International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 07, Issue 11, November 2022,
https://doi.org/10.23958/ijirms/vol07-i11/1535

Original article

Examination of Surgically Important Healthy Life Expectancy and Respiratory Tract Deaths: The Relationship between Tuberculosis-Related Deaths and Health Adjusted Life Expectancy (HALE)

Dr. İsmail ÖZSAN

Department General Surgery, Okan University Medicine Faculty, Istanbul/TURKEY

*Corresponding author: Dr. İsmail ÖZSAN; *dr_ozsanozsan@yahoo.com*

Received 12 October 2022; Accepted 31 October 2022; Published 02 November 2022

Abstract

Background: The aim of the research is to evaluate the relationship between surgically important healthy life expectancy and respiratory tract deaths on the relationship between tuberculosis-related deaths and Health Adjusted Life Expectancy (HALE). ***Methods:*** ICD-10 (International Classification of Diseases 10th Revision) mortality and HALE data of WHO were used. In ICD-10 mortality data, a total of 12 countries have been reported tuberculosis caused deaths from 1996 to 2017. In total, 7 countries had sufficient data for panel data analyze from 2000 to 2011. ***Results:*** Tuberculosis caused female, male and total deaths were negatively correlated with HALE at birth and HALE at 60 ages ($p<0.01$). HALE at birth and HALE at 60 ages did not have significant contribution to tuberculosis related deaths for both genders and in total ($p>0.05$). Fixed, random or time fixed models did not explain effects of HALE on tuberculosis related deaths. ***Conclusion:*** Mortality of tuberculosis is more common in males, and in respiratory related TB. It is suggested to examine the effects of diseases that decrease life expectancy specifically on HALE. In this regard, the research may lead to studies examining the relationship between other mortality-related diseases and HALE in Public Health Perspective.

Keywords: ***Tuberculosis; ICD-10; countries; mortality.***

Introduction

Tuberculosis (TB) is a disease of mycobacteria belonging to the Mycobacterium tuberculosis. Although it is not directly correlated with general surgery, literature reports that TB causes complications in surgical procedures, and even may make sugery riskious [1-3]. TB has more than 10 million cases per year, and it is predicted that less than two thirds are reported. Between 2000 and 2017, TB deaths decrease by 42%, and its incidence rate is currently 1.5%. Health workers, HIV infection patients, and others having a high risk of M. tuberculosis are in specific risk groups [4-6]. Clinical features include appetite loss, chronic cough, fever, hemoptysis, sputum production and weight loss [7]. In extrapulmonary tuberculosis (EPTB), M. tuberculosis affects organs and tissues outside the pulmonary parenchyma [8]. Use of antimicrobials dramatically reduced mortality related TB. On the other hand, TB has become one of the highest mortality causes among infectious diseases after HIV. In 2016, 1.3 million deaths among HIV negative patients having immunodeficiency claimed TB [9]. Although treatment of TB mainly depend on medication, multi drug resistant TB and extensive drug resistant TB have become global health challenges [10]. WHO decelerated a report on reducing disease as End TB Strategy. In this report, epidemiology of disease was evaluated comprehensively in not only medical perspective, but also social perspective [11]. Despite of struggle against TB, it is still one of the important public health issues.

Heath expectancy is a main indicator for global and regional public health monitoring [12]. In 1999, WHO started to produce annual life tables for all member states including country level, regional and global trends and patterns in all causes and mortalities based on causes. In these reports, life expectancy at birth, at 60 ages, differences by gender and age group are evaluated. Healthy life expectancy (HALE) is a new version of these life tables, and adjustments for comorbidity are calculated accordance with World Health Statistics [13]. In 2000, WHO reported HALE by sex for 191 member states of WHO [14]. Hale mainly quantify the number of years expected with good health, and completes Disability-Adjusted Life Years (DALY) measured by WHO [15]. Although there have been other indicators for health and life, some researches argue that HALE is the best summary indicator for global public health [16].

Although there have been researches on HALE and tuberculosis to date, it is for adequate study of the effect of death deaths on HALE. In the research, it was aimed to evaluate the relationship between surgically important healthy life expectancy and respiratory tract deaths on the relationship between tuberculosis-related deaths and Health Adjusted Life Expectancy (HALE).

Materials and Methods

In the research, ICD-10 (International Classification of Diseases 10th Revision) mortality and Health Adjusted Life Expectancy (HALE) data of WHO were used. In ICD-10 mortality data, a total of 12 countries have been reported tuberculosis caused deaths from 1996 to 2017. However, 7 countries had sufficient data for panel data analyze from 2000 to 2011.

In ICD-10 Mortality Data, tuberculosis caused deaths were classified into two groups as "1005- Respiratory tuberculosis" and "1006- Other tuberculosis". In statistical difference analysis, these mortality codes were analyzed and compared separately whereas these codes were combined in panel data analysis as "tuberculosis related deaths". In ICD-10 Mortality Data, deaths were given as male and female patients. In panel data analysis, both genders and total number of deaths were evaluated.

This is an observational study. The Yeditepe University Ethics Committee has confirmed that no ethical approval is required.

Parameters were described with mean and standard deviations. Kolmogorov Smirnov test was used for normality of tested data. Since all parameters were distributed non normally ($p<0.05$), Mann Whitney U and Spearman's rho correlation were used. Levin-Lin-Chu and Pesaran's CADF unit root tests for research parameters. Logarithmic transitions were used for parameters including unit root, and three panel data assumption models were used as Entity Fixed Effects Model, Random Effects Model, Entity and Time Fixed Effects Model. StataMP 14.1 for windows and SPSS 17.0 for windows programs were used at 95% confidence interval.

Results

Respiratory related tuberculosis is more common than other causes related tuberculosis with significant differences for all countries ($p<0.05$). Total deaths based on cause for countries and difference analysis results were given in the Table 1.

Russian Federation has the most common tuberculosis mortality rate, followed by Ukraine. Male and Female deaths based on cause for countries and difference analysis results were given in the Table 2.

In total, male deaths were more common for both respiratory related and other causes related tuberculosis. In addition, within group comparisons showed that respiratory related deaths are more common in both gender groups ($p<0.05$). Spearman's rho correlation analysis results for HALE and tuberculosis related deaths were given in the Table 3.

Correlation analysis results showed that tuberculosis caused female, male and total deaths were negatively correlated with HALE at birth and HALE at 60 ages ($p<0.01$).

According to LLC and Pesaran's CADF test results, only female birth parameter had unit root in panel data analysis. Thus, logarithm of female death parameter was used in the panel data. In order to understand cross country relationship of HALE and tuberculosis caused death, three panel data analysis types were used. Fixed, random and time fixed models were used in the research. Panel data analysis results for HALE and tuberculosis related deaths were given in the Table 4.

According to results of panel data analysis, male deaths caused by tuberculosis had significant and negative contribution to HALE at birth and HALE at 60 age ($p<0.05$). For female deaths from tuberculosis is only significant in time fixed effects model for both HALE at birth and HALE at 60 age ($p<0.05$). According to R2 values, entity time and fixed effects model was the most suitable model for panel with 72.0% explanatory level for HALE at birth and74.0% explanatory level for HALE at 60 age ($p<0.05$), arguing that tuberculosis related deaths mainly depend on time.

Table 1: Total deaths based on cause for countries and difference analysis results (1996-2017) *

Country	Respiratory related tuberculosis	Other tuberculosis	p
Seychelles	1.80±0.92	-	N/A
Brunei Darussalam	6.93±3.24	3.20±1.47	0.001[a]
Cyprus	2.00±0.01	-	N/A
Oman	10.00±0.01	3.00±0.01	0.317[a]
Sri Lanka	937.86±74.80	11.00±5.35	0.001[a]
Syrian Arab Republic	43.92±8.41	2.91±2.21	0.000[a]
Azerbaijan	946.00±115.07	31.25±15.35	0.029[a]
Belarus	682.00±183.36	90.78±27.08	0.000[a]
Kazakhstan	2312.89±831.00	115.11±30.30	0.000[a]
Russian Federation	22610.31±5589.02	2890.94±438.30	0.000[a]
Turkmenistan	616.29±156.57	24.82±14.21	0.000[a]
Ukraine	5211.36±2020.05	2634.27±745.95	0.002[a]
Total	4174.38±8003.87	777.92±1264.15	0.000[a]

*a. Mann Whitney U Test, N/A: Not applicable, *Event reported years within time period.*

Table 2: Male and Female deaths based on cause for countries and difference analysis results (1996-2017) *

Country	Males		Females	
	Respiratory related tuberculosis	Other tuberculosis	Respiratory related tuberculosis	Other tuberculosis
Seychelles	1.30±1.16		0.50±0.53	
Brunei Darussalam	4.33±2.66	1.87±1.36	2.60±1.72	1.33±1.45
Cyprus	2.00±0.01			
Oman	9.00±0.01		1.00±0.01	3.00±0.01
Sri Lanka	703.43±67.67	6.29±2.98	234.43±22.29	4.71±2.98
Syrian Arab Republic	26.67±6.18	1.64±1.29	17.25±5.07	1.27±1.35
Azerbaijan	751.50±75.98	16.75±7.32	194.50±44.40	14.50±9.04
Belarus	590.33±167.78	70.44±22.26	91.67±19.10	20.33±7.52
Kazakhstan	1801.56±651.95	80.78±20.06	511.33±180.15	34.33±13.19
Russian Federation	18967.38±5193.11	2268.75±361.10	3642.94±639.17	622.19±114.05
Turkmenistan	455.00±127.53	16.47±9.29	161.29±33.85	8.35±6.05

Ukraine	4324.36±1707.61	2166.91±570.88	887.00±317.33	467.36±187.23
Total	3470.06±6773.34	619.34±1009.96	704.32±1260.15	158.58±259.11

**Event reported years within time period*

Table 3: Spearman's rho correlation analysis results for HALE and tuberculosis related deaths

	Female	Male	Total deaths	HALE birth
Male	0.971*			
Total deaths	0.985*	0.996*		
HALE at birth	-0.668*	-0.650*	-0.661*	
HALE_60 at ages	-0.586*	-0.625*	-0.623*	0.829*

**p<0.01*

Table 4: Panel data analysis results for HALE and tuberculosis related deaths

	Entity Fixed Effects Model	Random Effects Model	Entity and Time Fixed Effects Model
HALE at birth			
Female deaths	-0.715	-0.365	-1.332*
Male deaths	-0.001*	-0.001*	-0.001*
Constant	68.098	65.737	65.647
R^2	0.329	0.288	0.720
F-statistics for Hausmann Test	30.84	46.80 (Wald)	128.66 (Wald)
HALE at 60 ages			
Female deaths	-0.278	-0.160	-0.389*
Male deaths	-0.001*	-0.001*	-0.001*
Constant	16.265	15.042	14.866
R^2	0.341	0.388	0.740
F-statistics for Hausmann Test	13.57	19.54 (Wald)	142.15 (Wald)

Discussion

In TB cases caused by M. tuberclosis mycrobacteria in the past, with the development and use of antimicrobials, mortality rates decreased significantly and TB ceased to be an important public health. However, as a result of the development of multi drug resistant TB and extensive drug resistant TB and the increase of immune system disrupting diseases such as HIV, TB has become one of the most important global health problems and deaths caused by infections [17-20]. In our study, according to WHO ICD-10 data, it was observed that tuberculosis-related deaths were reported in 14 countries in the world, of which 12 countries had tuberculosis-related deaths over a year. Undoubtedly, deaths from tuberculosis are not limited to the ICD-10 data set. However, statistical studies are needed to understand and reduce the mortality of the disease, and data reported for these studies are needed. In this regard, it can be stated that the error margins of the data used in the research are related to the error margin in the ICD-10 report published by WHO.

When the distribution of tuberculosis-related deaths by country is analyzed, it can be stated that these deaths occur mostly in low-income countries. In addition, the fact that tuberculosis-related deaths in the majority of countries such as Russia, Ukraine, Turkmenistan and Kazakhstan suggest that deaths due to illness may also be related to regional factors.

Studies on tuberculosis disease and tuberculosis deaths report that the disease is more common in men than in women. In the majority of tuberculosis studies, the disease is more in contact with the airways. In addition, although there are other types, it is mainly included in research as a respiratory disease [21-28]. In our study, respiratory tuberculosis rates and males tuberculosis rates were higher in males than females. Again, in both men and women, respiratory tuberculosis deaths were higher than other causes of tuberculosis deaths.

Since health is an international public good, there is a need for indicators to assess health in the international area. HALE, calculated by WHO, is at the top of these indicators. HALE determines the healthy life expectations of individuals [29-30]. In this respect, there should be a negative relationship between HALE and the factors that negatively affect quality of life and expectations. In our study, a statistically significant and negative relationship was found between deaths in men and women and total deaths and HALE. According to the correlation coefficients, female deaths with HALE at birth parameter, and male deaths with HALE at 60 ages parameter were higher. Therefore, HALE, expected at birth, is mostly related to women, HALE, expected at age 60, is mostly related to men.

Panel data analysis reveals the relationship between multiple variables horizontally and vertically in measurements performed at multiple centers. In this regard, it can be stated that panel data analysis increases the measured relations from the regional basis and raises them to the global base. Since tuberculosis-related deaths reported by WHO all over the world between 1996 and 2017 were examined in our study, panel data analysis is a mandatory method. According to the results obtained, while fixed and random effects are significant in men, the trend in both of them is significant in women. This means that male deaths have a direct effect on HALE, while female deaths fluctuate over time. Therefore, in order to examine the effect of tuberculosis-related deaths of women on HALE, the time variable should not be neglected. In addition, it can be stated that adequate measures in tuberculosis-related female deaths have not been taken in the relevant countries worldwide.

Conclusion

Results of the study showed that tuberculosis related deaths are common in low income and have regional structure. Mortality of tuberculosis is more common in males, and in respiratory related TB. In female patients, tuberculosis related mortality depends on time and fixed structure. Both male and female deaths related with tuberculosis negatively affect HALE at birth and HALE at 60 ages.

Although HALE is an important indicator in revealing the healthy life expectancy, it deals with the healthy life expectancy in general, and there are not enough studies for different diseases. For this reason, it is required to examine the effects of diseases that decrease life expectancy specifically on HALE. In this regard, the research may lead to studies examining the relationship between other mortality-related diseases and HALE.

Acknowledgements

We thank Kadir YILMAZ for his valuable statistical support.

Conflict of Interests

None declared.

References

[1] Somocurcio JG, Sotomayor A, Shin S, Portilla S, Valcarcel M, Guerra D, Furin J. Surgery for patients with drug-resistant tuberculosis: report of 121 cases receiving community-based treatment in Lima, Peru. Thorax. 2007 May;62(5):416-21. doi: 10.1136/thx.2005.051961. Epub 2006 Aug 23.

[2] Madansein R, Parida S, Padayatchi N, Singh N, Master I, Naidu K, Zumla A, Maeurer M. Surgical treatment of complications of pulmonary tuberculosis, including drug-resistant tuberculosis. Int J Infect Dis. 2015 Mar;32:61-7. doi: 10.1016/j.ijid.2015.01.019. PMID: 25809758.

[3] Sotgiu G, Spanevello A, Migliori GB. History of tuberculosis and drug resistance. N Engl J Med. 2013 Jan 3;368(1):88-9. doi: 10.1056/NEJMc1212308. PMID: 23281997.

[4] Voniatis C, Migliori GB, Voniatis M, Georgiou A, D'Ambrosio L, Centis R, Raviglione MC. Tuberculosis elimination: dream or reality? The case of Cyprus. Eur Respir J. 2014 Aug;44(2):543-6. doi: 10.1183/09031936.00044314. Epub 2014 Apr 17. PMID: 24743969.

[5] Blasi F, Matteelli A, Sotgiu G, Cirillo DM, Palmieri F, Fattorini L, Migliori GB. Moving towards tuberculosis elimination: a call for action from Italy and a possible model for other low tuberculosis incidence countries. Eur Respir J. 2017 Feb 2;49(2):1602242. doi: 10.1183/13993003.02242-2016. PMID: 28153873.

[6] Bañuls AL, Sanou A, Van Anh NT, Godreuil S. Mycobacterium tuberculosis: ecology and evolution of a human bacterium. J Med Microbiol. 2015 Nov;64(11):1261-1269. doi: 10.1099/jmm.0.000171. Epub 2015 Jan 11. PMID: 26385049.

[7] Zumla A, Raviglione M, Hafner R, von Reyn CF. Tuberculosis. N Engl J Med. 2013 Feb 21;368(8):745-55. doi: 10.1056/NEJMra1200894. PMID: 23425167.

[8] Ramirez Lapausa, M., Menendez Saldana, A., & Noguerado Asensio, A. Extrapulmonary tubercolosis:an overview. Revista Española de Sanidad Penitenciaria, 2015; 17, 3–11.

[9] Glaziou P, Floyd K, Raviglione MC. Global Epidemiology of Tuberculosis. Semin Respir Crit Care Med. 2018 Jun;39(3):271-285. doi: 10.1055/s-0038-1651492. Epub 2018 Aug 2. PMID: 30071543.

[10] Petersen E, Khamis F, Migliori GB, Bay JG, Marais B, Wejse C, Zumla A. De-isolation of patients with pulmonary tuberculosis after start of treatment - clear, unequivocal guidelines are missing. Int J Infect Dis. 2017 Mar;56:34-38. doi: 10.1016/j.ijid.2017.01.029. Epub 2017 Feb 3. PMID: 28163167.

[11] World Health Organization. Global Tuberculosis Report. Document WHO/HTM/TB/2017.23. Geneva, World Health Organization, 2017. Available from: http://apps.who.int/iris/bitstream/10665/259366/1/9789241565516-eng.pdf?ua=1.

[12] Saito Y, Robine JM, Crimmins EM. The methods and materials of health expectancy. Stat J IAOS. 2014;30(3):209-223. doi: 10.3233/SJI-140840. PMID: 30319718; PMCID: PMC6178833.

[13] WHO methods for life expectancy and healthy life expectancy. Global Health Estimates Technical Paper, 2014, WHO/HIS/HSI/GHE/2014.5.

[14] Salomon, J., Mathers, C., Murray, C., & Ferguson, B. Methods for life expectancy and healthy life expectancy uncertainty analysis. Global Programme on Evidence for Health Policy Working Paper, 2001; (10), 1–18. Retrieved from http://www.who.int/entity/healthinfo/paper10.pdf

[15] GBD 2017 DALYs and HALE Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018 Nov 10;392(10159):1859-1922. doi: 10.1016/S0140-6736(18)32335-3. Erratum in: Lancet. 2019 Jun 22;393(10190):e44. PMID: 30415748; PMCID: PMC6252083.

[16] Lee JY, Ock M, Kim SH, Go DS, Kim HJ, Jo MW. Health-Adjusted Life Expectancy (HALE) in Korea: 2005-2011. J Korean Med Sci. 2016 Nov;31 Suppl 2(Suppl 2):S139-S145. doi: 10.3346/jkms.2016.31.S2.S139. PMID: 27775251; PMCID: PMC5081295.

[17] Schmit KM, Shah N, Kammerer S, Bamrah Morris S, Marks SM. Tuberculosis Transmission or Mortality Among Persons Living with HIV, USA, 2011-2016. J Racial Ethn Health Disparities. 2020 Oct;7(5):865-873. doi: 10.1007/s40615-020-00709-7. Epub 2020 Feb 14. PMID: 32060748; PMCID: PMC7918278.

[18] Hatherill M, White RG, Hawn TR. Clinical Development of New TB Vaccines: Recent Advances and Next Steps. Front Microbiol. 2020 Jan 30;10:3154. doi: 10.3389/fmicb.2019.03154. PMID: 32082273; PMCID: PMC7002896.

[19] Nimmo C, Millard J, Brien K, Moodley S, van Dorp L, Lutchminarain K, Wolf A, Grant AD, Balloux F, Pym AS, Padayatchi N, O'Donnell M. Bedaquiline resistance in drug-resistant tuberculosis HIV co-infected patients. Eur Respir J. 2020 Jun 4;55(6):1902383. doi: 10.1183/13993003.02383-2019. PMID: 32060065; PMCID: PMC7270361.

[20] Picone CM, Freitas AC, Gutierrez EB, Avelino-Silva VI. Access and adherence to isoniazid preventive therapy and occurrence of active TB in a cohort of people living with HIV: a retrospective cohort study in Sao Paulo, Brazil. Rev Inst Med Trop Sao Paulo. 2020 Feb 7;62:e8. doi: 10.1590/S1678-9946202062008. PMID: 32049259; PMCID: PMC7014552.

[21] Ambaw F, Mayston R, Hanlon C, Alem A. Incidence of depression in people with newly diagnosed tuberculosis in Ethiopia: a cohort study. Glob Ment Health (Camb). 2020 Jan 3;7:e1. doi: 10.1017/gmh.2019.27. PMID: 32076571; PMCID: PMC7003520.

[22] Reichler MR, Khan A, Yuan Y, Chen B, McAuley J, Mangura B, Sterling TR; Tuberculosis Epidemiologic Studies Consortium Task Order 2 Team. Duration of Exposure Among Close Contacts of Patients With Infectious Tuberculosis and Risk of Latent Tuberculosis Infection. Clin Infect Dis. 2020 Oct 23;71(7):1627-1634. doi: 10.1093/cid/ciz1044. PMID: 32044987.

[23] Wang J, Xiong K, Zhao S, Zhang C, Zhang J, Xu L, Ma A. Long-Term Effects of Multi-Drug-Resistant Tuberculosis Treatment on Gut Microbiota and Its Health Consequences. Front Microbiol. 2020 Jan 30;11:53. doi: 10.3389/fmicb.2020.00053. PMID: 32082283; PMCID: PMC7002438.

[24] Bespyatykh J, Shitikov E, Bespiatykh D, Guliaev A, Klimina K, Veselovsky V, Arapidi G, Dogonadze M, Zhuravlev V, Ilina E, Govorun V. Metabolic Changes of Mycobacterium tuberculosis during the Anti-Tuberculosis Therapy. Pathogens. 2020 Feb 18;9(2):131. doi: 10.3390/pathogens9020131. PMID: 32085490; PMCID: PMC7168336.

[25] Arulanantham A, Jayarajah U, Dharmasiri R, Jeyanthakumar R, Siriwardena KN, Ilangamge S. Squamous Cell Carcinoma in the Post Tuberculosis Lung after 30 Years of Treatment Completion. Case Rep Surg. 2020 Jan 30;2020:8570212. doi: 10.1155/2020/8570212. PMID: 32082689; PMCID: PMC7011466.

[26] Rotar Z, Svetina P, Tomsic M, Hočevar A, Prapotnik S. Tuberculosis among patients treated with TNF inhibitors for rheumatoid arthritis, ankylosing spondylitis and psoriatic arthritis in Slovenia: a cohort study. BMJ Open. 2020 Feb 5;10(2):e034356. doi: 10.1136/bmjopen-2019-034356. PMID: 32029494; PMCID: PMC7045120.

[27] Wong SA, Lee Meijuan D, Loh SW, Thoon KC, Tan NWH, Chong CY. Pediatric Abdominal Tuberculosis in Singapore: A 10-Year Retrospective Series. Glob Pediatr Health. 2020 Feb 5;7:2333794X20903952. doi: 10.1177/2333794X20903952. PMID: 32076630; PMCID: PMC7003167.

[28] Min J, Kim HW, Stagg HR, Lipman M, Rangaka MX, Myong JP, Yim HW, Lim JU, Lee Y, Koo HK, Lee SS, Park JS, Cho KS, Kim JS. Latent tuberculosis infection screening and treatment in congregate settings (TB FREE COREA): protocol for a prospective observational study in Korea. BMJ Open. 2020 Feb 18;10(2):e034098. doi: 10.1136/bmjopen-2019-034098. PMID: 32075836; PMCID: PMC7045012.

[29] Bushnik T, Tjepkema M, Martel L. Socioeconomic disparities in life and health expectancy among the household population in Canada. Health Rep. 2020 Jan 15;31(1):3-14. doi: 10.25318/82-003-x202000100001-eng. PMID: 31940148.

[30] Hu X, Sun X, Li Y, Gu Y, Huang M, Wei J, Zhen X, Gu S, Dong H. Potential gains in health-adjusted life expectancy from reducing four main non-communicable diseases among Chinese elderly. BMC Geriatr. 2019 Jan 18;19(1):16. doi: 10.1186/s12877-019-1032-3. PMID: 30658578; PMCID: PMC6339408.