A cross-sectional study of tuberculosis among workers in Tygerberg Academic Hospital, Western Cape province, South Africa

by
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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

December 2013

Abstract

Introduction: The morbidity and mortality associated with tuberculosis (TB) disease is of grave consequences for the health and employment of afflicted individuals. Healthcare workers are identified amongst high risk groups in communities. The prevalence/incidence of TB is dependent on the presence of associated risk factors which varies in diversity and intensity in different communities and workplaces. Understanding the risk factors operating in any given environment is indispensable to any tuberculosis control programme.

Objective: The objective of this study was to describe the occurrence and trends of TB disease as well as to determine the risk factors associated with the disease among Tygerberg hospital employees.

Method: A cross-sectional descriptive study design with a nested case-control component was used to determine the occurrence (and trends) and risk factors of TB disease respectively**.**

Occurrence and trends of tuberculosis: The frequencies, distribution and trends of TB disease from 2008 to 2011 were obtained by calculating and comparing the annual incidence rates for each variable. Cases were identified from the occupational health clinic TB register, while the various denominator data were obtained from the Human Resource database.

Determination of risk factors: Cases were recruited from the occupational health clinic TB register and controls were randomly selected from unaffected workers during the study period. Self-administered risk factor questionnaires were completed by both cases and controls. Multivariate logistic regression analysis was used to determine the association between known and suspected risk factors and the occurrence of TB disease amongst employees.

Results: Sixty six cases of TB disease occurred in the workforce during the study period resulting in an annual average incidence rate of 397/100,000 population (95% CI: 307/100,000-505/100,000). Twenty three (34.8%) of the 66 cases occurred in Housekeeping staff, making them the most affected sub-group [1181/100,000 population (95% CI: 747/100,000-1768/100,000)]. The rate of TB disease in nurses was 1.7 times (95%CI: 1.4-2.0) that of doctors. Workers in the 40-49 years age-group experienced the highest incidence [490/100,000 population (95%CI: 329.6/100,000-706.8/100,000)] of TB disease compared to the other age-groups. There was no obvious difference in gender occurrences. Disease rates varied among different racial groups, with the highest rate in black employees [1473/100,000 population, (95%CI: 924/100,000-1981/100,000)]. Distribution of TB disease in the institution was widespread, with security department being the most affected [2500/100,000 population (95%CI: 311/100,000-9262/100,000)]. There was a downward but statistically insignificant (annual range 9-23; p=0.28) trend

in the rate of disease occurrence over the study period. No previous training on TB prevention (OR: 2.97, 95% CI: 1.15 - 7.71), HIV (OR: 67.08, 95% CI: 7.54 – 596.64) and working without knowledge of TB risk profile of the workplace (OR: 8.66, 95% CI: 1.10 – 67.96) were associated with TB disease occurrence.

Conclusion: Occurrence of TB disease among Tygerberg hospital employees was low compared to that of the general population of its drainage areas. Disease occurrence in the facility was wide and varied with respect to occupational groups, workplaces and time. Well-established risk factors for TB infection (and disease) were found to be determinants of disease occurrence in the facility.

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Table 3. Frequency of occurrence of active TB disease based on the race of employees

Year Race	2008	2009	2010	2011	Average annual incidence rates (95%CI)
White employees					
Cases	2	0	2	0	
Population	873	850	807	826	
Incidence rate	229/100,000	0/100,000	248/100,000	0/100,000	119/100,000 (33/100,000-305/100,000)
Coloured employees					
Cases	10	6	8	8	
Population	2701	2660	2744	2739	
Incidence rate	370/100,000	226/100,000	292/100,000	292/100,000	295/100,000 (209/100,000-416/100,000)
Black employees					
Cases	11	3	9	6	
Population	389	454	608	651	
Incidence rate	2828/100,000	661/100,000	1480/100,000	922/100,000	1473/100,000 (925/100,000-1975/100,000)
Indian employees					
Cases	0	0	1	0	
Population	81	85	85	81	
Incidence rate	0/100,000	0/100,000	1176/100,000	0/100,000	294/100,000 (08/100,000-1665/100,000)

Table 4. Frequency of occurrence of active TB based on the gender of employees

Year Gender	2008	2009	2010	2011	Average annual incidence rates (95%CI)
Male gender					
Cases	7	4	4	3	
Population	1014	1017	1039	1052	
Incidence rates	690/100,000	393/100,000	385/100,000	285/100,000	438/100,000 (259/100,000-690/100,000)
Female gender					
Cases	16	5	16	11	
Population	3030	3032	3205	3245	
Incidence rates	528/100,000	165/100,000	499/100,000	339/100,000	383/100,000 (283/100,000-508/100,000)

The occurrence of active TB disease with regards to workplaces showed a wide variation in both distribution and incidence rates. Cases occurred in both clinical and non-clinical areas of the hospital. The lowest incidence rates in the hospital occurred in those working in administration (240/100,000 population; 95%CI: 117.6-697.2 per 100,000) and the highest in the security department (2500/100,000 population; 95%CI: 311-9262 per 100,000). Workplaces with the highest rates of occurrence were oncology (1,726/100,000 population; 95%CI: 209-6228 per 100,000), food services (1,603/100,000 population; 95%CI: 691-3153 per 100,000) and technical department (1110/100,000 population (95%CI: 470-2145 per 100,000). Relatively low rates were experienced mostly in the clinical departments of medicine (510/100,000 population 95%CI: 243.9-935.4 per 100,000), obstetrics and gynaecology (414/100,000 population; 95%CI: 107-1006 per 100,000) and surgery (409/100,000 population; 95%CI: 222-681 per 100,000). A detailed summary of active TB disease occurrence with regards to various departments is presented in table 5 and a diagrammatic representation is shown in figure 2.

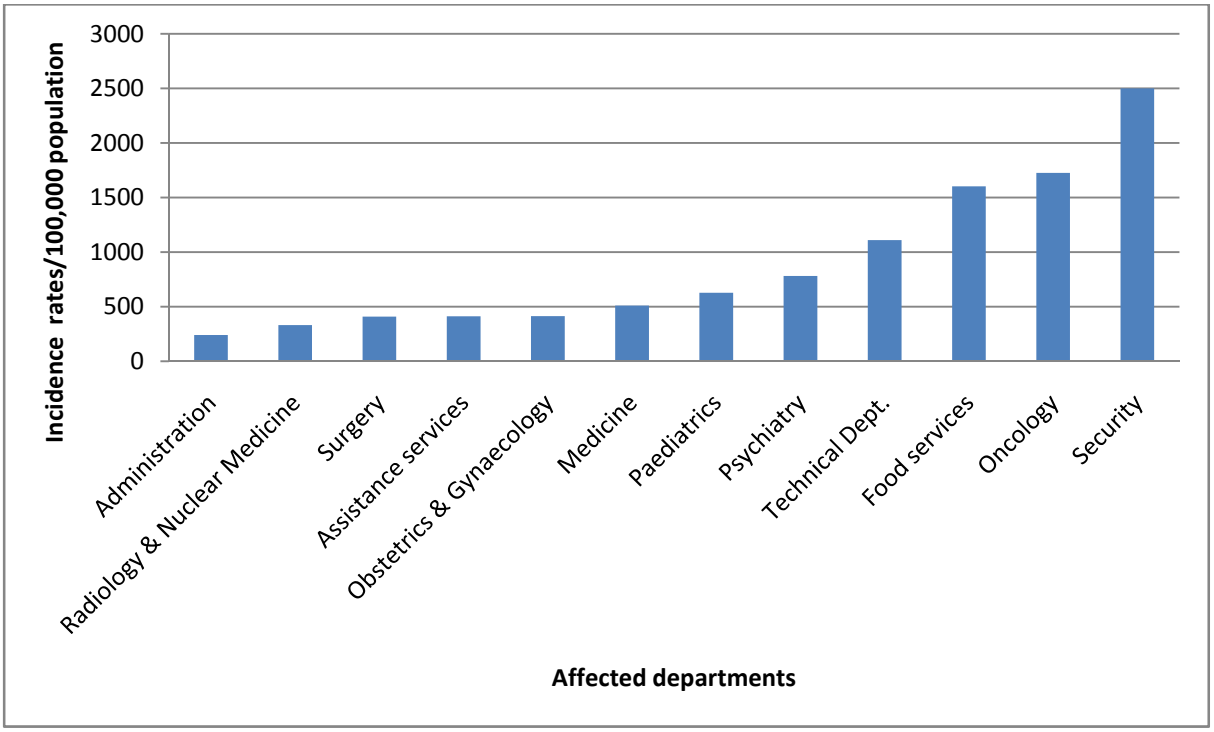

Figure 2. Incidence rates of active TB disease in different departments in Tygerberg hospital.

Table 5. Frequency of occurrence of active TB disease based on workplaces

Year	2008	2009	2010	2011	Average annual incidence rates (95%CI)
Departments					
Department of medicine & medical wards					
Cases	3	1	4	2	
Population	498	495	483	490	
Incidence rates	602/100,000	202/100,000	828/100,000	408/100,000	510/100,000 (244/100,000-935/100,000)
Department of surgery & surgical wards					
Cases	6	0	5	3	
Population	834	849	849	919	
Incidence rates	719/100,000	0/100,000	589/100,000	326/100,000	409/100,000 (222/100,000-681/100,000)
Department of obstetrics and gynaecology & associated wards					
Cases	3	0	1	0	
Population	235	250	265	268	
Incidence rates	1277/100,000	0/100,000	377/100,000	0/100,000	414/100,000 (107/100,000-1006/100,000)
Department of paediatrics & paediatric wards					
Cases	2	0	2	3	
Population	239	298	293	304	
Incidence rates	837/100,000	0/100,000	683/100,000	987/100,000	627/100,000 (248/100,000-1272/100,000)
Department of psychiatry & psychiatric wards					
Cases	0	0	0	1	
Population	30	31	32	32	
Incidence rates	0/100,000	0/100,000	0/100,000	3125/100,000	781/100,000 (20/100,000-4457/100,000)
Radiology & Nuclear medicine					
Cases	0	2	0	0	
Population	152	151	152	152	
Incidence rates	0/100,000	1325/100,000	0/100,000	0/100,000	331/100,000 (40/100,000-1190/100,000)
Oncology					
Cases	1	0	1	0	
Population	30	29	28	29	
Incidence rates	3333/100,000	0/100,000	3571/100,000	0/100,000	1726/100,000 (209/100,000-6228/100,000)

Table 5. Frequency of occurrence of active TB disease based on workplaces (cont.)

Food services department					
Cases	4	0	3	1	
Population	128	125	120	127	
Incidence rates	3125/100,000	0/100,000	2500/100,000	787/100,000	1603/100,000 (691/100,000-3153/100,000)
Administrative employees & administrative department					
Cases	0	2	2	2	
Population	589	608	629	636	
Incidence rates	0/100,000	329/100,000	318/100,000	314/100,000	240/100,000 (118/100,000-697/100,000)
Security personnel					
Cases	0	1	1	0	
Population	17	20	20	21	
Incidence rates	0/100,000	5000/100,000	5000/100,000	0/100,000	2500/100,000 (311/100,000-9262/100,000)
Technical department and all technical & maintenance personnel					
Cases	4	2	1	1	
Population	177	177	185	196	
Incidence rates	2260/100,000	1130/100,000	541/100,000	510/100,000	1110/100,000 (470/100,000-2145/100,000)
Assistance services (porters & translators)					
Cases	0	1	0	1	
Population	125	121	123	122	
Incidence rates	0/100,000	826/100,000	0/100,000	820/100,000	412/100,000 (49/100,000-1471/100,000)

Risk factors of active TB disease

Seventy five workers were diagnosed with active TB disease from January 2008 to June 2012. Of the 75 affected employees, 58 completed the questionnaire for risk factor analysis accounting for a participation rate of 77.3%. Of those who did not enrol for the study, 5 declined participation, 1 had passed away and 11 could not be contacted (relocated to another province, working for another employer, etc.). Of the 174 original randomized controls chosen for the study, 112 of them completed the questionnaires and 46 were replaced (declined participation/unavailable) by the next employee on the list of random control resulting to a total of 158 controls (case to control ratio of 1:2.7). The remaining 16 questionnaires could not be completed as selected controls as well as their replacements refused participation. The baseline characteristics of participants are summarized on table 6. It indicated that of all the variables tested; only alcohol consumption differs statistically between cases and controls participants.

Apart from the variables indicated on the multivariate model, univariate logistic regression analysis of other tested possible risk factors (found in the study questionnaire) showed insignificant associations between active TB disease in participants and the number of patient contacts per participant per day [<10 patients (OR: 2.6; p=0.9), ≥10 patients (OR: 1.8; p=0.2)], co-morbidity of active TB disease with any other disease condition including HIV (OR: 1.5; p=0.18), stress exposure during the study period (OR: 1.7; p=0.10), regular protective device use (OR: 1.8; p=0.07), race[(black OR: 2.5 ; p=0.10), coloured(OR: 3; p=0.28), Indian (OR: 1.4; p=0.49), age (OR: 1.0; p=0.27), prolonged working hours i.e. > 8hours (OR: 1; p=0.6) duration of work in healthcare (OR:1; p=0.36), gender (OR:1.2; p=0.60), yearly flu attack (OR:1.2; p=0.65), number of household contacts (OR:1.0; p=0.60) and cooking methods(OR: 2.0; p=0.30). The factors associated with increased risk of active TB disease based on univariate analysis were HIV (OR: 50.14, 95%CI: 6.41- 392.11), no previous training on TB prevention (OR: 1.94, 95%CI: 1.05 – 3.59) and unknown status of TB vaccination (OR: 2.8, 95% CI: 1.21-6.57).

However, in the multivariate logistic regression model, the risk factors identified for active TB disease after adjusting for all inter-variable interactions were; HIV (OR: 67.08, 95% CI:7.54 – 596.64), no previous training on TB prevention (OR: 2.97, 95% CI:1.15 - 7.71) and working with no knowledge of TB risk profile of the workplace (OR: 8.66, 95% CI: 1.10 – 67.96). A summary of the multivariate logistic regression analysis is displayed in table 7.

Table 6. Baseline characteristics of participants enrolled in the study

Characteristics n (%) Categorical variables	Cases (n=58)	Controls (n=158)	p-value
Marital status			
▪ **married**	31(53.4)	84(53.5)	
▪ **unmarried**	27(46.6)	73(46.5)	0.99
Gender of participants			
▪ **male**	17(29.3)	52(33.1)	
▪ **female**	41(70.7)	105(66.9)	0.60
Highest level of education attained by participants			
▪ **higher education**	18(31.6)	53(33.8)	
▪ **post primary education**	32(56.1)	92(58.6)	0.57
▪ **primary education**	7(12.3)	12(7.6)	
Daily work-shift schedule			
▪ **routine day shift**	38(65.5)	98(62.4)	
▪ **night shift**	3(5.2)	3(1.9)	0.34
▪ **both day and night shifts**	17(29.3)	56(35.7)	
Yearly flu attack			
▪ **no**	28(50)	80(52.6)	
▪ **yes**	29(50)	72(47.4)	0.65
Alcohol consumption by participants			
▪ **no**	44(77.2)	88(56.4)	
▪ **yes**	13(22.8)	68(43.6)	0.00
Co-morbidity status of participants (TB with any other disease)			
▪ **no co-morbidity**	21(37.5)	74(47.7)	
▪ **has co-morbidity**	35(62.5)	81(52.3)	0.19
Nature of hobbies			
▪ **involves no contact with public**	47(83.9)	114(77.0)	
▪ **involves contact with public**	9(16.1)	34(23.0)	0.28
Use of personal protection (PPE) against TB			
▪ **yes**	34(58.6)	85(54.8)	
▪ **no**	24(41.4)	70(45.2)	0.53
Race of participants			
▪ **white**	5(08.6)	23(14.6)	
▪ **coloured**	29(50.0)	92(58.2)	0.22
▪ **Indian**	2(03.4)	3(01.9)	
▪ **black**	22(37.9)	40(25.3)	
Continuous variable [median(interquartile range)]			
Number of household contacts of participants	4.0 (3)	4.0 (2)	0.91
Number of room contacts of participants	1.0 (2)	1.0 (1)	0.46
Work duration in TBH (years)	11.0 (19)	11.8 (21)	0.98
Work duration in healthcare sector (years)	20.5 (21)	13.0 (20.5)	0.25
Time worked per day (hours)	9.0 (3)	9.5 (4)	0.66
No. of patients contacts per day	21.0 (24)	12.0 (25)	0.05

Table 7. Multivariate logistic regression analysis of possible risk factors for active TB disease in Tygerberg hospital

Risk factors	Unadjusted OR	95%CI (Unadjusted OR)	Adjusted OR	95% CI (adjusted OR)	p-value (adjusted OR)
Age(continuous data)	1.02	0.97 – 1.05	1.05	1.00 – 1.10	0.05
smoking history					
▪ never smoked	1		1		
▪ previous smoker	1.30	0.49 – 3.44	2.20	0.62– 7.76	0.22
▪ current smoker	1.03	0.50 – 2.10	1.30	0.47 – 3.46	0.63
Training on TB prevention					
▪ received training on TB prevention	1		1		
▪never received training on TB prevention	1.94	1.05 – 3.59	2.57	1.10 – 5.99	0.03
TB vaccination status of participants					
▪ vaccinated participants	1		1		
▪participants with unknown vaccination status	1.42	0.70 – 2.89	0.96	0.39 – 2.33	0.92
▪participants with no history of vaccination	2.82	1.21 – 6.57	1.66	0.54 – 5.1	0.38
Participants' assessment of work area TB risk profile					
▪ low risk area	1		1		
▪ don't know	4.49	0.99 – 20.30	7.56	1.14 – 50.20	0.04
▪ high risk area	3.32	0.96 – 11.52	4.07	0.89 – 18.58	0.07
Contact with known TB cases					
▪ no contact	1		1		
▪ contact in TBH	1.71	0.88 – 3.36	1.35	0.54 – 3.37	0.51
Alcohol consumption by participants					
▪ none	1		1		
▪ yes	0.38	0.19 - 0.77	0.44	0.17-1.10	0.08
Regular use of personal protective equipment					
▪ none	1		1		
▪ yes	0.96	0.81 – 1.13	0.79	0.34 – 1.83	0.58
HIV infection					
▪ HIV negative participants	1		1		
▪ HIV positive participants	50.14	6.41 – 392.10	50.94	5.26 - 493.73	0.00
Diabetes mellitus					
▪ diabetics	1		1		
▪ non-diabetics	1.71	0.76 – 3.86	1.67	0.58 – 4.89	0.34
Race					
▪ white	1		1		
▪ Indian	1.45	0.51 – 4.16	1.12	0.33 – 3.74	0.86
▪ coloured	3.07	0.40-23.44	4.24	0.38 – 46.91	0.24
▪ black	2.53	0.84-7.59	2.44	0.55 – 10.81	0.24

CHAPTER FOUR: DISCUSSION AND CONCLUSION

Although healthcare workers across the globe have been shown by many studies to have higher risks for TB than the populations they serve[26, 30], this study did not reflect the assertion. The incidence rate of active TB disease in healthcare workers in Tygerberg hospital (397/100,000 population) was lower than the rate in the surrounding population (Cape Town(799/100,000 population)[18, 38] and Western Cape (935/100,000 population)[18]) and nationally[17]. The result of this study is consistent with the finding of an earlier study in Mpumalanga which showed a relatively lower rate of active TB disease in healthcare workers compared to the general population[39]. However, a study by Kranzer & co-workers in Cape Town rather found an increased risk of active TB disease among community healthcare workers[40]. The rate of disease occurrence in the institution also compares favourably with other study findings in similar settings in some parts of South Africa and the continent[25, 41-43]. This finding is interesting considering the background community TB risk profile of the population served by the institution and the institutional level in the healthcare structure. The institution is located in a region with one of the highest TB occurrences in the country and is a major reference centre in the province and as such, is expected to experience higher disease frequency amongst its workers. The lower rate of active TB disease occurrence may be ascribed to two possible reasons; the referral status (tertiary) of the institution in a province with the best primary and secondary healthcare delivery system in the country means that many cases of active TB disease may have been identified and treated at a lower healthcare level with consequently lower TB risk in patients referred for consultation in the institution. Secondly, the presence of an active (and competent) occupational health service and Unit for Infection Prevention and Control (UIPC) might have contributed in mitigating the risk within the institution. The occupational health department and the UIPC carry out education and training of workers on TB prevention, assesses the risk of TB associated with different work areas and procedures on an on-going basis and recommend risk mitigating measures including the provision of respirators where relevant. The department is also responsible for the diagnosis, treatment and removal of employees with active TB disease from the workplace as well as ensuring complete resolution of disease prior to job rehabilitation.

Contrary to expectation, the study showed that the annual incidence rates of active TB disease in doctors & nurses (groups with very close contact with patients) were comparatively (and statistically) lower with respect to the rate in non-clinical workers such as housekeeping staff. This finding may be interpreted bearing in mind, the multifactorial basis of TB disease causation.

The lower rates of disease in nurses & doctors may be due to a comparatively higher level of awareness in these groups of persons, the majority of whom have had information and training on TB prevention. It may be useful for subsequent studies to evaluate the rate of TB disease occurrence in this group of workers relatively to that of their respective social class in order to postulate the effect of the risk associated with the nature of their work. The high incidence of TB disease in housekeeping staff could be explained, considering that their workplace activities bring them in close contact with patients (as they clean) and the majority of them belong to the lower socio-economic group in the society (known for higher community based TB risk profile[44, 45]). This group should be particularly monitored as they form the major source of TB hazard in the workplace. Mitigating the risk in this group is likely to have a positive effect in limiting TB transmission within the facility (not only for other workers but for patients as well).

The decline in the rates of active TB disease in the institution during the study period, though not statistically significant in the short-term (i.e. after three years of implementation of control measures) may require subsequent re-evaluation to determine its long-term effect. This is necessary, considering that the relatively low rates of occurrence of active TB disease (associated with a small sample size) may require a longer duration to obtain a sample size large enough to detect any difference (due to the recently introduced control measures) in the rates of occurrence over time as statistically significant. Unfortunately, the study could not forecast the occurrence of active TB disease beyond the study period. Such a finding would have been important for evaluating the current intervention (which includes the identification of target areas, provision of respirators for use in high risk areas and procedures, and regular information and training of employees on TB prevention in targeted groups). It would have also provided information capable of impacting on management decisions with regards to active TB containment.

The distribution of active TB disease based on the personal characteristics of age, race and occupation showed useful information relevant for disease control in the institution. The occurrence of the disease was particularly high in the older age groups (40-49 and ≥ 50 years old), black employees and household workers in the institution. Employees with these characteristics should receive special attention during medical surveillance as well as during clinical evaluation of cases with relevant symptomatic presentations. The distribution of the disease in workers of the institution reflects the socio-demographic characteristics (age, race and socio-economic status) influencing TB occurrence in the general population[46].

Other personal risk characteristics of TB occurrence relevant to the transmission, control (environmental and medical surveillance) and clinical management of the disease in the institution were the HIV background and TB infectivity of affected employees. Up to 30.2% of all TB affected employees in the study were HIV positive and up to half of all cases were sputum smear positive at presentation (highly infectious). Human immunodeficiency viral infection is a well-established risk factor for both transmission and development of active TB [47] and its presence in employees involved in healthcare work has implications for TB control. The effect of this background risk in TB affected workers of Tygerberg hospital is seen in the high prevalence of HIV in patients with recurrent active TB in this study. Several studies have also identified the HIV background of persons as a risk factor for extra-pulmonary disease [4, 5]. Therefore, the high incidence of extra-pulmonary TB and the high prevalence of HIV in extra-pulmonary TB affected employees in this study add to that evidence. Studies in South Africa have described this background risk (HIV) as high amongst certain categories of employees working in the healthcare sector[48, 49] and therefore requires considerations for disease control measures in Tygerberg hospital. The effects of active TB disease, HIV and other HIV-related complications on illness-related absenteeism in the workplace environment in South Africa cannot be over-emphasized. The emergence of multi-drug resistance TB, in addition to the aforementioned effects only increases the complexity in the clinical and workplace management of TB-affected employees. The presence of multidrug resistant TB (MDR-TB) strains in up to 6.3% of TB disease cases (and involving mostly healthcare workers) in the institution requires urgent attention. Infection with resistant strains of TB is associated with increase in disease severity, disability and illness-related absenteeism. A study carried out in a public TB referral hospital in Kwazulu Natal concluded that healthcare workers were substantially more likely to be hospitalized with either MDR-TB or XDR-TB compared to non-healthcare workers[50]. Current health policy in the facility requires MDR-TB affected employees to be removed from the workplace until at least two consecutive sputum cultures are negative, provided that the person is physically fit to return to work. If one considers that healthcare workers are highly skilled group of workers with acute shortage in the labour market, then the urgency in controlling the occurrence of TB disease in them warrants emphasis.

Workplace occurrence of active TB showed a widespread distribution in the institution, with higher rates occurring in non-clinical areas (security and kitchen). This is indicative of the wide-spread distribution of TB risks across different departments in the hospital. It further emphasizes the need for controls to be widely instituted within the facility rather than focussed only in areas where contact with patients occurs.

Generally, control measures and medical surveillance in most institutions have always targeted clinical areas with less emphasis on non-clinical areas but based on the findings of this study, a mind-shift is necessary to target both areas in Tygerberg hospital. The widespread distribution of active TB in the facility raises two fundamental issues: the sources of exposure and acquisition of TB among employees in the facility (workplace vs. community) and the criterion of patient contacts in the workplace as a major determinant for workers' benefits.

Understanding the risk factors driving TB occurrence in the facility is indispensable in controlling the disease. With regards to active TB disease among workers in the hospital; the lack of previous training on TB prevention, the HIV background of employees and the lack of awareness of the TB risk profile of their workplaces by some employees were identified as possible risk factors underlying disease occurrence. Unless further studies show contrary evidence, control measures against active TB in the institution require among others, the management of these risk factors. Studies performed in similar settings elsewhere have also identified some of the above risk factors as influencing transmission rates among workers[51].

Many other known risk factors for TB transmission present in the facility did not show significant associations with TB transmission. Reasonably expected workplace risk factors such as the number of patient contacts per day, contact with patients and patients' specimens, direct contact with known active TB disease cases in the hospital and the length of daily working hours did not show significant association with active TB disease in the facility. However, caution needs to be exercised in the interpretation of these results. The matching of controls to cases based on occupation prior to randomization might have distributed the above variables in a more or less equal extent between the groups and hence their results. Other possible reasons may be due to the biases associated with subjectivity of the responses to the questions in the questionnaire and inadequate power to detect small differences between the groups due to the small sample size of participants. The effect of the small sample size of participants (cases & controls) is seen in the wide confidence intervals associated with the incidence rates of some variables in this study. The baseline socio-demographic characteristics (table 6) of gender, marital status, level of education, race, monthly income and number of household contacts were shown not to be statistically different between cases & controls and hence may not have affected the study result.

This study has some specific strength that warrants emphasis; it is the first in the hospital that quantifies the frequencies of occurrence and defines the distribution of active TB disease in the entire workforce.

By defining the occurrence of active TB disease with regards to place and person characteristics, the study has implications in medical surveillance as it identifies high risk groups and workplaces for targeted interventions. The findings from the study may be useful for administrative purposes. The study results may be used as an evaluation tool by management, in deciding the necessity for response with regards to managing TB disease in the facility and in so doing, meet the legislative obligation of ensuring a healthy work environment. By identifying the possible risk factors driving TB transmission (and disease occurrence) within the workforce, the study may contribute to risk mitigating strategies (and therefore, disease control) for the disease in the institution.

However, this study is not without weaknesses. Apart from the already mentioned weaknesses associated with the risk factor identification aspect of the study, the following weaknesses can affect either or both aspects of the study; Selection bias is a likely possibility in the risk factors aspect of the study. Only 77.3% of active TB cases took part in the risk factor identification aspect of the study and if their responses with respect to the tested risk factors are different from those who did not participate in the study, then some bias would have been introduced in the findings. The effect of such bias if present, might have introduced either type I or II errors depending on the responses of those who did not take part in the study. Measurement bias resulting from misclassification is also a possible source of bias in the risk factors determination aspect of the study. The answers to most questions in the study questionnaire were subjective and therefore prone to bias. Likely sources of misclassification may have been in responses to HIV status in controls, smoking history, alcohol consumption, regular use of personal protective devices, number of patient contacts per day, etc. The above responses which usually under-represent the magnitude of the variables is likely to biased the effect towards the null value. In the descriptive aspect of the study, measurement bias could have arisen from under-reporting of active TB disease in employees who sought medical care outside the facility (even though they are instructed to report TB disease in the occupational health clinic for statutory benefits). “Recall bias” is also a possibility in the risk factor identification aspect of the study. Recall was typically problematic in some individuals with regards to TB vaccination and average number of patient contacts per day in both cases and controls. Since difficulties with recall were not particular to either of the groups, the effect (if significant) is likely to bias the result in either direction (i.e. towards or away from the null value).

In conclusion, Occurrence of active TB disease among employees of Tygerberg hospital was low compared to that of the general population of its drainage areas. The occurrence was wide and varied with respect to occupational groups, workplaces and time. Well-established risk factors

for TB transmission (and disease) in other settings (and medical literature) were identified as variables associated with disease occurrence in the facility. However, the constant presence of active TB disease cases in the workplace requires continuous evaluation, monitoring and mitigation of risk factors associated with TB in the facility.

RECOMMENDATIONS

The following recommendations may be invaluable in the management of TB in the hospital:

Regular TB risk assessment in the facility is necessary in view of the current disease burden. Such an assessment should be carried out throughout the hospital at least annually in the most affected areas. The frequency of assessment could be varied depending on the future incidence of disease and in any case as decided by management in conjunction with the health and safety committee of the hospital. The use of the Western Cape's Facility Risk Assessment Tool for TB (FRATT) is one of many tools which can be used for such an evaluation.

Information and training on TB prevention and symptom recognition should be carried out regularly especially in departments and occupations most affected. This will empower employees and encourage their participation in disease control. As shown in this study, the lack of training on TB prevention is identified as one of the possible risk factors associated with TB transmission in the facility. Early symptom recognition and consultation on an on-going basis will not only limit transmission within the workplace but will also reduce the level of disability associated with active TB disease amongst employees.

Medical surveillance should be undertaken especially in the most affected workplaces. A cheap, practical and useful program may take the form of screening questionnaire for symptoms of active TB disease, administered quarterly (or more frequently depending on magnitude of the disease) in respective departments. This will enable suspected cases to be referred for early diagnosis and removal from workplaces so as to prevent or lower transmissions in the workplace.

Accommodation of workers with high personal risk profiles in low risk areas should be considered with due regards to ethical and current legislative requirements especially regarding discrimination (see Employment Equity Act 1998, Basic Condition Employment Act 1997, Labour Relations Act 1995 and the bill of rights, South African constitution). Based on this study, workers with HIV and recurrent active TB disease should be considered for accommodation in work areas with low TB risk if they currently work in high risk areas. The workplace management of newly diagnosed HIV cases should include TB risk management (including workplace placements).

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APPENDIX

Study questionnaire (see attachment)

TUBERCULOSIS RISK QUESTIONNAIRE

[FOR SCREENING OF WORKERS IN TYGERBERG HOSPITAL (TBH)]

This study examines possible risk factors for TB in employees of Tygerberg Hospital. We want to use this information to make the workplace safer. Please, complete the questionnaire as accurately as you can. **This questionnaire is for study purposes ONLY and will not be shared with any other person**. Your name should not appear on this questionnaire.

DATE: _____ Study number_____

1. What is your gender? Male ☐ Female ☐

2. How old are you? _____years Date of birth: day ☐ month ☐ year ☐

3. What is your race? Black/ African ☐ Coloured ☐ White ☐ Indian ☐

Others (specify)_____

4. What is your Height ☐ Weight ☐

5. Did your weight change significantly in the past 4 years (if yes, describe)

	Yes/Increased	Yes/Decreased	No	Don't Know
2008	☐	☐	☐	☐
2009	☐	☐	☐	☐
2010	☐	☐	☐	☐
2011	☐	☐	☐	☐

6. What was your marital status in the following years? e.g. single, married, divorced

- 2008
- 2009
- 2010
- 2011

7. What is the highest level of education that you have COMPLETED?

None Primary school matric diploma

Degree postgraduate

Other (specify): ----------

8. What was your occupation in the following years (e.g. Nurse, student, etc.):

- 2008
- 2009
- 2010
- 2011

9. Please list all your suburbs of residence in the past four years e.g. Khayelitsha, Boston, Kraaifontein, Parow, etc.

- 2008
- 2009
- 2010
- 2011

10. How long have you worked (your working career) in the health services?

- ☐ Months
- ☐ Years

11. How long have you been working as a TBH employee?

- ☐ Months
- ☐ Years

12. List all the departments that you have worked in at TBH in the last four years e.g.

- 2008 ☐
- 2009 ☐
- 2010 ☐
- 2011 ☐

13. On the average, how many hours did you work in TBH during a typical workday?

- 2008 ☐
- 2009 ☐
- 2010 ☐
- 2011 ☐

14. On average how many hours did you work in another health facility (other than TBH) every day (or every week) (e.g. for extra income/ "moonlighting", etc.)?

	Per day	per week
•2008		
•2009		
•2010		
•2011		

15. Did your major daily work activities in TBH in the last 4 years involve;

- close contact with patients Yes/ No
- close contact with patients' specimens Yes/ No
- close contact with both patients and patients' specimens Yes/ No
- None of the above

16. How would you describe your daily work activities in the past four years?

2008	Worked mainly day shift		Night shift		Both day and night shift
2009	Worked mainly day shift		Night shift		Both day and night shift
2010	Worked mainly day shift		Night shift		Both day and night shift
2011	Worked mainly day shift		Night shift		Both day and night shift

17. On average, estimate how many patients (or patient specimens) you came into contact with during a typical day at work in the following years:

- 2008
- 2009
- 2010
- 2011

18. Have you been diagnosed with TB in the past four years?

- 2008; Yes ☐ No ☐
- 2009; Yes ☐ No ☐
- 2010; Yes ☐ No ☐
- 2011; Yes ☐ No ☐

19. Have you been involved in physical exercise for the purpose of improving your fitness in the following years? (if yes, how often were you involved in fitness exercises?)

	Yes/Daily	Yes/Weekly	Yes/Occasionally	No
•2008;	☐	☐	☐	☐
•2009;	☐	☐	☐	☐
•2010;	☐	☐	☐	☐
•2011;	☐	☐	☐	☐

20. How many persons lived with you (in the same house) in the following years?
(e.g. 0, 1, 2, 3 etc.)

- 2008 ☐
- 2009 ☐
- 2010 ☐
- 2011 ☐

-How many persons did you share your room with?

- 2008 ☐
- 2009 ☐
- 2010 ☐
- 2011 ☐

21. How many sexual partners did you have in the following years?

	0	1	2	3	4	5	>5	
• 2008	☐	☐	☐	☐	☐	☐	☐	
•2009	☐	☐	☐	☐	☐	☐	☐	
•2010	☐	☐	☐	☐	☐	☐	☐	
•2011	☐	☐	☐	☐	☐	☐	☐	

22. Do you suffer from flu almost every year? Yes ☐ No ☐

23. How much alcohol do you normally consume? (1 unit = 1 beer or 1 glass of wine or 1 tot of spirits)

- Nothing ☐
- Less than 1 unit per month ☐
- 1 unit per month ☐
- 1 unit per week ☐
- 1 unit per day ☐
- >1 unit per day ☐

24. Smoking History (complete all that applies to you and delete as appropriate)

- I never smoked ☐
- I am a current smoker ☐
- I used to smoke but stopped ☐ days/weeks/months/years ago
- I have smoked for ☐ ays/weeks/months/years-(time)
- I currently smoke/ when I smoked before, I used to smoke

Less than 10 sticks per day ☐

Between 10 and 20 sticks per day ☐

More than 20 sticks per day ☐

25. Recreational drug history e.g. tik, cocaine, mandrax, dagga, etc. (complete all that applies to you and delete as appropriate)

- I never used drugs ☐
- I currently use drugs ☐
- I used to use drugs but stopped ☐ ays/weeks/months/years ago
- I have used drug for ☐ ays/weeks/months/years
- I currently use/ I used to use drugs
  - Every day or almost every day ☐
  - Every week or almost every week ☐
  - Every month or almost every month ☐
  - Less than once per month ☐

26. Tick appropriately, if you have been diagnosed with any of the following diseases and indicate the year of diagnosis.

Diseases					Year of diagnosis
HIV	Yes		No		
Diabetes	Yes		No		
Arthritis	Yes		No		
Renal disease	Yes		No		
Asthma	Yes		No		
COPD	Yes		No		
Cancer	Yes		No		
Allergies	Yes		No		
Hypertension	Yes		No		
Silicosis	Yes		No		

Others (specify)----------

27. Have you had a significant stressful period in your life in the last 4 years?

Yes ☐ No ☐

- If yes, please describe the event in the specific year, including the duration thereof:
- 2008;----------

- 2009;---------- ----------

- 2010; ----------

- 2011;---------- ----------
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28. Have you lived with, worked closely with or attended to any person that you KNOW was diagnosed with TB in the past 4 years? (If yes, where did the contact occur?)

	Yes/at home	Yes/ at TBH	Yes/other places	No
• 2008;	☐	☐	☐	☐
•2009;	☐	☐	☐	☐
•2010;	☐	☐	☐	☐
•2011;	☐	☐	☐	☐

Other (specify) ----------

29. How do you normally get to work?

- •Private car ☐
- • Taxi ☐
- • Major Bus ☐
- • Walking ☐
- • Bicycle ☐
- • Other (please specify)----------

When you come to work, how long does it normally take you? _____

30. What do you normally use to prepare your food at home?

- • Electric stove ☐
- • Paraffin stove ☐
- • Fire / wood ☐
- • Coal ☐
- •Others (specify)----------

31. Please, list your main Hobbies

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32. Please describe in your own words what tuberculosis (TB) is by completing the following:

TB is ---------- and it is caused by ----------

TB is transmitted through Air ☐ Water ☐ Sex ☐

Others (specify)----------

33. Do you think you work in an area where there is a high risk for getting TB?

Yes ☐ No ☐ n't know ☐

Name the area ☐

34. Do you use any form of protection against TB daily when at work?

Yes ☐ ☐

If yes; what do you use? Apron ☐ Gloves ☐ Face-cover ☐

Others (specify) ----------

35. Is there someone in the workplace in the past 4 years who reminded you frequently on the need to protect yourself against TB? (If yes, how often did this person remind you?)

	Yes/Daily	Yes/Weekly	Yes/Occasionally	No
2008	☐	☐	☐	☐
2009	☐	☐	☐	☐
2010	☐	☐	☐	☐
2011	☐	☐	☐	☐

36. Have you received training on the following?

- How to prevent TB? Yes ☐ No ☐
- How to use personal protective equipment (PPE)? Yes ☐ No ☐

-How do you feel (what is your personal opinion) about using PPE?----------

- Do you use them regularly? Yes ☐ No ☐

37. Have you ever received (BCG) vaccination against TB before?

Yes ☐ No ☐ don't know ☐

If yes, how long ago did you last receive the vaccination?

☐ nths ☐ ars

38. Did you receive the Flu vaccine during the following years?

- 2008; yes ☐ No ☐ Don't know ☐
- 2009; yes ☐ No ☐ Don't know ☐
- 2010; yes ☐ No ☐ Don't know ☐
- 2011; yes ☐ No ☐ Don't know ☐

Thank you for your participation!!!