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Predictors of Low Body Mass Index Among Patients with Smear Positive Pulmonary Tuberculosis in Kenya

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aim: To determine the predictors of low body mass index (BMI) among tuberculosis (TB) cases in three high TB/HIV burden provinces in Kenya.
Study Design: Cross-sectional survey, July 2010 to May 2011.
Study Setting: Three high TB/HIV burden provinces in Kenya.
Study Population: Notified new smear positive TB cases on anti-TB treatment.
Sample Size: 1,298
Data Collection: Structured questionnaire.
Data Analysis: The association of nutritional status (normal versus low BMI) is tested using a chi square for categorical variables while student t-test was used for continuous variables. Explanatory factors that were significantly associated with nutritional status (p value <0.05) were subjected to a logistic regression. HIV status was considered a priori

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risk factor in the multivariate model.
Results: Of the participants, 57% (734/1298) and 43% (564/1298) had normal and low BMI respectively. There was no significant difference (p-value 0.71) by HIV status between normal BMI and low BMI. Employment, water source and HIV status were identified as significant predictors of low BMI in smear positive TB cases. Adjusting for all other factors in the multivariate model, lack of employment with the base being having an employment, was significantly found to have increased odds of low BMI of 1.8 times (95% CI 1.39 -2.26; p value <0.001). HIV status was not found to be a significant predictor of low BMI in TB cases.
Conclusion: Lack of employment is a predictor of low BMI in TB cases in Kenya. Nutritional status does not differ by HIV status.

Keywords: Tuberculosis; HIV; Malnutrition; Kenya; low BMI.

1. INTRODUCTION

Tuberculosis (TB) continues to pose a major public health problem in Kenya. Several factors contribute to establishment of infection and reactivation of *Mycobacterium TB* infection to disease which include: poverty, illiteracy, poor housing, overcrowding, malnutrition, HIV infection, immigration and poor access to health care. Most of these factors are commonly found in low resource settings. TB is the second leading cause of infectious disease mortality (1.8 million/year), after HIV/AIDS. There are more than 9 million new cases each year globally. One-third of the world's population, and 50% of adults in sub-Saharan Africa, and Asia, are infected with TB, representing an enormous pool of individuals at risk for developing the disease [1,2]. Kenya in 2012 notified 99,159 cases of all forms of TB disease. HIV infection is associated with fueling reactivation of TB, with an adult HIV prevalence in Kenya of 5.6% [3] and 39% of TB cases co-infected with HIV [4], HIV infection should be considered in any TB intervention in this setting. In addition, 40% of the Kenyan populace are impoverished living below 2 US$ per day and 31% undernourished [5]. TB and nutrition services in Kenya are currently not integrated as there is no policy guideline on integrating these services.

Malnutrition indicators are assessed using body mass index (BMI). BMI is classified as normal if it lies between 18.5 - 25.0, low if $\leq$18.0 and high if $\geq$ 25.0 [6]. Low BMI is an important risk factor for the development of TB, as it affects cell-mediated immunity which is the principal host defense against TB and leads to secondary immunodeficiency, ultimately increasing the risk of reactivation of latent TB and progression to active disease [7,8]. TB disease is a “consumptive” condition further aggravating the malnourished state and resulting in a “wasting syndrome” [9]. When concurrent TB and HIV diseases are present, it leads to further TB disease dissemination, increased nutritional demands, suppressed appetite, micro and macronutrient malabsorption and altered metabolism [10]. This results in delayed recovery and higher mortality rates [11].

An important adjuvant strategy in management of TB cases should include nutrition support as a justified intervention to accelerate recovery [1]. Given the high prevalence of HIV infection in the Kenya and a high rate of TB/HIV co-infected patients, this study sought to determine predictors of low BMI among patients with smear positive pulmonary TB in three high TB/HIV burden provinces in Kenya, to justify nutrition as an integral part of TB management if Millennium Development Goal (MDG) 6 is to be attained.

2. METHODS

2.1 Study Design

Cross-sectional survey carried out between July 2010 and May 2011.

2.2 Study Setting

There are eight provinces in Kenya with varied population, TB and HIV burden. This study focused on three high TB/HIV burden provinces: Nairobi, Nyanza and Rift Valley. In 2009, Nairobi, Nyanza and Rift Valley had an estimated population of 3,138,369; 5,442,711 and 10,006,805 respectively. The three provinces notified 6,498; 5,801 and 7,168 smear positive cases respectively compared to 37,402 for the all country accounting for 52% of the total case load in 2009. According to Kenya Aids Indicator survey of 2012, the HIV prevalence was 15.1 %, 4.9% and 3.7% in Nyanza, Nairobi and Rift Valley respectively, compared to a National average of 5.6% (3). The high smear positive TB case load and high HIV sero prevalence in the three provinces informed the selection for inclusion in the study.

All the three provinces offer similar TB and HIV services under the Division of Leprosy Tuberculosis and Lung Diseases (DLTLD) while receiving HIV care services under the Kenyan Ministry of Health National Aids Control Program (NASCOP). According to the Kenyan guidelines, all TB cases are offered and tested for HIV in the context of consent, confidentiality and counseling. TB patients dually infected with HIV are started on anti-retroviral's (ARV's) as soon as possible according to World Health Organization (WHO) guidelines.

2.3 Study Population

The study participants were notified smear positive TB cases on anti-TB treatment that were above 18 years of age and gave informed consent. Patients WHO had completed TB treatment were not enrolled to the study. At analysis level, those WHO had a high BMI (> 25) were excluded from the analysis.

2.4 Sampling Procedure and Sample Size

A simple random sampling with finite population correction factor formula was used to calculate the sample size. A sample size of 2,045 was obtained which included 20% non-response. The sample size was then allocated proportionately to the provinces based on 2009 TB case load. Nyanza province was allocated 35%, Rift Valley 34% and Nairobi 31% of the sample size calculated. The allocated sample size to the provinces was further allocated to the districts based on TB case load. At the district level, the TB district register was used as a sampling frame and the required sample size randomly selected.

2.5 Data Collection

Pre-tested structured questionnaire was used to collect data. Data from the questionnaires was transferred to an access database. No patient identifiers were collected. The field coordinator verified 6% of randomly selected filled questionnaires.

2.6 Data Variables

The following variables were collected: age, sex, weight, height, residence, province, level of education, marital status, type of housing, water source, employment, alcohol intake, cigarette smoking and HIV status.

A variable for the outcome of interest BMI was generated from weight and height. Persons with a BMI of <18.0 were classified as low BMI, 18.5 – 25.0 as normal BMI, while those with a BMI of >25 were classified as high BMI. Low BMI is the outcome of measure in this study.

2.7 Data Analysis

Data quality assurance was carried out at all levels, while ensuring confidentiality. Socio demographic data stratified by HIV status is presented, since TB and HIV often co-exist and both influence the nutrition status of patients. However, for risk factors of malnutrition, we present results stratified by normal BMI and low BMI.

Descriptive statistics and missing data were quantified with respect to the nutritional status for all patient characteristics and other risk factors for low BMI are reported. The absolute count and accompanying proportions are reported for categorical data while the mean and standard deviation (SD) have been reported for age.

The association of nutritional status (normal versus low BMI) was tested using chi square for categorical variables while student t-test was used for continuous variables. Explanatory factors that were identified to be significantly associated with nutritional status (p value <0.05) were used for a logistic regression to test the magnitude of association for each of the categories. Further, a multivariate model was fitted with factors that were significant in the bivariate logistic regression sequentially added and a likelihood ratio test p value cut off of 0.05 was used to determine the model that predicted low BMI best. HIV status was considered a *priori* risk factor in the multivariate model.

For the logistic regression analysis, the odds ratio, accompanying 95% confidence intervals and wald test p values (two-tailed) was reported. All analysis was done using STATA version 11 (STATA Corp, Texas, USA).

2.8 Ethical Considerations

This study was approved by the Scientific Steering Committee and Ethical Review Committee at Kenya Medical Research Institute (KEMRI).

3. RESULTS

This study was carried out between July 2010 and May 2011 and a total of 1,298 smear positive TB cases were analyzed. Fifty seven percent (734/1298) had normal BMI and 43% (564/1298) had low BMI. The mean age (SD) of HIV negative and positive patients was 33(12) and 35(10) respectively. Mean age, sex, residence, province, level of education, type of house and water source differed significantly (p-value < 0.05) between HIV negative and positive TB cases. There was however, no significant difference (p-value 0.71) by HIV status between smear positive TB cases WHO had normal BMI and low BMI (Table 1).

Table 1. Social, demographic, economic and clinical characteristics by HIV status of TB cases WHO underwent nutrition assessment in three high TB/HIV burden provinces, July 2010 to May 2011, Kenya

		HIV Negative N=745 N (%)	HIV Positive N=421 N (%)	P-value
Age	Mean (SD)	32 (12)	35 (10)	<0.001
Sex	Female	246(34)	193(49)	<0.001
Male		470(66)	199(51)	
Residence	Rural	335(47)	230(56)	0.002
Urban		381(53)	179(44)	
Province	Nairobi	281(38)	108(26)	<0.001
Nyanza		160(22)	208(49)	
Rift Valley		304(41)	105(25)	
Level of Education	College/tertiary	117(16)	35(8)	<0.001
education		71(10)	25(6)	
No Schooling		273(37)	205(49)	
Primary school		282(38)	155(37)	
Secondary School				
Marital	**status**	5(4)	40(10)	<0.001
Divorced/Separated		432(58)	246(59)	
Married		262(35)	83(20)	
Single		23(3)	51(12)	
Widowed				
Type of house	Permanent	313(42)	130(31)	0.003
Semi-permanent		354(48)	238(57)	
Other		72910)	49(12)	
Not reported		6(1)	4(1)	
Water Source	Borehole/well	111(15)	81(19)	0.003
Stream/river		187(25)	125(30)	
Tap water		404(54)	179(43)	
Other		37(5)	33(8)	
Not reported		4(1)	2(1)	
Employment	Yes	387(52)	207(49)	0.105
No		352(47)	214(51)	
Not reported		6(1)	0(0)	
Nutrition status	Low BMI	327(44)	180(43)	0.707
Normal BMI		418(56)	241(57)	
Alcohol intake	Yes	173(23)	96(23)	0.554
No		564(76)	323(77)	
Not reported		8(1)	2(1)	
Cigarette Smoking	Yes	66(9)	37(9)	0.527
No		649(87)	361(86)	
Not reported		30(4)	23(6)	

The following social, demographic, economic and clinical characteristics were significantly (p-value <0.05) associated with low BMI: residence, province of origin, education, marital status, water source and employment. HIV status (p-value = 0.71) was found not to be significantly associated with low BMI (Table 2).

Table 2. Association between social, demographic, economic and clinical characteristics with low Body Mass Index (BMI) in smear positive pulmonary TB cases WHO underwent nutrition assessment in three high TB/HIV burden provinces, July 2010 to May 2011, Kenya

		Normal BMI (N=734) N (%)	Low BMI (N=564) N (%)	P-value
Age	Mean(SD)	33(11)	33(13)	0.840
Sex	Female	278(40)	202(38)	0.346
Male		415(60)	337(63)	
Residence	Rural	322(46)	293(54)	0.004
Urban		385(55)	252(46)	
Province of origin	Nairobi	277(38)	172(31)	0.003
Nyanza		227(31)	167(30)	
Rift Valley		230(31)	225(40)	
Education	College/tertiary	103(14)	66(12)	0.013
education		297(41)	192(34)	
Secondary School		283(39)	247(44)	
Primary School		50(7)	56(10	
No Schooling				
Marital status	Married	437(60)	307(55)	
Single		218(30)	187(33)	0.028
Divorced/Separated		43(6)	24(4)	
Widowed		34(5)	43(8)	
Type of housing	Permanent	306(42)	193(34)	
Semi-permanent		353(48)	305(54)	0.055
Other		69(9)	60(11)	
Missing		4(1)	6(1)	
Water source	Bore hole/well	109(15)	99(18)	0.003
Stream/River		170(23)	170(30)	
Tap Water		401(55)	266(47)	
Other		50(7)	24(4)	
Missing		2(0.3)	4(1)	
Employment	No	314(43)	317(56)	<0.001
Yes		416(57)	245(44)	
Missing		2(0.3)	0(0)	
HIV status	Negative	418(64)	327(65)	0.707
Positive		241(37)	180(36)	
Alcohol intake	No	573(78)	415(74)	0.170
Yes		156(21)	144(26)	
Missing		4(1)	5(1)	
Cigarette smoking	No	631(86)	494(88)	0.688
Yes		68(9)	47(8)	
Missing		33(5)	23(4)	

From Table 3, of the risk factors, HIV status and type of housing were not significantly associated with low BMI. An interesting finding was that, compared to patients WHO were HIV negative, their HIV positive counterparts did not have increased odds of having a low BMI (OR 1.00; 95% CI 0.78 – 1.28). Although there was a suggested trend of increasing odds of low BMI with a decline in the level of education, when compared to college education, a test for trend was not significant (p value 0.38).

Table 3. Risk factors associated low Body Mass Index (BMI) in smear positive pulmonary TB cases WHO underwent nutrition assessment in three high TB/HIV burden provinces, July 2010 to May 2011, Kenya

		odds ratio	95% CI		P-value
			lower	Upper	
Residence	Rural (base)				
Urban		0.72	0.57	0.90	0.004
Education	College/tertiary education				
(base)		1.01	0.71	1.44	
Secondary School		1.36	0.96	1.94	0.013
Primary school		1.75	1.07	2.86	
No Schooling					
Marital status	Married (base)				
Single		1.22	0.96	1.56	
Divorced/Separated		0.79	0.47	1.34	0.029
Widowed		1.80	1.12	2.89	
Employment	Yes (base)				
No		1.71	1.37	2.14	<0.001
Missing		0.85	0.15	4.67	
Type of housing	Permanent (base)				
Semi-permanent		1.37	1.08	1.74	
Other		1.38	0.93	2.04	0.055
Missing		1.59	0.50	4.99	
Water source	Tap water (base)				
Borehole/well		1.37	1.00	1.87	0.003
Stream/river		1.51	1.16	1.96	
Other		0.72	0.43	1.21	
Missing		3.02	0.55	16.58	
HIV status	Negative (Base)				
Positive		1.00	0.78	1.28	0.992

As shown in Table 4, after successful iterations residence, employment, water source and HIV status were identified as the significant predictors of low BMI in smear positive TB cases. Adjusting for all other factors in the multivariate model, lack of employment with the base being having an employment, had a significantly increased odds of low BMI of 1.8 times (95% CI 1.39 -2.26; p value <0.001). HIV status was not found to be a significant predictor of low BMI in TB cases.

Table 4. Predictors of low Body Mass Index (BMI) in smear positive pulmonary TB cases WHO underwent nutrition assessment in three high TB/HIV burden provinces, July 2010 to May 2011, Kenya

		Odds ratio	95% CI		P-value
			lower	Upper	
Residence	Rural(base)				
Urban		0.86	0.62	1.21	0.39
Employment	Yes (base)				
No		1.77	1.39	2.26	<0.001
Water source	Tap water (base)				
Stream/River		1.04	0.71	1.51	0.848
Borehole/Well		0.83	0.56	1.25	0.376
Other		0.45	0.25	0.83	0.01
Not reported		1.92	0.34	10.86	0.462
HIV status	Negative (base)				
Positive		0.97	0.75	1.24	0.785

Likelihood ratio test p value = 0.04

4. DISCUSSION

This study found lack of employment as a predictor of low BMI among patients with smear positive pulmonary TB in three high TB/HIV burden provinces in Kenya. Being HIV infected was not found to be a predictor of low BMI among this group of patients.

This finding is not surprising because low BMI means inadequate dietary intake, which is a common occurrence in impoverished communities, WHO lack employment, hence lack a means to buy food [8]. Poverty is a product of lack of employment which is associated with poor nutrition status and has a dose response relationship with incidence of TB disease [12,13]. The role of diet in patients with TB disease has been studied for decades [14]. Poor nutrition has been found to be a strong risk factor for TB reactivation and mortality; food supplementation has been shown to accelerate therapeutic benefits [13]. A HIV infected cohort in Tanzania, showed that low BMI or falling BMI is associated with a higher risk of developing HIV associated TB [15]. This is compelling evidence from a setting such as Kenya to critically define criteria of identifying HIV infected patients WHO would be at a risk of having or developing low BMI like those WHO lack employment as shown in our data. We did not find HIV infection as a predictor of low BMI, which is plausible given the impact of anti-retroviral treatment in Kenya [16].

This study underscores the need for nutrition support in TB cases that have low BMI and lack employment. In Bangladesh, there is evidence that half the patients WHO were underweight at the start of TB treatment remained so till the end [17,18]. This shows a need for identifying those with or at risk of low BMI for nutrition support over and beyond TB drug treatment which is the first line intervention. We propose that combining these two interventions could lead to better case management. Countries in low resource setting with a high burden of TB like Kenya should start raising questions and develop context specific guidelines on nutrition care for TB cases while awaiting global guidelines [17].

The main limitation of this study is its cross sectional design which does not provide for determination of causality. In addition, the study population is a settled community from an area with high dual TB/HIV burden and only smear positive TB cases were studied. It will be interesting to find out the predictors of low BMI in other types of TB cases. Extrapolation of this finding especially in nomadic populations may be a challenge. Other factors that could potentially affect nutritional status like cultural practises were not studied. Despite these limitations it has been possible to highlight an important predictor of low BMI in TB cases in Kenya.

6. CONCLUSION

Lack of employment is a predictor of low BMI in TB cases. Nutritional status does not differ by HIV status. TB programs should consider developing guidelines to identify high risk TB cases for nutrition support as an integral adjuvant therapy.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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