), 25.

The Institute of Environmental Science and Research. (2023). *Tuberculosis in New Zealand: Annual Report 2020.* (FW23022). P. E. 2023.

Thorne, S. (2016). *Interpretive Description: Qualitative Research for Applied Practice* (2 ed.). Routledge. https://doi.org/https://doi.org/10.4324/9781315545196

Tomaszewski, L. E., Zarestky, J., & Gonzalez, E. (2020). Planning Qualitative Research: Design and Decision Making for New Researchers. *International Journal of Qualitative Methods*, *19*, 1609406920967174. https://doi.org/10.1177/1609406920967174

Trainor, L. R., & and Bundon, A. (2021). Developing the craft: reflexive accounts of doing reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *13*(5), 705-726. https://doi.org/10.1080/2159676X.2020.1840423

Tupai-Firestone, R., Matheson, A., Prapavessis, D., Hamara, M., Kaholokula, K. a., Tuisano, H., Tevita, G., Henderson, J., Schleser, M., & Ellison-Loschmann, L. (2017). Pasifika Youth Empowerment Programme: a potential public health approach in tackling obesity-health related issues. *AlterNative: An International Journal of Indigenous Peoples*, *14*(1), 63-72. https://doi.org/10.1177/1177180117746440

Uskun, E., Uskun, S. B., Uysalgenc, M., & Yagız, M. (2008). Effectiveness of a training intervention on immunization to increase knowledge of primary healthcare workers and vaccination coverage rates. *Public Health*, *122*(9), 949-958. https://doi.org/https://doi.org/10.1016/j.puhe.2007.10.005

Vaioleti, T. M. (2006). Talanoa research methodology: a developing position on pacific research. *Waikato Journal of Education*, *12*, 21-34. https://researchcommons.waikato.ac.nz/entities/publication/0c38f668-8e96-4824-85bc-2fd0e82490d9

Verrall, A. J., Hill, P. H., Thorburn, D., Maze, M., Perumal, L., Grimwade, K., Thornley, C. N., Freeman, J., Nisbet, M., & Blackmore, T. K. (2020). Towards elimination of tuberculosis in New Zealand. *NZMJ 133*(1513). https://nzmj.org.nz/media/pages/journal/vol-133-no-1513/towards-elimination-of-tuberculosis-in-new-zealand/41b1aabd5d-1696474965/towards-elimination-of-tuberculosis-in-new-zealand.pdf

Viney, K., Puloka, V., Tukuitonga, C., & Souares, Y. (2014). *Commonwealth Health Partnerships 2014* (A. R. R. Jones-Parry, Ed. 1st ed., Vol. 1). Nexus Strategic Partnerships.

Viney, K., Hoy, D., Roth, A., Kelly, P., Harley, D., & Sleigh, A. (2015). The epidemiology of tuberculosis in the Pacific, 2000 to 2013. *Western Pacific Surveillance and Response Journal*, *6*, 59-67. https://doi.org/10.5365/wpsar.2015.6.1.001

Voss, L., Campbell, M., Tildesley, C., Hay, D., Vaughan, A., & Thornley, C. (2006). Paediatric tuberculosis in a Pacific Islands community in New Zealand. *Journal of*

Paediatrics and Child Health, *42*(3), 118-122. https://doi.org/https://doi.org/10.1111/j.1440-1754.2006.00809.x

Wallgren, A. (1955). Should Mass Vaccination with BCG be Discontinued in Scandinavia? *Acta Paediatrica*, *44*(3), 237-253. https://doi.org/https://doi.org/10.1111/j.1651-2227.1955.tb04136.x

Wiegandt, A., & Stapledon, R. (2010). *Framework to address multidrug-resistant TB in the Pacific Island countries and territories* (AACR2, Ed.). Secretariat of the Pacific Community.

Wieland, M. L., Weis, J. A., Yawn, B. P., Sullivan, S. M., Millington, K. L., Smith, C. M., Bertram, S., Nigon, J. A., & Sia, I. G. (2012). Perceptions of tuberculosis among immigrants and refugees at an adult education center: a community-based participatory research approach. *J Immigr Minor Health*, *14*(1), 14-22. https://doi.org/10.1007/s10903-010-9391-z

Wilkinson, C. (2013). Ethnographic methods. In *Critical Approaches to Security* (pp. 129-145). Routledge.

Williamson, M., & Harrison, L. (2010). Providing culturally appropriate care: A literature review. *International Journal of Nursing Studies*, *47*(6), 761-769. https://doi.org/https://doi.org/10.1016/j.ijnurstu.2009.12.012

Wilson, D., Moloney, E., Parr, J. M., Aspinall, C., & Slark, J. (2021). Creating an Indigenous Māori-centred model of relational health: A literature review of Māori models of health. *J Clin Nurs*, *30*(23-24), 3539-3555. https://doi.org/10.1111/jocn.15859

Workneh, M. H., Bjune, G. A., & Yimer, S. A. (2017). Prevalence and associated factors of tuberculosis and diabetes mellitus comorbidity: A systematic review. *PLOS ONE*, *12*(4), e0175925. https://doi.org/10.1371/journal.pone.0175925

World Health Organization. (1955). STATISTICAL report of WHO/UNICEF BCG vaccination programmes. *Bulletin of the World Health Organization*, *12*(1-2), 301-310.

World Health Organization. (2001). BCG in immunization programmes. *Weekly epidemiological record*, *5*(76), 33 - 40. http://www.who.int/wer

World Health Organization. (2006). *THE STOP TB STRATEGY*. https://stoptb.org/assets/documents/resources/publications/plan_strategy/The_Stop_Tb_Strategy_Final.pdf

World Health Organization. (2008). BCG vaccination. In *Implementing the WHO Stop TB Strategy: A Handbook for National Tuberculosis Control Programmes.* (Vol. 8). Worls Health Organization. https://www.ncbi.nlm.nih.gov/books/NBK310750/

World Health Organization. (2014). Administering, reading and interpreting a tuberculin skin test. In 2 (Ed.), *Guidance for National Tuberculosis Programmes on the Management of Tuberculosis in Children*. https://www.ncbi.nlm.nih.gov/books/NBK214439/

World Health Organization. (2021). *WHO global lists of high burden countries for tuberculosis (TB), TB/HIV and multidrug/rifampicin-resistant TB (MDR/RR-TB), 2021–2025*. G. W. H. O. L. C. B.-N. IGO.

World Health Organization. (2023). *Global tuberculosis report 2023* ISBN 978-92-4-008385-1). https://iris.who.int/bitstream/handle/10665/373828/9789240083851-eng.pdf?sequence=1

World Health Organization. (2024). *Global tuberculosis report 2024* ISBN 978-92-4-010153-1). https://iris.who.int/bitstream/handle/10665/379339/9789240101531-eng.pdf?sequence=1

World Health Organization. (2025). *Tuberculosis*. https://www.who.int/news-room/fact-sheets/detail/tuberculosis#:~:text=Over%2080%25%20of%20cases%20and,Western%20Pacific%20Region%20(17%25).

Wright, S., & Hornblow, A. (2008). Emerging needs, evolving services: The health of Pacific peoples in New Zealand. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *3*(1), 21-33. https://doi.org/10.1080/1177083X.2008.9522430

Yadav, S. (2024). Stigma in Tuberculosis: Time to Act on an Important and Largely Unaddressed Issue. *Cureus*, *16*(6), e61964. https://doi.org/10.7759/cureus.61964

Yanagawa, M., Morishita, F., Oh, K. H., Rahevar, K., Islam, T. A., & Yadav, S. (2023). Epidemiology of tuberculosis in the Pacific island countries and areas, 2000–2020. *Western Pacific Surveillance and Response*, *14*(1). https://doi.org/https://doi.org/10.5365/wpsar.2023.14.1.996

Yang, C., Luo, T., Shen, X., Wu, J., Gan, M., Xu, P., Wu, Z., Lin, S., Tian, J., Liu, Q., Yuan, Z., Mei, J., DeRiemer, K., & Gao, Q. (2017). Transmission of multidrug-resistant Mycobacterium tuberculosis in Shanghai, China: a retrospective observational study using whole-genome sequencing and epidemiological investigation. *Lancet Infect Dis*, *17*(3), 275-284. https://doi.org/10.1016/s1473-3099(16)30418-2

Zumla, A., Mwaba, P., Huggett, J., Kapata, N., Chanda, D., & Grange, J. (2009). Reflections on the white plague. *The Lancet Infectious Diseases*, *9*(3), 197-202. https://doi.org/10.1016/S1473-3099(09)70045-3

Zwerling, A., Behr, M, A., Verma, A., Brewer, T, F. Menzies, D., & Pai, M. (2011). The BCG World Atlas: A Database of Global BCG Vaccination Policies and Practices. *PLOS Medicine*, *8*(3), e1001012. https://doi.org/10.1371/journal.pmed.1001012

Appendices

Appendix A: Ethics Approval

12 July 2024

Nadia Charania
Faculty of Health and Environmental Sciences

Dear Nadia

Re Ethics Application: **24/109 Epidemiology of Tuberculosis and BCG vaccine uptake among Pasifika in Aotearoa New Zealand**

Thank you for your responses to AUTEC's conditions.

Your ethics application has been approved for three years until 12 July 2027.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC.
2. All public facing documents must have the AUTEC approval number and be of a high standard of spelling and grammar. Dates on the Information Sheet(s) and Consent Form(s) must be consistent.
3. Any amendments to the project must be approved by AUTEC prior to being implemented.
4. A progress report is due annually on the anniversary of the approval date.
5. A final report is due at the expiration of the approval period, or, upon completion of project.
6. Any serious or adverse events must be reported to AUTEC, this includes unforeseen issues that might affect continued ethical acceptability of the project.
7. AUTEC grants ethical approval only. You are responsible for obtaining management permission for access from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

The application number and title need to be referenced on all correspondence related to this project.

All forms are available online http://www.aut.ac.nz/research/researchethics

For any enquiries, please contact ethics@aut.ac.nz
(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Auckland University of Technology, D-88, Private Bag 92006, Auckland 1142, New Zealand.
T: +64 9 921 9999 ext. 8316: E: ethics@aut.ac.nz: www.aut.ac.nz/researchethics

Appendix B: Participant Information Sheet

1 Participant Information Sheet

Date Information Sheet Produced:

27 March 2024

2 Project Title

Epidemiology of Tuberculosis and BCG vaccine uptake among Pasifika in Aotearoa New Zealand

An Invitation

Kia ora and Mauri, my name is Rhonita Schutz and I am a student at Auckland University of Technology (AUT). I am currently doing my Master's degree supervised by Drs Nadia Charania, Taniela Lolohea and Janine Paynter. We would like to invite you to take part in my research study. The study will aim to explore the perceptions of senior key-informants on BCG vaccine uptake and current BCG vaccine programs with a focus on Pasifika population. It will be a privilege to have you onboard but only if you chose to do so. The study will not advantage or disadvantage you with absence of conflict of interest.

3 What is the purpose of this research?

The study aims to explore your perceptions on neonatal BCG vaccine uptake and the current programs such as BCG eligibility criteria. The study is interested in exploring the decision-making process and factors considered when assessing populations at risk of Tuberculosis (TB). The findings of the study will produce a thesis, reports and presentations for guidance on policy and practice for TB protection.

4 Why am I being invited to participate in this research?

You have been invited to participate through network connections of supervision team and Te Niwha infectious disease platform. You have been invited as a potential participant as a key-informant for BCG vaccine policy and program and have held your position for more than three years. To be included as a participant in the study you would be kindly asked to please provide informed written consent, those who do not provide consent will not be able to participate in the study.

5 How do I agree to participate in this research?

Participation is completely voluntary, and you will also have the opportunity to review transcripts of your interviews if you wish. You can opt to not discuss certain question/topics and can withdraw from the study at any stage. If you chose to withdraw you may also opt for the study to not use data you have already provided.

6 What will happen in this research?

The study privileges a Pasifika framework that involve maroro (conversation) similar to the research tool talanoa. The maroro will take about an hour and will aim to be in-person at your time and location of choice, however a Microsoft Teams option can also be provided. The session will be audio-recorded, and notes will also be taken. During maroro session you will be asked some questions on BCG vaccine uptake and policies/programs on BCG vaccination with a focus on the Pasifika population. We would also like to explore decision making process and the factors that are considered for policy and program implementation.

7 What are the discomforts and risks?

Discomfort or risks are not expected to occur during maroro session and you are free to skip questions you do not wish to discuss.

8 How will these discomforts and risks be alleviated?

AUT Student Counselling and Mental Health is able to offer three free sessions of confidential counselling support for adult participants in an AUT research project. These sessions are only available for issues that have arisen directly as a result of participation in the research and are not for other general counselling needs. To access these services, you will need to:

- drop into our centre at WB203 City Campus, email counselling@aut.ac.nz or call 921 9292.
- let the receptionist know that you are a research participant, and provide the title of my research and my name and contact details as given in this Information Sheet.

You can find out more information about AUT counsellors and counselling on https://www.aut.ac.nz/student-life/student-support/counselling-and-mental-health

9 What are the benefits?

Your perceptions and views on BCG vaccine uptake and current policies/programs will bring substantial understanding and insight into BCG immunisation and guide ways of protecting more vulnerable groups of the population to TB, particularly the Pasifika population. The findings will be shared to Pasifika stakeholders and communities via presentations, journal articles and a thesis. You will also be provided with $100 koha voucher and kai if meeting in-person as thanks for your time and contributions.

10 How will my privacy be protected?

Confidentiality will be upheld including your identity, your shared information and audio recordings will be kept in private and not shared with anyone other than the student and supervisors on the research team. Any other research team member will sign confidentiality agreements.

11 What are the costs of participating in this research?

There are no costs for participating in the study

12 What opportunity do I have to consider this invitation?

You may consider participating in this study over 2 weeks, we kindly ask that you respond to our invitation letter/email if you wish to participate.

13 Will I receive feedback on the results of this research?

You will receive the report of final findings and overall study which can be sent to your email address if you choose this option on the consent form.

14 What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Dr Nadia Charania, email address Nadia.charania@aut.ac.nz, and work phone number* 09 921 9999 ext 5430.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, *ethics@aut.ac.nz* , (+649) 921 9999 ext 6038.

15 Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Project Supervisor Contact Details:

Dr Nadia Charania, nadia.charania@aut.ac.nz, (p) 09 921 9999 ext 5430

Approved by the Auckland University of Technology Ethics Committee on *12 July 2024*, AUTEC Reference number *24/109*.

Appendix C: Consent Form

Consent Form

Project title: ***Epidemiology of Tuberculosis and BCG vaccine uptake among Pasifika in Aotearoa New Zealand***

Project Supervisor: ***Dr Nadia Charania, Dr Taniela Lolohea and Dr Janine Paynter***

Researcher: ***Rhonita Schutz***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated dd mmmm yyyy.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I understand that this research is related to the researcher's qualification (Masters of Public Health)
- ○ I agree to take part in this research.
- ○ I wish to receive my transcript to review (please tick one): Yes○ No○
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature:

.....

Participant's name:

.....

Participant's Contact Details (if appropriate):

……..

……..

……..

……..

Date:

Approved by the Auckland University of Technology Ethics Committee on 12 July 2024 AUTEC Reference number 24/109

Note: The Participant should retain a copy of this form.

Appendix D: Maroro Guide

Questions to guide the Maroro with participant:

1. What do you think are the most important aspects of the BCG vaccine and programme in terms of TB prevention in Aotearoa New Zealand particularly among the Pasifika population?

2. What steps in the process of policy development and implementation do you think are the most important to reduce TB disease burden among the Pasifika population?

3. How are vulnerable/at-risk groups of the population to TB identified?

4. What do you think of the current TB prevention efforts in regard to BCG vaccination?

5. Do you think the current BCG vaccine initiatives/policy is appropriate in terms of supporting vaccine uptake among the Pasifika population in the New Zealand context?

6. How well are the eligibility criteria capturing population groups at-risk? Do you have any suggestions for improvements?

7. In terms of the diverse ethnicities within the Pasifika population, how can we better understand and address cultural nuances and factors that can influence perceptions of TB disease, prevention, and treatment options?

8. Do you have any other suggestions to reduce TB burden among the Pasifika population in New Zealand?