GLOBAL JOURNAL OF MEDICINE AND PUBLIC HEALTH

Social determinants of tuberculosis in sub-Saharan Africa: A systematic review

Ismaila Adamu Saidu [1, 2 *], *Zaheer Nasir* [3], *Baba Waru Goni* [4]

GJMEDPH 2014; Vol. 3, issue 4

*Corresponding Author
E-mail: sa2edia@yahoo.com

1 School of Health & Human Sciences, University of Essex, Wovenhoe Park, Colchester CO4 3SQ UK

2 Department of Physiotherapy, College of Medical Sciences, University of Maiduguri, Maiduguri, Nigeria

3 Healthy Infrastructure Research Centre, Department of Civil, Environmental & Geomatic Engineering, University College London, London WC1E 6BT, UK

4 Infectious Disease Unit, Department of Medicine, University of Maiduguri Teaching Hospital, Maiduguri, Nigeria

Funding – none

Conflict of interest – none

ABSTRACT

Ensuring an efficient and equitable delivery of quality assured diagnosis and treatment of tuberculosis (TB) is the major drive of the TB control programme and the alternatives for incorporating preventative efforts have not yet been fully considered. The aim of the study was to examine the social determinants of TB transmission in sub-Saharan Africa. Four electronic databases (Medline, CINAHL, PubMed, and Web of Science) were systematically searched to obtained relevant articles and critical appraisal skill programme tools were used to analyze data. Out 515 articles obtained from the electronic database search only 18 met the inclusion and exclusion criteria of the systematic review. The study shows that male sex, young age (25-34 years), low education, unemployment, low income, poverty, tobacco smoking, and alcohol abuse are the identified social determinants of tuberculosis in sub-Saharan Africa. Therefore, focus on social determinates of TB, adjunct to early diagnosis and successful treatment completion, can play a pivotal role in reducing the soaring levels to TB transmission in sub-Saharan Africa.

Keywords: Social determinants, Tuberculosis, Transmission, Sub-Saharan Africa

INTRODUCTION

Tuberculosis (TB) is the third leading causes of death among adults in sub-Saharan Africa after human immunodeficiency virus (HIV) and malaria.[1-4] Recent estimation by World Health Organization (WHO) ranked sub-Saharan Africa second after South-east Asia with high burden of TB and it accounts for 37% of global TB incidence.[3] The upsurge in the incidence of TB in sub-Saharan Africa is linked to poverty, poor political will, decay in healthcare infrastructure and high rate of HIV infection.[5-7] The current Stop TB initiative has demonstrated affirmative impact on mortality rate and treatment outcome. However, in sub-Saharan Africa, the TB incidence still lingers and there is little or if any achievement in TB prevention and control.[8,9] Stop TB strategy, focusing on early diagnosis and successful treatment completion, has been the primary intervention in global TB control. Nevertheless, in recent times, socio economic determinants have gained attention in their role to support TB control.[10–17]

Social determinants of health inequities involve material circumstances; psychosocial circumstances; behavioural and/or biological factors and the health system itself. The Commission on Social Determinants of Health (CSDH) has highlighted that 'the circumstances in which people grow, live, work, and age, and the systems put in place to deal with illness' leads to health inequities.[18] Socioeconomic and political mechanisms lead to social stratification of populations, which in turn shape the determinants of health. The structural determinants of health are the mechanisms that generate stratification and the ensuing socioeconomic position of individuals in a

society which leads to inequities in social determinants of health.[13-14] The structural stratifiers that generate stratification comprise of income, education, occupation, social class, gender and race/ethnicity.[15-16]

Beside the tuberculosis control programs, based on diagnostics and treatment, focus on prevention can also help to arrest the TB levels in resource-limited countries. Thus, identifying factors that influence transmission of TB such as social determinants can provide pivotal knowledge to design and implement effective prevention and control strategies. Although, recent effort have been made to review literature on social determinants of TB [15-17] they were neither conducted as systematic review nor focused on a particular region. There is dearth of systematic review on social determinants of TB in high prevalent region such as sub-Saharan Africa. It is reasonable to argue that social determinants of health would vary greatly among different communities due to socio-economic, socio-demographic, political, environmental and cultural differences.[18] There is urgent need to gather knowledge on the social risk factors of TB in different regions globally. The present study was carried out to critically examine the social determinants of TB in sub-Saharan Africa. The findings will assist greatly to identify the underlying social risk factor of TB transmission in sub-Saharan Africa and in designing.

METHODOLOGY

The method adopted for this study was a systematic review and the approach employed was based on the guidelines highlighted by the Cochrane Collaboration.[19] Cochrane Collaboration protocol for writing a systematic review is valid and reliable. [20,21] The ethical approval of the School of Health and Human Sciences, University of Essex was sought and approved before the start of the study.

Inclusion and Exclusion Criteria

Only studies conducted on TB involving human subjects; epidemiology of TB related social determinant of health; carried out in sub-Saharan Africa; among participants ≥15 years; written in English language; and published within last 10 years (2001-2011) were included. Other inclusion criteria comprised of studies including both genders. However, the study excluded all studies conducted on non-human subject; not conducted in sub-Saharan Africa; participants <15 years; not written in English language, and published before 2001 or after 2011. Also letters, editorials, presentations, periodicals and reports were excluded, including studies on biomedical aspect of TB; studies on treatment of TB; on drug resistant TB; and studies carried out on only one gender. Furthermore, studies conducted to determine the risk factor of TB transmission such as HIV, and diabetes other than social determinant were not included in the study.

Study Procedure

The Berry picking model (BPM) search strategy for non-empirical studies was employed for this review. [22] Electronic database searches were conducted using PubMed, Medline, CINAHL and Web of science. For each database accessed, Medical Subject Heading (MeSH) terms were used in combination to obtain data. To combine search terms and separate concept in order to retrieve the relevant articles, Boolean operators I (OR, AND, and NOT) and Boolean operator II (truncation (*)) were used. In this search procedure, aabstract and index search, area scanning, citation searching, journal run, and footnote chasing as well as author scanning of authors such as WHO, UNICEF, and department of health of countries in sub-Saharan Africa were searched for any relevant additional information. However, none of these searches yielded any new addition because the once obtained from this added search approach were already included from the database search.

Process for Selecting Literature

The relevant articles retrieved from the electronic databases used for the systematic review were manually selected in three stages. At the first stage after the input of the relevant keywords into each database, the title of articles generated who met the inclusion and exclusion criteria were screened to obtain only articles with titles relevant to the topic of the review. Only articles with relevant titles were included and qualified for abstract consideration in stage 2. In stage 2, the abstract of each of the articles obtained based on title screening further studied for relevancy and only abstracts that contained relevant

information related to the review were considered. Only the articles with relevant abstract were finally considered for full text study. The full text of the articles retrieved from the abstract screening was also studied for relevancy and inclusion (stage 3). The articles, in which the method did not meet inclusion criteria and the results presented were not relevant to the topic, were excluded. A flow-chart is used to present the summary of the procedure and number of articles considered (**Figure 1**).

Analysis of Findings

The articles obtained from full text examination were included for the literature review. Each article was critically appraised based on the type of research design with a corresponding critical appraisal skill programme (CASP) tool.[23-25] The CASP tools used for this literature were obtained from the Solution for Public Health. Only use for academic purpose was permitted and not profit making.[26] The use of CASP tool for literature is valid and reliable.[27, 28]

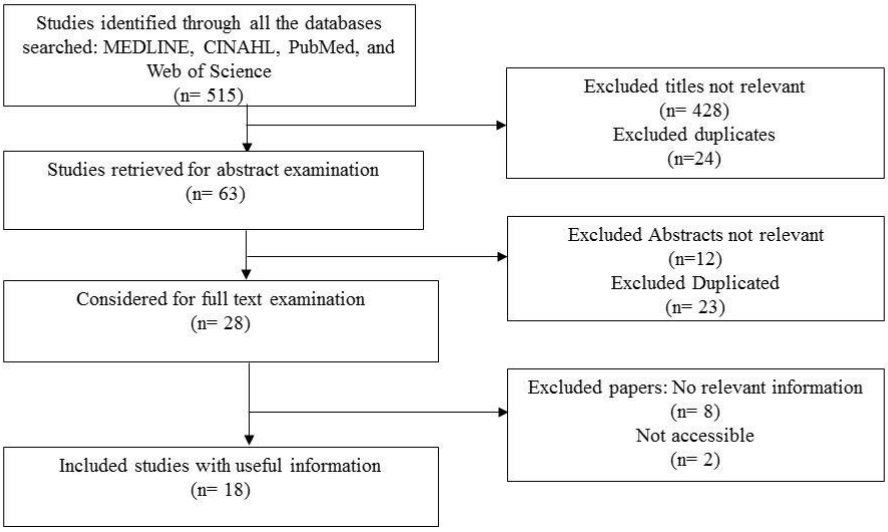

Figure 1. Flow diagram of literature search strategy

RESULTS

A total of 515 articles were first retrieved from the entire databases search, 26 articles from CINAHL, 108 from MEDLINE, 242 from PubMed, and 139 from web of science. For each of the database used as search engine, the relevant articles obtained were first matched-by database and any article title that appeared more than once was recorded as a duplicate. Similarly, the overall relevant articles retrieved from each database were entirely matched together to eliminate duplicated papers (those appeared more than one time)[23] and the articles that were not relevant (428) and duplicated articles (24) were eliminated. Sixty-three articles remained for abstract examination (table 1). Out of the 515 articles obtained only 18 made the inclusion criteria out of which 3 were cohort studies, 7 case-control studies and 8 cross-sectional studies (table 1). In this systematic literature review, the findings were presented in five emerged themes. These include social-demographic, socioeconomic status, social behaviour, nutrition, and living condition/physical environment.

Socio-demographic

Age

Boccia et al.[29] in a 1-year follow-up case-control study nested in the previous population-based prevalence survey conducted in Zambia involving 424 participants (106 cases and 318 controls) observed that participants aged between 30-44 years and ≥45 years had increased odds of TB infection by 90% and 110% respectively compared with those individuals aged between 15-29 years. Corbett et al.[30] conducted a population-based cross-sectional study in Zimbabwe involving 110432 adults (aged ≥16 years), argued that persons aged between 25-34 years and 35-44 years had almost 4 and 3-folds increased

likelihood of TB infection compared to those aged <25 years respectively while those aged ≥45 years were 70% more likely to be infected with TB compared to <25 years persons. Similar findings was reported by den Boon et al.[31] in a population-based cross-sectional study including 3512 individuals in South Africa found participants between the age of 25-34 years and 35-44 years had increased likelihood of TB infection by almost 4-folds and 3-folds respectively and those ≥55 years had 88% increased likelihood compared with those aged of 15-24 years.

Gender

Sekandi et al.[32] in a cross-sectional study involving 930 participants (305 females and 625 males) found no significant difference in risk of TB infection between males and female participants. This means that both males and females participants had similar risk of TB infection. Contrary, Lienhardt et al.[33] in a 3-years community-base case-control study conducted their study in 3 West African states (Guinée, Guinea-Bissau, and Gambia) involving 2376 participants (846 cases, 702 household controls, and 828 community controls) reported that male participants had significant increased risk of TB transmission by 143% compared to females. Gustafson et al.[34] in a 2-years prospective cohort conducted in Guinea-Bissau including 25189 participants also observed that males participants had significant increased odds of TB infection by almost 2-folds compared to females participants.

Ethnicity

In Gambia, Hill et al.[35] conducted 2-years case-control study including 300 participants (100 cases and 200 controls). They compared Mandinka the majority ethnic group with minorities (Wolof, and Fula). The study found that Wolof and Fula ethnicity had increased likelihood of TB infection by almost 3-folds and 80% compared to Mandinka ethnicity respectively. Consistently, in a neighbouring Guinea-Bissau, Gustafson et al.[34] also observed that ethnic minorities Manjaco, Fula, and Mandinga had increased odds of TB infection by almost 2-folds compared to Pepel the majority ethnicity which constitute 40% of the population

In contrast, Harling et al.[36] in a multilevel analysis aimed to determine social epidemiology of TB among South Africans, combined data from 2 cross-sectional studies (1996 South African national census (SANC) and 1998 South African Demographic and Health Survey (SADHS) involving 13043 participants (7613 females and 5430 males) observed that in South Africa, the White and Asian ethnic minorities had significant reduction in likelihood of TB infection compared with Black African ethnic majorities by 58%.

Marital Status

In Malawi, Crampin et al.[37] conducted a case-control study involving 1590 participants (598 cases and 992 controls). They found that participants who were single and widowed/divorced had increased likelihood by 90% and 184% compared to married participants respectively. This is consistent with the result obtained by Hill et al.[35] and Lienhardt et al.[33] that participants who were single and widowed/divorced had increased risk of TB infection by roughly 2-folds compared to married participants. In the above mentioned studies[33,35,37] the results were adjusted for confounder and relationship was statistically significant.

Socioeconomic Status

Income

Hanrahan et al.[38] in a 5-years cohort study among 3456 South African HIV-infected adults used average person's income per month as an indicator. The participants were grouped into 3 categories: those with monthly income <R1000, R1001-5000, and >R5000, found that persons in R1001-5000/month and >5000 category had increased odds of TB by 110% and 82% respectively compared to <R1000/month category. In a 2-year case-control study by Lienhardt et al.[39] including 620 participants (315 cases and 305 controls) in Gambia using household assets score (0-1, 2-3 and ≥4 scores (high scores means more affluent), found that those in 2-3 score and ≥4 score group had increased odds of TB infection by 114% and 118% respectively compared to those in 0-1 score group. Harling et al.[36] used asset score quintile to measure income and argued that participants in the lowest quintile were at nearly twice the likelihood of TB infection while a significant protective effect of about 75% was noticed in the

wealthiest quintile when both compared with persons in middle quintile.

Education

Hill et al.[35] and Crampin et al.[37] reported that participants who are uneducated had increased likelihood of TB transmission by 60% and 130% respectively compared with educated. This findings is consistent with Lienhardt et al. [38] who also found that uneducated (0 years) persons had increased odds of TB infection by 108% and 96% compared to persons with 1-5 years and >5 years of education respectively.

Employment

Harling et al. [36] in multilevel analysis reported that being employed in the past 1 year significantly decreased a person's likelihood of TB infection by almost 25% compared with those unemployed in the past 1 year. On the contrary, Hanrahan et al. [38] argued that there was no statistically significant relationship in the risk of TB infection between employed and unemployed. This suggests that both the employed and unemployed had equal likelihood of TB infection.

Occupation

Stuckler et al.[40] recently in a population-based survey used the WHO Global Tuberculosis Database (2009 Edition) for TB morbidity and mortality measures and the ecological data on TB and mining for 44 of 46 countries in the WHO's African region. The result of this study suggested that for each 10% rise in mining production was correlated with significant 0.9% increase in TB incidence.

Kehinde et al.[41] in a hospital-based cross-sectional study involving 271 participants aged ≥20 years in a single setting in Nigeria, reported that unskilled health care workers (HCWs) had higher risk of TB by 105% compared to skilled HCWs. Kayanja et al.[42] in a similar study involving 396 HCWs from 3 different settings in Uganda, found that nurses and support staff had increased likelihood by about 2-folds and technicians had significant reduction in likelihood of TB by 42% when both compared with clerical/administrative staff. Consistently, Eyob et al.[43] in a hospital-based retrospective cohort study with 10 years (1989-1998) follow-up involving 175 HCWs with median age of 34 years in Ethiopia observed that the incidence rates of TB/100,000 person-year of follow-up, ranges from lowest to highest among HCWs, were X-ray technician (0), nurses (833), doctors (1587), laboratory technician (4545) and 7042 for drivers. Contrarily, Galgalo et al.[44] conducted a hospital-based case-control study involving 381 HCWs (65 cases and 316 control) in Kenya and after 4 years follow-up found that there was no statistical significant difference in risk of TB infection among clinical staff (nurses, support staff, doctors, laboratory scientist) when compared administrative staff.

Social Behaviour

Alcohol Abuse

Consistently, Lienhardt et al.[33], Crampin et al.[37] and Kayanja et al.[42] argue that participants who consume alcohol had significant increased risk of TB disease by almost 2-fold when compared with those that do not consume alcohol.

Smoking

Hill et al.[35], Crampin et al.[37] and den Boon et al.[31] found that smokers are almost 2-folds more likely of TB transmission compared with non-smokers after adjustment for confounders.

Nutrition

Gangaidzo et al.[45] conducted 1-year case-control study in Zimbabwe to evaluate the relationship of increased dietary iron with pulmonary TB (186 participants (98 cases and 98 controls) aged ≥15 years), found that overload dietary iron intake significantly increased likelihood of TB infection by almost 4-fold after adjustment for confounders. In Tanzania, Mfinanga et al. [46] conducted a cross-sectional study including 426 participants among livestock keeper and the general population reported that cultural practice of eating uncooked meat and drinking fresh raw cow blood increased the likelihood of TB disease by roughly 2-folds compared to those who do engaged in such practice. They also argued that intake of unpasteurized cow milk was statistically significant in increased likelihood of TB infection compared to those who consumed boil cow milk and goat milk.

Table 1. Summary of the studies included in the systematic review

S/No	Author	Location	Population	Exposure	Outcome	Adjusted variables	Findings
Cohort Studies							
1	Hanrahan et al (2010) [32]	South Africa	3456	TB infection	sputum smear test+/biopsy+	Age, sex, HIV	Low income & unemployment is associated with increased risk of TB
2	Gustafson et al (2004) [33]	Guinea-Bissau	25189	TB infection	CXR/sputum smear test+	Age, sex, SES, BMI	Increasing age, male sex, ethnicity, adult crowding, family structure, and poor housing conditions were independent risk factors for TB.
3	Eyob et al (2002) [34]	Ethiopia	175	TB infection	CXR/sputum smear test+/biopsy+	Did not adjust for any confounder	HCW (Nurses, doctors, laboratory technician and drivers) were associated with increased TB incidence.
Case-control Study							
4	Boccia et al (2009) [35]	Zambia	424 (106 cases & 318 controls)	TB infection	Quantiferon-TB Gold+	Age, sex, SES	Higher socioeconomic position, rather than lower, was associated with significantly higher risk of TB infection.
5	Galgalo et al (2008) [36]	Kenya	381 (65 cases & 316 controls)	TB infection	CXR/sputum smear test+	HIV, working condition	Clinical staff (nurses, support staff, doctors, laboratory scientist) were associated with increased risk of TB infection compared administrative staff
6	Hill et al (2006) [37]	Gambia	300 (100 cases & 200 controls)	TB infection	Sputum smear test+ /sputum culture test+	Age, sex, SES, smoking, environmental factors	Marital status, ethnicity, adult crowding, smoking, occupation and poor housing conditions were independent risk factors for TB
7	Lienhardt et al (2005) [38]	Gambia, Guinée & Guinea-Bissau	2376[†]	TB infection	Sputum smear test+ /sputum culture test+	Age, sex, SES, HIV	TB was associated with male sex, smoking, marital status, adult crowding, and renting the house
8	Crampin et al (2004) [39]	Malawi	1590 (598 cases & 992 controls)	TB infection	sputum smear test+/biopsy+	Age, sex, area, HIV	Marital status, low SES, smoking, and poor living condition were associated with

							increased risk of TB infection
9	Lienhardt et al (2003) [40]	Gambia	620 (315 cases & 305 controls)	Pulmonary TB infection	Sputum smear test+ /sputum culture test+	Age, household size	The risk of TB was higher in males and increased with age, social proximity to the case.
10	Gangaidzo et al (2001) [41]	Zimbabwe	186 (98 cases & 98 controls)	In dietary iron load	FBC/ serum ferritin/iron concentrations Sputum smear test+/	HIV, liver function	Increased dietary iron was associated with high risk of TB
Cross-sectional Study							
11	Stuckler et al (2011) [42]	Sub-Saharan Africa	Not stated (secondary data analysis)	TB infection/mining	TB test was based on WHO diagnosis	HIV, SES, export dependence, urbanization rates, population size	Mining is a significant determinant of countrywide variation in TB among sub-Saharan African nations.
12	Kehinde et al (2010) [43]	Nigeria	271	TB infection/health care occupation	Sputum smear test+ /sputum culture test+	BCG vaccination history	Subjects aged ≥20 years, female gender and unskilled professional had higher risk of occupationally-acquired TB
13	Corbett et al (2009) [44]	Zimbabwe	12426	TB infection	Sputum smear test+ and sputum culture test+	Age, sex, HIV	Overcrowding, male sex, were the major risk factors for TB
14	Sekandi et al (2009) [45]	Uganda	1000	TB infection	Sputum smear test+	Did not adjust for potential confounder	No significant difference in risk of TB infection between males and female participants
15	Harling et al (2008) [46]	South Africa	13043	TB infection	Sputum smear test+ /CXR/TST ≥10 mm	Age, sex, SES, BMI smoking, alcohol, ethnicity	TB was associated with cigarette smoking, alcohol intake, low education, unemployment and lower household wealth.
16	den Boon et al (2005) [47]	South Africa	2401	Ever tobacco smoking	TST ≥10 mm (n= 1,832	Age, sex, SES,	Smoking associated with TST+, dose response observed based on pack years
17	Kayanja et al (2005) [48]	Uganda	396	TB infection	CXR/TST ≥10 mm	Age, HIV, BCG scar, department of work	Nurses, support staff and technician had increased likelihood of TB compared with clerical/administrative staff
18	Mfinanga et al (2008) [49]	Tanzania	426	TB infection	Sputum smear test+ /CXR/TST ≥10 mm	Did not adjust for confounder	Consumption of unpasteurized milk, blood and meat were associated with TB

Living/Working Condition and Physical Environment

Housing Occupancy

Harling et al.[36] argued that one additional adult per bedroom significantly increased the likelihood of lifetime TB infection among participants by 96%. Urban dwellers had reported that participants with middle and higher score of crowding index had increased odds of TB infection by roughly 2-folds and 3-folds respectively compared to those with lower score. Additionally, Lienhardt et al.[33] also observed that dwelling >10 and 6-10 adults per household had significant increased odds of TB disease by almost 3-folds and 137% respectively compared with those 1-5 adults per household dwellers.

Housing Design

Hill et al.[35] observed that those persons with 2-4 windows/room had 11% decreased in likelihood of TB infection compared to those with 0-1 window/room. Lienhardt et al.[33] also argued that participants who had 1 and >2 windows had nearly 30% significant reduction in risk of TB infection compared to those without window.

House Ownership

Lienhardt et al.[33] and Lienhardt et al.[39] in a case-control study argued that lack of personal ownership of house significantly increased the odds of TB infection by 142% and 133% respectively compared with those who owned personal house.

Place of Residence

Boccia et al.[29] and Harling et al. [36] observed that urban dwellers had significant increased risk of TB infection when compared with rural dwellers by 130% and 106% respectively.

Source of Water Supply

Lienhardt et al.[33] observed that participants who used 'well' and 'others' (stream, river, and lake) had significant increased odds of TB infection by 86% and 74% compared to those who used tap water others' (stream, river, and lake) respectively. Boccia et al.[29] found no significant difference in risk of TB transmission between participants who used inside household piped water supply compared with those who used outside household piped water supply.

DISCUSSION

Socio-demographic

This present study reveals that male sex, young age of 25-34 years, ethnic minorities, and marital status (single and divorced/widowed) were the socio-demographic factors associated with increased risk for TB transmission in sub-Saharan Africa. Hill et al.[35] and Lienhardt et al.[33] report that ethnic minorities, and the devoiced/widowed are usually persons from low social gradient and the divorced/widowed mostly females are still experiencing social exclusion and deprivation in sub-Saharan Africa. Public health practice should liaise with other programmes such as MDGs which have gender issue and TB prevention as part of their agenda and empower females through job and skill acquisition schemes, increase girl-child education, and encourage improvement in family cohesion among the sub-Saharan Africa population and this will reduce the social inequalities thereby preventing the TB transmission. There should be social reform in order to minimize the degree of relative deprivation among the young age, single, ethnic minorities and the divorced and widowed. The importance of social reform could be observed in Brazil where it has helped significantly in decreasing infectious diseases such as TB, malaria, and HIV prevalence including reduction in social and health inequalities cross the population. [47]

Socioeconomic Status

This present study reveals that poverty, low income, low educational status, and unskilled occupation were associated with increased risk for TB infection in sub-Saharan Africa. TB initiative should be enthusiastically engaged in some national strategy to tackle poverty such as development of poverty reduction policy document and related procedure which will guarantee that the TB prevention and control strategy promotes fairness in access and financial protection for the low socioeconomic gradient and the poor. Public health through its TB initiatives should also use social support for TB cases and families, microfinance system and vocational training to empower the less privilege population which in long run will reduce TB transmission.

The integration of public health issues, especially spread of infectious diseases, into socioeconomic

development polices may lead to equitable income distribution, equitable basic education, access to quality healthcare facilities and services which in turn will assist in their prevention beyond that of TB. Deteriorated healthcare system and poor working condition in mines has been attributed to increased risk of TB transmission among HCW[43] and miners[40] respectively in Africa south of Sahara. Thus, working condition for the miners and HCWs should be improved and this can be achieved by collaboration between public health and policy makers to come up with policy document on standard requirement for conducive working environment which will reduce TB transmission. This form of legislation has countries such Brazil, England, US and Argentina to achieve reduction in TB transmission among miners [48] including HCW in the US during the early 20th Century. [49]

Social Behaviour

Also this present study reveals that tobacco smoking and alcohol abuse were associated with increased risk for TB infection. The integration of public health initiatives such as tobacco smoking cessation and alcohol harm reduction programme into the present TB control and prevention strategy may help strengthen TB control and prevention efforts. This is also true; because the current TB prevention and control programme that included HIV infection programme is making great impact in reduction of TB prevalence among HIV patients including TB-related morbidity in Southeast Asia [7,50,51] and Latin Americans regions of high TB and HIV burden. [52] Public health should liaise with legislature to enforce tobacco companies to not only smoking causes lung cancer but to include TB infection as harmful effect of tobacco smoking and this may help to decrease TB transmission in sub-Saharan Africa. Public awareness regarding the causal link between TB infection and smoking and alcohol should be increased through the use of radio, poster, fliers and billboard especially in local languages for better understanding as it is been done for HIV/AIDS infection which is making great impact on HIV reduction in sub-Saharan Africa.

Nutrition

This study shows that poor dietary intake particularly consumption of uncooked meat, unpasteurized milk and elevated serum iron were risk factors for TB infection. The public health authorities should collaborate with government to improve food security to reduce malnutrition and unhealthy dietary intake which will reduce the TB transmission. Therefore, TB control programme should liaise with food safety agencies including legislature to emphasis the food process industries to determine the average daily dietary iron requirement and label it on food package to avoid iron overload which will prevent TB transmission. This is true because such is being done for diabetes and is yielding good outcome. The public should be enlighten on the harmful effect of consumption of uncooked meat, fresh cow blood, and unpasteurized milk and avoid such practice as it causes TB transmission. In addition, consumption of properly cook the meat, boil the cow blood and milk should be encouraged which will help to prevent TB transmission among this population. Also the public health should liaise with agricultural department to engage in routine and active latent TB screening of the cow for quarantine and treatment so that human-animal TB transmission will be prevented.

Living/Working Condition and Physical Environment

Increased living occupancy, poor ventilation, and state of ownership, as well as place of residence, and unsafe source of drinking water supply were found to increased likelihood for TB infection in this present study. From historical background, TB is known as a disease of poverty and is associated with poor housing environments. On average, people with low socioeconomic status are likely to be in overcrowded and poorly ventilated living environments, have more frequent contact with active TB cases, more food insecurities, low levels of awareness about healthy behaviour and limited access to health care.[15] Residents of area in which there are high concentrations of poverty are likely to encounter built environments that are ageing, poorly maintained, and have inadequate enforcement of public health and environmental regulations.[53] In addition, lack of housing ownership may lead to poor building hygiene maintenance. There is an increased probability of inhaling droplets expelled by infectious individuals in overcrowded and poorly ventilated

spaces.[54] Ventilation and air movement in buildings has been strongly associated with transmission of air borne infectious diseases.[55]

Public health should encourage the government, and private sectors to embark on standardized mass housing development so that people in sub-Saharan Africa can be able to own personal houses through mortgage facility. This is because the lack of housing ownership may lead to poor housing design and maintenance of building hygiene and in the long run increase risk of TB transmission. In addition, building regulations for size, space, ventilation performance, and construction materials of residential buildings should be developed and implemented. These regulations should take into account the health, safety and wellbeing of inhabitant rather mere aesthetics and economic considerations. In sub-Saharan Africa, building engineers should collaborate with public health practice to develop healthy and affordable housing infrastructure. During the 19th Century, in the Western Europe, the decline of TB incidence has been attributed to improvements in housing and environmental conditions.[56,57] In resource limited countries, improved and healthier use and management of existing housing infrastructure can be adopted as sustainable public health intervention. For example, identification of certain features in existing housing infrastructure which enhance indoor environmental quality and interventions to incorporate them in existing housing infrastructure can be adopted as sustainable public health intervention. It is very likely that these interventions would be widely accepted in the local communities as they recognize the existing housing infrastructure, socio- economic conditions and cultural norms of these communities. In addition, the public awareness regarding the impact of hygienic use of household space on reducing the TB transmission should be highlighted by using different Medias. Schools and basic health units can be used as hubs to develop social circuits to disseminate this information. Infrastructure development, provision of basic social amenities and job creation in the rural area will reduce rural-urban migration and in long run will contribute to TB prevention.

It is worth mentioning that many studies have highlighted the importance of environment to TB transmission yet there is paucity of knowledge to gauge the significance of environmental factors in TB transmission. Although environmental conditions (e.g. ventilation rates, indoor air flow, floor area per person, built structure and design) influence the factors enhancing the risk of exposure and thus the risk of infection to TB (e.g. concentration of infectious droplet nuclei, proximity to infectious source and duration of exposure) these have rarely been part of epidemiological studies on TB transmission.

It was also observed in this review that urban dwelling and unsafe source of water supply such as well, stream, river and lake were also among the attributable risk factors of TB infection. Therefore, to reduce risk of TB infection among urban dwellers, the public health should encourage the government on infrastructural development in the rural area, provision of basic social amenities and job creation which will reduce rural-urban migration and in long run will help to decrease increase living density. Improving sanitation situation in the urban areas is also essential in strengthening and achieving TB prevention and control among urban-dwellers. Similarly, improving the hygiene of sources of water supply to ensure safe source of drinking is key in preventing TB prevalence and this has markedly been observed to have reduced cholera epidemic in low resource countries such as sub-Saharan Africa. [58] Therefore, Public health should collaborate with water supply agency in sub-Saharan Africa to improving the quality of water treatment plan and process in order to ensure delivery of safe water supply to the vulnerable population. Because sub-Saharan Africa is a region characterized with poor resource, there is need to collaborate with NGO to provide standard wind or solar powered water borehole to improve safe water supply. Also, they should be discouraged from use of the same source of drinking water with animal which will prevent contamination with infectious organism such as *M.tuberculosis*, including fetching of water from upper belt of the stream and river where activities such as washing is not taking place. More so, in the rural community the public health practice should teach and encourage the population on simple water treatment methods such as boiling, filtration, and use of bleach as simple chlorination technique to ensure that the water is safe for use.

The government, healthcare workers, public health practice and the public at large are to improve their respective commitment in TB prevention and control programme. The commitment required from the government is to improve funding, provision and improvement of healthcare facility including training and re-training of TB care personnel along with accountability of TB control and prevention programme. Improvement in surveillance, record keeping, prompt and routine programme monitoring and evaluation to identify gap for upgrading including increase effort of active TB case finding through routine screening of all vulnerable population will assist in prompt treatment and prophylaxis initiation including improve service delivery. The healthcare workers should improve attitude toward patients respect so that the public will have confidence in uptake of TB prevention approaches outlined by the public health and the public should improve compliance to treatment and uptake of the routine screening in identifying cases.
In sub-Saharan Africa countries where TB drugs are not given for free, public health practice in such nations should encourage the government, donor agencies and NGOs to subsidize or offer free TB services which may encourage uptake of TB prophylaxis among persons with contact of active TB cases and latent TB.

Limitations of the study and Gaps in the Literature
The limitation of this study is the inclusion of only articles written in English Language because it the only language understood by the researcher and this might have caused missing out some important information for the review. The use of monolingual articles in literature may lead to language bias. [59]Another limitation to this study is that almost 50% of the studies included used small sample size and nearly 44% were cross-sectional studies that do not measure causality and these may limit generalizability of findings from this study. The gaps identified in this systematic review were migration, sanitation, transportation, access to quality healthcare facility, and air pollution as all the studies did not examine how they can also influence the risk of TB infection in sub-Saharan Africa.

CONCLUSION

The focus on upstream drivers of TB epidemic (social determinants) along with medical interventions (diagnosis and successful treatment) holds the key to arrest the soaring levels of TB infection in SubSaharan countries. Adjunct to socio- economic reforms the scope for latent TB screening should prioritize high risk groups identified in this study for early diagnosis, prophylaxis and treatment which will assist to prevent TB transmission. Policy makers in sub-Saharan African should stand up to challenges and improved its commitment to fight TB in order to make the objectives of MDG and TB control programme realistic by the year 2015 and 2050 respectively.

Authors Statements: The ethical approval for conducting this systematic review was sought and obtained from the school of health and human sciences, University of Essex, UK.

REFERENCES

1. Jamison DT, Feachem RG, Makgoba MW, Bos ER, Baingana FK, Hofman KJ et al. Eds. *Disease and Mortality in Sub-Saharan Africa* (2nd ed). Washington, The International Bank for Reconstruction and Development / The World Bank 2006

2. Glynn JR, Alghamdi S, Mallard K, McNerney R, Ndlovu R, Munthali L, et al. Changes in Mycobacterium tuberculosis Genotype Families Over 20 Years in a Population-Based Study in Northern Malawi *PLoS One* 2010;5(4): e13003

3. World Health Organization. *Global tuberculosis control-2010*. Geneva, WHO 2010a

4. World Health Organization. *Tuberculosis [fact sheets]*. Geneva, WHO 2010b

5. Guo N, Marra F, Marra C. Measuring health-related quality of life in tuberculosis: A systemic review. *Health Qual Life Outcomes* 2009;7(14):7-14

6. Dhuria M, Sharma N, Ingle GK. Impact of Tuberculosis on the Quality of Life. *Indian J Comm Med* 2008;33(1):58–59

7. World Health Organization. *Global tuberculosis control 2009: Epidemiology, strategy, financing [Report]*. Geneva, WHO 2009

8. Kritzinger FE, Boon SD, Verver S, Enarson DA, Lombard CJ, Borgdorff MW, et al. No decrease in annual risk of tuberculosis infection in endemic area in Cape Town, South Africa. *Tropical Med Intl Health* 2009;14(2):136–142

9. Lönnroth K, Jaramillo E, Williams B, Dye C, Raviglione M. *Tuberculosis: the role of risk factors and social determinants*. In: Blas E, Sivasankara Kurup A, eds. *Equity, social determinants and public health programmes.* Geneva, Switzerland: WHO, 2010: pp 219–241.

10. Lönnroth K, Castro KG, Chakaya JM, Chauhan LS, Floyd K, Glaziou P, et al. Tuberculosis control and elimination 2010–50: cure, care, and social development. *Lancet* 2010; 375: 1814–1829.

11. Dye C, Lönnroth K, Jaramillo E, Williams B G, Raviglione M. Trends in tuberculosis incidence and their determinants in 134 countries. *Bull World Health Organ* 2009; 87: 683–691.

12. Kelly MP, Morgan A, Bonnefoy J, Butt J, Bergman V, Mackenbach J, et al. *The social determinants of health: Developing an evidence base for political action*. WHO Commission on the Social Determinants of Health, Geneva. 2007

13. Marmot M. Social determinants of health inequalities *The Lancet* 2005;365(9464):1099-1104

14. Rasanathan K, Kurup AS, Jaramillo E, Lönnroth K. The social determinants of health: key to global tuberculosis control. *Int J Tuberc Lung Dis* 2011;15(6):S30–36

15. Lönnroth K, Jaramillo E, Wiilaims BG, Dye C, Raviglione M. Drivers of tuberculosis epidemic: The role of risk factors and social determinants. *Soc Sci Med* 2009;28:2240-2246

16. Hargreaves JR, Boccia D, Evans CA, Adato M, Petticrew M, Porter JD. The Social Determinants of Tuberculosis: From evidence to action. *J Public Health* 2011;101:654–662

17. Holtgrave DR & Crosby RA. Social determinant of tuberculosis case rates in the United Stated. *Am J Prev Med* 2004;26:159 -162

18. Commission for Social Determinant of Health. *Closing the gap in a generation: health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health.* Geneva, World Health Organization. 2008

19. Higgins JPT & Green S. eds. *Cochrane handbook for Systematic Reviews of Interventions* (Version 5.1.0). The Cochrane Collaboration 2011

20. Wieseler B & McGauran N. Reporting a Systematic Review. *Chest* 2011;137(5):1240-1246

21. Bjordal JM, Bogen B, Lopes-Martins RA, Klovning A. Can Cochrane Reviews in controversial areas be biased? A sensitivity analysis based on the protocol of a Systematic Cochrane Review on low-level laser therapy in osteoarthritis. *Photomed Laser Surg* 2005;23(5): 453-458.

22. Bates MJ. The design of browsing and berry-picking techniques for the online search interface. *Online review 1989;13*(5):407-423

23. Bowling A. *Research Methods in Health: Investigating Health and Health Services* (2nd Edn) Buckingham, Open University Press 2002:

24. Aveyard H. *Doing a Literature Review in Health and Social Care: A practical guide*, McGraw-Hill. 2010:

25. Bowling A & Ebrahim S. eds. *Handbook of health research methods: Investigation, measurement*

and analysis. London, Open University Press. 2007: 62

26. Solution for Public Health. *Critical appraisal skill programme*. Oxfordshire, SPH 2010

27. Griffiths F. *Research method for health care practice*. London, SAGE Publications Ltd 2009:42-54

28. Smits PBA, Verbeek JHAM, de Buisonjé CD. Problem based learning in continuing medical education: a review of controlled evaluation studies. *BMJ* 2002;324:153

29. Boccia D, Hargreaves J, Ayles H, Fielding K, Simwinga M, Godfrey-Faussett P. Tuberculosis infection in Zambia: the association with relative wealth. *Am J Tropical Med Hygiene* 2008;80:1004-11.

30. Corbett EL, Bandason T, Cheung YB, Makamure B, Dauya E, Munyati SS, et al. Prevalent infectious tuberculosis in Harare, Zimbabwe: burden, risk factors and implications for control. *IJTLD* 2009;13:1231-77.

31. den Boon S, van Lill SW, Borgdorff MW, Verver S, Bateman ED, Lombard CJ, et al. Association between smoking and tuberculosis infection: a population survey in a high tuberculosis incidence area. *Thorax* 2005;60:555-7.

32. Sekandi JN, Neuhauser D, Smyth K, Whalen CC. Active case finding of undetected tuberculosis among chronic coughers in a slum setting in Kampala, Uganda. *IJTLD* 2009;13:508-13.

33. Lienhardt C, Fielding K, Sillah JS, Bah B, Gustafson P, Warndorff D, et al. Investigation of the risk factors for tuberculosis: a case-control study in three countries in West Africa. *Int J Epidemiol* 2005;3:914-23.

34. Gustafson P, Gomes VF, Vieira CS, Rabna P, Seng R, Johansson P, et al. Tuberculosis in Bissau: incidence and risk factors in an urban community in sub-Saharan Africa. *Int J Epidemiol* 2004;33:163-72.

35. Hill PC, Jackson-Sillah D, Donkor SA, Otu J, Adegbola RA, Lienhardt C. Risk factors for pulmonary tuberculosis: a clinic-based case control study in The Gambia. *BMC Public Health* 2006;6:1-7.

36. Harling G, Ehrlich R, Myer L. The social epidemiology of tuberculosis in South Africa: A multilevel analysis. *Sol Sci Med* 2008;66:492–505.

37. Crampin AC, Glynn JR, Floyd S, Malema SS, Mwinuka VK, Ngwira BM, et al. Tuberculosis and gender: exploring the patterns in a case control study in Malawi. *IJTLD* 2004;8:194-203.

38. Hanrahan CF, Golub JE, Mohapi L, Tshabangu N, Modisenyane T, Chaisson RE, et al. Body mass index and risk of tuberculosis and death *AIDS* 2010;24:1501-8.

39. Lienhardt C, Fielding K, Sillah J, Tunkara A, Donkor S, Manneh K, et al. Risk factors for tuberculosis infection in sub-Saharan Africa: a contact study in The Gambia. *Am J Resp Crit Care Med* 2003;168:448-55.

40. Stuckler D, Basu S, McKee M, Lurie M. Mining and risk of tuberculosis in sub-Saharan Africa. *Am J Public Health* 2011;101:524-30.

41. Kehinde AO, Baba A, Bakare RA, Ige OM, Gbadeyanka CF, Salako AO, et al. Risk factors for pulmonary tuberculosis among health-care workers in Ibadan, Nigeria. *Afri J Med Med Sci* 2010;39:105-12.

42. Kayanja HK, Debanne S, King C, et al. Tuberculosis infection among health care workers in Kampala, Uganda. *IJTLD* 2005;9:686-8.

43. Eyob G, Gebeyhu M, Goshu S, Girma M, Lemma E, Fontanet A. Increase in tuberculosis incidence among the staff working at the tuberculosis demonstration and training centre in Addis Ababa, Ethiopia: a retrospective cohort study (1989-1998). *IJTLD* 2002;6:85-8.

44. Galgalo T, Dalal S, Cain KP, Oeltmann J, Tetteh C, Kamau JG, et al. Tuberculosis risk among staff of a large public hospital in Kenya. *IJTLD* 2008;12:949-54.

45. Gangaidzo IT, Moyo VM, Mvundura E, Aggrey G, Murphree NL, Khumalo H, et al. Association of pulmonary tuberculosis with increased dietary iron. *The J Infect Dis* 2001;184:936-9.

46. Mfinanga SG, Mørkve O, Kazwala RR, Cleaveland S, Sharp JM, Shirima G, et al. The role of livestock keeping in tuberculosis trends in Arusha, Tanzania. *IJTLD* 2003;7:695-704.

47. Barreto ML, Teixeira MG, Bastos FI, Ximenes RAA, Barata RB, Rodrigues LC. Successes and failures in the control of infectious diseases in Brazil: social and environmental context, policies, interventions, and research needs. *The Lancet* 2011;377:1877-89.

48. Stephens C, Ahern M. *Worker and community health impacts related to mining operations internationally: A rapid review of the literature*. International Institute for Environment and Development (IIED); 2001

49. Fennelly KP, Iseman MD. Health care workers and tuberculosis: The battle of a century. *IJTLD* 1999;3:363–4.

50. Nair N, Wares F, Sahu S. Tuberculosis in the WHO South-East Asia Region. *Bull WHO* 2010;88:164.

51. Beyrer C, Suwanvanichkij V, Mullany LC, Richards AK, Franck N Samuels A, et al. Responding to AIDS, tuberculosis, malaria, and emerging infectious diseases in Burma: Dilemmas of policy and practice. *PLoS Med* 2006;3:e393.

52. Robledo JA, Mejía GI, Morcillo N, Chacón L, Camacho M, Luna J , et al. Evaluation of a rapid culture method for tuberculosis diagnosis: A Latin American multi-center study. *IJTLD* 2006;10:613–19.

53. Schulz A, Northridge ME. Social determinants of health: Implications for environmental health promotion. *Health Educ Behav* 2004;31:455-71.

54. Wanyeki I, Olson S, Brassard P, Menzies D, Ross N, Behr M, et al. Dwellings, crowding, and tuberculosis in Montreal. *Soc Sci & Med* 2006,63:501-11.

55. Li Y, Leung GM, Tang JW, Yang X, Chao CY, Lin JZ, et al. Role of ventilation in airborne transmission of infectious agents in the built environment - A multidisciplinary systematic review. *Indoor Air* 2007,17:2-18.

56. Donegan JLM. Tuberculosis: Is the BCG vaccination any good? http://www.whale.to/v/donegan.html [accessed on 22/06/2013]

57. Lienhardt C. From exposure too disease: The role of environmental factors in susceptibility to and development of tuberculosis. *Epidemiol Rev* 2001;23:288-301

58. World Health Organization. *WHO recommended strategies for the prevention and control of communicable diseases.* WHO; 2001 [WHO/CDS/CPE/S/2001]

59. van deVijver F, Tanzer NK. Bias and equivalence in cross-cultural assessment: An overview. *Revue europ de psych appliq* 2004;54:119–35.