A programme evaluation of the effects of an intensified TB screening strategy on changes in facility level TB case finding in City Health PHC facilities in Cape Town

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Ten Key Words

Tuberculosis

Intensified TB Screening

Passive Case Finding

Presumptive TB

Systematic Screening

Screened for TB

Screened Positive for TB Symptoms

Laboratory tested for TB

Laboratory diagnosed TB

Initiated on TB treatment

List of Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
aOR	Adjusted odds ratio
ARV	Anti-retroviral
ART	Anti-retroviral therapy
CD4 count	Cluster of differentiation 4
CI	Confidence intervals
HCWs	Health care workers
HCT	HIV counselling and testing
HIV	Human Immunodeficiency Virus
IPT	Isoniazid preventive therapy
ILTFU	Initial lost to follow up
MDHS	Metro District Health Services
MPH	Master in Public Health
MTB	Mycobacterium tuberculosis
OPD	Outpatient Department
OR	Odds ratio
PHC	Primary health care
PLWH	People living with HIV
PTB	Pulmonary tuberculosis
PREHMIS	Patient Record and Health Management Information System
RMR	Routine data information sheet
SoPH	School of Public Health
SP	Standardised patient
UWC	University of the Western Cape

TB	Tuberculosis
WCG	Western Cape Government
WHO	World Health Organisation
Xpert *MTB*/RIF	GeneXpert

Definition of key terms

Active case finding	The systematic screening of specific risk groups for the identification of people with suspected active TB
High risk groups	Any group of people with significantly higher TB incidence or prevalence than the general population
Systematic screening	The systematic identification of people with suspected active TB
Incident TB cases	Incident cases are those that are newly diagnosed (ideally those in whom the disease has just developed) with TB disease
New patients	New patients have never had treatment for TB, or have taken anti-TB drugs for less than 1 month
Passive case finding	Detection of TB cases from those self-presenting to health facilities with symptoms suggestive of TB
Presumptive TB case	Presumptive TB case refers to a patient who presents with symptoms or signs suggestive of TB (previously known as a TB suspect)
Prevalent TB cases	Prevalent cases are those whose TB disease developed or was diagnosed before they were identified
Previously treated patients	Previously treated patients have received 1 month or more of anti-TB drugs in the past
Sputum culture	The examination of a sputum sample using AFB culture is the inoculation of a clinical sputum specimen onto culture media and incubating for up to six (6) weeks to detect of growth or no growth during this incubation period; the presence or absence of acid fast bacilli as an indicator of *Mycobacterium tuberculosis* infection.
Sputum smear microscopy	The examination of a sputum sample under a microscope, after appropriate preparation, for determining the presence or absence of acid fast bacilli as an indicator of *Mycobacterium tuberculosis* infection.
Systematic screening	The systematic identification of people with suspected active TB, in a predetermined target group, using tests, examinations or other procedures that can be applied rapidly. Among those with suspected TB, the diagnosis needs to be established through the application of diagnostic tests and clinical assessment

TB case detection rate	The ratio of notified TB cases to incident TB cases per year
TB contact	Generally indicative of household contacts, i.e. those sharing a household with the index TB case, but may be extended to other persons with which an index case spends a considerable part of the day over an extended period of time.
TB incidence	TB incidence is the number of new cases, usually of active TB disease that have occurred during a certain time period which is usually a year
TB index case	The patient diagnosed with active tuberculosis
TB prevalence	The prevalence of tuberculosis is defined as the number of TB cases in a population at a given point in time
Xpert MTB/RIF	The examination of a sputum sample using the Xpert *MTB*/RIF assay which is a molecular test that simultaneously detects the presence or absence of *Mycobacterium tuberculosis* complex and resistance to rifampicin

Abstract

Background

In South Africa, tuberculosis (TB) detection remains a major problem, as notified cases are estimated to account for only 68% of all incident cases. Health services have relied on passive case finding and this leads to missed or delayed diagnosis. In Cape Town, City Health has embarked on an active surveillance programme to systematically screen all adults seeking health care at PHC facilities for active TB, in order to identify undiagnosed incident TB cases and avert missed opportunities for treating TB.

Aim

The aim of this study was to evaluate the effects of an intensified TB screening strategy on changes in facility level TB case finding in City Health PHC facilities in Cape Town.

Methodology

The study design was a before-after study of changes in facility level TB case finding following implementation of an intensified TB screening strategy, by comparing data on patients screened and tested from the same facilities in 2015 and 2017. The study population consisted of all patients ≥5 years seeking care at 82 City Health PHC facilities in Cape Town who were screened for active TB and registered in the PREHMIS TB Identification Registers in 2015 and 2017. The TB cascade was analysed from screening to treatment initiation and disaggregated to sub-district and facility with the main outcome indicator defined as TB cases detected per 1,000 PHC headcount (Case detection rate). Multi-variate analysis was done to determine if there was an association of a diagnosis of active TB identified through the intensified TB screening strategy with individual patient variables and year of diagnosis. Permission was obtained from the City Health to access the data. A waiver of individual patient consent was obtained from the UWC Biomedical Research Ethics Committee.

Results

A total of 98,873 entries in PREHMIS were analysed. There was a 3.5 fold increase in the PHC headcount ≥5 years screened for TB symptoms in 2015 compared to 2017. Despite this, there was a 7.6% decline in numbers of recorded presumptive TB patients in the two years, as well as a 1.7% decline in the overall PHC headcount ≥5 years. The profile of presumptive patients remained the same. Of the patients who had a TB symptom screen performed, 22.9% screened positive for TB symptoms in 2015 compared to 5.9% in 2017. Overall, the number of patients with a positive sputum test declined by 9.2% over the two years and the number of patients initiated onto TB treatment declined by 7.2%. In 2015, one patient with active TB

disease was detected for every 29 patients screened. In 2017, one active TB patient was detected for every 116 patients screened. Despite the increased screening, the case detection rate per 1,000 PHC headcount ≥5 years declined slightly from 4.0 in 2015 to 3.7 in 2017. There were wide disparities in case detection rates between the health sub-districts in 2015 compared to 2017. Scatterplots showed no significant correlation between percentage PHC headcount ≥5 years screened for TB symptoms and case detection rate per 1,000 PHC headcount in the 82 PHC facilities in 2015 (r=0.064; p=0.568) or in 2017 (r=-0.124; p=0.268). Being male, HIV positive, history of previous TB treatment episodes and being a contact of a known drug resistant TB index case were all associated with a diagnosis of active TB disease on univariate and multivariate analysis.

Conclusion

Improving TB case detection together with earlier treatment initiation should contribute to reducing TB transmission. However, the key finding from this study is that the current strategy of "universal" screening did not increase TB case detection. Despite very big increases in reported screening rates, presumptive cases identified and overall case detection in fact decreased over the period. The data from individual facilities and sub-districts showed variable uptake rates but no consistent pattern (up or down) of presumptive or confirmed cases with increased screening. A limitation of the analysis is that without control groups, and in the context of declining TB incidence, it is not possible to say what the case detection rate would have been without the universal screening programme. However, taken together, the findings suggest that intensified TB screening in City Health TB clinics is ineffective, and other strategies of "universal testing" would need to be considered and further researched.

Declaration

I declare that, ***'A programme evaluation of the effects of an intensified TB screening strategy on changes in facility level TB case finding in City Health PHC facilities in Cape Town',*** is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Judy Caldwell November 2018

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Chapter 1: Introduction

1.1 Background

Tuberculosis (TB) remains a major global health problem. The WHO Global Report (2017) reported that TB incidence is declining at about 2% per year and mortality at about 3% per year. In spite of the reported declining TB incidence rate, 6.3 million new cases of TB were reported in 2016 and it remains the leading cause of death from a single infectious agent, ranking above HIV/AIDS.

The World Health Assembly adopted the End TB Strategy in May 2014, which aims to end the global TB epidemic by 2035 (WHO, 2015). Specific targets set in the End TB Strategy include a 90% reduction in TB deaths and an 80% reduction in TB incidence (new cases per year) between 2015 and 2030. Both incidence and mortality need to decline at rates of 5% per annum respectively to reach the first milestones of the End TB Strategy.

A key challenge to achieving these targets is that it is estimated that only two thirds of global infectious TB cases are notified, with the remaining one third of undiagnosed TB cases sustaining on going transmission of TB (WHO Global Report, 2017).

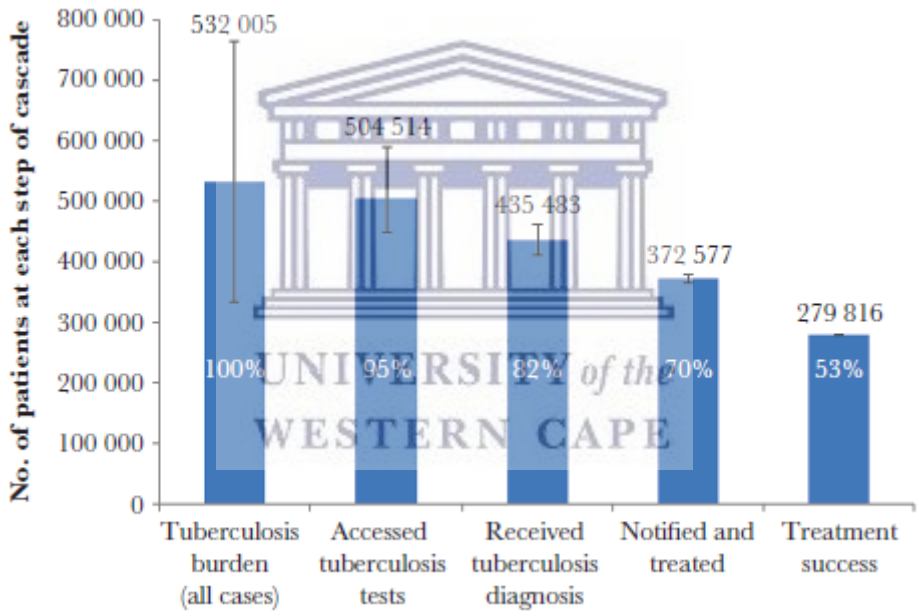
In South Africa, TB incidence and mortality rates are following similar declining global trends with a reported TB incidence rate of 781 per 100 000 population in 2016, down from 834 per 100 000 population reported in 2015 (WHO Global TB Report, 2017). However, the current rate of decline is still too slow to meet the 2035 End TB Strategy targets. Despite a declining TB incidence rate, TB detection remains a major problem in South Africa, as notified cases are estimated to account for only 68% of all incident cases. This is below the WHO global target of detecting ≥70% of cases (WHO, 2016).

The timeous provision of TB therapy to people diagnosed with TB leads to improved clinical outcomes (Golub et al., 2013). However, diagnosing tuberculosis disease (TB) is reliant on self-presentation of persons with TB symptoms to health care facilities and a high index of suspicion among health care workers (HCWs). Many people with active TB are asymptomatic in the early stages, are unlikely to seek care early and may not be properly diagnosed when seeking health care. This leads to missed or delayed diagnosis for infectious cases who still continue to transmit TB in the community. Current case detection levels may

be insufficient to detect enough cases of infectious TB to make an impact on the epidemic (Shapiro, 2013).

Naidoo et al. (2017) undertook an analysis of the TB care cascade in South Africa, estimating the number and proportion of individuals with TB, who accessed tests, were diagnosed with TB, initiated treatment, and successfully completed treatment (Figure 1). Estimates were derived from national electronic TB register data, laboratory data, and published studies. The purpose was to enumerate losses in each step of the TB care cascade to inform appropriate programmatic responses and targeted interventions by the National TB Programme in South Africa, in order to meet the targets of the End TB Strategy.

Figure 1 Tuberculosis Care Cascade in South Africa (copied from Naidoo et al., 2017)[1]



Naidoo et al. (2017) estimated that only 5% of the estimated TB cases did not access testing. This small gap could possibly be attributed to patients having access to TB diagnostic services through the wide network of free public primary health care facilities in South Africa. However, in spite of this estimated small gap in the proportion of TB cases not accessing testing, empirical evidence from recent studies in South Africa suggests that there are still numerous missed opportunities at primary health care (PHC) facilities to test patients for TB. In these studies, more than three quarters of patients reporting their TB symptoms to

[1] *Incidence estimates for South Africa, which are based on case notification data and expert opinion on case detection gaps. The proportion at each step of the cascade is expressed in relation to the estimated burden. Note: The wide confidence interval for the tuberculosis burden reflects the World Health Organization*

health care workers (HCWs) were not tested (Chihota et. al, 2015). A significant proportion may have culture positive TB (Claassens et al., 2013). The South African government is committed to improving TB control, and has considered the most strategic, easily scalable, and locally contextualized solutions to achieve progress towards the WHO End TB goals. One of the strategies defined under the Find-Treat-Prevent framework is to reduce TB incidence and mortality by improving TB case-finding (NTP Strategic Plan, 2017).

The End TB Strategy (2015) advocates systematic screening of high-risk groups for active disease to improve early case detection, as early detection helps to reduce the risks of TB transmission. Modelling has shown that increased screening of all PHC facility attendees for TB disease (active surveillance) may have a substantial epidemiological impact. WHO (2013:19) defines the systematic screening for active TB "*as the systematic identification of people with suspected active TB, in a predetermined target group, using tests, examinations or other procedures that can be applied rapidly. Among those with suspected TB, the diagnosis needs to be established through the application of diagnostic tests and clinical assessment."* Patient initiated pathways to a TB diagnosis can thus be complemented by screening, by asking all people who seek care in a health facility if they have any TB symptoms. The identification of TB symptoms is the first step in provider initiated screening for TB.

In an implementation study in a busy PHC clinic in an informal settlement in Johannesburg, researchers prospectively evaluated a model for systematic TB symptom screening and HIV counselling and testing (HCT) for all adult clients attending the facility (Van Rie et al., 2014). During the 6 month implementation phase, 89.6% of all clinic attendees were screened for TB symptoms, of whom 14% had a positive TB symptom screen. The findings of this study suggest that systematic screening and appropriate testing in PHC facilities is effective in increasing TB case finding and may be an affordable and sustainable first step to increase case finding in high burden settings.

A recent study conducted in outpatient departments in Ghana compared the yield of TB cases using different screening approaches (Ohene et al., 2017). Two symptom based TB screening protocols, with varying cough duration were implemented with general outpatients, people living with HIV (PLWH), diabetics and contacts. The yield of TB cases per 100,000 population screened was highest among PLHIV, contacts, and diabetics. The findings of this

study suggest that more sensitive methods of screening based on risk factors is effective in increasing TB case finding in health facilities.

The findings from these studies suggest that systematic screening and appropriate testing in PHC facilities is effective in increasing TB case finding. In addition, for such opportunities to result in increased TB case-findings, symptom screening needs to be actively followed up with sputum testing (Khan, 2009).

1.2 Study Setting

Cape Town has a population of just over 4 million people (Census 2011). Only 24% of the population is insured for health care. The uninsured population are reliant on public health services offered by City Health and Metro District Health Service (MDHS) of the Western Cape Government (WCG). All PHC services are provided free of charge. City Health and MDHS jointly provide primary health care services in eight sub-districts with City Health responsible for managing 86 and MDHS 44 fixed PHC facilities (Table 1). City Health provides preventive care, reproductive health, TB, HIV and STI services, curative services to children <13years of age and curative and chronic disease services to adults at a limited number of facilities. MDHS provides preventive care, reproductive health, TB, HIV and STI services, curative and chronic disease services to adults and curative services at a limited number of facilities to children <13years of age. TB diagnostic services are available in all PHC facilities of both City Health and MDHS.

Table 1 Package of services rendered by City Health & MDHS

	City Health	MDHS
Child health	81	14
Reproductive health	86	44
STI	86	44
Adult curative	12	44
TB diagnostic	86	44
TB treatment	85	24
HIV testing	86	44
ART	59	33

In Cape Town, City Health have embarked on an active surveillance programme and set a target to systematically screen 50% of all adults seeking health care at PHC facilities for active TB disease. The purpose of screening all patients attending PHC facilities is to try and identify undiagnosed incident TB cases and avert missed opportunities for treating TB. Specific TB screening stickers were printed with the WHO recommended four-symptom TB screen and were distributed with an implementation guideline, to all PHC facilities in 2016 (Appendix 1).

1.3 Problem Statement

WHO guidelines on systematic screening for TB (2013:11) state that there is strong evidence that in settings with high TB prevalence in the general population, systematic screening for active TB should be considered amongst all people who seek health care, and that people living with HIV should be systematically screened for active TB at each visit to a health facility. Increased screening of PHC facility attendees for TB may have the greatest epidemiological impact and should reduce diagnostic delay, which in turn, reduces on-going transmission. Protocols and procedures have been implemented to systematically screen people living with HIV for active TB at each visit to a health facility. However, the additional value of screening all other patients attending PHC services for other preventive and curative services is not known.

1.4 Purpose of the Study

The purpose of this study is to evaluate if the strategy implemented by City Health to systematically screen all people who seek health care at PHC facilities for active TB disease has translated into increased TB case finding and averted missed opportunities to diagnose TB.

The findings of this study will shed light on the effectiveness, feasibility and sustainability of routine TB screening programmes in PHC facilities and can be used to influence future design of policy and implementation practices. The findings of this study can also be used by local health managers to improve screening and testing at identified facilities with poor screening and those where symptomatic patients are not being tested for TB.

Chapter 2: Literature Review

2.1 Introduction

This chapter reviews available evidence that supports WHO Screening Guidelines (2013) recommendations that in settings with high TB prevalence in the population, systematic screening for active TB should be considered amongst a number of population groups. These groups are: people who are seeking health care or who are in health care; who belong to selected risk groups (e.g. HIV infection); those with close contacts of people with TB; and other subpopulations that have very poor access to health care. The rationale is that an increase in TB screening of all adults attending PHC facilities will translate into increased TB testing, diagnosis and treatment of undiagnosed incident cases and avert missed opportunities to diagnose TB.

Most people who develop TB can be cured, with a timely diagnosis and correct treatment (Shapiro, 2013). In the absence of effective vaccines, the principal public health approach to TB control has been passive case finding, which is the detection of TB cases from those self-presenting to health facilities with symptoms suggestive of TB (Uplekar et al., 2013). Whilst the approach of passive case finding combined with better treatment has contributed to improvements, the overall epidemiological impact has been inadequate, with case detection trends stagnating and TB incidence rates declining at rates far lower than expected (Lonnroth et al., 2013). Several explanations have been offered for the low case-detection rate, including poor health seeking behaviour of patients with respiratory symptoms; poor access to primary health care; delays in providing a diagnosis once the patient presents at a health service and the non-availability of appropriate tests and treatment (Davis et al., 2011). These observations have prompted more active approaches to early TB case detection, focusing on "active'' case-finding strategies, which target high-risk groups.

WHO (2013) has produced recommendations on systematic screening for active TB which set out principles and guidance for prioritisation of risk groups for screening. Systematic screening for active TB is predominantly provider-initiated and targets people who do not seek health care because they do not have or recognize symptoms or they do not perceive that they have a health problem that warrants medical attention, or there are barriers to accessing care, or for other reasons. It may also target people seeking routine health care who do or do

not have symptoms or signs compatible with TB and who may not be identified by "passive case-finding" as possibly having TB (WHO, 2013).

The End TB Strategy (2015) advocates systematic screening of high-risk groups for active disease to improve early case detection, as early detection helps to reduce the risks of TB transmission. A TB risk group may be defined as any group of people with significantly higher TB incidence or prevalence than the general population. A risk group may be a group of people sharing a specific individual-level risk factor (e.g., HIV infection), or people living in a specific geographical location (e.g., urban slum) or institution (e.g., prison) associated with a high burden of TB (Lonnroth et al., 2013). For case detection to be effective, health-care providers must first refer at-risk patients for TB testing, then ensure that referred patients complete testing, and finally make certain that patients with positive test results are notified as cases of TB and initiated on treatment (Davis et al., 2011).

Modelling has shown that increased screening of all PHC facility attendees for TB disease in settings with high TB prevalence in the population may have a substantial epidemiological impact (WHO, 2015). The End TB Strategy therefore advocates that: 1) all adult PHC facility attendees are screened for presence of a chronic cough (lasting longer than 2 weeks); 2) all adult PHC facility attendees who present with symptoms suggestive of TB are tested for active TB disease; and 3) all those who test positive for TB are placed on appropriate TB treatment immediately.

2.2 Evidence related to systematic screening for TB

The objectives of active case finding are to diagnose and treat patients earlier, thereby reducing negative treatment outcomes, sequelae, and socioeconomic consequences, as well as reducing the period of infectiousness and therefore transmission (WHO, 2013). A range of context specific approaches across the globe have experimented with enhanced TB case detection through screening, ranging from introducing a screening element into passive case finding to implementing comprehensive outreach programmes. Studies in Zimbabwe (Corbett et al., 2010), Cambodia (Eang et al., 2012) and Brazil (Miller et al., 2010) have reported improved case detection and declining TB burden associated with more active screening.

The tools available to TB programmes are symptom screening, chest x-rays and sputum testing and are crucial in ensuring the efficacy of systematic screening (Uplekar et al., 2013). Screening however, is inappropriate unless diagnostic and treatment services of sufficient

quality are available or can be made available in parallel with implementing screening initiatives (Lonnroth et al., 2013). TB screening tests are not intended to be diagnostic and are used to elicit responses of symptoms suggestive of TB. WHO (2011) recommend a four-symptom TB screen: cough ≥2weeks, fever, night sweats, and weight loss. The absence of all four symptoms is considered a negative screen. The presence of any one of these four symptoms is considered a positive screen and those who report any one of the symptoms may have active TB and a diagnosis is established using additional diagnostic tests. Symptom questionnaires provide a quick and convenient way to identify individuals who then need investigation and have a high sensitivity when used to define presumptive TB among patients who present themselves to health-care facilities for investigation of ill-health (Corbett et al., 2010).

A systematic review published by Kranzer et al. (2013) assessed the evidence that screening for TB disease 1) increases the number of TB cases initiated on anti-tuberculosis treatment, 2) identifies cases earlier in the course of disease, 3) reduces mortality and morbidity, and 4) impacts on TB epidemiology. Most of the studies included were observational studies with significant variations in the study populations, settings and screening approaches. The review found that screening increased the number of new cases in the short term. However, in many settings, more than half of prevalent cases in the community remained undiagnosed. Screening tends to find cases earlier and with less severe disease, but this may be attributed to case finding studies using more sensitive diagnostic methods than are available to routine programmes, rather than the effects of the increased screening itself. There was insufficient evidence from the studies to indicate whether active screening impacted on epidemiology, such as TB prevalence.

2.3 Screening for TB amongst people living with HIV

TB and HIV are overlapping epidemics. TB is an important gateway to HIV care and TB is a major presenting opportunistic infection in the majority of HIV positive patients with low CD4 counts. International Standards for TB Care (2014) recommend that HIV testing should be done on all patients suspected of or with TB particularly in areas with high HIV prevalence. Two separate studies in India reported low rates of HIV testing amongst presumptive TB patients; where only 44.6% and 68.0% had a known HIV status and of whom 3.3% and 8% were HIV positive, in the two studies respectively (Palanivel et al., 2013 & Kumar et al., 2017).

WHO guidelines on systematic screening for TB (2013) state that there is strong evidence for systematically screening people living with HIV (PLWH) for active TB at each visit to a health facility. TB screening is recommended for people with HIV infection to facilitate early diagnosis and safe initiation of anti-retroviral therapy (ART) and isoniazid preventive therapy (IPT).

In a meta-analysis, Kranzer et al. (2010) estimated that between 3.6% and 24.7% of HIV infected patients attending ART services in sub-Saharan Africa, who are screened during intensified case finding, receive a diagnosis of tuberculosis. The results from three different facility level studies showing the prevalence of undiagnosed culture-positive TB amongst ART enrolees are shown in Table 2. In two studies conducted at ART clinics in South Africa, there were similarities in the rates of prevalent TB amongst patients, varying from 19-26% (Lawn et al., 2009 & Basset et al., 2010). In another study conducted by Cain et al. (2010) in eight outpatient clinics in Cambodia, Thailand, and Vietnam, TB was diagnosed in 15% of all patients.

Table 2 Prevalence of undiagnosed culture-positive TB in facility level studies from high HIV prevalent settings

Author, year	Country	Population	Participants n	Culture +TB %
Lawn, 2009	South Africa	ART clinic	235	25.7
Bassett, 2010	South Africa	HIV clinic	825	19.0
Cain, 2010	South East Asia	ART clinic	1,724	15.5

The findings of these studies support the International Standards for TB Care and WHO recommendations that HIV testing should be done on all patients suspected of or with TB and PLWH should be systematically screened for active TB at each visit to a health facility.

2.4 Screening close contacts of TB index patients

Close contacts of known TB index patients are a specific high risk group. WHO guidelines on systematic screening for TB (2013) state that there is strong evidence to support systematically screening all household and other close contacts of confirmed TB index cases for active disease.

Morrison et al. (2008) conducted a systematic review to determine case detection rates through household contact investigation. They found a yield for all TB of 4.5%; bacteriological confirmation in 2.3% and latent TB infection in 51.4% of contacts investigated.

In a recent study conducted by Little et al. (2018) it was reported that symptom screening among household contacts had low sensitivity and specificity for active TB and found a TB prevalence of 3.9% amongst close household contacts tested. Kweza et al. (2018) reported that amongst presumptive TB patients who tested positive 7.7% reported a current contact and 18% reported a contact within the past year.

Data from a study in Brazil suggested that the prevalence of TB infection and progression to active TB among household contacts exposed to drug sensitive and drug resistant cases were comparable, despite a longer duration of exposure of contacts to drug resistant TB index cases (Teixeira et al., 2001).

These results suggest that contact investigation with testing merits serious consideration as a means to improve early case detection and decrease transmission of mycobacterium tuberculosis (*MTB*) in high-incidence areas as close contacts of known TB index patients are a specific high risk group.

2.5 Facility based TB screening

WHO guidelines on systematic screening for TB (2013) state a conditional recommendation that in settings where the TB prevalence is 100/100 000 population or higher, systematic screening for active TB may be considered among people who are seeking health care or are in health care. There have been a number of initiatives, in diverse settings such as general outpatient departments (OPD) in hospitals, specific (e.g. diabetic) OPD clinics, PHC facilities or private providers, to introduce systematic screening for TB within health facilities (Table 3).

Table 3 Results from facility level studies on in-facility TB screening amongst patients seeking care

Author, year	Country	Population	Participants n	TB Screen + n	TB + n
Berkowitz, 2018	South Africa	Diabetic clinic	440	202 (45.9%)	13 (6.4%)
Van Rie, 2014	South Africa	PHC clinic	26,279	3287 (12.5%)	90 (2.7%)
Uplekar, 2013	Swaziland	Hospital OPD	251,867	14,998 (6.0%)	1,254 (8.3%)
Uplekar, 2013	Afghanistan	PHC clinic	889,120	22,228 (2.5%)	1,986 (8.9%)
Uplekar, 2013	Pakistan	Private providers	469,896	8,458 (1.8%)	2,416 (28.5%)
Bloss, 2012	Botswana	PHC clinic	11,779	926 (7.8%)	19 (2.0%)

Results from studies conducted in settings with high TB prevalence in the general population have shown an increased prevalence of undiagnosed TB among people who seek health care. Uplekar et al. (2013) reported that in Afghanistan, 2.5% clinic attendees from 47 health facilities screened positive for TB symptoms and were tested with smear microscopy of which 8.9% were AFB positive. Private providers and community lay workers screened patients attending 54 private clinics and one hospital in a project in Pakistan over a period of one year; 1.8% of attendees who screened positive for TB symptoms were tested and 28.5% had a bacteriologically confirmed TB diagnosis (Uplekar et al., 2013).

Similarly, several studies conducted in high TB prevalence and high HIV burden southern African settings have shown an increased prevalence of undiagnosed TB amongst PHC facility attendees who were systematically screened for TB symptoms.

In a study conducted in Swaziland, all patients attending 32 outpatient (OPD) departments at hospitals were systematically screened for TB symptoms before seeing a clinician. Of those screened, 6% screened positive for TB symptoms and were offered an Xpert *MTB*/ RIF test and 8.3% received a bacteriologically confirmed diagnosis of active TB disease (Uplekar et al., 2013).

TB screening was implemented among adults at patient intake in five clinics in Botswana (Bloss et al., 2012). Amongst those screened for TB at intake, 7.8% screened positive and 2% were diagnosed with TB.

The results from another study conducted at a PHC clinic in Cape Town highlighted the importance of screening for HIV and active TB in older population groups who are in health

care. The study found a 3.0% prevalence of active TB among diabetes mellitus patients; and of the prevalent TB cases, 53.9% had no TB symptoms and 61.5% were HIV co–infected (Berkowitz et al., 2018).

Van Rie et al. (2014) prospectively evaluated a model for systematic TB symptom screening and HIV counselling and testing (HCT) for all adult clients attending the facility in a busy PHC clinic in an informal settlement in Johannesburg. During the 6 month implementation phase, 89.6% of all clinic attendees were screened for TB symptoms, of which 14% had a positive TB symptom screen. However, only 35% of those with a positive TB symptom screen had a sputum specimen collected for testing and of these 8% had a bacteriologically confirmed result. In order to identify one case with active TB disease, 262 clients needed to be screened.

The findings from these studies suggest routine that TB screening in health facilities is effective in increasing TB case finding, supporting the WHO conditional recommendation of systematically screening people who seek health care. However, with the exception of Van Rie et al. (2014), none of the studies evaluated and reported sustainability of screening in the long term. Van Rie et al. (2014) reported significantly lower proportions of clients screened for TB symptoms 6 and 12 months after initiation of the programme, highlighting the difficulties of implementing and sustaining TB screening in real-life settings.

2.5.1 Different screening approaches to active TB case finding in facility based TB screening

Uplekar et al. (2013) has recommended that choices of screening and diagnostic algorithms be based on the profile of the prioritised risk groups, the TB prevalence in the risk groups, the availability of tests, the capacity of diagnostic facilities and feasibility of using different tests in context of screening.

In Ghana, two symptom based TB screening approaches of varying cough duration were used to screen and test for TB among general outpatients, PLWH, diabetics and contacts and yields compared (Ohene et al., 2017). In the first approach, the conventional 2 weeks cough duration with or without other TB suggestive symptoms was the criterion to test for TB. In the second approach the screening criteria were cough of >24 hours, as well as a history of at least one of the following symptoms: fever, weight loss and drenching night sweats. In the second approach using >24-hour cough, significantly more presumptive TB cases were

identified among outpatients (0.82% versus 0.63%), more were tested (90.1% versus 86.7%), but less smear positive patients were identified among those tested (8.0% versus 9.4%). Overall, all forms of TB cases identified per 100,000 screened were significantly higher in the >24-hour cough approach. This approach yielded more TB cases although it required TB testing for a larger number of patients. The yield of TB cases per 100,000 population screened was highest among PLWH, TB contacts, and diabetics. The findings of this study suggest that more sensitive methods of screening based on risk factors is effective in increasing TB case finding.

2.5.2 Missed opportunities in facility based TB screening

In South Africa, patients have access to free TB diagnostic services through a wide network of public primary health care facilities. Based on estimates derived from national electronic TB register data and laboratory data, testing was not accessed in only 5% of the estimated number of TB cases (Naidoo et al., 2017). However, in spite of widespread access to TB testing and care, empirical evidence from recent studies in South Africa suggests that there are still numerous missed opportunities at PHC facilities to test patients for TB (Table 4).

Several explanations have been offered for missed opportunities to diagnose TB amongst patients seeking health care, and include amongst others; poor access to primary health care; delays in providing a diagnosis once the patient presents at a health service and the availability of appropriate tests and treatment (Davis et al., 2011). The results below are from high TB and HIV prevalence settings and underscore the missed opportunities to diagnose active TB disease among people who are seek health care.

Table 4 Results from facility level studies on missed opportunities to diagnose TB amongst patients seeking care in South Africa

Author, year	Population	Participants n	TB Screen + n	TB + n
Claassens, 2013	PHC clinics	665	423 (63.6%)	21 (4.9%)
Chihota, 2015	PHC clinics	3,604	2,130 (59.1%)	ND
Kweza, 2018	PHC clinics	1,255	779 (62.0)	39 (5.0%)

2.5.2.1 Identifying those that do not report TB symptoms as their primary complaint

In Cape Town, Claassens et al. (2013) conducted exit interviews at two PHC facilities and found only 3.8% of participants who exited the health facility had been questioned by HCWs

about respiratory symptoms. Of those exiting, 5% had culture positive TB, all of whom were symptomatic, had not been screened, and had attended the facility for other reasons and had not reported respiratory symptoms to HCWs. The findings suggest incorporating TB screening into routine health activities at intake could avert missed opportunities to diagnose active TB disease.

2.5.2.2 Delays in providing a diagnosis and appropriate testing once patients present at a health service

Chihota et al. (2015) conducted exit interviews amongst adults with respiratory symptoms at 40 clinics in four provinces. The purpose was to determine amongst the adults who reported TB symptoms to HCWs, the proportion that had a sputum test and the factors associated with having a sputum test. Just under one-third (31.6%) of participants reported the main reason for visiting the clinic was for TB symptoms. Of those that had reported their TB symptoms to a HCW, 77% were not tested for TB. The findings of this study suggest that opportunities are being missed to identify patients with active TB disease where patients present with symptoms suggestive of TB at a health care facility.

The findings of a study by Kweza et al. (2018) were similar to those of Chihota suggesting that opportunities are missed to identify patients with active TB disease where patients present with symptoms suggestive of TB. TB symptomatic individuals exiting 20 PHC facilities in Buffalo City Metropolitan Health District were interviewed and asked to provide sputum for testing. Clinic staff had screened 79% of participants seeking care for TB related symptoms; however only 21.5% reported submitting sputum and only 9.8% had results available. Of the participants not tested by clinic staff, 5% tested positive for TB.

These studies did not delve into reasons for the missed opportunities to identify patients with active TB disease, be they staffing shortfalls, inadequate provider education, a scarcity of testing supplies, lack of guiding policies, or other reasons.

2.5.2.3 Poor health seeking behaviour of patients with respiratory symptoms

Early diagnosis and immediate initiation of treatment are essential for an effective TB control programme. Delay in diagnosis is significant to both disease prognosis at the individual level and transmission within the community.

According to findings by Skinner et al. (2016) many adult patients waited for advanced symptoms to appear, and were very ill or even dysfunctional when they finally presented at health care facilities, often with smear-positive disease. Asch et al. (1998) found patients delayed in seeking care as they thought they could treat themselves, or were disconnected from the health care system by unemployment or lack of access to regular health care. The findings were similar to a study in Pakistan, where more than 50% of patients practiced self-treatment, and 42% first visited their pharmacy for medication for symptoms (WHO, 2006).

Storla et al. (2008) conducted a systematic review of studies addressing delay in diagnosis and treatment of TB. Factors were associated with both patient and health system delays. Main factors associated with patient delay included alcohol or substance abuse, poverty, low access to health care facilities, rural residence, old age, belonging to an indigenous group and incomprehensive attitudes, beliefs and knowledge about TB. Factors associated with health care delay included co-existence of chronic cough and/or other lung diseases, having extra pulmonary or negative sputum smear TB, less severe and non-specific symptoms or absence of haemoptysis, poor health care infrastructure and seeking traditional and private practitioners first.

Kerrigan, et.al (2017) conducted a qualitative study to inform the development of active case finding strategies, where semi-structured in-depth interviews were conducted among TB patients, their household members and HCWs in a rural province in South Africa. TB patients and community members reported difficulty identifying TB symptoms and seeking care in a timely fashion. All stakeholder groups felt that more proactive case finding strategies would be beneficial. Incorporating TB screening into routine health activities at intake at PHC facilities was identified as the most acceptable method based on participants' preference ranking of the active case finding strategies.

Findings from these studies suggest that systematic TB screening in PHC facilities and appropriate testing should not be limited to patients who report respiratory symptoms or those who are HIV positive. Given the high prevalence of TB in South Africa, incorporating TB screening into routine health activities at intake could avert missed opportunities to diagnose active TB disease.

2.5.3 Initial lost to follow-up after facility-based TB screening and testing

Patients with a laboratory confirmed diagnosis of TB and who never start anti-TB treatment are classified as initial lost to follow-up (ILTFU). Pre-treatment ILTFU can hinder TB control efforts as individuals who test positive for active TB but do not initiate treatment contribute to on-going transmission within communities. In the analysis undertaken by Naidoo et al. (2017) of the TB care cascade in South Africa, where the number and proportion of individuals with TB who accessed tests, were diagnosed with TB, initiated treatment, and successfully completed treatment were estimated. It was found an estimated 12% of all cases were diagnosed but not notified and treated.

MacPherson et al. (2013) conducted a systematic review and meta-analysis to assess the magnitude of ILTFU in TB patients before treatment initiation. From the eligible studies pre-treatment ILTFU rates varied from 4 to 38%.

Khan et al. (2009) reported 5.2% of smear positive patients identified through active case finding strategies were ILTFU during diagnosis and therefore could not be started on treatment. At a regional hospital in Ghana, of the laboratory confirmed cases 38% were ILTFU (Afutu, 2012). Similar rates of initial ILTFU, 21.6% were found at a referral hospital in northern India (Mehra et al., 2013). Cele et al. (2016) measured initial TB ILTFU in PHC clinics in a district with a high incidence of TB in South Africa and reported initial ILTFU rates of 17.9% and of those traced, 53% had already died.

Skinner et al. (2016) reported the key issues contributing to ILTFU to be a combination of poor knowledge, or low awareness of TB treatment; stigma around TB including its connection to HIV; immediate problems in the respondents' lives particularly poverty, lack of access to transport and the need to continue working; and problems in the healthcare facilities including under resourced facilities, poor functioning health systems and negative staff attitudes.

The high level of ILTFU in TB is one of the "unresolved issues" in TB control programmes that needs to be addressed. These findings suggest that unless health systems are responsive to retain and commence presumptive TB patients on treatment once they have been screened and tested, screening efforts may have little impact.

2.5.4 Quality of TB diagnostic evaluation in PHC facilities

TB screening is inappropriate unless diagnostic and treatment services of sufficient quality are available. Studies of the quality of TB diagnostic evaluation of patients in high burden countries have generally shown poor adherence to international or national guidelines. Naidoo, et al. (2017) reported that poor compliance with the diagnostic algorithm have major implications for case detection and reported that if algorithms were adhered to it would reduce the number of TB cases missed by almost 32,000.

Cattamanchi et al. (2011) conducted structured in-depth interviews with staff working in health centres in Uganda to elicit their perceptions regarding barriers to TB screening and diagnosis. Participants identified key health system barriers hindering TB screening and diagnosis and included amongst others, inadequate space and infrastructure, lack of training, high workload and low staff motivation. Contextual barrier challenges to TB diagnosis including the time and costs borne by patients to seek and complete TB screening and testing, poor health literacy, and stigma against patients with TB. These contextual barriers interacted with health system barriers to contribute to sub-standard TB screening and diagnosis.

Christian et al. (2018) suggest that increasing healthcare coverage is unlikely to improve health outcomes if the quality of care and protocol implementation is lagging. This multi-district Standardised (mystery) Patient (SP) study was conducted at 39 PHC facilities in two provinces in South Africa to objectively measure the quality of TB screening at PHC facilities using the SP method. The methodology applied allowed researchers to observe how HCWs identify, test and advise presumptive TB patients, and whether this aligned with clinical protocols and best practice. It was found that only 43% of interactions resulted in SPs receiving a TB sputum test and being offered an HIV test; just over half were asked whether household contacts had confirmed TB and only 28% received an explanation on the importance of returning to the facility to receive TB test results. The SP method highlighted gaps in clinical practice, gaps and weaknesses in TB protocol implementation signalling missed opportunities for diagnosis.

2.6 Conclusion

The studies suggest that there are many missed opportunities to screen for TB. However for such opportunities to result in increased TB case-findings, symptom screening needs to be actively followed up with sputum testing and improved adherence to clinical protocols.

The findings of these studies support conducting further operational research to assess whether the change in the TB screening strategy in City Health PHC facilities in Cape Town has translated into identifying and testing more presumptive TB cases and starting those who test positive on TB treatment.

Chapter 3: Aims and Objectives

3.1 Study Aim

The aim of this study was to evaluate the effects of an intensified TB screening strategy on changes in facility level TB case finding in City Health fixed PHC facilities in Cape Town.

3.2 Study Objectives

The objectives of this study were:

1. To compare the proportion of all patients five years and older i) screened positive for TB symptoms, ii) investigated, iii) diagnosed and iv) commenced on TB therapy in PHC facilities in 2015 and 2017, before and after the implementation of the intensified TB screening strategy;

2. To determine whether there was an association of a diagnosis of active TB identified through the intensified TB screening strategy with age, having a history of previous TB, gender, HIV status and year of diagnosis.

3. If case finding following intensified screening is increased, to quantify how many patients need to be screened for TB in PHC facilities to detect one case with active TB disease;

Chapter 4: Research Methodology

4.1 Study Design

The study design was a before and after study of changes in facility level TB case finding following implementation of an intensified TB screening strategy, by comparing data on patients screened and tested from the same facilities in 2015 and 2017. As the strategy was implemented in all facilities simultaneously, there were no control groups.

4.2 Study Population

The study population consisted of all patients five years and older seeking care at 82 City Health PHC facilities in Cape Town who were screened for active TB and registered in PREHMIS TB Identification Register for the period 2015 and 2017.

4.3 Sampling

No sampling was conducted and all the surveillance data on the system was used.

4.4 Data Collection

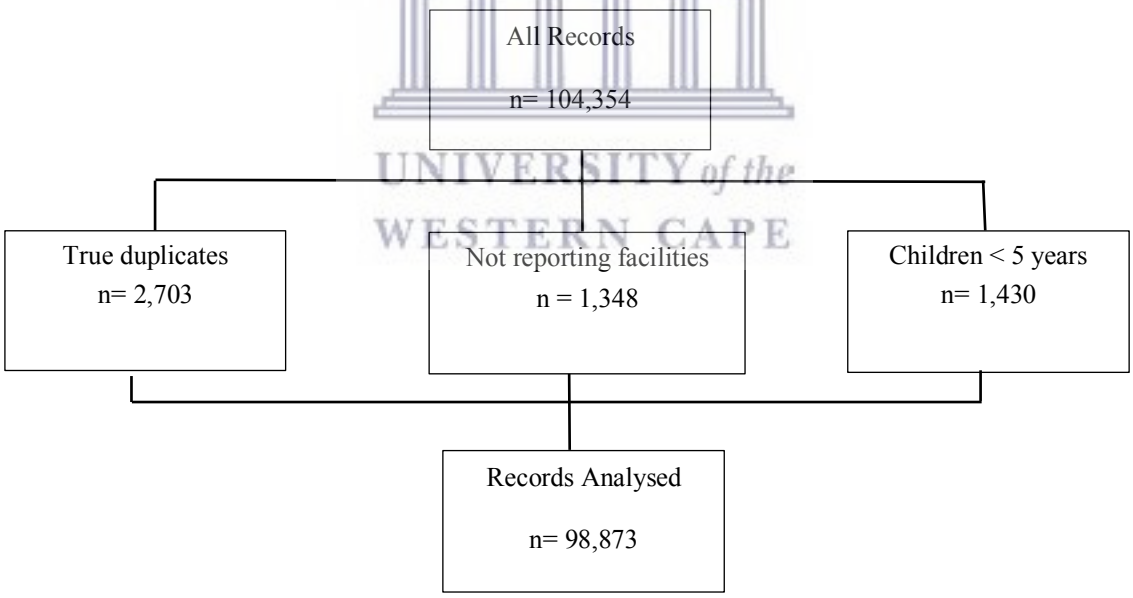
Data in PREHMIS are derived from patient information which are collected and recorded in standard PHC facility patient folders. Data fields in the electronic TB Identification Register are standardised and data elements are captured in the same sequence for each patient. This register allows for real time reporting of all presumptive TB cases and the outcomes of the sputum tests.

Data on PHC headcount five years and older and presumptive TB patients (from the electronic TB Identification register) were extracted from the back end of the PREHMIS electronic database per facility and per month for the period January to December in 2015 and 2017 in excel spread sheet formats. Individual patient information extracted from the TB Identification register included laboratory tested for TB, laboratory diagnosed for TB, commencement on TB treatment and age, gender, HIV status, and history of previous TB. Names were removed from the individual patient entries. Facility-level aggregated data by year were extracted for PHC headcount and number of patients screened for TB symptoms.

4.5 Pre-Analysis Data Cleaning

Extensive pre-analysis data cleaning was done. Data were imported from the PREHIMS (csv file format) into an Access database to identify potential duplicate records. Queries were performed to identify duplicate records using patient number, date of birth and gender and further refined using intake date and days between encounters. True duplicates were identified as matching on the above criteria and having intake dates of between 0-29 days apart. Using these criteria, 5,531 potential duplicates were identified out of a total of 104,354 records. The data were then exported back into Excel, and duplicates checked against facility name, laboratory results and care status. If there was evidence of a TB test result and patient was linked to care, the second record was deleted. A total of 2,703 duplicate records were deleted from the database. A further 1,348 records from PHC facilities who did not report data for both time periods of analysis were deleted. Finally, the 1,430 records of children under 5 years were removed.. A total of 98,873 records were thus available for analysis (Figure 2).

Figure 2 Data cleaning flow chart



The following data inaccuracies were identified and corrections made:

- 22 records with no gender assigned were changed to unknown
- 12,464 in which HIV status was not specified were changed to HIV status unknown
- 73 records where patient category was not assigned were changed to unknown
- 73 records which did not have TB laboratory results were changed to unknown

In order to conduct the analysis by sub-district, a column was added to the database and all PHC facilities were linked to a specific sub-district.

4.6 Analysis

The statistical analysis was conducted using STATA (version 14.2, StataCorp LP, College Station, Texas). Statistical support was provided by a qualified epidemiologist.

Descriptive analyses was done to compare baseline characteristics of the two patient cohorts. These were summarised as proportions for categorical variables, and medians with interquartile ranges (IQRs) for continuous variables. The indicators were analysed by year for 2015 and 2017. A chi square test was applied to test for differences in ratios and rates over the two time periods, per PHC facility and sub-district.

The total number and proportions were used to demonstrate the cascade of testing and treatment initiation using a simple flow diagram to demonstrate the proportion of PHC Headcount 5 years and older i) screened for TB symptoms, ii) screened positive for TB symptoms, iii) investigated, iv) diagnosed and v) commenced on TB therapy in PHC facilities.

Scatterplots were used to describe the correlation between case detection rates and percentage patients screened by facility for each period using Spearmans correlation coefficient.

Univariate and multivariate analysis was performed to determine associations between individual patient characteristics (age, having a history of previous TB, gender, HIV status, year of diagnosis). Odds ratios and 95% confidence intervals were calculated. Significance testing was performed using two sided P-values of <0.05. Forward selection methods were used to build the multivariate models and the log likelihood ratio test was used to compare nested models. The most appropriate model was chosen based on the log likelihood ratio test with the highest Chi squared value and a P-value < 0.05. The Akaikes Information Criterion (AIC) was used to compare non-nested models with the best model having the lowest AIC. The Pearson goodness-of-fit test was used to assess the overall fit of the models, with a P-value < 0.05 indicating good fit. Model diagnostics was performed to check the form of the linear predictor, the adequacy of the link function and identify any outlying or influential observations.

4.7 Indicators

The following outcome and process indicators were measured in each facility in 2015 and again in 2017.

4.7.1 Outcome Indicator

Indicator	Numerator	Denominator
Clients 5 years and older per 1000 PHC headcount initiated on TB treatment	Number clients 5 years and older initiated on TB treatment	Number PHC headcount 5 years and older

4.7.2 Process Indicators

Indicator	Numerator	Denominator
% PHC Headcount 5 years and older screened for TB	Number clients 5 years and older screened for TB symptoms	Number PHC headcount 5 years and older
% PHC Headcount 5 years and older screened positive for TB symptoms	Number clients 5 years and older identified with TB symptoms	Number clients 5 years and older screened for TB symptoms
% Client 5 years and older with TB symptoms laboratory tested for TB	Number clients 5 years and older with TB symptoms laboratory tested for TB	Number clients 5 years and older identified with TB symptoms
% Client 5 years and older with laboratory diagnosed TB	Number clients 5 years and older with laboratory diagnosed TB	Number clients 5 years and older with TB symptoms laboratory tested for TB
% Client 5 years and older diagnosed initiated on TB treatment	Number clients 5 years and older diagnosed initiated on TB treatment	Number clients 5 years and older with laboratory diagnosed TB

4.8 Validity

Measurement bias could have occurred as all the data fields in the electronic TB Identification Registers were not completed. This however was minimal and here were no notable differences in the completion rates in 2015 compared to 2017. These data are also regularly captured and updated for reports that are required at a city, provincial and national level thus indicative that the data needs to be verified, accurate and more complete.

All patients were screened using the standard WHO four-symptom TB questionnaire namely cough ≥ 2 weeks, fever, weight loss, and night sweats (WHO, 2011). All sputum tests were conducted at one regional laboratory that has strict internal quality assurance procedures to ensure uniformity and standardization. The laboratory follows a standardised testing algorithm; therefore all patients would have had the same probability of the same tests being conducted on samples submitted.

4.9 Reliability

Data fields in the presumptive TB register were standardised and data was captured in the same sequence and ordered manner for each client.

4.10 Generalizability

It is assumed that the adults attending facilities in 2015 and 2017 are representative of the population seeking care at City Health PHC facilities and the patient profile was similar those seeking care at MDHS facilities.

It was anticipated that the findings would have broader relevance as this research study could be generalised to other populations or groups in different PHC settings with a similar disease burden where patients are screened and tested for TB.

4.11 Limitations of Study

A limitation was that the existing variables in PREHMIS were pre-determined, and the researcher had minimal control on additional variables, such as reason for visit to PHC facility that could have added value to this study. A possible further limitation was that routine programmatic data was used which was not collected specifically for this study, thus certain variables may have been unavailable and data quality poor. Absence of control groups was a further limitation of this study. Changes in TB case finding could have been due to

background secular trends, for example in patient demand for testing or the result of other interventions.

4.12 Ethical Considerations

The data used in this analysis was routine data collected by the City Health. Data was extracted from PREHMIS. City Health are the custodians of patients accessing their services, hence prior to the extraction of the data and data analysis, permission was sought from City Health to use the data (Appendix 2).

This was a retrospective review of routine data and it was not feasible to retrace all individuals and obtain permission for the collection of the routine data. No personal identifiers were included in the data sets used for analysis and reporting. An application for a waiver of informed consent was sought from the UWC Biomedical Research Ethics Committee. Access to data was limited and every effort was made to protect the confidentiality of individual data. The data file was password protected and was stored on an external hard drive.

Ethics approval for this project was obtained from the UWC Biomedical Research Ethics Committee (Appendix 3). At the conclusion of this study, City Health will be provided with a full report on study findings.

Chapter 5: Results

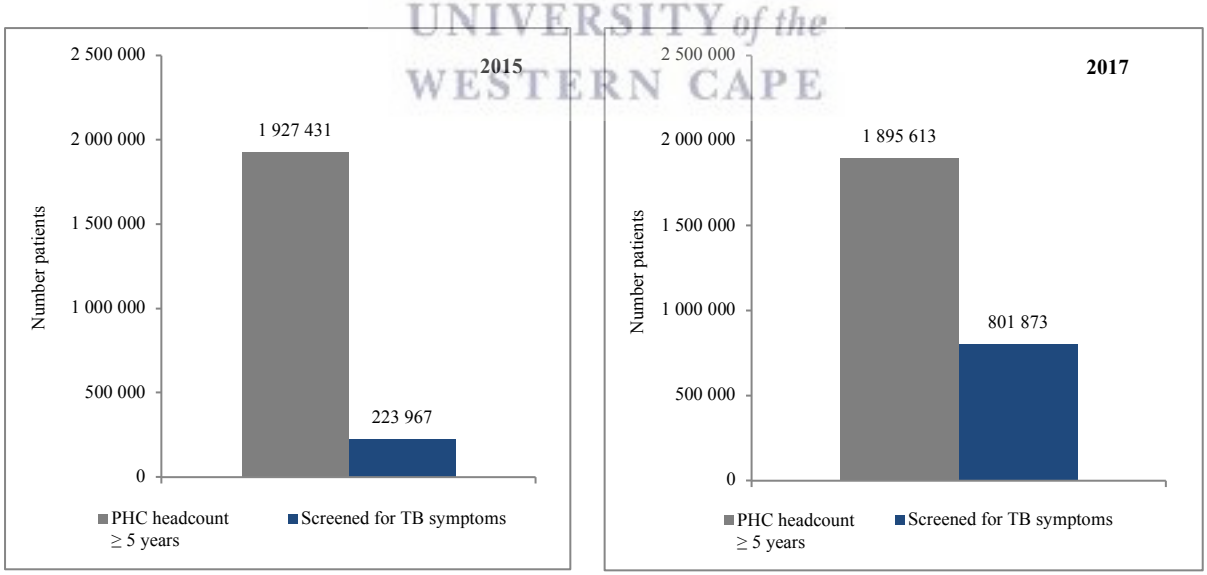
5.1 Introduction

Data were extracted from PREHMIS for 82 primary health care facilities for the periods 2015 and 2017. A total of 104,354 records were extracted of which 98,873 presumptive TB patient records (i.e. with positive TB symptom screen) were included in the analysis, 51,387 and 47,486 in the 2015 and 2017 cohorts, respectively.

5.2 TB Symptom Screen

Figure 3 shows the headcounts ≥5 years and the numbers reportedly screened for TB symptoms in 2015 and 2017, respectively. There was an overall 1.7% decline in the PHC headcount ≥5 years from 1,927,431 in 2015 to 1,895,613 in 2017 (Figure 1). There was a 3.5 fold increase in the PHC headcount ≥5 years screened for TB symptoms increased from 223,967 in 2015 to 801,873 in 2017 (11.6% versus 42.3%).

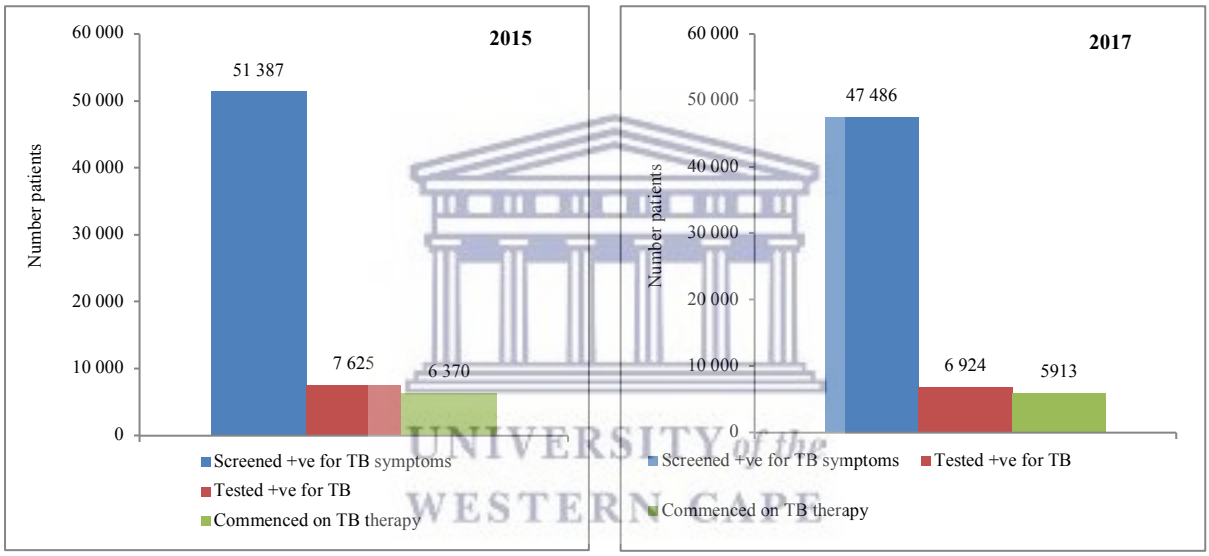
Figure 3 PHC headcount≥ 5 years and number who were screened for TB symptoms in 2015 and 2017 cohorts



Of the patients who had a TB symptom screen performed, 22.9% screened positive for TB symptoms in 2015 compared to 5.9% in 2017 (Figure 4). In both years, a high proportion of patients with a positive TB symptom screen had sputum samples obtained and sent for

testing: 99.3% in 2015 and 95.4% in 2017. Of all the presumptive TB patients who had sputum samples sent for testing in 2015, 7,625 had a positive sputum test for *MTB* on either Xpert *MTB*/RIF, TB smear or TB culture compared 6,924 in 2017 (14.9% versus 15.3%). Overall the number of patients with a positive sputum test declined by 9.2% over the two years. In 2015, 83.5% of the patients who had a sputum test positive for *MTB* were commenced on TB therapy, compared to 85.4% in 2017. Overall the number of patients initiated onto TB treatment declined by 7.2% over the two years.

Figure 4 Proportion screened positive for TB symptoms, investigated, diagnosed positive and commenced on TB therapy



5.3 Demographic Characteristics of Presumptive TB patients

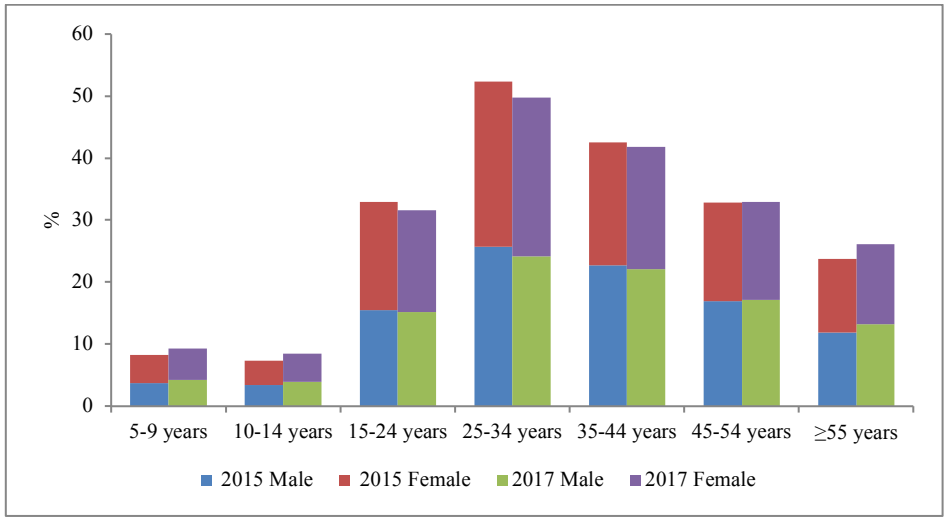
The baseline characteristics of the 2015 and 2017 presumptive TB case cohorts are compared in Table 5. There was a 7.6% decline in numbers of recorded presumptive TB patients in the two years. However, the overall profile of presumptive patients remained the same. Just over half (51.3%) of presumptive TB patients were male in both cohorts. HIV status was recorded for 94.2% of the patients, 23.3% of whom (n =23,103) were HIV positive. The median age of presumptive TB patients was 36 years (IQR 25-47). History of previous TB episodes was recorded for 96.2% of patients, 79.9% of whom (n= 79,014) had no history of a previous TB treatment episode.

Table 5 A comparison of baseline characteristics of presumptive TB patients in 2015 and 2017

	2015 cohort *n* (%)	2017 cohort *n* (%)
All patients	51,387 (51.9)	47,486 (48.0)
Sex		
Male	26,379 (51.3)	24,383 (51.3)
Female	25,004 (48.6)	23,086 (48.6)
HIV status		
HIV-positive	12,418 (24.1)	10,685 (22.5)
HIV-negative	36,090 (70.2)	34,059 (71.7)
HIV status unknown	2,879 (5.6)	2,742 (5.7)
Age, years, median (IQR)	36 (25-46)	36 (25-47)
Patient Category		
Unknown	1,452 (2.8)	2,318 (4.8)
New	42,118 (81.9)	36,896 (77.7)
Retreatment	7,726 (15.0)	8,185 (17.2)
Drug Resistant Contact	91 (0.1)	87 (0.1)

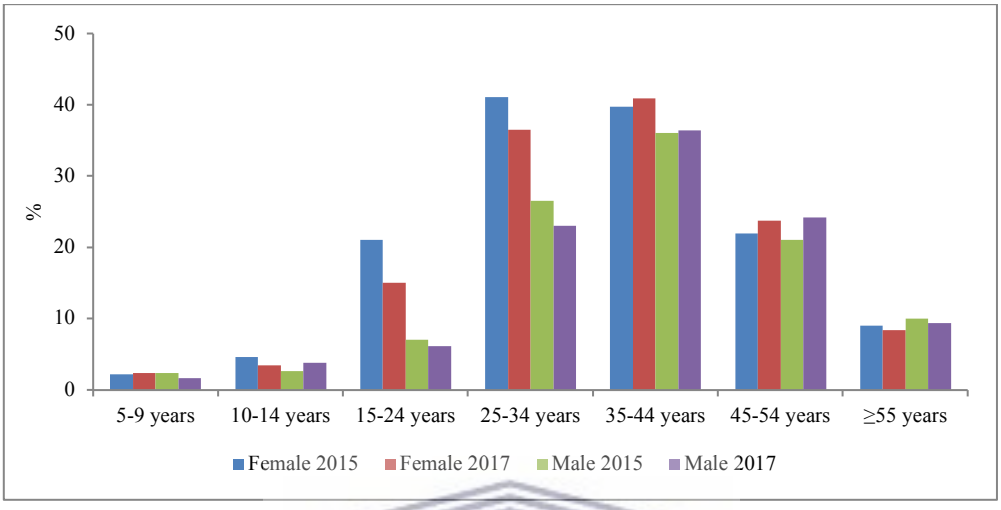
The presumptive TB patients spanned the entire age range. Figure 5 shows a comparison of the age categories and sex of presumptive TB patients in the 2015 and 2017 cohorts. The majority (79.2%) of all the presumptive TB patients were aged between 15 and 54 years (n= 78,326). A 2.8% decline was observed in these age categories between 2015 and 2017. The largest declines were in males and females aged 25- 34 years, with declines of 13.1% and 11.2% respectively. There was simultaneously a 10.2% increase in those 55 years and older. Eight percent (n= 8,246) of presumptive TB patients were aged between 5 and 14 years where a 13.7% increase was observed between 2015 and 2017.

Figure 5 Percentage age-sex distribution of presumptive TB patients in 2015 and 2017



A higher proportion of women in age categories 15-24 years and 25-34 years were HIV positive compared to males, equalising from 35 years onwards (Figure 6).

Figure 6 HIV positive status by age and sex of presumptive TB patients in 2015 and 2017



5.3.1 Demographic characteristics of presumptive TB patients by sub-district

There were similarities in the proportion of presumptive TB patients by sex across the sub-districts (Table 6). The most notable increase was observed in Klipfontein sub-district where there was a 36.7% increase in males in 2017 compared to 2015. The proportion of males versus females was significantly different (p=<0.001).

Table 6 A comparison of sex of presumptive TB patients in 2015 and 2017 by sub-district

	2015 cohort *n* (%)			*P* value	2017 cohort *n* (%)			*P* value
Sub-District	Male	Female	Unknown		Male	Female	Unknown	
Eastern	3,879 (51.7)	3,628 (48.3)	0		3,604 (51.9)	3,330 (48.0)	2 (0.03)	
Khayelitsha	1,705 (53.7)	1,466 (46.2)	0		2,591 (53.0)	2,291 (46.9)	1 (0.02)	
Klipfontein	2,592 (54.0)	2,202 (45.9)	0		2,760 (55.4)	2,225 (44.6)	1 (0.02)	
Mitchells Plain	4,014 (50.3)	3,969 (49.7)	0	<0.001	3,544 (50.5)	3,467 (49.4)	2 (0.03)	<0.001
Northern	3,565 (50.5)	3,488 (49.4)	2 (0.03)		2,261 (50.7)	2,192 (49.1)	3 (0.07)	
Southern	2,204 (52.3)	2,006 (47.6)	0		2,050 (52..3)	1,864 (47.6)	1 (0.03)	
Tygerberg	6,432 (49.5)	6,555 (50.4)	2 (0.02)		6,000 (48.6)	6,322 (51.2)	6 (0.05)	
Western	1,988 (54.0)	1,690 (46.0)	0		1,573 (53.0)	1,395 (47.0)	1 (0.03)	

There were significant variations in the proportion of presumptive TB patients who were HIV positive across the sub-districts (Table 7). Almost half of the presumptive TB patients in Khayelitsha were HIV positive compared to Tygerberg sub-district where only 13% were HIV positive. A 61.4% increase in HIV positive presumptive TB patients was observed in Khayelitsha sub-district between 2015 and 2017, In all other sub-districts declines in the percentage of HIV positive presumptive TB patients was observed, most notably a decline of 52.4% was noted in Northern sub-district. The proportion of HIV positive versus HIV negative patients was significantly different (p=<0.001).

Table 7 A comparison of HIV status of presumptive TB patients in 2015 and 2017 by sub-district

	2015 cohort *n* (%)			*P* value	2017 cohort n (%)			*P* value
Sub-District	HIV+ve	HIV-ve	Unknown		HIV+ve	HIV-ve	Unknown	
Eastern	2,038 (27.2)	5,239 (69.8)	230 (3.0)	<0.001	1,627 (23.5)	5,034 (72.6)	275 (3.9)	<0.001
Khayelitsha	1,511 (47.7)	1,546 (48.7)	114 (3.6)		2,438 (49.9)	2,277 (46.6)	168 (3.4)	
Klipfontein	853 (17.8)	3,556 (74.2)	385 (8.0)		872 (17.5)	3,634 (72.9)	480 (9.6)	
Mitchells Plain	1,509 (18.9)	6,094 (76.3)	380 (4.8)		1,307 (18.6)	5,363 (76.5)	343 (4.9)	
Northern	2,722 (38.6)	3,885 (55.1)	448 (6.3)		1,296 (29.1)	2,876 (64.5)	284 (6.4)	
Southern	999 (23.7)	3,069 (72.9)	142 (3.4)		813 (20.8)	2,962 (75.7)	140 (3.5)	
Tygerberg	1,763 (13.6)	10,256 (78.9)	970 (7.5)		1,619 (13.1)	9,974 (80.9)	735 (6.0)	
Western	1,023 (27.8)	2,445 (66.5)	210 (5.7)		713 (24.0)	1,939 (65.3)	317 (10.7)	

There were variations in the proportion of presumptive TB patients who had a recorded history of previous TB treatment episodes across the sub-districts (Table 8) comparing 2015 to 2017. Increases were observed in Khayelitsha (140.5%), Klipfontein (6.7%), Southern (29.4%) and Tygerberg (32.3%). The proportion of new versus retreatment patients was significantly different (p=<0.001).

Table 8 A comparison of patient category of presumptive TB patients in 2015 and 2017 by sub-district

	2015 cohort *n* (%)				*P* value	2017 n (%)				*P* value
Sub-District	Unknown	New	ReRx	DR-TB contact		Unknown	New	ReRx	DR-TB contact	
Eastern	83 (1.1)	5,929 (79.0)	1,480 (19.7)	15 (0.2)		300 (4.3)	5,310 (76.5)	1,322 (19.0)	4 (0.1)	
Khayelitsha	25 (0.8)	2,623 (82.7)	511 (16.1)	12 (0.4)		326 (6.7)	3,314 (67.8)	1,229 (25.1)	14 (0.3)	
Klipfontein	23 (0.5)	3,873 (51.2)	896 (18.7)	2 (0.04)		335(6.7)	3,692 (74.0)	956 (19.1)	3 (0.1)	
Mitchells Plain	443 (5.5)	6,268 (78.5)	1,259 (15.7)	13 (0.2)	<0.001	309 (4.4)	5,559 (79.2)	1,140 (16.3)	5 (0.1)	<0.001
Northern	142 (2.0)	5,629 (79.8)	1,265 (18.0)	19 (0.2)		212 (4.7)	3,490 (78.3)	751 (16.8)	3 (0.1)	
Southern	217 (5.1)	3,738 (89.0)	252 (6.0)	3 (0.1)		105 (2.7)	3,472 (88.7)	326 (8.3)	12 (0.3)	
Tygerberg	439 (3.4)	10,883 (83.8)	1,644 (12.6)	23 (0.2)		558 (4.5)	9,553 (77.5)	2,175 (17.6)	42 (0.4)	
Western	80 (2.2)	3,175 (86.3)	419 (11.4)	4 (0.1)		173 (5.8)	2,506 (84.4)	286 (9.6)	4 (0.1)	

5.4 Positive test for Mycobacterium Tuberculosis

Positive *MTB* test results by test type are shown in Table 9. Of the 14,549 presumptive TB patients who tested positive for *MTB* in the two years, 88.3% (n=12,848) had a positive sputum test for *MTB* on Xpert *MTB*/RIF, of whom 3.4% (n=488) tested *MTB*/RIF resistant.

Table 9 Proportion of presumptive TB patients ≥5 years who were sputum test positive by test type in 2015 and 2017

	2015 cohort *n* (%)	2017 cohort *n* (%)
Tested positive for TB	7,625	6,924
Xpert *MTB*/RIF sensitive	6,386 (83,7)	5,917 (85.5)
Xpert *MTB*/RIF inconclusive	37 (0,5)	20 (0.3)
Xpert *MTB*/RIF resistant	279 (3,7)	209 (3.0)
TB smear positive	372 (4,9)	331 (4.8)
TB culture positive	551 (7,2)	447 (6,5)

Positive *MTB* test results are shown in Table 10. Just under two thirds of presumptive TB patients who tested positive for *MTB* were male (60.8%). Between 2015 and 2017 the proportion of males and females was not significantly different (p=0.132). The HIV prevalence of TB patients was 33.9%. Between 2015 and 2017 the proportion of HIV positive and HIV negative was significantly different (p=<0.001). The majority (55.1%) who tested positive for *MTB* were in the age group 25- 44 years (n= 8,037). There was an 11.9% increase in patients who have a recorded history of previous TB treatment episodes. Between 2015 and 2017 the proportion of new and retreatment patients was significantly different (p= <0.001). A 11.7% decline was noted amongst females and a 12.4% decline in age groups 15-34 years between 2015 and 2017; these are consistent with declines reported in patients aged 25- 34 years (Figure 5). Between 2015 and 2017 the proportion of patients by age category was not significantly different (p=<0.092). There was a 14.7% decline in HIV positive patients between 2015 and 2017 and this reflects the higher proportion of women in age categories 15-34 years were HIV positive compared to males (Figure 6).

Table 10 Percentage presumptive TB patients tested positive for TB by sex, HIV status, patient category and age category in 2015 and 2017

	2015 cohort *n* (%)	2017 cohort *n* (%)	*P* value
Sex			
Male	4,601 (60.3)	4,253 (61.4)	0,132*
Female	3,024 (39.6)	2,669 (38.5)	
HIV status			
HIV-positive	2,662 (34.9)	2,271 (32.8)	
HIV-negative	4,639 (60.8)	4,285 (61.8)	<0.001*
HIV status unknown	324 (4.2)	368 (5.3)	
Patient Category			
Unknown	158 (2.0)	53 (0.7)	
New	5,966 78.2)	5,203 (75.1)	
Retreatment	1,475 (19.3)	1,651 (23.8)	<0.001*
Drug Resistant Contact	26 (0.3)	17 (0.2)	
Age Categories			
5-9 years	28 (0.3)	28 (0.4)	
10-14 years	97 (1.2)	98 (1.4)	
15-24 years	1,480 (19.4)	1,263 (18.2)	
25-34 years	2,385 (31.2)	2,122 (30.6)	0,092*
35-44 years	1,826 (23.9)	1,704 (24.6)	
45-54 years	1,218 (15.9)	1,089 (15.7)	
≥55 years	591 (7.7)	620 (8.9)	

* chi squared: difference between 2015 and 2017 by sex, HIV status, patient category and age categories

5.5 Presumptive TB patients tested positive for TB commenced on TB treatment

Of the presumptive TB patients who tested positive for TB, 84.4% (n= 12,283) commenced TB treatment with 15.3% (n=2,224) lost to follow-up (Table 11). Between 2015 and 2017 the proportion of patients LTFU, died and on TB treatment was significantly different (p=0.007)

Table 11 Percentage presumptive TB patients tested positive for TB by care status in 2015 and 2017

	2015 cohort *n* (%)	2017 cohort *n* (%)	*P* value
LTFU	1,234 (16.1)	990 (14.3)	
Died	21 (0.28)	21 (0.30)	0.007
On TB Rx	6,370 (83.5)	5,913 (85.4)	

Table 12 shows the rates of lost to follow-up between males and females, there was no significant difference in the rates of lost to follow-up when comparing females to males in 2015 (p=0.731) and 2017 (p=0.962).

Table 12 Percentage presumptive TB patients tested positive for TB lost to follow-up by sex in 2015 and 2017

	2015 n (%)			*P* value	2017 n (%)			*P* value
	LTF	Died	On TB Rx		LTF	Died	On TB Rx	
Male	749 (16,28)	11 (0,24)	3,841 (83,48)	0.731*	601 (14,13)	13 (0,31)	3,639 (85,56)	0.962*
Female	485 (16,04)	10 (0,33)	2,529 (83,63)		389 (14,57)	8 (0,30)	2,272 (85,13)	

* chi squared: difference between sexes

5.6 Case Detection Rates

In 2015, one patient with active TB disease was detected for every 29 patients screened. In 2017, one active TB patient was detected for every 116 patients screened. Despite the increased screening, the case detection rate per 1,000 PHC headcount ≥5 years declined slightly from 4.0 in 2015 to 3.7 in 2017.

There were wide disparities in case detection rates between the health sub-districts in 2015 (Table 13) compared to 2017 (Table 14). Khayelitsha had the highest number of patients testing positive for TB in both 2015 and 2017 however had the lowest case detection rates. Northern sub-district had a similar number of patients testing positive for TB compared to Khayelitsha, however had the highest case detection rates overall.

Overall all sub-districts increased the PHC headcount ≥5 years screened for TB in 2017 compared to 2015; however all sub-districts reported a decline in the number of patients screened positive for TB symptoms in 2017 compared to 2015, with the exception of Khayelitsha and Klipfontein who reported 54% and 4% increases respectively. All sub-districts reported declines in those tested positive in 2017 compared to 2015, with the exception of Khayelitsha and Klipfontein who reported 63.1% and 12.3% increases respectively.

Western sub-district and Northern sub-district had to screen 7.6 and 6.2 times more patients to detect one patient with active TB disease in 2017 compared 2015, where Khayelitsha sub-district only had to screen 1.4 times more patients to detect one patient with active TB disease. Similarly, all sub-districts reported declines in case detection rates in 2017 compared to 2015, with the exception of Khayelitsha and Klipfontein who reported 0.9% and 1% increases respectively.

Table 13 Screening, testing and TB case detection rate per 1,000 PHC headcount ≥5 years by health sub-district in 2015

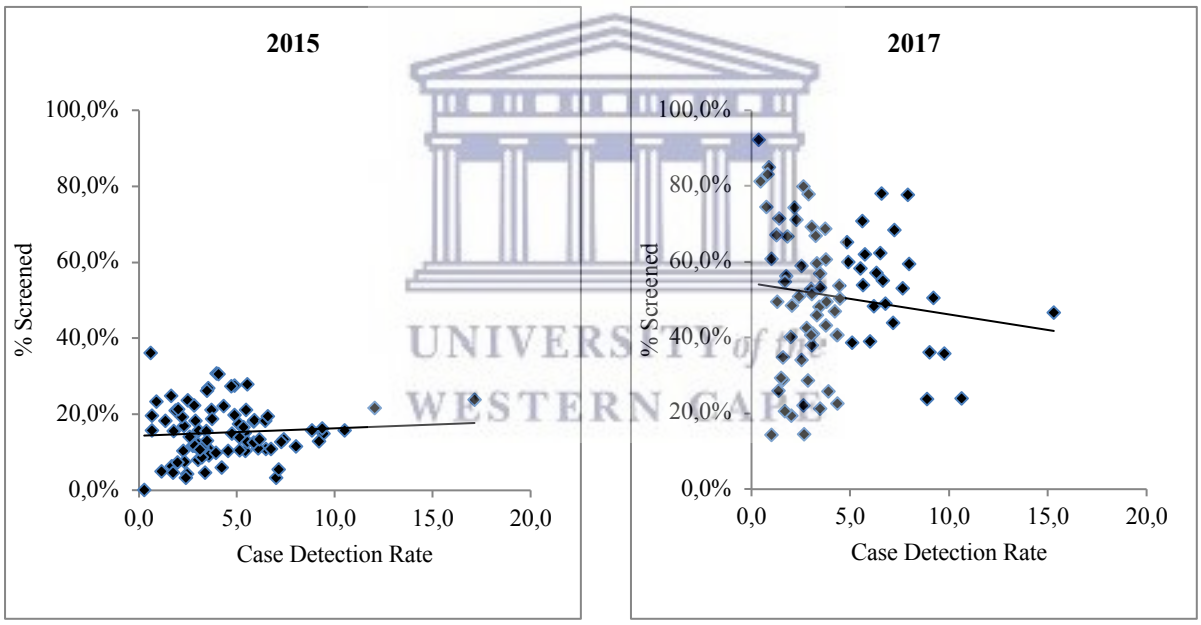
	2015										
	PHC headcount ≥ 5 years	Screen for TB symptoms ≥5 years		Screened +ve for TB symptoms		Investigated for TB		Tested +ve for TB		Commenced on TB therapy		Case detection rate
Eastern	258 528	30 129	11,7%	7 507	24,9%	7 462	99,4%	1 214	16,3%	1 082	87,5%	4,7
Khayelitsha	330 087	34 310	10,4%	3 171	9,2%	3 153	99,4%	575	18,2%	457	76,5%	1,7
Klipfontein	188 954	29 467	15,6%	4 794	16,3%	4 772	99,5%	734	15,4%	605	80,9%	3,9
Mitchells Plain	325 308	38 226	11,8%	7 983	20,9%	7 924	99,3%	1 206	15,2%	1 023	83,5%	3,7
Northern	169 265	19 463	11,5%	7 055	36,2%	6 990	99,1%	1 094	15,7%	905	80,1%	6,5
Southern	210 818	24 376	11,6%	4 210	17,3%	4 180	99,3%	657	15,7%	545	82,5%	3,1
Tygerberg	246 422	32 890	13,3%	12 989	39,5%	12 896	99,3%	1 518	11,8%	1 173	75,8%	6,2
Western	198 049	15 106	7,6%	3 678	24,3%	3 669	99,8%	627	17,1%	580	92,7%	3,2

Table 14 Screening, testing and TB case detection per 1,000 PHC headcount ≥5 years by sub-district in 2017

	2017										
	PHC headcount ≥ 5 years	Screen for TB symptoms ≥5 years		Screened +ve for TB symptoms		Investigated for TB		Tested +ve for TB		Commenced on TB therapy		Case detection rate
Eastern	247 721	107 037	43,2%	6 936	6,5%	6 688	96,4%	1 016	15,2%	901	89,0%	4,1
Khayelitsha	361 585	77 259	21,4%	4 883	6,3%	4 588	94,0%	938	20,4%	655	69,6%	2,6
Klipfontein	169 007	87 030	51,5%	4 986	5,7%	4 658	93,4%	824	17,7%	714	87,4%	4,9
Mitchells Plain	314 058	126 039	40,1%	7 013	5,6%	6 701	95,6%	1 034	15,4%	935	91,0%	3,3
Northern	164 127	93 699	57,1%	4 456	4,8%	4 265	95,7%	852	20,0%	767	92,0%	5,2
Southern	197 206	110 300	55,9%	3 915	3,5%	3 807	97,2%	517	13,6%	463	90,3%	2,6
Tygerberg	254 579	116 110	45,6%	12 328	10,6%	11 797	95,7%	1 284	10,9%	1067	84,2%	5,0
Western	187 330	84 399	45,1%	2 969	3,5%	2 821	95,0%	459	16,3%	411	90,0%	2,5

The scatterplot (Figure 7) shows the correlation between percentage PHC headcount ≥5 years screened for TB symptoms and case detection rate per 1,000 PHC headcount in 82 PHC facilities in 2015 and 2017 (Appendix 4). There was no significant linear association between percentage screened for TB symptoms and case detection rate in 2015 (r=0.064; p=0.568) or in 2017 (r=-0.124; p=0.268). In 2015 screening levels ranged from 3% to 36% with case detection rates ranging from 0.3 to 17, with most screening clustered at less than 20% and case detection rates less than 8. In 2017 screening levels ranged from 14% to 92% with case detection rates ranging from 0.4 to 15, with most screening clustered between 40% to 60% and case detection rates remaining at less than 8.

Figure 7 Correlation between % PHC headcount ≥5 years screened for TB symptoms and case detection rate per 1,000 PHC headcount in 2015 and 2017



5.7 Multivariate analysis of factors associated with a diagnosis of active TB

Multivariate logistical regression analysis was done to determine if there was an association of a diagnosis of active TB identified with individual patient variables (sex, HIV status, age, history of previous TB and year of diagnosis), sub-district as a group level variable, and year of screening. Results of univariable and multivariable analyses are shown in Table 15.

Table 15 Univariable and multivariable analyses of factors associated with a diagnosis of active TB

	Univariable		Multivariable	
Characteristic	OR (95%CI)	P value	aOR (95%CI)	P value
Sex				
Male	1,55 (1.49 - 1.61)	<0.001	1.59 (1.53 - 1.65)	<0.001
Female	1		1	
Unknown	0.79 (0.18 - 3.42)	0.755	1.00 (0.22 - 4.43)	0.990
HIV status				
HIV-positive	1.94 (1.87 - 2.02)	<0.001	1.65 (1.58 - 1.72)	<0.001
HIV-negative	1		1	
HIV status unknown	0.99 (0.91 - 1.08)	0.958	0.98 (0.90 - 1.07)	0.002
Age Categories				
5-9 years	0.06 (0.46 - 0.79)	<0.001	0.76 (0.58 - 0.99)	<0.001
10-14 years	0.23 (0.20 - 0.27)	<0.001	0.28 (0.24- 0.33)	<0.001
15-24 years	0.95 (0.90 - 1.00)	0.094	1.10 (1.04 - 1.16)	<0.001
25-34 years	1		1	
35-44 years	0.93 (0.88 - 0.98)	0.006	0.85 (0.81 - 0.90)	<0.001
45-54 years	0.74 (0.70 - 0.79)	<0.001	0.75 (0.71 - 0.79)	<0.001
≥55 years	0.49 (0.46 - 0.52)	<0.001	0.54 (0.50 - 0.58)	<0.001
Patient Category				
Unknown	1.08 (0.93 - 1.25)	0.295	0.99 (0.85 - 1.16)	0.999
New	1		1	
Retreatment	1.49 (1.42 - 1.55)	<0.001	1.30 (1.24 - 1.36)	<0.001
Drug Resistant Contact	2.12 (1.49 - 3.02)	<0.001	1.97 (1.38 - 2.83)	<0.001
Year				
2015	1		1	
2017	1.02 (0.98 - 1.05)	0.262	1.03 (0.99 - 1.07)	0.063
Sub-District				
Eastern	1.38 (1.30 - 1.46)	<0.001	1.24 (1.16 - 1.32)	0.001
Khayelitsha	2.14 (1.99 - 2.29)	<0.001	1.62 (1.50 - 1.74)	<0.001
Klipfontein	1.52 (1.42 - 1.62)	<0.001	1.44 (1.34 - 1.54)	<0.001
Mitchells Plain	1.38 (1.30 -1.46)	<0.001	1.32 (1.24 - 1.40)	<0.001
Northern	1.60 (1.50 - 1.70)	<0.001	1.37 (1.28 - 1.46)	<0.001
Southern	1.29 (1.20 -1.39)	<0.001	1.23 (1.14 - 1.32)	<0.001
Tygerberg	1		1	
Western	1.52 (1.41 - 1.64)	<0.001	1.37 (1.27 - 1.48)	0.049

Being male, HIV positive, history of previous TB treatment episodes and being a contact of a known drug resistant TB index case were all associated with a diagnosis of active TB disease on univariate and multivariate analysis.

The probability of a diagnosis of active TB was similar in age category 15-24 years and 25-34 years. Presumptive TB patients in age category 10-14 years (aOR 0.28 , 95% CI, 0.24-0.33, *p*=<0.001)were the least likely to have a diagnosis of active TB disease as compared to the age category 25-34 years.

Presumptive TB patients with a history of previous treatment episodes were 30% (95% CI, 1.24 - 1.36, *p*=<0.001) more likely to have a diagnosis of active TB disease compared to presumptive TB patients who have never had a previous TB treatment episode. Presumptive TB patients who had contact with a confirmed drug resistant index patient were 97% (95% CI, 1.38 - 2.83, *p*=<0.001) more likely to have a diagnosis of active TB disease compared to presumptive TB patients who have never had a previous TB treatment.

There was no difference in the likelihood of a diagnosis of active TB disease when comparing by year of diagnosis (aOR 1.03, 95% CI, 0.99 – 1.07, *p*= 0.063).

In the multivariate analysis the likelihood of presumptive TB patients having a diagnosis of active TB was similar across sub-districts, with the exception of Khayelitsha Sub-District where it was 62% (95% CI, (1.50 – 21.74, *p*=<0.001) more likely compared to Tygerberg Sub-District.

Chapter 6: Discussion

6.1 Discussion

The purpose of this study was to evaluate if the strategy implemented by City Health to systematically screen all people who seek health care at PHC facilities, regardless of their risk profile or reasons for presenting to health services, for active TB disease has translated into increased TB testing, diagnosis and treatment of undiagnosed incident cases and averted missed opportunities to diagnose TB. The study assessed changes from 2015 to 2017 of a large sample in a real world setting in the context of a service provision profile consisting of mainly HIV and TB treatment and other preventive health services.

6.1.1 Case Detection

Despite, very big increases in reported screening rates, from 11.6% to 42.3%, presumptive cases identified and overall case detection in fact decreased over the period (the latter from 4.0 per 1,000 PHC headcount ≥ 5 years in 2015 to 3.7 in 2017). The data from individual facilities and sub-districts showed variable uptake rates but no consistent pattern (up or down) of presumptive or confirmed cases with increased screening. Although not statistically significant, increased screening rates appeared to be associated with decreased levels of case detection.

As levels of case detection remained similar, a possible interpretation could be that as overall incidence of TB is declining in Cape Town; the screening has played a role in maintaining case detection rates. Hermans et al. (2015) reported that in Cape Town as ART coverage increased TB notification rates and TB incidence declined and that decreases were highest in HIV positive populations. A possible further explanation could be that protocols and procedures have been implemented to systematically screen PLWH for active TB at each visit to a PHC facility and that there is limited additional value of screening all other patients attending PHC services for other preventive services.

None of the studies reviewed reported case detection per 1,000 PHC headcount, but rather as a proportion of those screened for TB symptoms. In Botswana (Bloss, et al., 2012) and Johannesburg (Van Rie, et al., 2014) reported a 0.2% and a 0.4% case detection rate of all patients screened whilst this study found a case detection rate of 1.4% amongst patients screened.

In good screening programmes, about 10% of sputum samples collected from presumptive TB patients should be sputum-confirmed. Rates of bacteriologically confirmed TB were 14.9% in 2015 and 15.3% in 2017. These were much higher compared to recent studies conducted in Swaziland (Uplekar et al., 2013), Botswana (Bloss, et al., 2012) and Johannesburg (Van Rie, et.al, 2014) which reported rates of 8.4%, 2.1% and 8% of bacteriologically confirmed TB respectively.

There were variable rates of bacteriologically confirmed TB between the sub-districts, ranging from 18.8% in Khayelitsha to 11.1% in Tygerberg. The multivariable logistic regression analysis showed that the odds of having a diagnosis of active TB disease was 1.94 fold higher amongst presumptive TB patients in Khayelitsha. Of interest is that in Northern sub-district the rates of bacteriologically confirmed TB (16.9%) were similar to those of Khayelitsha, however the case detection rate was 5.8 per 1,000 PHC headcount ≥ 5 years compared to only 2.1 in Khayelitsha. This could reflect different patient profiles and public sector utilisation patterns, or alternatively, insufficient screening in Khayelitsha, a sub-district profiled by high rates of HIV and TB prevalence as well as the added burden of high levels of social deprivation.

In South Africa, all PHC clinic attendees are required to have a TB symptom screen at entry. However, it is possible that large scale symptom screening in PHC clinics may negatively impact the quality of symptom screening that takes place. Massyn et al. (2017) reported that in 2016/17 nationally the TB symptom ≥5 years screened in facility rate was 51.6%. However, there was no evidence that this resulted in an increase in the identification of cases with active TB disease. As with the City Health PHC facilities, in the absence of a counterfactual (controls) it is uncertain if case detection rates would have declined even further should the "universal" screening strategy have not been implemented.

Another possible explanation is that "universal" screening independent of symptomatology of all people seeking health care at PHC facilities has diluted the effect of prior screening strategies. Several studies have reported low sensitivity to the four question TB screening tool recommended by WHO. Claassens et al. (2017) reported that results from the ZAMSTAR study found that the sensitivity of using only cough >2 weeks as a screening rule was less than 25% in both SA and Zambia. Studies have suggested that many TB patients

who are minimally symptomatic symptom-driven TB screening may be an insufficient case finding tool (Van Schalkwyk, et al., 2018).

6.1.2 Factors associated with a diagnosis of active TB

Being male, HIV positive, history of previous TB treatment episodes and being a contact of a known drug resistant TB index case were all associated with a diagnosis of active TB disease on univariate and multivariate analysis.

6.1.2.1 Sex

Gender differentials in TB have been reported worldwide. WHO Global Report (2017) estimated that globally men accounted for 65% of incident cases of TB. In this study just over half (51.3%) of presumptive TB patients were male in both cohorts. The multivariable logistic regression analysis showed that the odds of having a diagnosis of active TB disease was 1.59 fold higher amongst males. This is similar to findings from a study conducted in South-Western Uganda, where it was reported that the TB prevalence was higher among males than females with presumptive TB and that the increased risk of TB among males was independent of other TB risk factors (Boum, et al., 2014). These findings emphasize the need for gender focused interventions aimed at reducing TB transmission.

6.1.2.2 HIV+ve

International Standards for TB Care (2014) recommend that HIV testing should be done on all patients suspected of or with TB particularly in areas with high HIV prevalence as TB is an important gateway to HIV care and is a major presenting opportunistic infection in the majority of HIV positive patients with low CD4 counts. In HIV positive patients ART reduces individual TB risk by two-thirds, however patients on ART remain at an advanced risk for recurrent TB due to partial immune restoration.

The multivariable logistic regression analysis showed that the odds of having a diagnosis of active TB disease were 1.65 fold higher in HIV positive presumptive TB patients. There was a high uptake of HIV testing with 94.2% of the presumptive patients having HIV status recorded and of whom 23.3% were HIV positive. Results from two separate Indian studies reported much lower rates of known HIV status of 44.6% and 68% and of whom 3.3% and 8% were HIV positive respectively (Palanivel, et al., 2013 & Kumar, et al., 2017).

It is unknown what proportion of the patients who were HIV positive were on ART and what proportion had HIV status confirmed by point of care testing at the time of being investigated for TB. Patients with HIV associated tuberculosis have asymptomatic disease or very minor symptoms and this could account for why the proportion of HIV positive presumptive TB patients is lower than reported in the TB treatment programme where it has been reported that just less than 50 % of patients on TB treatment in Cape Town are HIV positive (Hermans, et al., 2017). In the same study it was reported that 28% of HIV positive patients were commenced on TB treatment empirically, suggesting that potentially in large proportion of HIV positive patients a diagnosis of active TB disease is missed through routine TB symptom screening.

6.1.2.3 Age

Ages of presumptive TB clients spanned the entire range and were similar in both cohorts. The majority (79.2%) of all the presumptive TB patients were aged between 15 and 54 years, with only 8.2% of presumptive TB patients aged between 5 and 14 years and 12.4% being ≥55 years. In the regression analysis the probability of a diagnosis of active TB was similar in age categories 15-24 years and 25-34 years.

A significantly higher proportion of women in age categories 15-24 years and 25-34 years were HIV positive compared to males. This is consistent with age distribution reported by Statistics South Africa (2017) who reported that one-fifth of South African women in their reproductive ages (15-49 years) are HIV positive, with the prevalence highest among women aged 25-34 and women in the teenage population were eight times that of their male equivalents.

6.1.2.4 Patient Category

There is evidence from tuberculosis high-burden settings that exogenous reinfection contributes considerably to recurrent disease. Relapse occurred early after treatment completion, whereas reinfection dominated after one year and accounted for at least half of recurrent disease (Marx, et al., 2014). Hermans et al. (2017) reported in Cape Town rates of 30% previously treated from TB treatment programme data. The multivariate regression analysis showed that the odds of having a diagnosis of active TB disease was 1.30 fold higher in TB presumptive patients with a history of previous TB treatment episodes. It was

surprising to note that only 16% of presumptive TB patients had a recorded history of a previous TB treatment episode. Similar rates of previous history of TB episodes were reported amongst presumptive TB patients testing positive in a study conducted by Kweza et al. (2018). A possible explanation could be poor history taking of previous TB treatment episodes amongst presumptive TB patients or failure of patients to disclose previous TB treatment episodes.

The odds of having a diagnosis of active TB disease were 1.97 fold higher in presumptive TB who had a recorded history of contact with known drug resistant TB index case. Kweza et al. (2018) reported that amongst presumptive TB patients who tested positive 7.7% reported as having a current contact and 18% reported contact within the past year. In a recent study conducted it was found there was TB prevalence of 3.9% amongst close household contacts of recently diagnosed TB index patients. This study reported that symptom screening among household contacts had low sensitivity and specificity for active TB (Little et al., 2018). Data from a study in Brazil suggested that the prevalence of tuberculous infection and progression to active TB among household contacts exposed to drug sensitive and drug resistant cases were comparable, despite a longer duration of exposure of contacts to drug resistant TB index cases (Teixeira et al., 2001). Close contacts of known TB index patients are a specific high risk group and consideration could be given to exploring alternative methods of screening this group.

6.1.2.5 Investigated for TB

Naidoo et al (2017) estimated that about 13% of all cases were lost between TB testing and diagnosis and asserted that this was partly due to failure to comply with diagnostic algorithms. Results from a study conducted by Kweza et al. (2018) in Eastern Cape reported that about half of the study participants visited the clinics because of their TB symptoms; 80% of them reported that they were screened for TB in the clinic, but only 18% submitted a sputum sample to the clinic staff.

The findings from this study found that patients with a positive TB symptom screen were highly likely (97.5%) to have sputum samples obtained and sent for testing and only 5% of those tested did not have a test result recorded. Of the outstanding results, it is unknown what proportion of these outstanding results tested positive or whether results were indeed obtained and acted on by clinicians. In this study it is unknown how many patients who had a positive

TB symptom screen in PHC facilities were not recorded in the TB identification register and thus not tested and it could be speculated that rates of lost to follow up between a positive screening test and testing is much higher.

In South Africa, sputum smear microscopy has been replaced with Xpert *MTB*/RIF as the initial diagnostic test for TB in people who report at least one positive TB symptom on the WHO screening tool. A further observation by Naidoo et al. (2017) found that in South Africa <60% of presumptive TB patients received an Xpert *MTB*/RIF test and the remainder were tested with less sensitive smear microscopy. Churchyard et al. (2015) compared the effect Xpert *MTB*/RIF with fluorescence microscopy and noted a 50% higher rate of presumptive TB patients with bacteriological confirmation of TB in the Xpert *MTB*/RIF group.

There was exceptional adherence to testing algorithms with 88% of presumptive TB patients receiving an Xpert *MTB*/RIF test; the remaining 11.7% were tested by smear microscopy and/or TB culture. The local diagnostic algorithm applied in this setting advocates that patients with a recent history of TB disease (≤ 2 years) should not have a diagnostic TB test using Xpert *MTB*/RIF as there is a likelihood of a false positive test result and should be tested by smear microscopy and culture. The local diagnostic algorithm not to use Xpert *MTB*/RIF test in patients with a history of a recent previous TB treatment episode is supported by findings from a study conducted by Theron et al. (2018) which found the specificity of Xpert *MTB*/RIF to be lower in patients with a recent history of previous TB. A limitation of this study was that although history of previous TB episodes was recorded, it was not recorded how recent this previous episode was and thus explain why there was not a greater concordance with the local diagnostic algorithm.

6.1.2.6 Initial Lost to Follow Up

An initial lost to follow up (ILTFU) is someone who has been diagnosed with sputum-confirmed PTB, but has no record of having started treatment so remains an infection risk for others (Harries, et al., 2009). Pre-treatment ILTFU can hinder TB control efforts and is a concern for TB programmes globally as the TB burden will not be reduced if patients diagnosed with TB are not started on treatment. Rapid case identification of individuals with sputum positive TB and rapid initiation of anti-tuberculosis chemotherapy are key to controlling TB.

In a systematic review and meta-analysis conducted by MacPherson et al. (2013) it was reported pre-treatment ILTFU rates from the various studies varied from 4.0% to 38.0% and was common in studies from Africa. Naidoo et al. (2017) estimated in TB care cascade in South Africa that 12.0% of patients did not initiate treatment. This study found the pre-treatment ILTFU rates were similar in both cohorts with 15.3% of presumptive TB patients ILTFU. There is no significant difference in the rates of lost to follow-up when comparing females (15.4%) to males (15.3%).The frequency of ILTFU was not uniform in all sub-districts with 8.2% in the Western sub-district and 26.4% in Khayelitsha sub-district. These findings are similar to a study conducted by Cele et al. (2016) conducted in KwaZulu Natal which found ILTFU occurred in 17.9 % of PTB cases and that there was no significant difference males and females and the frequency of ILTFU was not uniform in all sub-districts It reported that of the 16.0% of ILTFU who were traced, 53% had died before commencement of TB treatment. High rates of ILTFU (38%) were reported from a study in Ghana where sputum positive TB patients, diagnosed in the laboratory were never start anti-TB treatment (Afutu, et al., (2012).

Reductions in pre-treatment ILTFU have the potential to be a potent intervention and are more easily achievable within the current health infrastructure than active case finding.

6.2 Limitations

A limitation of the study was that routine programmatic data were used which were not collected specifically for this study, thus certain variables were unavailable; the existing variables in PREHMIS were pre-determined, and the researcher had no control on collection of additional variables. This study therefore was unable to measure and assess several factors that could have impacted on the effectiveness of screening such as reason for visit to PHC facility, and which presumptive TB patients were identified through passive case finding and those identified through active case finding. Although history of previous TB episodes was recorded, it was not specified how recent this previous episode was to explain why there was not a greater concordance with the local diagnostic algorithm.

Despite processes having been implemented to improve data collection, missing data was still found in the electronic database and database had missing data points, for different variables between patients.

There was a possible over estimation of the PHC headcount ≥ 5 years as headcount data included patient visits for those patients on TB treatment.

Initial lost to follow up were not traced to determine outcome, neither were these patients cross checked with names in TB treatment registers to ascertain if treatment was initiated.

This was a before and after study with no controls and the absence of control groups is a further limitation of this study. Changes in TB case finding may have been due to background secular trends. The data from the electronic presumptive TB registers is limited to the participants attending City Health PHC facilities; hence the findings did not extend to presumptive TB patients attending other public PHC facilities and those attending private facilities.

It is possible that the implementation of this strategy needs longer than one year to show a significant effect on improved case detection and should be re-evaluated once screening practices are further entrenched in routine health activities at PHC facilities.

Chapter 7: Conclusion and Recommendations

7.1 Conclusion

The importance of activities geared toward the detection and treatment of TB early within the disease process cannot be overstated. The symptomatic period, from the first appearance of TB symptoms to treatment initiation, presents huge challenges to health systems, particularly in early stages of disease where patients are minimally symptomatic. Improving TB case detection together with earlier treatment initiation should contribute to reducing TB transmission. However, the key finding from this study is that current strategies of "universal" screening have not shown to be effective in this context. Despite very big increases in reported screening rates, presumptive cases identified and overall case detection in fact decreased over the period. The data from individual facilities and sub-districts showed variable uptake rates but no consistent pattern (up or down) of presumptive or confirmed cases with increased screening, if anything increased screening rates were associated with decreased levels of case detection. Other strategies of "universal testing" would need to be considered and further research conducted.

A positive finding from this study was that patients with a positive TB symptom screen were highly likely to have sputum samples obtained and sent for testing and there was exceptional adherence to testing algorithms.

Another important finding was high rates of ILTFU were reported. Reductions in ILTFU have the potential to be a potent intervention and are more easily achievable within the current health infrastructure than active case finding.

7.2 Recommendations

- It is recommended City Health re-evaluate the current policy and implementation practices of "universal" screening of all people who seek health care at PHC facilities, regardless of their risk profile or reasons for presenting to health services.

- A recommendation could be to implement "universal testing" irrespective of symptoms for high risk groups identified in this study, i.e. HIV positive, history of previous TB treatment episodes and being a contact of a known TB index case.

However this will need to be evidenced by further research on yield, affordability and cost effectiveness.

- Another recommendation would be to consider broadening the criteria for a positive screen to include other key clinical and demographic characteristics in the screening tool, for instance body mass index and smoking history. This could possibly improve sensitivity to symptom screening alone, followed by the current diagnostic algorithm.

- It is recommended local health managers identify facilities with poor screening and those where symptomatic patients are not being tested for TB to improve screening and testing at these facilities.

- High rates of ILTFU need to be further investigated and strategies implemented to reduce these rates.

- In an effort to find the "missing cases", it is recommended consideration be given to making greater use of lay persons and CHWs to conduct and assist with active TB case-finding within their respective communities especially in tracing and screening household contacts of known TB index cases.

- The proportion of incomplete records needs further auditing and consideration given to strategies to improve data capturing. Data capturing could be improved by the direct import of laboratory results into the database and thus improve the number of results not available.

- It is recommended that consideration be given to improving the efficiency and effectiveness of the current electronic database by designing electronic gate keeping rules to eliminate unnecessary repeat testing.

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Appendix 1: Implementation guidelines for TB screening

STANDARD OPERATING PROCEDURE FOR TB SCREENING IN ALL PHC HEALTH FACILITIES

TITLE	TB Screening
DATE:	12 May 2016 (amended 26 September 2016)

BACKGROUND:

The South African National Department of Health (NDoH) adopted the WHO and STOP TB Partnership 90 90 90 strategy in March 2015 that will move South Africa towards achieving the 90-90-90 targets for HIV and TB by 2020. The targets for TB are that:

1. 90% of vulnerable groups screened for TB
2. 90% of those diagnosed with TB are treated
3. 90% treatment success rate

People with undiagnosed, untreated and potentially infectious TB are frequently seen in PHC facilities. There are many missed opportunities to screen clients for TB symptoms at each clinical visit. Clients with undiagnosed infectious TB pose a risk of nosocomial transmission in PHC facilities and transmission in communities.

This SOP thus serves as a guideline to facilitate implementation of routine TB screening in all PHC health facilities

1. All clients 5 years and older entering a PHC facility must be screened for TB
2. All clients 5 years and older entering a PHC facility must be asked to disclosure coughing status as they enter the facility
3. All clients identified with a cough should be fast tracked through the reception area to be screened for TB and those screened positive must be investigated further
4. The TB sticker can be used as supporting evidence of TB screening in individual client clinic folders
5. TB screening (including that done in settings in which it is recorded on standardised stationery or in clinical notes) must be recorded and reported on the routine monthly report (RMR tick sheet)
6. All clients using the facility must be encouraged to wear a paper mask for the duration they are in the facility

Responsibility for communicating SOP to all PHC staff and monitoring implementation	• Facility managers • Facility operational managers • HAST Managers • HAST Co-ordinators • Primary Health Care Managers
References and source material	• PACK- Screen client in the preparation room (page 3 – PACK guideline 2016) • PIDS (TB definitions)
Tools, material & equipment	• TB Screening Sticker • Standardised stationery and/or clinical notes • Routine monthly data sheet (RMR) • TB suspect sputum register (MDHS) • Prehmis (City PHC facilities) • NHLS: Trakcare
Purpose of indicator	• To monitor if all PHC facility attendees 5 years and older are screened for TB
Definition: numerator	• All clients 5 years and older attending PHC health facilities who are screened for TB symptoms • Count the number of clients who respond (positive and negative) to TB symptom screening questions

Denominator	• PHC headcount 5 years and older
Absolute Validation Rule	• All clients 5 years and older attending health facilities who were screened for TB symptoms (positive and negative) should be equal to or less than PHC head count 5 years and older.

PROCEDURE	**Responsible person**
Cough Hygiene • All clients entering the facility should be encouraged to wear paper masks for the duration they are in the facility irrespective if they are coughing and reason for visiting the health facility • Display various posters in prominent positons in the waiting area in reception and other high volume waiting areas encouraging clients to disclosure coughing status and promoting cough hygiene • Erect mask dispensers with paper masks in prominent positions and ensure these are readily available to all clients as they enter the facility in reception and all other high volume waiting areas together with tissues • Daily health education sessions on cough hygiene should be conducted in reception areas • All coughing clients should be informed that TB is spread by coughing and in their own interests and those of their fellow clients and staff, be requested to cough into tissues or their elbow, and not their hand or into the air	• Reception staff • Identified PHC facility TB champion and/or health promoters
TB Screening • A staff member should be assigned the responsibility of encouraging all clients to disclosure coughing status as they enter the facility – this is best done in the reception area • All clients identified with a cough should be fast tracked through the reception area to be screened for TB • All clients if screened positive must be investigated further and 2 sputum samples must be taken and sent for TB testing • All clients >5 years must be screened for TB with each and ***EVERY*** clinical visit - see PACK 2016 guidelines page 3 • Where and if possible, separate coughing clients from the general waiting area to a designated, well-ventilated sub-waiting area	• Professional Clinical Staff
Clinical Consulting Rooms equipped for TB Screening • Each clinical consulting room must be equipped with the following: o TB screening stickers o TB screening sheets for those who screen positive (history sheets) o NHLS sputum request forms o Sputum bottles o Plastic bags for sputum bottles	•
Client Screening Positive for TB Symptoms • If a client is screened positive (as recorded on TB screening sticker or in other stationery): o It is incumbent on the clinician treating the client to obtain sputum samples and not refer the client to another section of the facility for sputum collection o Obtain a detailed history from the client and record on TB Screening Tool o Label 2 sputum jars, explain sputum collection procedure to the client and request client to produce sputum sample in external sputum booth o Request the client to wait 1 hour before producing second sputum sample o Request the client to return to clinical consulting room with both sputum samples o Ensure the client is given a 48 hour TCA date to come back to receive results o Clinician to ensure sputum samples are placed in plastic bags together with	• Professional, clinical staff

completed sputum request forms o Patient folder and sputum samples to be delivered to procedure room and/or TB room for capture into the TB suspect register and manage according to the TB protocol	
Recording TB Screening • **Stationery with TB Screening prompts (HCT & ART)** o The standardised HCT and ART stationery have TB screening prompts – there is **no need to ADD TB screening sticker** o Tick screening in the appropriate section of the stationery o Record on RMR tick sheet ▪ MDHS: Client 5 years and older screened for TB symptoms ▪ City: Client screened negative/positive for TB symptoms ▪ In City facilities PHC folder to flow to reception for clerk to capture TB screening data in Prehmis • **Stationery with NO TB Screening prompts** o TB Screening sticker should be placed in PHC clinical records o Tick appropriate blocks according to response from client o Record on RMR tick sheet ▪ MDHS: Client 5 years and older screened for TB symptoms ▪ City: Client screened negative/positive for TB symptoms ▪ In City facilities PHC folder to flow to reception for clerk to capture TB screening in Prehmis • **TB Screening Sheet (patient who self- presents with TB symptoms for investigation)** o Complete TB screening sheet and place in PHC folder o Record on RMR tick sheet ▪ MDHS: Client 5 years and older screened positive for TB symptoms ▪ City: Client screened positive for TB symptoms ▪ Both MHDS and City: TB suspect and no. sputum samples sent ▪ In City facilities PHC folder to flow to reception for clerk to capture TB screened positive, TB suspect category and no. sputums sent in Prehmis	• Professional, clinical staff
Stock TB Screening Stickers • Sub-district HAST co-ordinators and sub-structure HAST clinical co-ordinators will provide each PHC facility with stock • Please place order with the relevant sub-district and/or sub-structure co-ordinator	

TB SCREENING

1. Have you been coughing for more than 2 weeks?	Y	N
2. Have you lost more than 1.5kg in the last month?	Y	N
3. Do you have a fever?	Y	N
4. Do you have drenching night sweats?	Y	N

If the client answers yes to any of these questions, **investigate for TB**

If the client answers no, but has had contact with someone with TB or has had TB before and they develop symptoms, advise them to immediately return for TB testing.

Appendix 2: Permission City Health

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

CITY HEALTH

Dr Natacha Berkowitz
Epidemiologist: Specialised Health

T: 021 400 4238 F: 021 421 4894
E: Natacha.Berkowitz@capetown.gov.za

2018-02-13

Re: Research Request: A programme evaluation of the effects of an intensified TB screening strategy on changes in facility level TB case finding in City Health PHC facilities in Cape Town 7909

Dear Ms Caldwell

Your research has been approved as per your request to access routine data City Health from PREHMIS. A copy of the approval City Health Director to undertake this research is attached.

Contact Person: Mr Johann Daniels
Tel: (021) 400 2981

Please note the following:

1. All individual patient information obtained must be kept confidential.
2. A copy of the final report must be sent to the City Health Head Office, P O Box 2815 Cape Town 8001, within 6 months of its completion (which is currently scheduled for Sep 2018).
3. Your project has been given an ID Number 7909: please use this in any future correspondence with us.
4. If this research gives rise to a publication, please submit a draft before publication for City Health comment and include a disclaimer in the publication that "the research findings and recommendations do not represent an official view of the City of Cape Town". **Approval from the ED social service will need to be obtained prior to publication.**

Thank you for your co-operation and please contact me if you require any further information or assistance.

Yours sincerely

DR N BERKOWITZ
Epidemiologist: SPECIALISED HEALTH

Cc. Dr K Jennings
Mr J Daniels

Appendix 3: Ethics Approval

OFFICE OF THE DIRECTOR: RESEARCH
RESEARCH AND INNOVATION DIVISION

Private Bag X17, Bellville 7535
South Africa
T: +27 21 959 2988/2948
F: +27 21 959 3170
E: research-ethics@uwc.ac.za
www.uwc.ac.za

13 October 2017

Ms J Caldwell
School of Public Health
Faculty of Community and Health Sciences

Ethics Reference Number: BM17/8/13

Project Title: A programme evaluation of the effects of an intensified TB screening strategy on changes in facility level TB case finding in City health PHC facilities in Cape Town.

Approval Period: 29 September 2017 – 29 September 2018

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual **renewal**.

The permission from the health facility/provincial health department must be submitted for record-keeping

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

PROVISIONAL REC NUMBER -130416-050

Appendix 4: Proportion of PHC headcount ≥5 years screened for TB symptoms, screened positive for TB symptoms, investigated, diagnosed positive and commenced on TB therapy in 82 PHC facilities

	2015 cohort n (%)												
	PHC headcount ≥ 5 years	Screen for TB symptoms ≥5 years		Screened +ve for TB symptoms		Investigated for TB		Tested +ve for TB		Commenced on TB therapy		Case detection	Started Rx
Blue Downs Clinic	14 018	455	3,2%	956	210,1%	948	99,2%	98	10,3%	80	81,6%	7,0	5,7
Dr Ivan Toms CDC	47 645	5 110	10,7%	1 004	19,6%	992	98,8%	171	17,2%	127	74,3%	3,6	2,7
Eerste River Clinic	25 906	2 797	10,8%	1 197	42,8%	1 196	99,9%	168	14,0%	161	95,8%	6,5	6,2
Gordon's Bay CDC	13 512	2 469	18,3%	326	13,2%	323	99,1%	39	12,1%	28	71,8%	2,9	2,1
Ikhwezi CDC	82 793	7 562	9,1%	1 097	14,5%	1 087	99,1%	294	27,0%	269	91,5%	3,6	3,2
Kuilsriver Clinic	7 272	1 803	24,8%	229	12,7%	229	100,0%	12	5,2%	9	75,0%	1,7	1,2
Sarepta Clinic	15 420	2 288	14,8%	836	36,5%	835	99,9%	145	17,4%	135	93,1%	9,4	8,8
Sir Lowry's Pass CDC	18 978	2 148	11,3%	311	14,5%	309	99,4%	56	18,1%	52	92,9%	3,0	2,7
Somerset West Clinic	10 637	2 929	27,5%	228	7,8%	227	99,6%	52	22,9%	45	86,5%	4,9	4,2
Wesbank Clinic	22 347	2 568	11,5%	1 323	51,5%	1 316	99,5%	179	13,6%	156	87,2%	8,0	7,0
Eastern	**258 528**	**30 129**	**11,7%**	**7 507**	**24,9%**	**7 462**	**99,4%**	**1 214**	**16,3%**	**1 062**	**87,5%**	4,7	4,1
Kuyasa CDC	55 165	6 473	11,7%	635	9,8%	631	99,4%	152	24,1%	121	79,6%	2,8	2,2
Luvuyo CDC	39 725	6 263	15,8%	390	6,2%	390	100,0%	26	6,7%	14	53,8%	0,7	0,4
Matthew Goniwe CDC	74 856	4 712	6,3%	719	15,3%	717	99,7%	124	17,3%	98	79,0%	1,7	1,3
Mayenzeke Clinic	18 720	3 146	16,8%	232	7,4%	229	98,7%	43	18,8%	36	83,7%	2,3	1,9
Nolungile Clinic	37 994	0	0,0%	16	#DIV/0!	12	75,0%	10	83,3%	227	2270,0%	0,3	6,0
Site B Youth Clinic	20 294	4 716	23,2%	91	1,9%	91	100,0%	18	19,8%	14	77,8%	0,9	0,7
Town 2 CDC	64 712	6 722	10,4%	905	13,5%	1188	131,3%	146	12,3%	119	81,5%	2,3	1,8
Zakhele Clinic	18 621	2 278	12,2%	182	8,0%	180	98,9%	56	31,1%	34	60,7%	3,0	1,8
Khayelitsha	**330 087**	**34 310**	**10,4%**	**3 171**	**9,2%**	**3153**	**99,4%**	**575**	**18,2%**	**440**	**76,5%**	1,7	1,3
Guguletu Clinic	28 821	5 227	18,1%	1 313	25,1%	1 307	99,5%	169	12,9%	122	72,2%	5,9	4,2
Hanover Park Clinic	12 951	1 950	15,1%	562	28,8%	561	99,8%	70	12,5%	63	90,0%	5,4	4,9
Heideveld Clinic	11 104	3 412	30,7%	239	7,0%	238	99,6%	44	18,5%	34	77,3%	4,0	3,1
Lansdowne Clinic	8 402	2 565	30,5%	178	6,9%	177	99,4%	34	19,2%	29	85,3%	4,0	3,5
Manenberg Clinic	18 823	3 450	18,3%	798	23,1%	794	99,5%	111	14,0%	96	86,5%	5,9	5,1

Masincedane Clinic	22 656	3 556	15,7%	332	9,3%	330	99,4%	69	20,9%	60	87,0%	3,0	2,6
Nyanga Clinic	37 243	1 586	4,3%	350	22,1%	348	99,4%	92	26,4%	74	80,4%	2,5	2,0
Silvertown Clinic	10 403	2 299	22,1%	449	19,5%	447	99,6%	45	10,1%	38	84,4%	4,3	3,7
Vuyani Clinic	38 551	5 422	14,1%	573	10,6%	570	99,5%	100	17,5%	78	78,0%	2,6	2,0
Klipfontein	**188 954**	**29 467**	**15,6%**	**4 794**	**16,3%**	**4 772**	**99,5%**	**734**	**15,4%**	**594**	**80,9%**	3,9	3,1
Crossroads 1 Clinic	15 233	3 221	21,1%	388	12,0%	381	98,2%	83	21,8%	76	91,6%	5,4	5,0
Eastridge Clinic	29 330	4 355	14,8%	920	21,1%	915	99,5%	139	15,2%	125	89,9%	4,7	4,3
Lentegeur Clinic	29 254	3 924	13,4%	1 531	39,0%	1 527	99,7%	216	14,1%	148	68,5%	7,4	5,1
Mzamomhle Clinic	63 868	5 037	7,9%	834	16,6%	823	98,7%	192	23,3%	164	85,4%	3,0	2,6
Phumlani Clinic	30 711	3 180	10,4%	793	24,9%	781	98,5%	140	17,9%	107	76,4%	4,6	3,5
Rocklands Clinic	13 634	3 649	26,8%	517	14,2%	515	99,6%	48	9,3%	42	87,5%	3,5	3,1
Tafelsig CDC	72 879	5 384	7,4%	1 573	29,2%	1 562	99,3%	169	10,8%	155	91,7%	2,3	2,1
Weltevreden Valley Clinic	58 280	6 604	11,3%	1 063	16,1%	1 056	99,3%	189	17,9%	162	85,7%	3,2	2,8
Westridge Clinic	12 119	2 872	23,7%	364	12,7%	364	100,0%	30	8,2%	28	93,3%	2,5	2,3
Mitchells Plain	**325 308**	**38 226**	**11,8%**	**7 983**	**20,9%**	**7 924**	**99,3%**	**1 206**	**15,2%**	**1 007**	**83,5%**	3,7	3,1
Bloekombos Clinic	48 897	2 881	5,9%	1 134	39,4%	1 130	99,6%	207	18,3%	171	82,6%	4,2	3,5
Brackenfell Clinic	8 494	1 771	20,9%	219	12,4%	215	98,2%	16	7,4%	10	62,5%	1,9	1,2
Brighton Clinic	8 042	2 106	26,2%	179	8,5%	178	99,4%	28	15,7%	15	53,6%	3,5	1,9
Durbanville Clinic	11 236	2 431	21,6%	1 370	56,4%	1 364	99,6%	135	9,9%	111	82,2%	12,0	9,9
Fisantekraal Clinic	12 425	2 263	18,2%	607	26,8%	606	99,8%	80	13,2%	68	85,0%	6,4	5,5
Harmonie Clinic	8 994	1 567	17,4%	449	28,7%	447	99,6%	46	10,3%	36	78,3%	5,1	4,0
Northpine Clinic	5 430	1 046	19,3%	75	7,2%	75	100,0%	12	16,0%	11	91,7%	2,2	2,0
Scottsdene Clinic	10 096	2 394	23,7%	1 284	53,6%	1 276	99,4%	173	13,6%	126	72,8%	17,1	12,5
Wallacedene Clinic	55 651	3 004	5,4%	1 738	57,9%	1 699	97,8%	397	23,4%	328	82,6%	7,1	5,9
Northern	**169 265**	**19 463**	**11,5%**	**7 055**	**36,2%**	**6 990**	**99,1%**	**1 094**	**15,7%**	**876**	**80,1%**	6,5	5,2
Alphen Clinic	905	252	27,8%	39	15,5%	39	100,0%	5	12,8%	5	100,0%	5,5	5,5
Claremont Clinic	7 823	1 648	21,1%	158	9,6%	155	98,1%	29	18,7%	26	89,7%	3,7	3,3
Diep River Clinic	5 102	960	18,8%	88	9,2%	86	97,7%	19	22,1%	15	78,9%	3,7	2,9
Fish Hoek Clinic	4 493	882	19,6%	23	2,6%	23	100,0%	3	13,0%	3	100,0%	0,7	0,7
Hout Bay Main Road Clinic	26 975	1 216	4,5%	234	19,2%	234	100,0%	47	20,1%	36	76,6%	1,7	1,3
Klip Road Clinic	11 498	1 263	11,0%	326	25,8%	326	100,0%	70	21,5%	66	94,3%	6,1	5,7
Lavender Hill Clinic	12 741	1 314	10,3%	364	27,7%	362	99,5%	69	19,1%	60	87,0%	5,4	4,7
Masiphumelele Clinic	34 590	3 010	8,7%	647	21,5%	638	98,6%	111	17,4%	89	80,2%	3,2	2,6
Muizenberg Clinic	3 349	1 211	36,2%	39	3,2%	39	100,0%	2	5,1%	1	50,0%	0,6	0,3
Ocean View CDC	39 857	1 978	5,0%	501	25,3%	497	99,2%	46	9,3%	42	91,3%	1,2	1,1
Parkwood Clinic	10 159	1 178	11,6%	269	22,8%	266	98,9%	29	10,9%	26	89,7%	2,9	2,6
Philippi Clinic	8 080	1 343	16,6%	181	13,5%	181	100,0%	43	23,8%	31	72,1%	5,3	3,8
Seawind Clinic	22 231	4 376	19,7%	750	17,1%	746	99,5%	108	14,5%	76	70,4%	4,9	3,4
Strandfontein Clinic	9 013	1 396	15,5%	287	20,6%	284	99,0%	31	10,9%	25	80,6%	3,4	2,8

Westlake Clinic	5 676	1 268	22,3%	156	12,3%	156	100,0%	16	10,3%	14	87,5%	2,8	2,5
Wynberg Clinic	8 326	1 081	13,0%	148	13,7%	148	100,0%	29	19,6%	27	93,1%	3,5	3,2
Southern	**210 818**	**24 376**	**11,6%**	**4 210**	**17,3%**	**4 180**	**99,3%**	**657**	**15,7%**	**542**	**82,5%**	3,1	2,6
Adriaanse Clinic	18 708	2 381	12,7%	1 178	49,5%	1 171	99,4%	136	11,6%	119	87,5%	7,3	6,4
Delft South Clinic	55 072	5 802	10,5%	2 230	38,4%	2 214	99,3%	282	12,7%	209	74,1%	5,1	3,8
Dirkie Uys Clinic	17 587	4 798	27,3%	961	20,0%	953	99,2%	83	8,7%	60	72,3%	4,7	3,4
Elsies River Clinic	18 208	2 350	12,9%	1 416	60,3%	1 406	99,3%	167	11,9%	113	67,7%	9,2	6,2
Kasselsvlei Clinic	16 773	2 646	15,8%	1 515	57,3%	1 499	98,9%	176	11,7%	140	79,5%	10,5	8,3
Netreg Clinic	12 843	2 076	16,2%	1 096	52,8%	1 093	99,7%	120	11,0%	85	70,8%	9,3	6,6
Parow Clinic	14 990	2 079	13,9%	705	33,9%	702	99,6%	77	11,0%	59	76,6%	5,1	3,9
Ravensmead Clinic	21 769	2 362	10,9%	1 373	58,1%	1 362	99,2%	147	10,8%	75	51,0%	6,8	3,4
St Vincent (CCT) CDC	44 576	4 357	9,8%	1 179	27,1%	1 169	99,2%	175	15,0%	156	89,1%	3,9	3,5
Uitsig Clinic	14 649	1 849	12,6%	661	35,7%	656	99,2%	81	12,3%	66	81,5%	5,5	4,5
Valhalla Park Clinic	11 247	2 190	19,5%	675	30,8%	671	99,4%	74	11,0%	69	93,2%	6,6	6,1
Tygerberg	**246 422**	**32 890**	**13,3%**	**12 989**	**39,5%**	**12 896**	**99,3%**	**1 518**	**11,8%**	**1 151**	**75,8%**	6,2	4,7
Albow Gardens CDC	69 553	2 300	3,3%	1 123	48,8%	1 122	99,9%	166	14,8%	154	92,8%	2,4	2,2
Chapel Street Clinic	16 338	1 195	7,3%	141	11,8%	141	100,0%	32	22,7%	30	93,8%	2,0	1,8
Factreton Clinic	10 914	1 160	10,6%	219	18,9%	217	99,1%	34	15,7%	23	67,6%	3,1	2,1
Langa Clinic	50 396	2 288	4,5%	986	43,1%	985	99,9%	170	17,3%	157	92,4%	3,4	3,1
Maitland Clinic	7 512	1 371	18,3%	179	13,1%	179	100,0%	10	5,6%	8	80,0%	1,3	1,1
Melkbosstrand Clinic	1 883	237	12,6%	52	21,9%	52	100,0%	11	21,2%	9	81,8%	5,8	4,8
Protea Park Clinic	11 994	1 883	15,7%	424	22,5%	421	99,3%	106	25,2%	100	94,3%	8,8	8,3
Saxon Sea Clinic	10 247	1 369	13,4%	362	26,4%	361	99,7%	63	17,5%	57	90,5%	6,1	5,6
Spencer Road Clinic	13 666	2 122	15,5%	135	6,4%	134	99,3%	24	17,9%	23	95,8%	1,8	1,7
Table View Clinic	5 546	1 181	21,3%	57	4,8%	57	100,0%	11	19,3%	10	90,9%	2,0	1,8
Western	**198 049**	**15 106**	**7,6%**	**3 678**	**24,3%**	**3 669**	**99,8%**	**627**	**17,1%**	**581**	**92,7%**	3,2	2,9

	2017 cohort n (%)												
	PHC headcount ≥ 5 years	Screen for TB symptoms ≥5 years		Screened +ve for TB symptoms		Investigated for TB		Tested +ve for TB		Commenced on TB therapy		Case detection	Started Rx
Blue Downs Clinic	14 896	8 185	54,9%	768	9,4%	731	95,2%	99	13,5%	76	76,8%	6,6	5,1
Dr Ivan Toms CDC	51 643	21 960	42,5%	856	3,9%	847	98,9%	144	17,0%	131	91,0%	2,8	2,5
Eerste River Clinic	24 028	14 857	61,8%	1 260	8,5%	1 172	93,0%	138	11,8%	133	96,4%	5,7	5,5
Gordon's Bay CDC	8 194	6 079	74,2%	261	4,3%	243	93,1%	18	7,4%	5	27,8%	2,2	0,6
Ikhwezi CDC	81 569	27 759	34,0%	1 210	4,4%	1 181	97,6%	208	17,6%	194	93,3%	2,5	2,4
Kuilsriver Clinic	6 940	3 659	52,7%	167	4,6%	166	99,4%	21	12,7%	12	57,1%	3,0	1,7
Sarepta Clinic	13 124	4 692	35,8%	710	15,1%	705	99,3%	128	18,2%	119	93,0%	9,8	9,1
Sir Lowry's Pass CDC	16 505	7 919	48,0%	369	4,7%	359	97,3%	57	15,9%	51	89,5%	3,5	3,1
Somerset West Clinic	10 713	7 159	66,8%	269	3,8%	219	81,4%	35	16,0%	18	51,4%	3,3	1,7
Wesbank Clinic	20 109	4 768	23,7%	1 066	22,4%	1 065	99,9%	179	16,8%	165	92,2%	8,9	8,2
Eastern	**247 721**	**107 037**	**43,2%**	**6 936**	**6,5%**	**6 688**	**96,4%**	**1 016**	**15,2%**	**904**	**89,0%**	4,1	3,6
Kuyasa CDC	71 117	13 754	19,3%	606	4,4%	578	95,4%	143	24,7%	135	94,4%	2,0	1,9
Luvuyo CDC	44 561	11 562	25,9%	499	4,3%	391	78,4%	61	15,6%	33	54,1%	1,4	0,7
Matthew Goniwe CDC	78 486	11 217	14,3%	450	4,0%	402	89,3%	80	19,9%	38	47,5%	1,0	0,5
Mayenzeke Clinic	20 082	5 784	28,8%	186	3,2%	182	97,8%	32	17,6%	25	78,1%	1,6	1,2
Nolungile Clinic	35 199	8 432	24,0%	1 564	18,5%	1 555	99,4%	374	24,1%	227	60,7%	10,6	6,4
Site B Youth Clinic	19 715	11 983	60,8%	77	0,6%	68	88,3%	20	29,4%	19	95,0%	1,0	1,0
Town 2 CDC	73 081	10 568	14,5%	1 251	11,8%	1 188	95,0%	195	16,4%	162	83,1%	2,7	2,2
Zakhele Clinic	19 344	3 959	20,5%	250	6,3%	224	89,6%	33	14,7%	14	42,4%	1,7	0,7
Khayelitsha	**361 585**	**77 259**	**21,4%**	**4 883**	**6,3%**	**4 588**	**94,0%**	**938**	**20,4%**	**653**	**69,6%**	2,6	1,8
Guguletu Clinic	31 852	21 755	68,3%	1 407	6,5%	1 357	96,4%	230	16,9%	195	84,8%	7,2	6,1
Hanover Park Clinic	11 783	6 853	58,2%	619	9,0%	588	95,0%	65	11,1%	56	86,2%	5,5	4,8
Heideveld Clinic	10 379	4 473	43,1%	216	4,8%	158	73,1%	39	24,7%	29	74,4%	3,8	2,8
Lansdowne Clinic	6 338	3 363	53,1%	164	4,9%	147	89,6%	22	15,0%	18	81,8%	3,5	2,8
Manenberg Clinic	14 308	7 207	50,4%	873	12,1%	828	94,8%	132	15,9%	119	90,2%	9,2	8,3
Masincedane Clinic	19 653	7 448	37,9%	248	3,3%	232	93,5%	60	25,9%	52	86,7%	3,1	2,6
Nyanga Clinic	33 332	16 764	50,3%	539	3,2%	511	94,8%	149	29,2%	137	91,9%	4,5	4,1
Silvertown Clinic	8 234	3 978	48,3%	301	7,6%	295	98,0%	17	5,8%	12	70,6%	2,1	1,5
Vuyani Clinic	33 128	15 189	45,8%	619	4,1%	542	87,6%	110	20,3%	102	92,7%	3,3	3,1
Klipfontein	**169 007**	**87 030**	**51,5%**	**4 986**	**5,7%**	**4 658**	**93,4%**	**824**	**17,7%**	**720**	**87,4%**	4,9	4,3
Crossroads 1 Clinic	18 955	7 777	41,0%	388	5,0%	375	96,6%	59	15,7%	52	88,1%	3,1	2,7
Eastridge Clinic	31 767	12 918	40,7%	936	7,2%	931	99,5%	137	14,7%	126	92,0%	4,3	4,0

Lentegeur Clinic	31 267	8 077	25,8%	1 089	13,5%	1 043	95,8%	122	11,7%	117	95,9%	3,9	3,7
Mzamomhle Clinic	66 293	33 673	50,8%	695	2,1%	678	97,6%	159	23,5%	142	89,3%	2,4	2,1
Phumlani Clinic	34 425	7 733	22,5%	586	7,6%	560	95,6%	150	26,8%	147	98,0%	4,4	4,3
Rocklands Clinic	12 333	5 785	46,9%	395	6,8%	378	95,7%	52	13,8%	49	94,2%	4,2	4,0
Tafelsig CDC	52 636	11 591	22,0%	1 598	13,8%	1 424	89,1%	138	9,7%	107	77,5%	2,6	2,0
Weltevreden Valley Clinic	53 970	32 110	59,5%	864	2,7%	858	99,3%	179	20,9%	165	92,2%	3,3	3,1
Westridge Clinic	12 412	6 375	51,4%	462	7,2%	454	98,3%	38	8,4%	36	94,7%	3,1	2,9
Mitchells Plain	**314 058**	**126 039**	**40,1%**	**7 013**	**5,6%**	**6 701**	**95,6%**	**1 034**	**15,4%**	**941**	**91,0%**	3,3	3,0
Bloekombos Clinic	47 859	27 210	56,9%	690	2,5%	680	98,6%	166	24,4%	152	91,6%	3,5	3,2
Brackenfell Clinic	7 836	5 594	71,4%	101	1,8%	215	212,9%	11	5,1%	10	90,9%	1,4	1,3
Brighton Clinic	7 425	5 272	71,0%	122	2,3%	120	98,4%	17	14,2%	14	82,4%	2,3	1,9
Durbanville Clinic	8 211	6 405	78,0%	457	7,1%	453	99,1%	54	11,9%	49	90,7%	6,6	6,0
Fisantekraal Clinic	12 825	5 214	40,7%	383	7,3%	383	100,0%	56	14,6%	54	96,4%	4,4	4,2
Harmonie Clinic	9 963	7 044	70,7%	542	7,7%	540	99,6%	56	10,4%	47	83,9%	5,6	4,7
Northpine Clinic	8 014	6 803	84,9%	44	0,6%	43	97,7%	7	16,3%	5	71,4%	0,9	0,6
Scottsdene Clinic	7 580	3 528	46,5%	635	18,0%	635	100,0%	116	18,3%	111	95,7%	15,3	14,6
Wallacedene Clinic	54 414	26 629	48,9%	1 482	5,6%	1 311	88,5%	369	28,1%	342	92,7%	6,8	6,3
Northern	**164 127**	**93 699**	**57,1%**	**4 456**	**4,8%**	**4 265**	**95,7%**	**852**	**20,0%**	**784**	**92,0%**	5,2	4,8
Alphen Clinic	2 751	2 535	92,1%	23	0,9%	22	95,7%	1	4,5%	1	100,0%	0,4	0,4
Claremont Clinic	7 059	4 706	66,7%	52	1,1%	51	98,1%	13	25,5%	12	92,3%	1,8	1,7
Diep River Clinic	4 673	3 136	67,1%	79	2,5%	70	88,6%	6	8,6%	6	100,0%	1,3	1,3
Fish Hoek Clinic	4 301	3 489	81,1%	40	1,1%	40	100,0%	2	5,0%	1	50,0%	0,5	0,2
Hout Bay Main Road Clinic	31 488	17 675	56,1%	277	1,6%	266	96,0%	55	20,7%	48	87,3%	1,7	1,5
Klip Road Clinic	15 112	9 040	59,8%	408	4,5%	405	99,3%	74	18,3%	62	83,8%	4,9	4,1
Lavender Hill Clinic	11 202	6 005	53,6%	317	5,3%	316	99,7%	50	15,8%	44	88,0%	4,5	3,9
Masiphumelele Clinic	25 681	15 111	58,8%	485	3,2%	476	98,1%	65	13,7%	62	95,4%	2,5	2,4
Muizenberg Clinic	3 685	3 060	83,0%	24	0,8%	23	95,8%	3	13,0%	3	100,0%	0,8	0,8
Ocean View CDC	29 096	8 527	29,3%	838	9,8%	800	95,5%	44	5,5%	38	86,4%	1,5	1,3
Parkwood Clinic	13 270	3 802	28,7%	256	6,7%	255	99,6%	38	14,9%	37	97,4%	2,9	2,8
Philippi Clinic	6 242	4 320	69,2%	112	2,6%	111	99,1%	19	17,1%	17	89,5%	3,0	2,7
Seawind Clinic	21 232	12 844	60,5%	513	4,0%	493	96,1%	80	16,2%	72	90,0%	3,8	3,4
Strandfontein Clinic	7 584	6 058	79,9%	230	3,8%	228	99,1%	20	8,8%	19	95,0%	2,6	2,5
Westlake Clinic	5 546	4 310	77,7%	98	2,3%	92	93,9%	16	17,4%	16	100,0%	2,9	2,9
Wynberg Clinic	8 284	5 682	68,6%	163	2,9%	159	97,5%	31	19,5%	29	93,5%	3,7	3,5
Southern	**197 206**	**110 300**	**55,9%**	**3 915**	**3,5%**	**3 807**	**97,2%**	**517**	**13,6%**	**467**	**90,3%**	2,6	2,4
Adriaanse Clinic	17 650	9 353	53,0%	1 384	14,8%	1 353	97,8%	135	10,0%	129	95,6%	7,6	7,3
Delft South Clinic	60 937	23 505	38,6%	2 513	10,7%	2 288	91,0%	311	13,6%	266	85,5%	5,1	4,4
Dirkie Uys Clinic	15 977	7 899	49,4%	693	8,8%	644	92,9%	61	9,5%	44	72,1%	3,8	2,8
Elsies River Clinic	16 990	6 123	36,0%	1 355	22,1%	1 341	99,0%	153	11,4%	123	80,4%	9,0	7,2

Kasselsvlei Clinic	19 043	11 838	62,2%	1 322	11,2%	1 311	99,2%	124	9,5%	116	93,5%	6,5	6,1
Netreg Clinic	10 249	5 845	57,0%	771	13,2%	751	97,4%	65	8,7%	35	53,8%	6,3	3,4
Parow Clinic	13 244	8 620	65,1%	650	7,5%	627	96,5%	64	10,2%	53	82,8%	4,8	4,0
Ravensmead Clinic	16 846	6 547	38,9%	802	12,2%	768	95,8%	101	13,2%	73	72,3%	6,0	4,3
St Vincent (CCT) CDC	57 396	23 039	40,1%	1 205	5,2%	1 157	96,0%	114	9,9%	108	94,7%	2,0	1,9
Uitsig Clinic	13 877	6 693	48,2%	879	13,1%	823	93,6%	86	10,4%	66	76,7%	6,2	4,8
Valhalla Park Clinic	12 370	6 648	53,7%	7 754	116,6%	734	9,5%	70	9,5%	68	97,1%	5,7	5,5
Tygerberg	**254 579**	**116 110**	**45,6%**	**12 328**	**10,6%**	**11 797**	**95,7%**	**1 284**	**10,9%**	**1 081**	**84,2%**	5,0	4,2
Albow Gardens CDC	71 223	24 715	34,7%	817	3,3%	728	89,1%	115	15,8%	106	92,2%	1,6	1,5
Chapel Street Clinic	12 350	2 615	21,2%	208	8,0%	195	93,8%	43	22,1%	34	79,1%	3,5	2,8
Factreton Clinic	10 246	4 167	40,7%	298	7,2%	290	97,3%	31	10,7%	23	74,2%	3,0	2,2
Langa Clinic	46 916	25 597	54,6%	555	2,2%	542	97,7%	79	14,6%	75	94,9%	1,7	1,6
Maitland Clinic	7 797	5 807	74,5%	201	3,5%	198	98,5%	6	3,0%	6	100,0%	0,8	0,8
Melkbosstrand Clinic	1 769	1 373	77,6%	54	3,9%	53	98,1%	14	26,4%	13	92,9%	7,9	7,3
Protea Park Clinic	10 897	6 466	59,3%	369	5,7%	357	96,7%	87	24,4%	81	93,1%	8,0	7,4
Saxon Sea Clinic	8 508	3 723	43,8%	312	8,4%	309	99,0%	61	19,7%	56	91,8%	7,2	6,6
Spencer Road Clinic	10 649	5 259	49,4%	118	2,2%	114	96,6%	14	12,3%	10	71,4%	1,3	0,9
Table View Clinic	6 975	4 677	67,1%	37	0,8%	35	94,6%	9	25,7%	9	100,0%	1,3	1,3
Western	**187 330**	**84 399**	**45,1%**	**2 969**	**3,5%**	**2 821**	**95,0%**	**459**	**16,3%**	**413**	**90,0%**	2,5	2,2